郑州期权讲习所
Zhengzhou Options Training Institute

郑州商品交易所
Zhengzhou Commodity Exchange

Zhengzhou Commodity Exchange Option Seminar

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Financial Contracts

Spot or ***Cash Transaction***

An agreement between a buyer and seller whereby the price is negotiated right now, and is immediately followed by an exchange of money for goods.

Forward Contract

An agreement between a buyer and seller whereby the price is negotiated right now, but the actual exchange of money for goods takes place at a later date.

Futures Contract

an exchange-traded forward contract

Option Contract

the right to decide at a later date

Call Option

the right to decide whether to buy

Put Option

the right to decide whether to sell

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Every option contract must specify:

- the goods to be bought or sold (the ***underlying***)
- the date on which the buyer of the option must make the final decision (the ***expiration date*** or ***expiry***)
- the amount to be paid for the goods (the ***strike price*** or the ***exercise price***)

The premium or price to be paid for the option is negotiated between the buyer and seller of the option.

Stock-type Settlement

Buy 100 shares of stock at $65 per share

total cost = 100 x $65 = $6,500

Stock price rises to $75

profit = 100 x +$10 = +$1,000 ***(unrealized)***

Sell stock at $75 per share

profit = 100 x +$10 = +$1,000 ***(realized)***

Futures-type Settlement

The ***nominal value*** or ***notional value*** of a commodity futures contract:

the unit value multiplied by the number of units to be delivered

unit value = $1400

units to be delivered = 100

nominal value = $1400 x 100
= $140,000

Futures-type Settlement

Buy a gold futures contract at 1400

total value of trade = $1400 x 100 = $140,000

payment from buyer to seller = 0

margin deposit with clearing house

Futures contract rises to 1420

profit = $20 x +100 = +$2,000 ***(realized)***

Futures contract falls to 1380

loss = -$20 x 100 = -$2,000 ***(realized)***

Variation – the daily realized profit or loss on an open futures position

Settlement of Exchange-Traded Contracts:

Stock is always subject to stock-type settlement

Futures are always subject to futures-type settlement (sometimes referred to as ***margin and variation***)

Options may be subject to either stock-type or futures-type settlement.

Settlement of Exchange-Traded Contracts:

On most option markets around the world options are subject to the same settlement procedure as the underlying contract –

If the underlying for the option is stock (or a security) the options are subject to stock-type settlement

If the underlying for the option is a futures contract the options are subject to futures-type settlement

Settlement of Exchange-Traded Contracts:

In the United States all options, whether options on stock or options on futures, are subject to stock-type settlement.

All options must be paid for fully in cash

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Option Contract Specifications

Underlying Contract – the security or commodity to be bought or sold

stock

stock index

futures contract

physical commodity

interest rate product

Expiration Date (Expiry) – the date on which the option buyer must make a final decision whether to buy or sell

Exercise Price or ***Strike Price*** – the price at which the underlying contract will be bought or sold

Type of contract – either a call (the right to buy) or a put (the right to sell)

Sugar	**September**	**5000**	**Call**
underlying contract	expiration date	exercise price	type
Cotton	**March**	**20000**	**Put**

Premium – the price paid for an option

Options may be subject to either…

stock-type settlement

futures-type settlement

Exercise – the process by which the buyer of an option converts the option into a long position in the underlying contract (a call) or a short position in the underlying contract (a put).

Assignment – the process by which the seller of an option is required to take a short position in the underlying contract (a call) or a long position in the underlying contract (a put).

If you ...

exercise a call	you choose to ***buy*** at the exercise price
are assigned on a call	you are forced to ***sell*** at the exercise price
exercise a put	you choose to ***sell*** at the exercise price
are assigned on a put	you are forced to ***buy*** at the exercise price

Exercise style

European – the option may be exercised only at expiration. Most stock index options are European.

American – the option may be exercised at any time prior to expiration. Most individual stock options and futures options are American.

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Serial Option Months – futures options with expiration months which do not match a futures contract

When exercised, a serial option results in a position in the nearest futures contract beyond the option expiration.

With trading in March, June, September, and December futures contracts……

An April or May option will exercise into a June future

A July or August option will exercise into a September future

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Intrinsic Value and Time Value

An option's price is made up of its

intrinsic value

time value (or ***time premium***).

An option has intrinsic value if it enables the holder to buy low and sell high, or sell high and buy low.

The intrinsic value is the difference between the buying and selling price.

You own a November 100 call with the underlying contract trading at 115. If you exercise the call you can:

buy at 100 / sell at 115 (buy low / sell high)

intrinsic value = 15

You own a March 150 put with the underlying contract trading at 130. If you exercise the put you can:

sell at 150 / buy at 130 (sell high / buy low)

intrinsic value = 20

An option’s intrinsic value can never be less than zero since no one would choose to buy high and sell low, or sell low and buy high. Therefore...

call intrinsic value = maximum [0, S-X]

put intrinsic value = maximum [0, X-S]

Since

price = intrinsic value + time value

time value = price - intrinsic value

An option’s intrinsic value is sometimes referred to as ***parity***.

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Futures trading at 1348

December 1300 call trading at 73

price	=	intrinsic value	+	time value
↓		↓		↓
73	=	48 (1348 - 1300)	+	25 (73 - 48)

Futures trading at 2369

November 2400 put trading at 51

price	=	intrinsic value	+	time value
↓		↓		↓
51	=	31 (2400 - 2369)	+	20 (51 - 31)

Depending on an option’s exercise price and the price of the underlying contract, an option is said to be either.....

- ***in-the-money***
- ***at-the-money***
- ***out-of-the-money***

in-the-money call: $S > X$

in-the-money put: $X > S$

(intrinsic value greater than zero)

out-of-the-money call: $S \leq X$

out-of-the-money put: $X \leq S$

(no intrinsic value)

at-the-money call or put: $S = X$

current underlying price

in-the-money calls | out-of-the-money calls

← lower exercise prices | higher exercise prices →

out-of-the-money puts | in-the-money puts

at-the-money calls and puts

underlying futures contract = 8510

exercise price	call	put
8000	I-T-M by 510	O-T-M by 510
8500	I-T-M by 10	O-T-M by 10
9000	O-T-M by 490	I-T-M by 490

The 8500 call and put are the at-the-money options.

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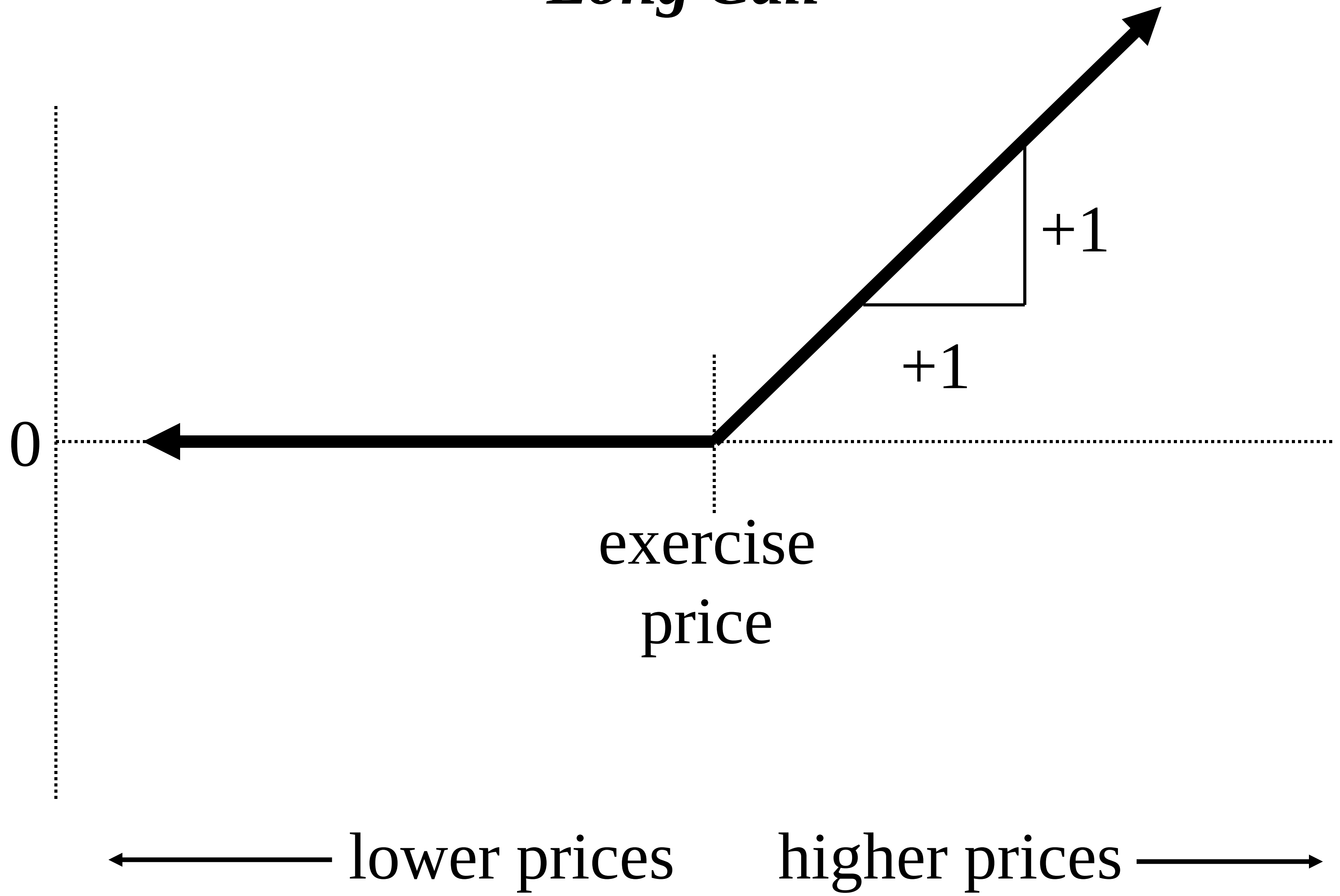
Expiration Profit and Loss Graphs

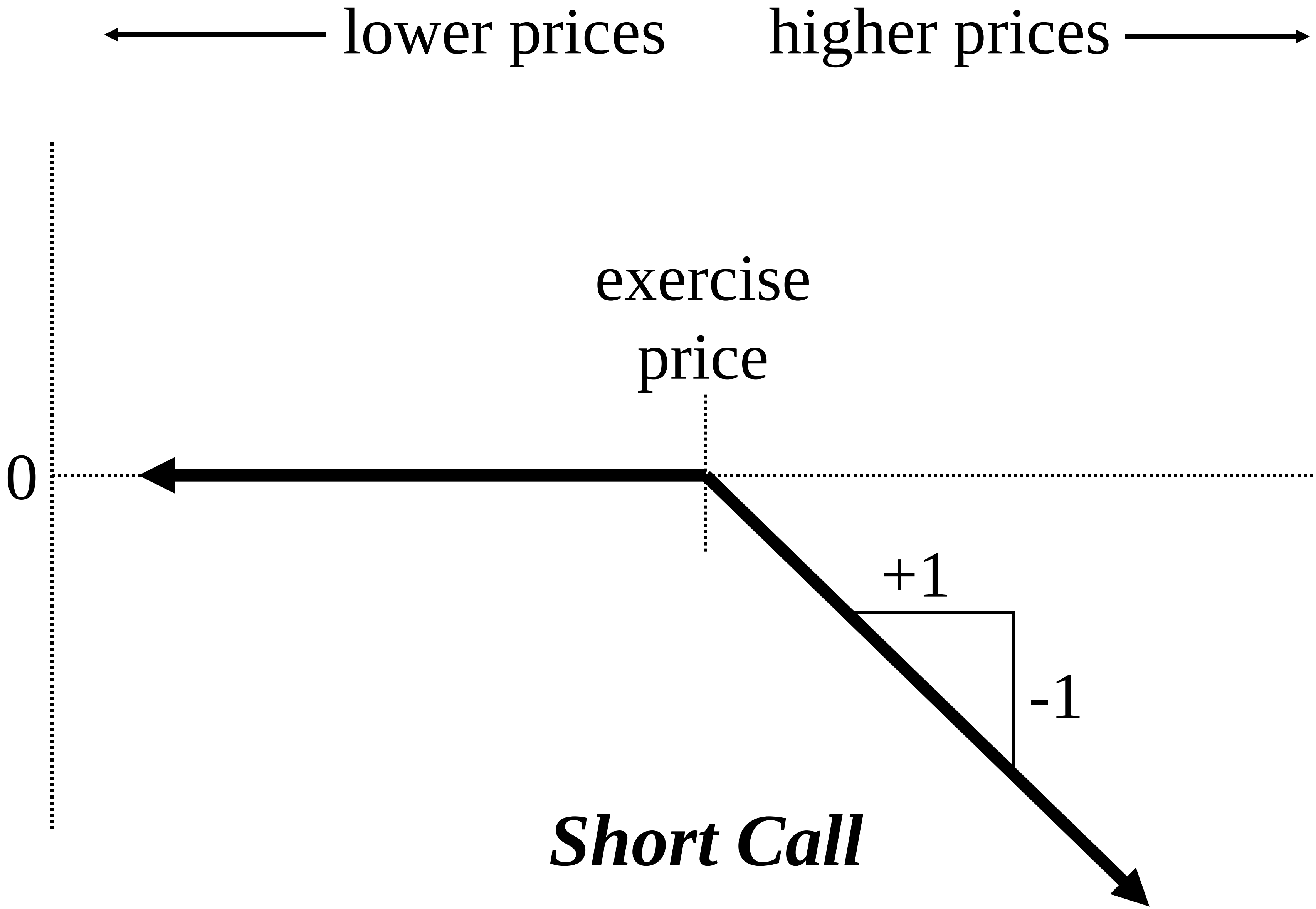
At expiration, an option is worth exactly its intrinsic value (parity)

- zero if the option is out-of-the-money
- the difference between the exercise price and underlying price if the option is in-the-money

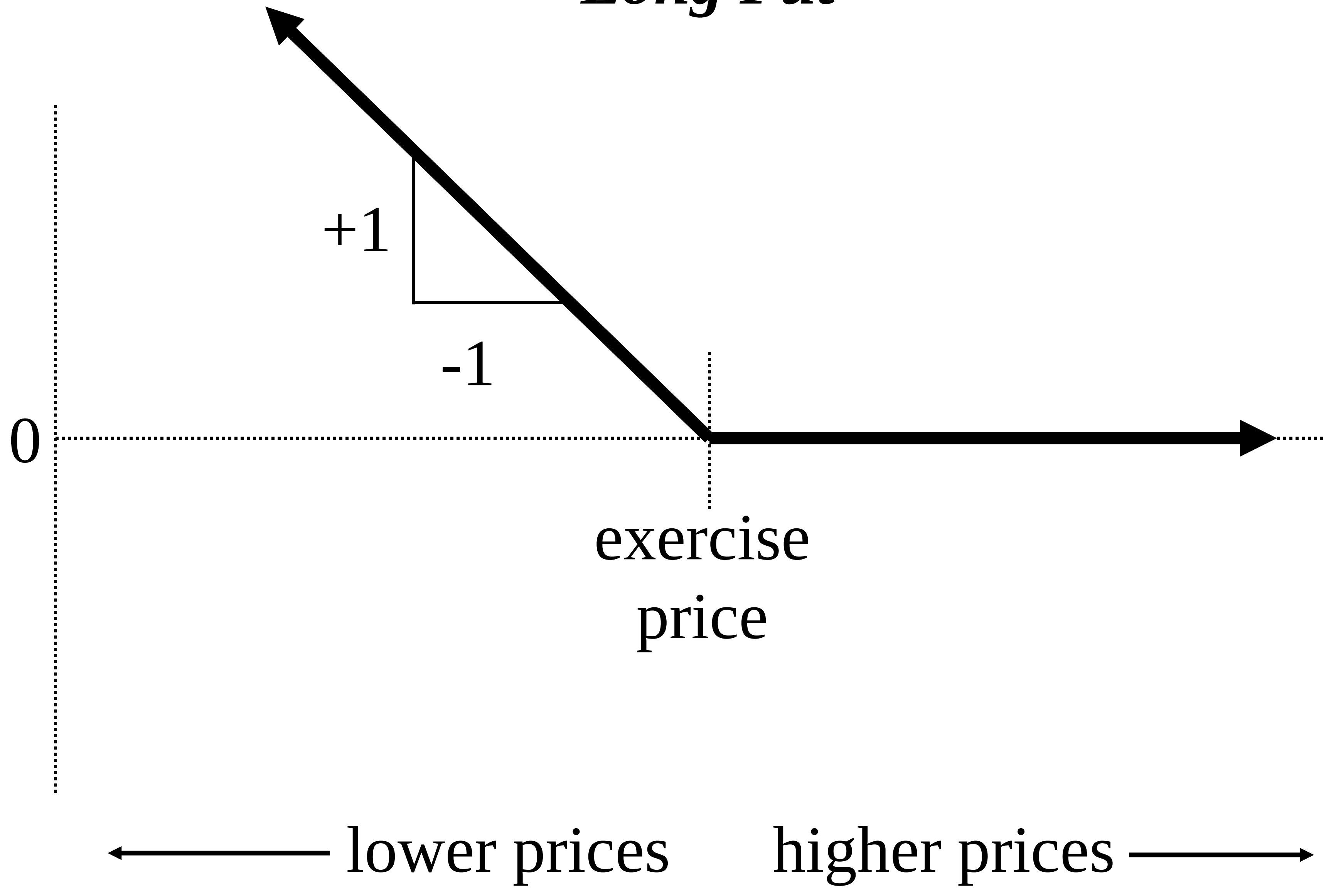
Parity Graph – a graph which represents the value of an option, or option position, at expiration

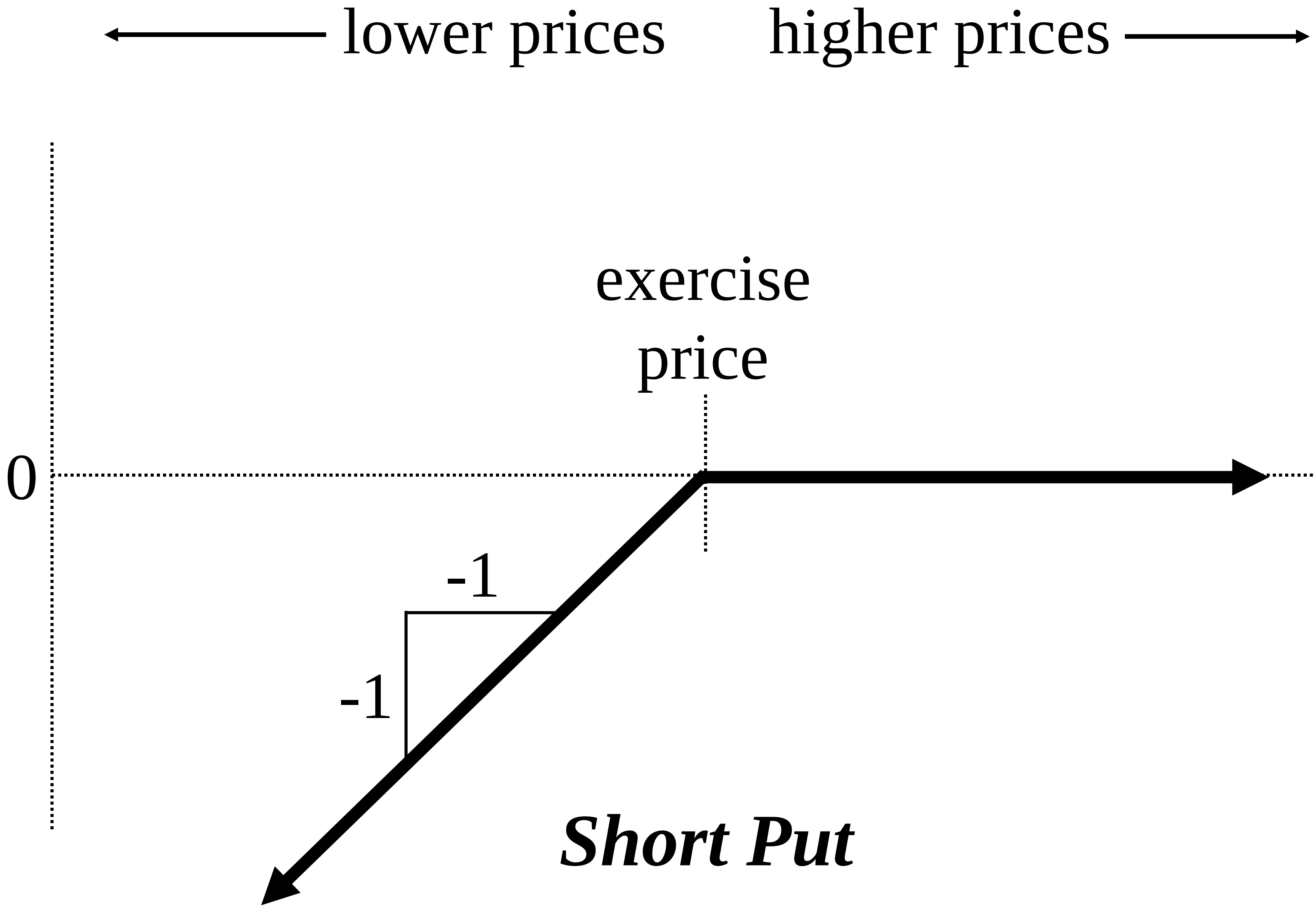
Long Call




lower prices
higher prices
exercise price
0
+1
-1
Short Call

Long Put

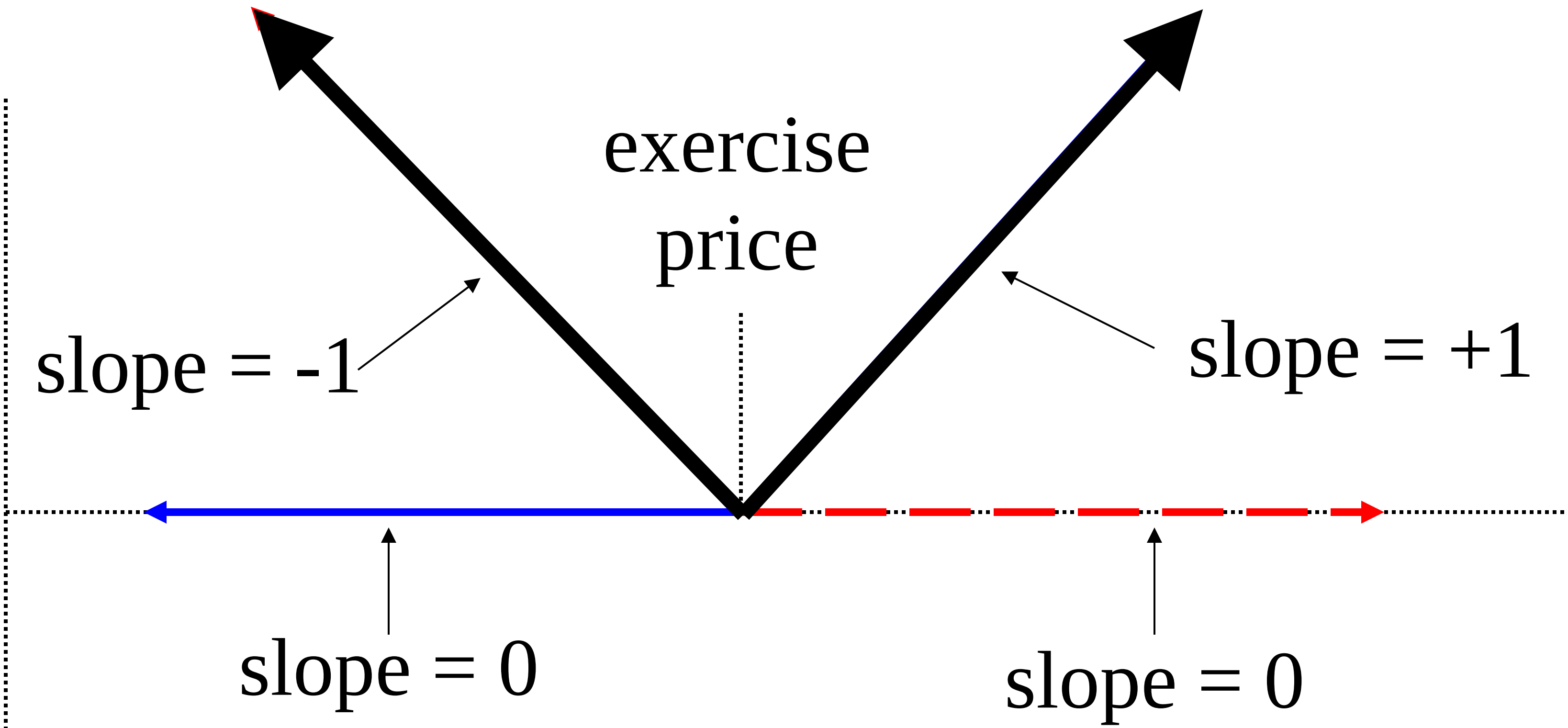



lower prices
higher prices
exercise price
0
-1
-1
Short Put

$$\text{Slope} = \frac{\text{change in option value}}{\text{change in underlying price}}$$

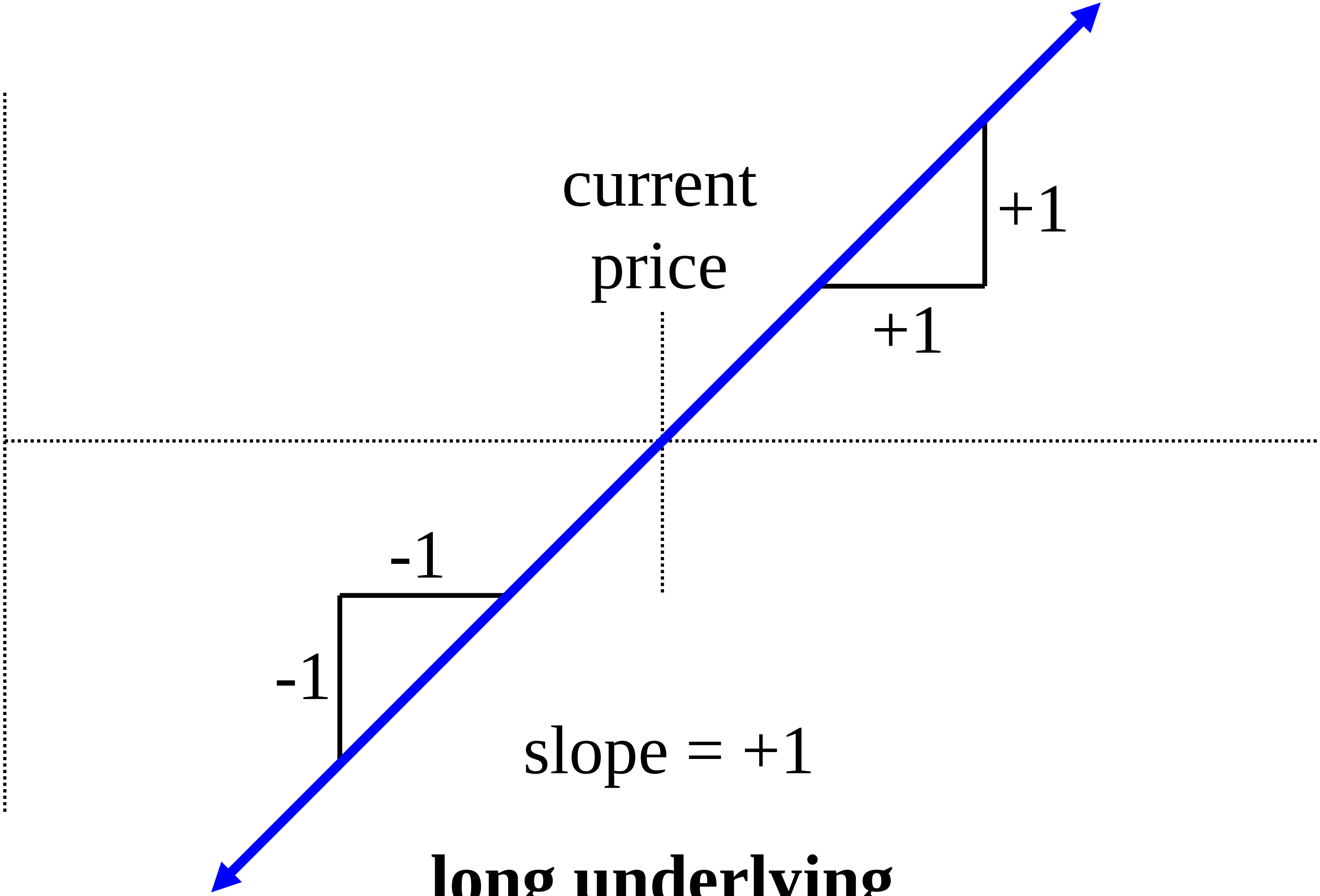
	out-of-the-money	in-the-money
long call	0	+1
short call	0	-1
long put	0	-1
short put	0	+1

long call and long put at the same exercise price

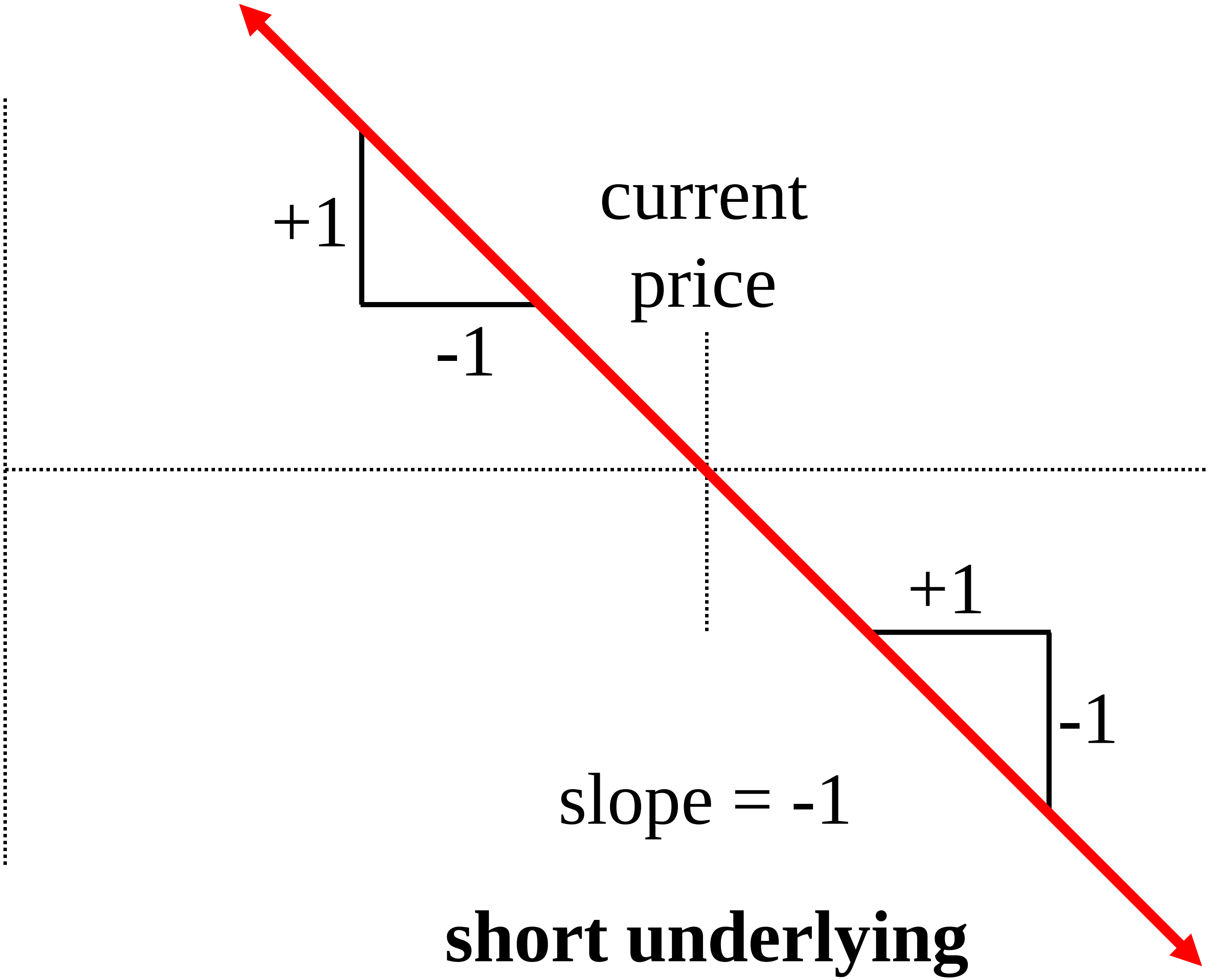


below exercise price
slope = 0 - 1 = -1

above exercise price
price = 0 + 1 = +1

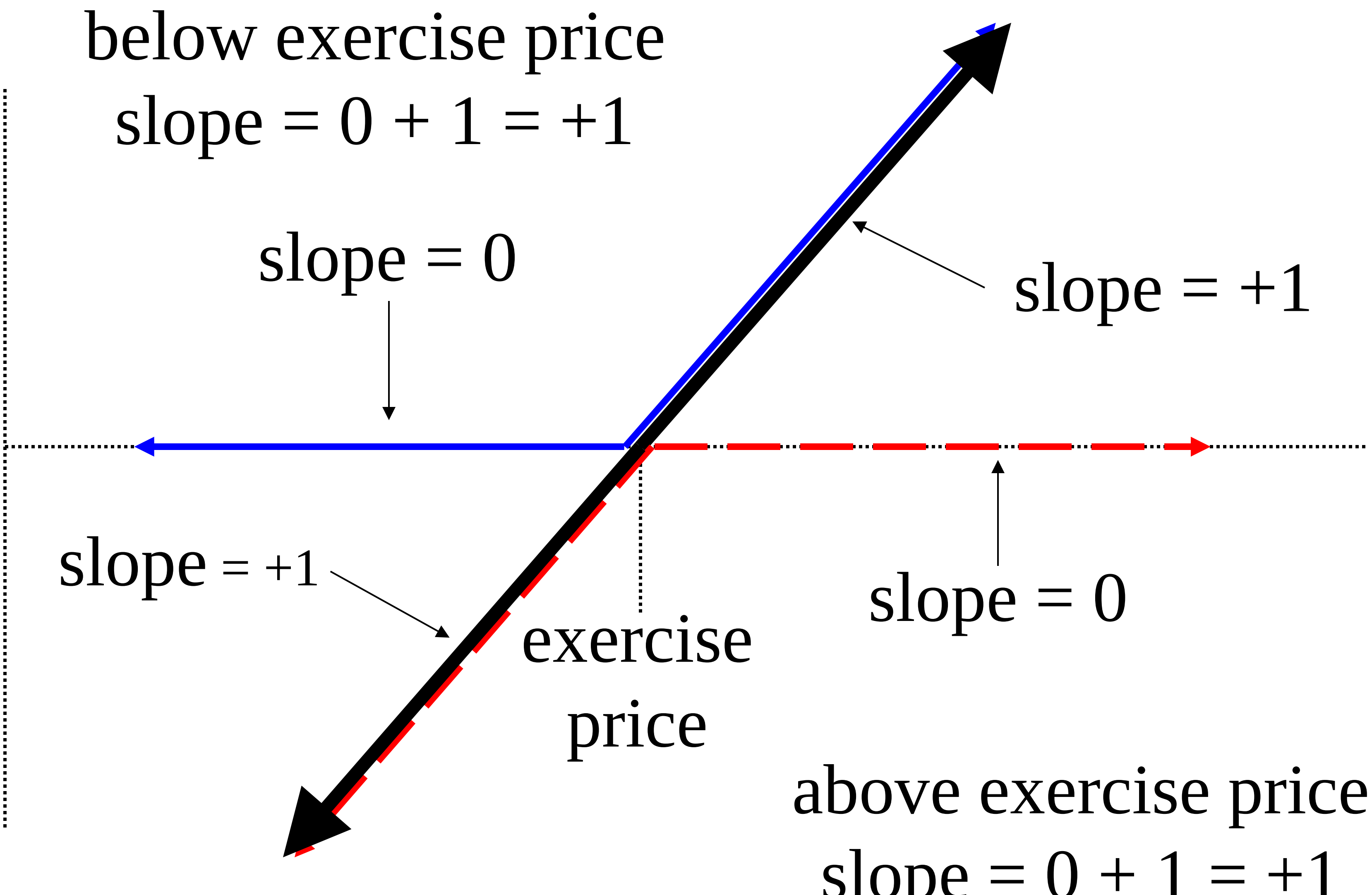


long underlying



short underlying

long call and short put, same exercise price



The profit and loss graph for an option position at expiration is the parity graph …

shifted downward by the amount paid when an option is purchased

or

shifted upward by the amount received when an option is sold

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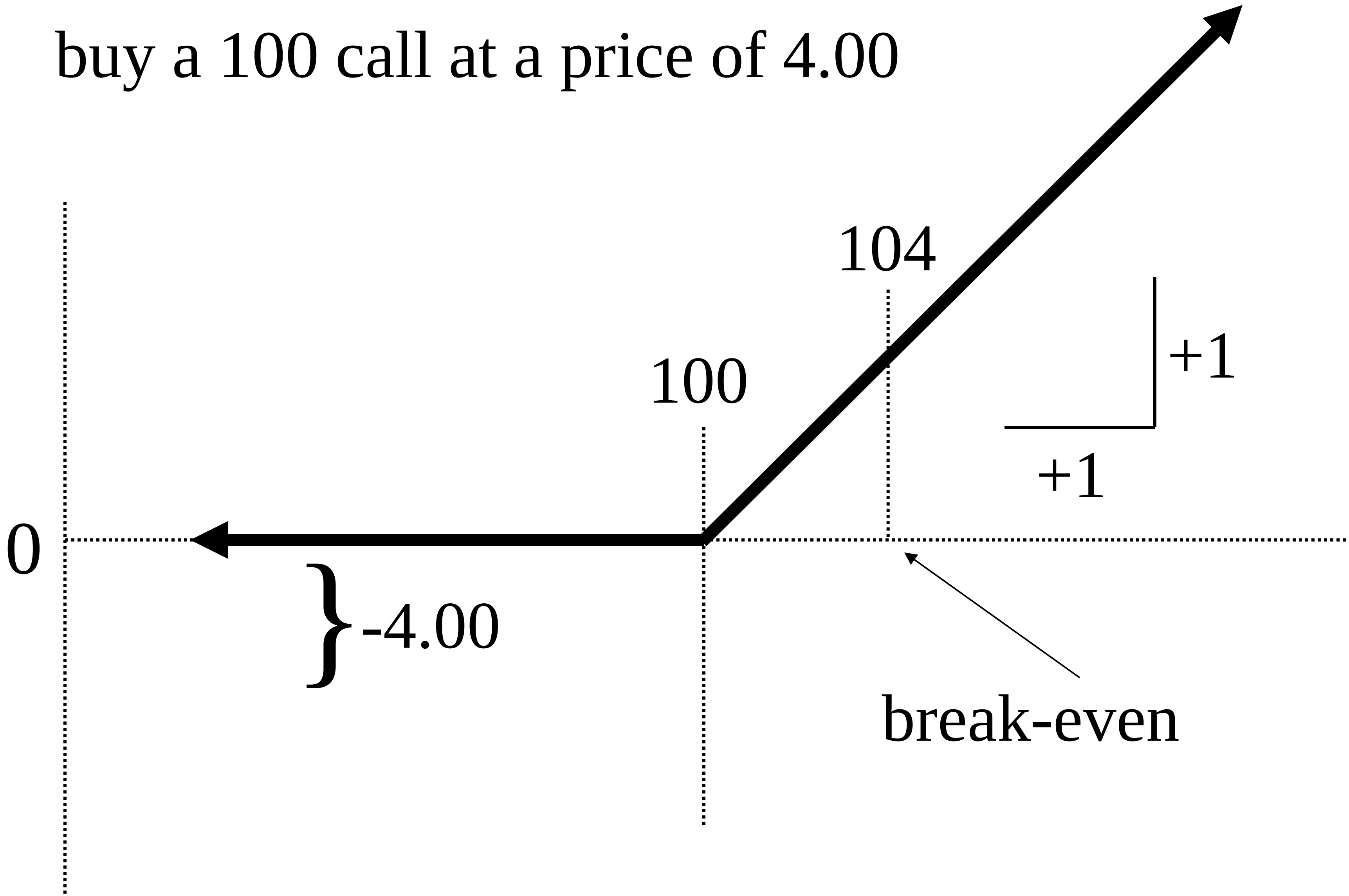
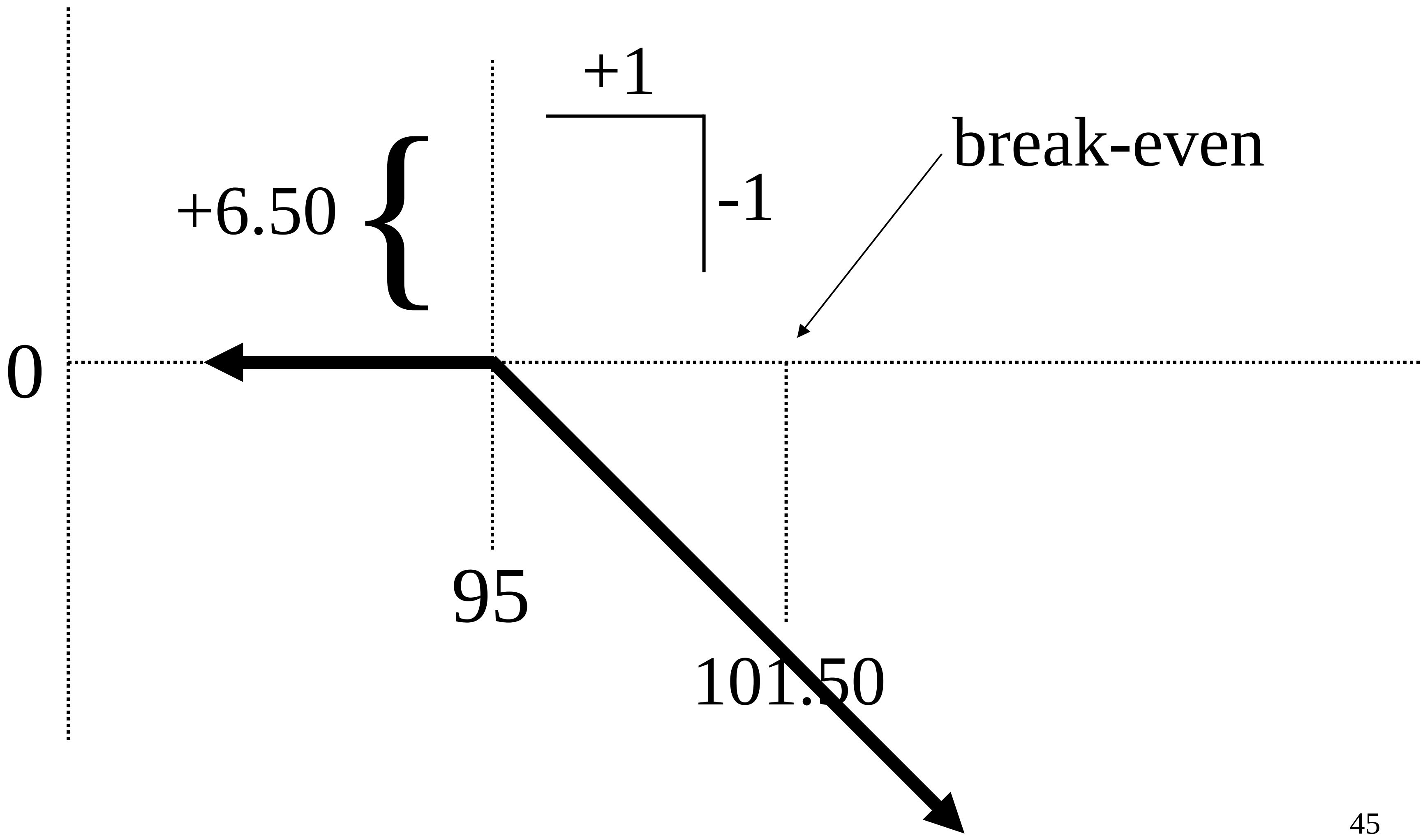
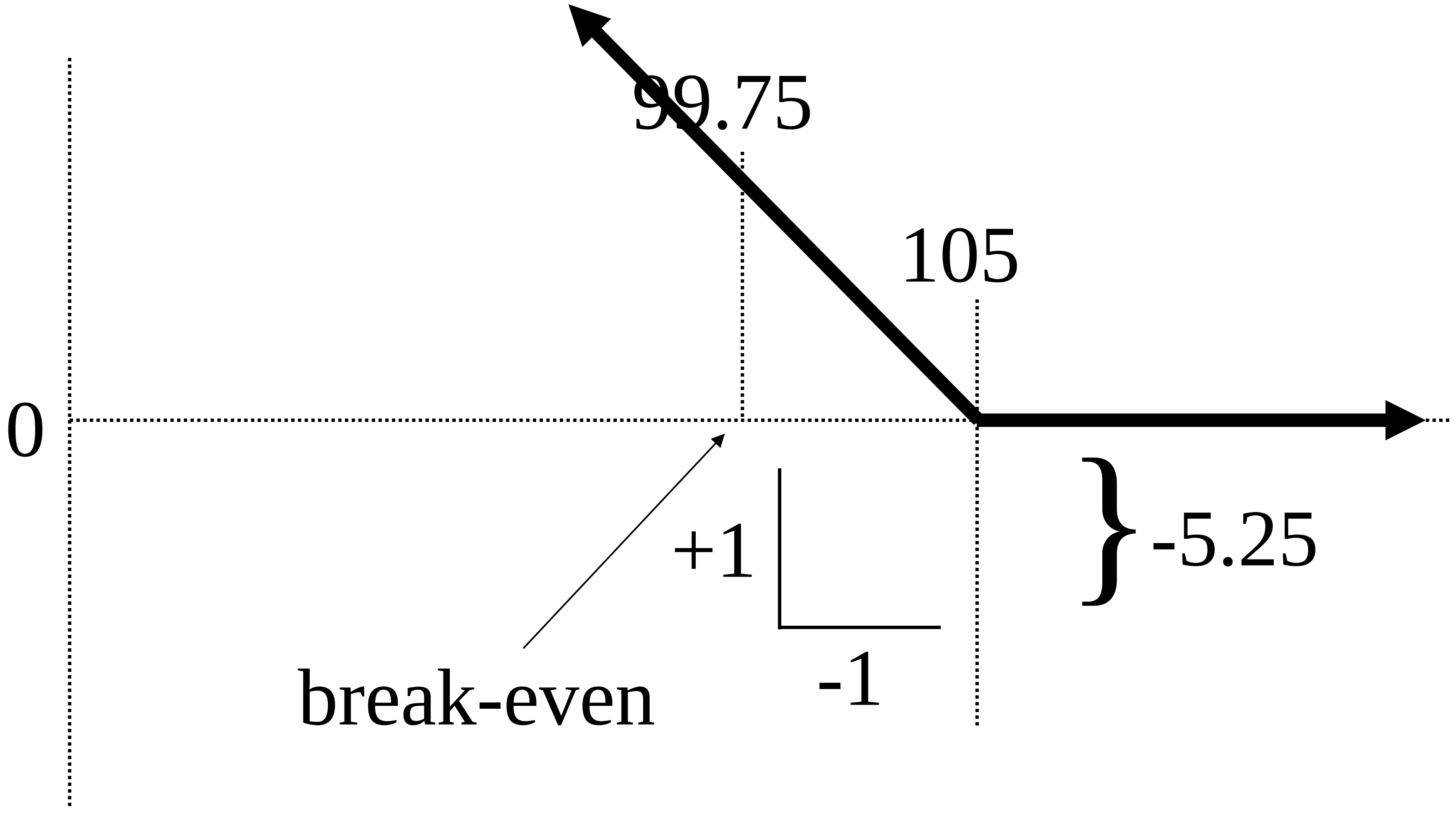
buy a 100 call at a price of 4.00



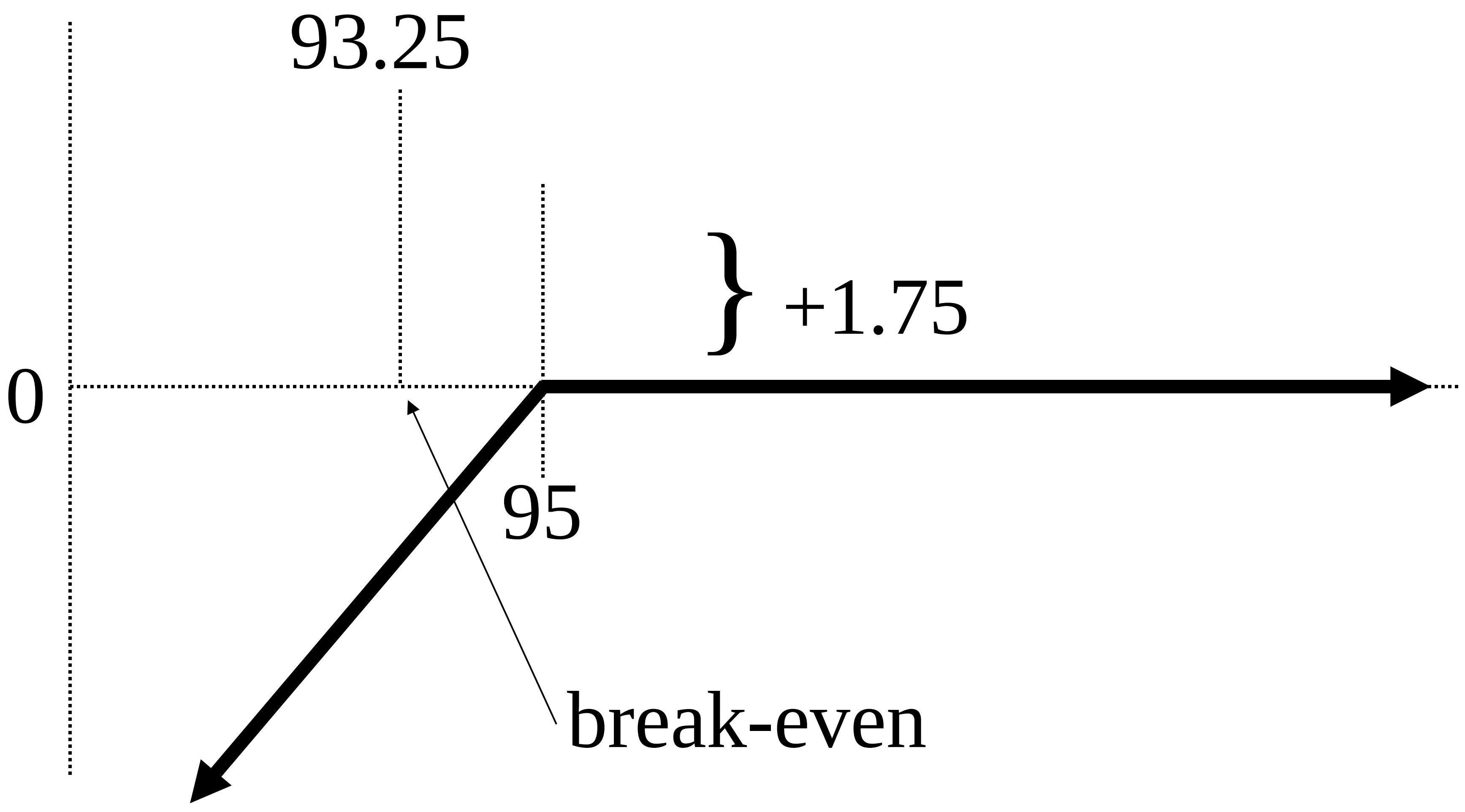
sell a 95 call at a price of 6.50



buy a 105 put at a price of 5.25



sell a 95 put at a price of 1.75



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Theoretical Pricing Models

What is the ***theoretical value*** of a roulette bet?

1, 2, 3, …… , 34, 35, 36, 0, 00

Choose one of 38 numbers

If your number doesn’t come up you receive nothing

If your number does come up you receive $36

Expected value (expected return)

$36 / 38 ≈ 95¢

Expected value

- depends primarily on the laws of probability
- does not have to correspond to a possible outcome
- is only reliable in the long run

The price for the privilege of choosing a number is $1.00

The casino has an ***edge*** of

$1.00 - 95¢ = 5¢

The price for the privilege of choosing a number is 88¢

The player has an edge of

95¢ - 88¢ = 7¢

Theoretical value (theoretical price, fair value, fair price):

The price you would be willing to pay now in order to just break even in the long run.

- expected value
- other considerations

If your number doesn't come up you receive receive nothing.

If your number does come up you receive $36, to be paid in two months.

interest rates = 12.00%

theoretical value

= present value of 95¢

= 95¢ / (1 + 2/12*12%)

= 95¢ / 1.02 ≈ **93¢**

Theoretical edge

The difference between the price of a proposition and its theoretical value

$1.00 - 93¢ = 7¢

Positive theoretical edge

- buy at a price lower than theoretical value

or

- sell at a price higher than theoretical value

Intelligent trading of options requires us to …..

- calculate a theoretical value
- choose an appropriate strategy
- control the risk

A model is a representation of the real world

A model is unlikely to be an exact representation of the real world

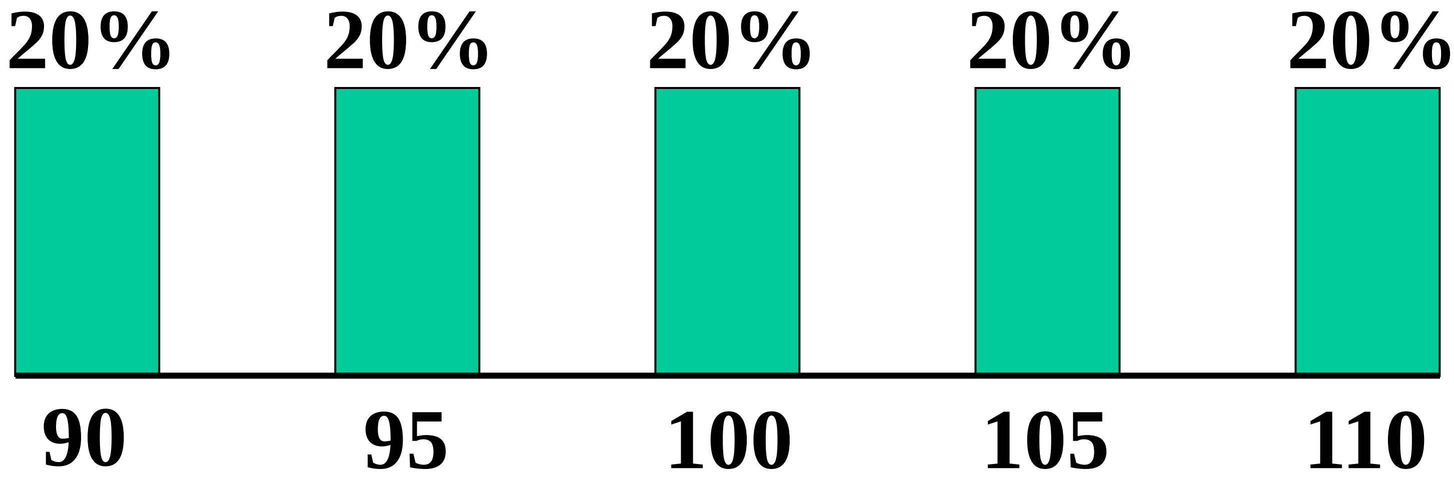
A model is limited by

- the accuracy of the assumptions on which the model is based
- the accuracy of the inputs into the model

Theoretical option pricing model

A mathematical model used to determine the theoretical value of an option contract under some set of assumptions about

- market conditions
- the terms of the option contract

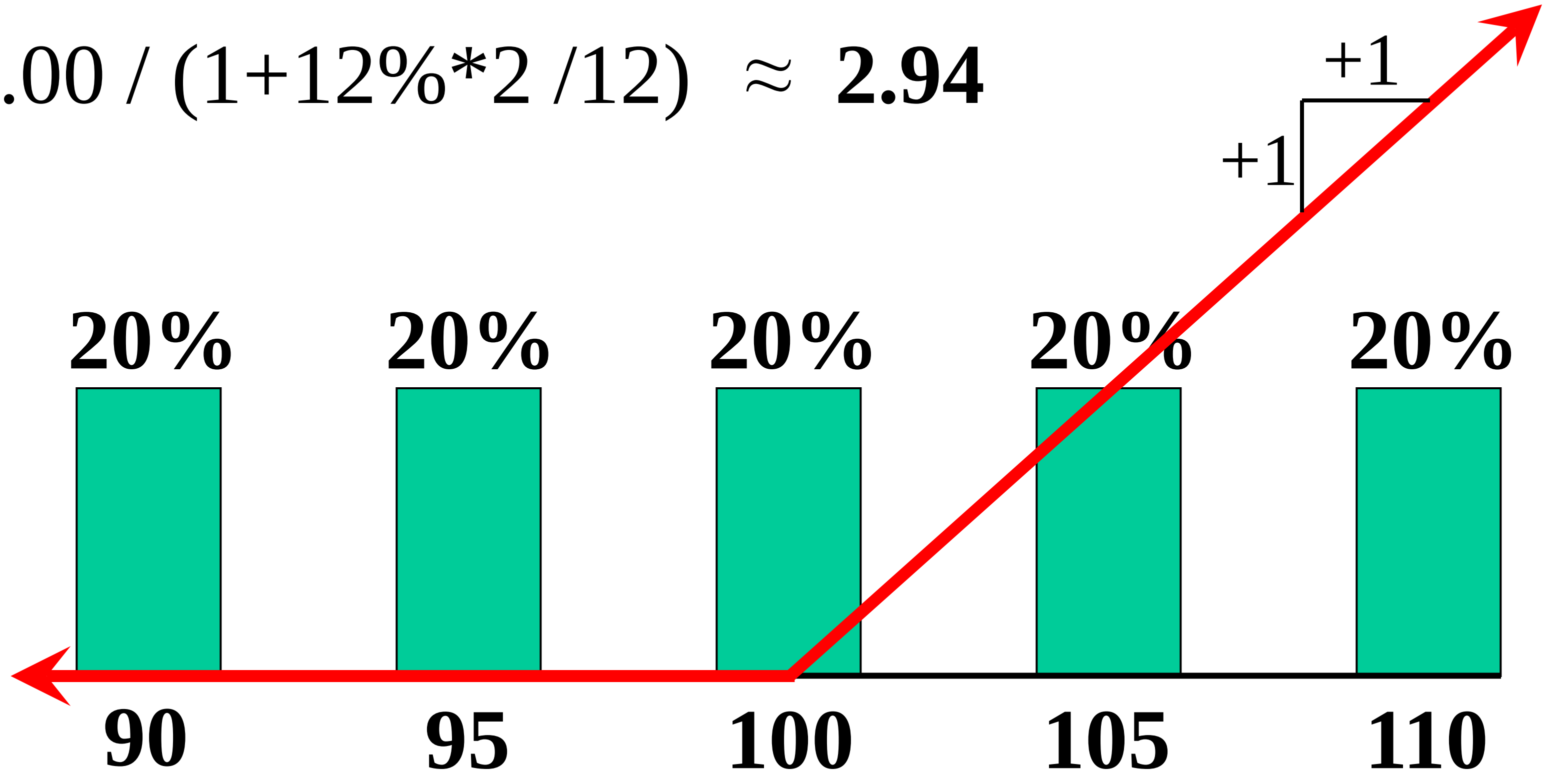


Expected value for the underlying?

20%*90 + 20%*95 ……. + 20%*110 = **100**

Present value? 2 months 12% per year

3.00 / (1+12%*2 /12) ≈ **2.94**

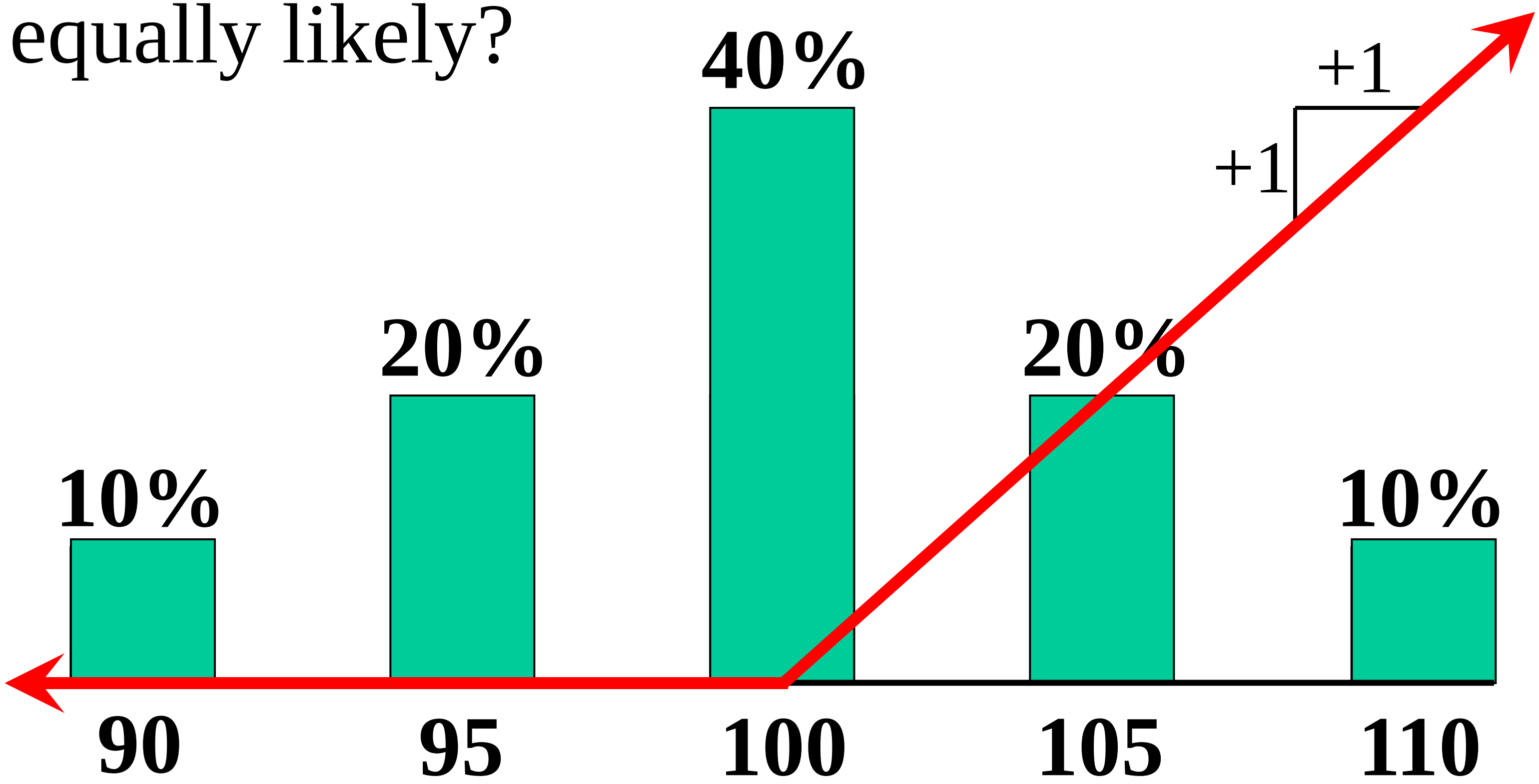


Expected value for the 100 call?

20%*0 + 20%*0 + 20%*0 + 20%*5 + 20%*10

= **3.00**

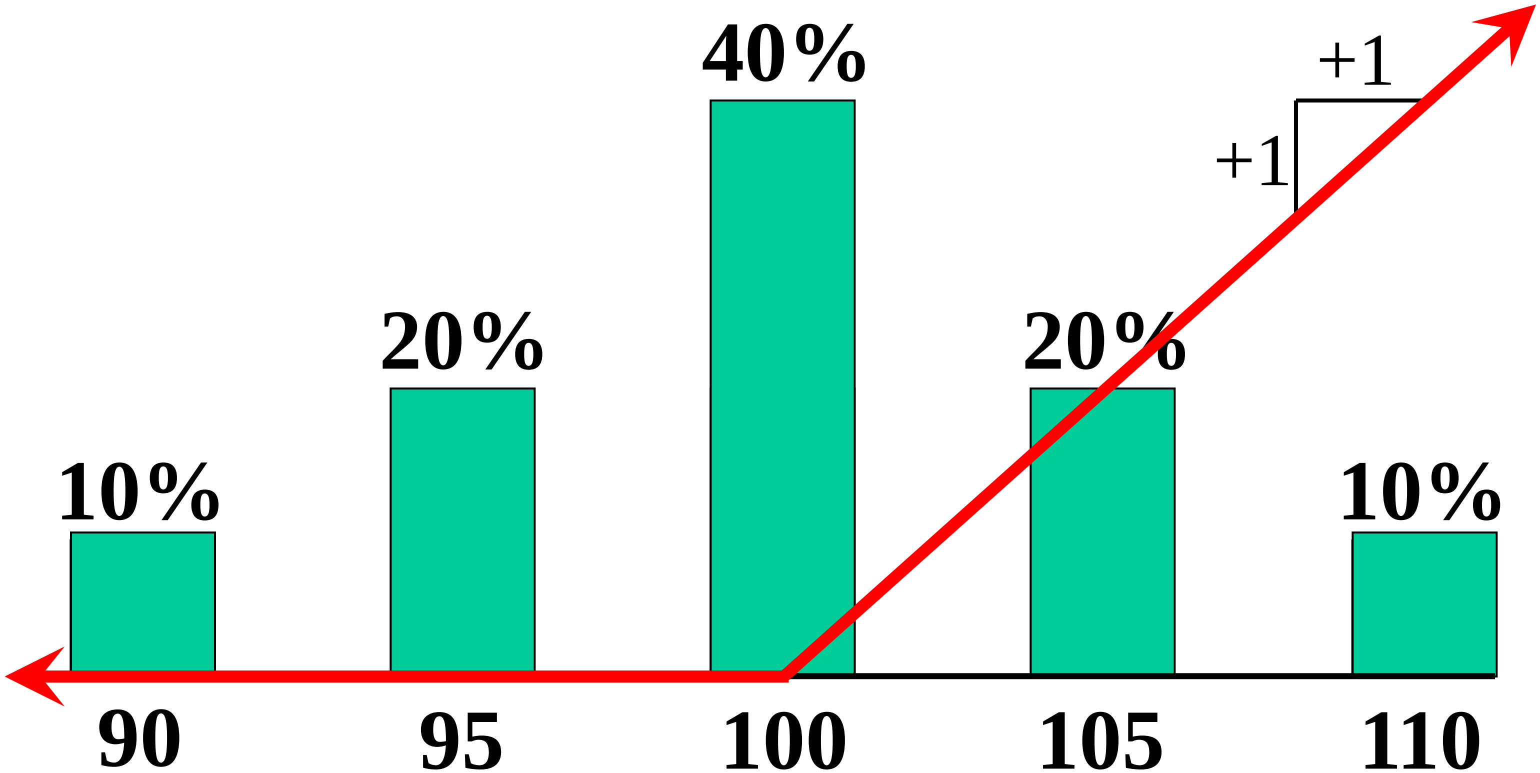
Should every outcome be equally likely?



Expected value for the underlying? **100**

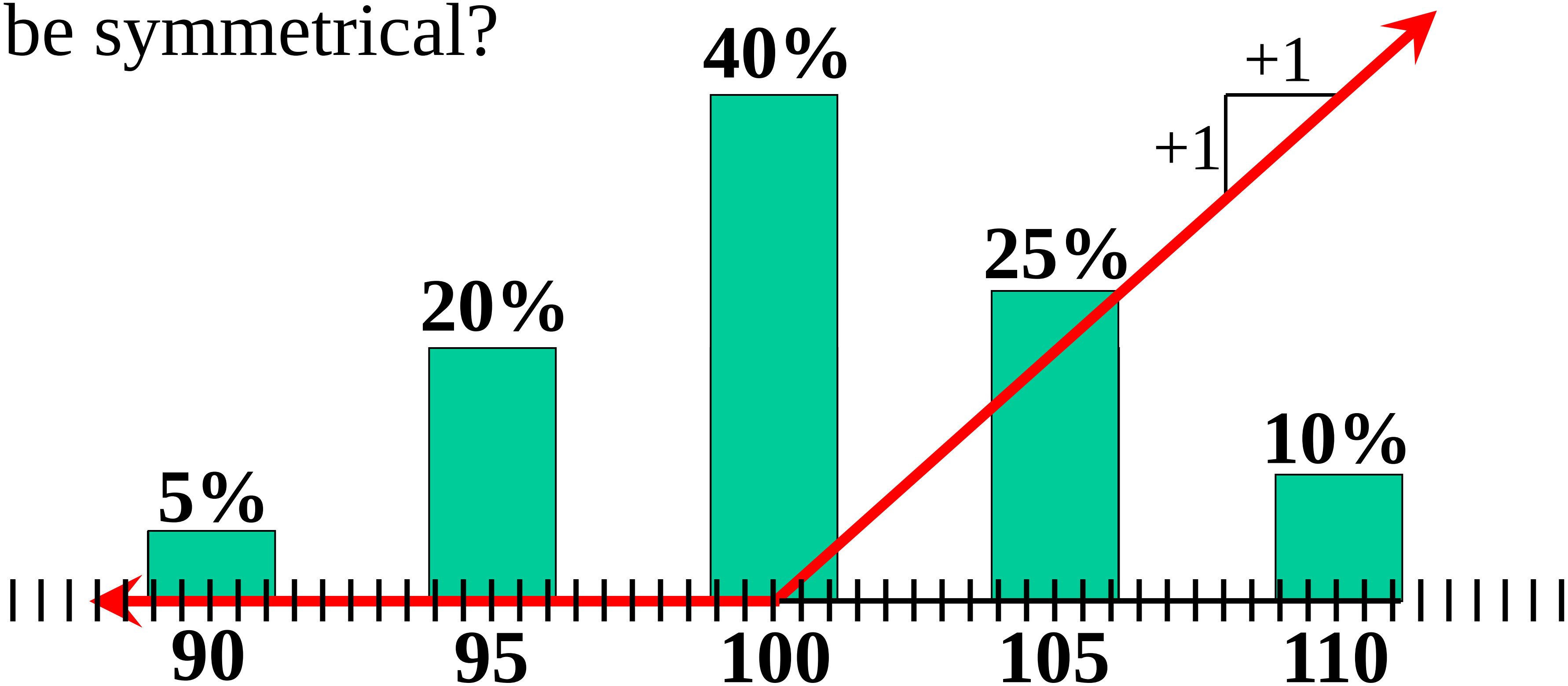
Expected value for 100 call?

20%*5 + 10%*10 = **2.00**



What should be the most likely underlying price at expiration? **forward price**

Must the probabilities be symmetrical?



Expected value for the underlying?

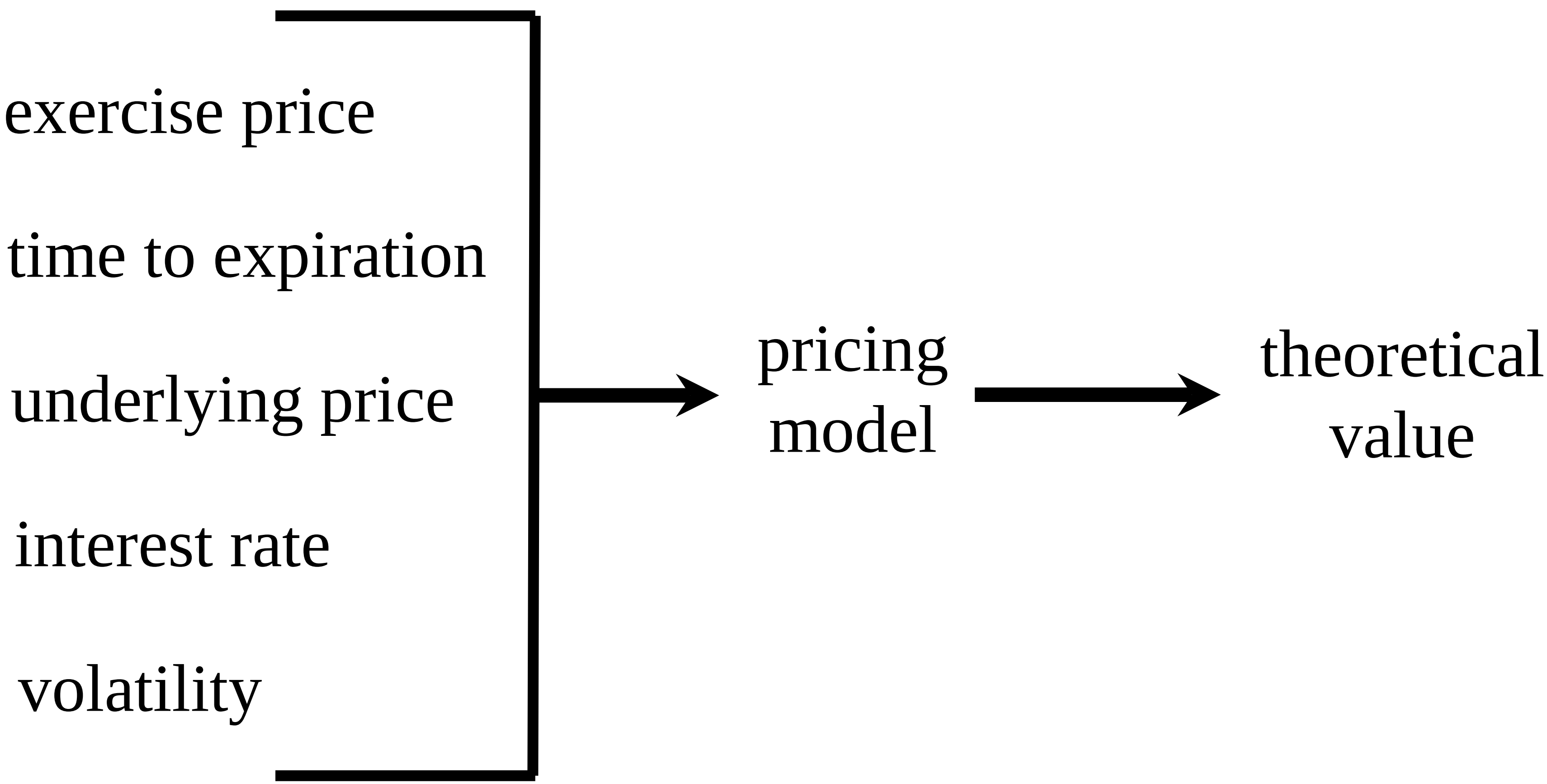
5%*90 + 20%*95 + 40%*100
+25%*105 + 10%*110 = **100.75**

100 call? 25%*5 + 10%*10 = **2.25**

All theoretical pricing models attempt to:

- propose a series of prices for the underlying contract at expiration
- assign appropriate probabilities to each underlying price, with the restriction that the expected value of the underlying contract must be equal to the forward price
- using the exercise price, underlying prices, and probabilities, calculate the option's expected value at expiration
- calculate the option's present value (theoretical value) by discounting the expected value by the appropriate interest component

Theoretical Pricing Models



Expected Value Exercise

124	126	128	130	132	134	136
4%	12%	19%	22%	21%	16%	6%

Using the above prices and probabilities for an underlying contract, what are the expected values for the following contracts:

underlying	126 call	130 call	133 call
	126 put	130 put	133 put

What do you notice about the difference between the values of calls and puts at the same exercise price?

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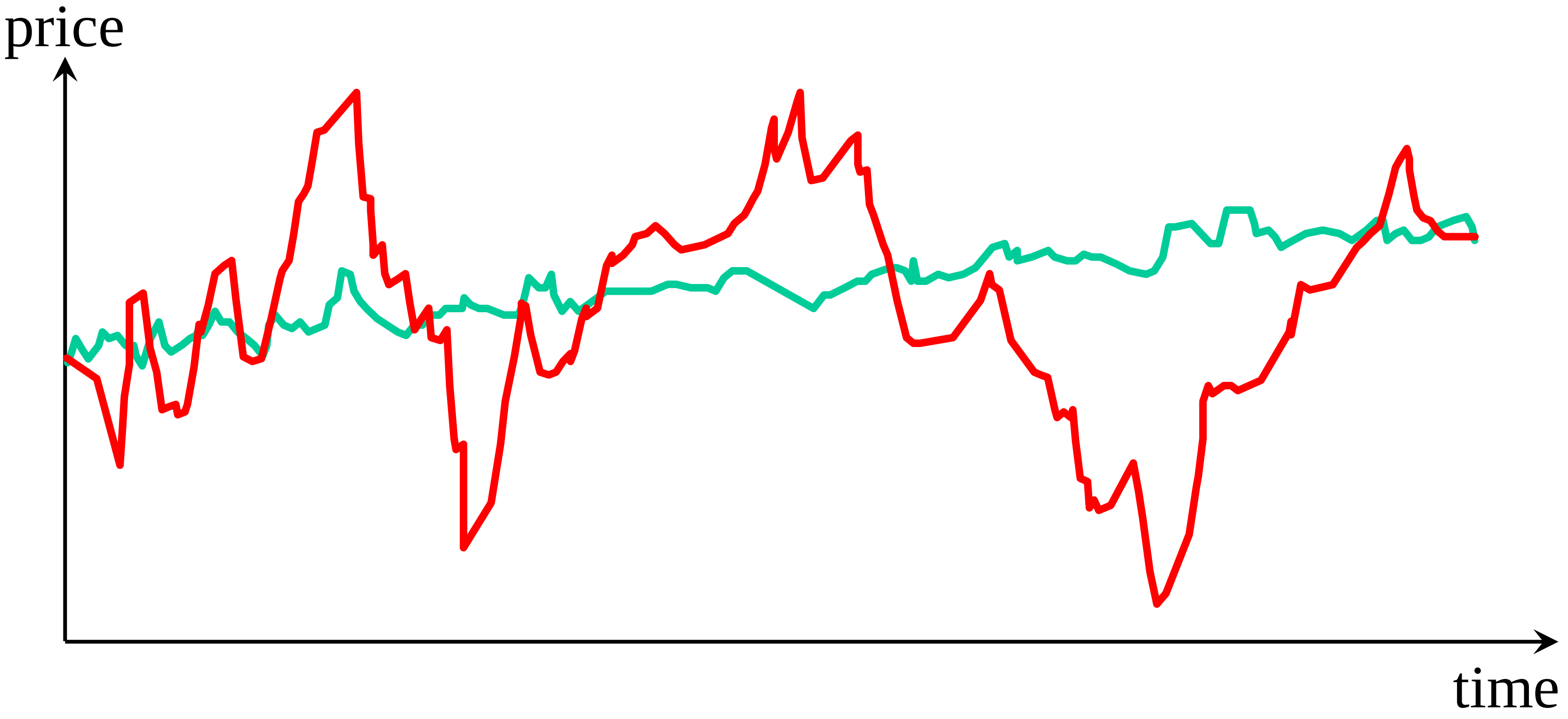
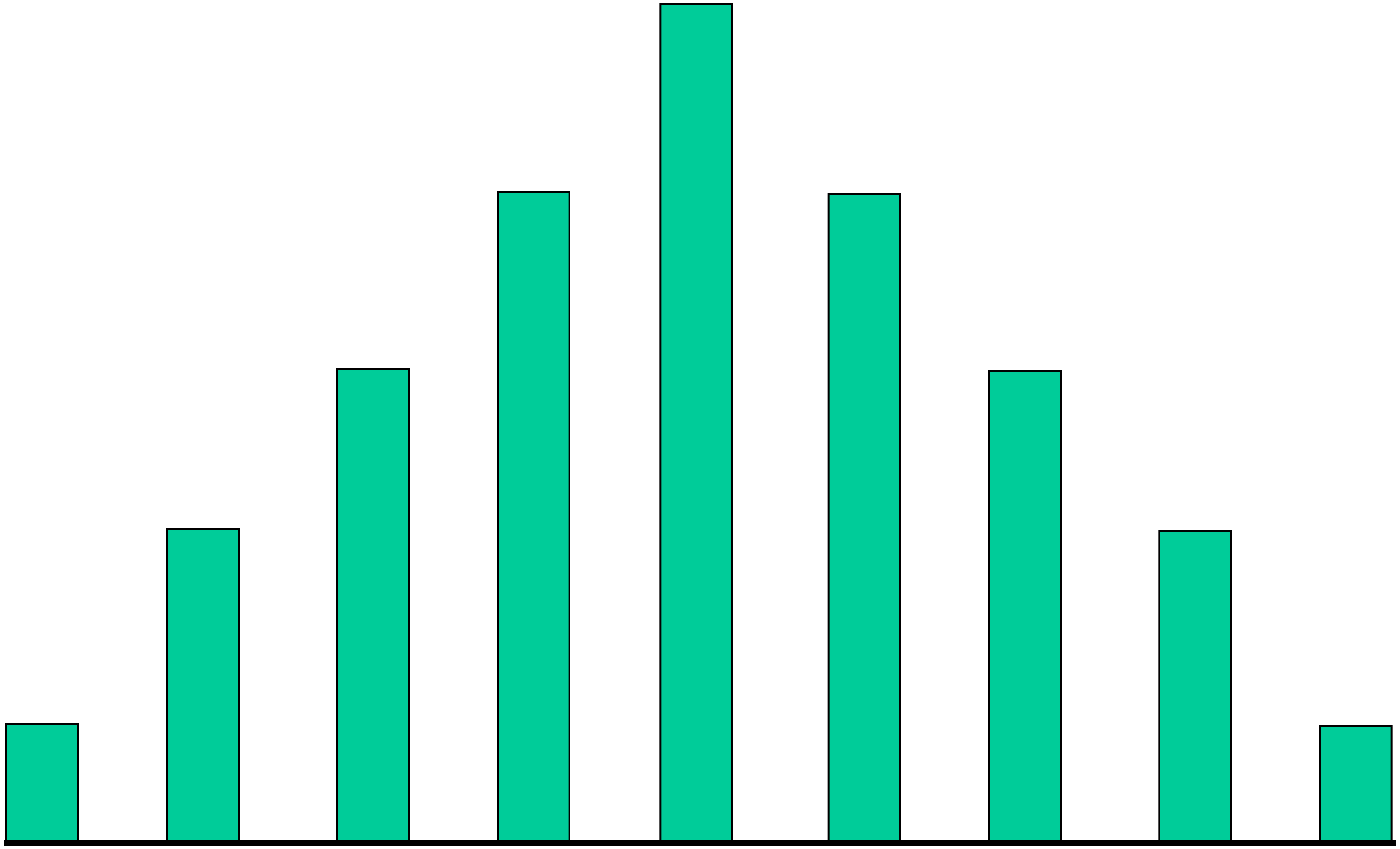
Volatility

What is volatility?

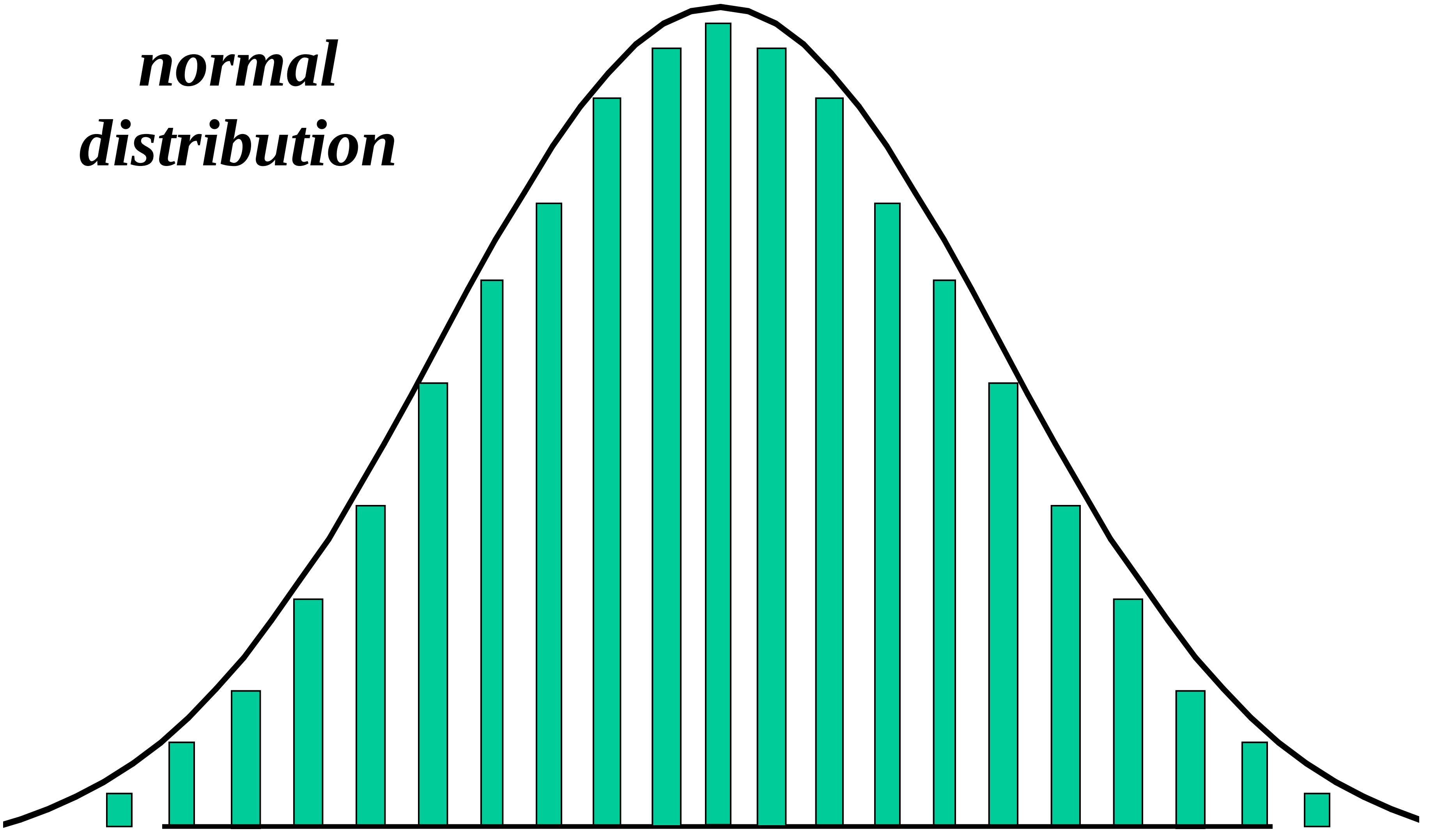



probabilities
underlying prices

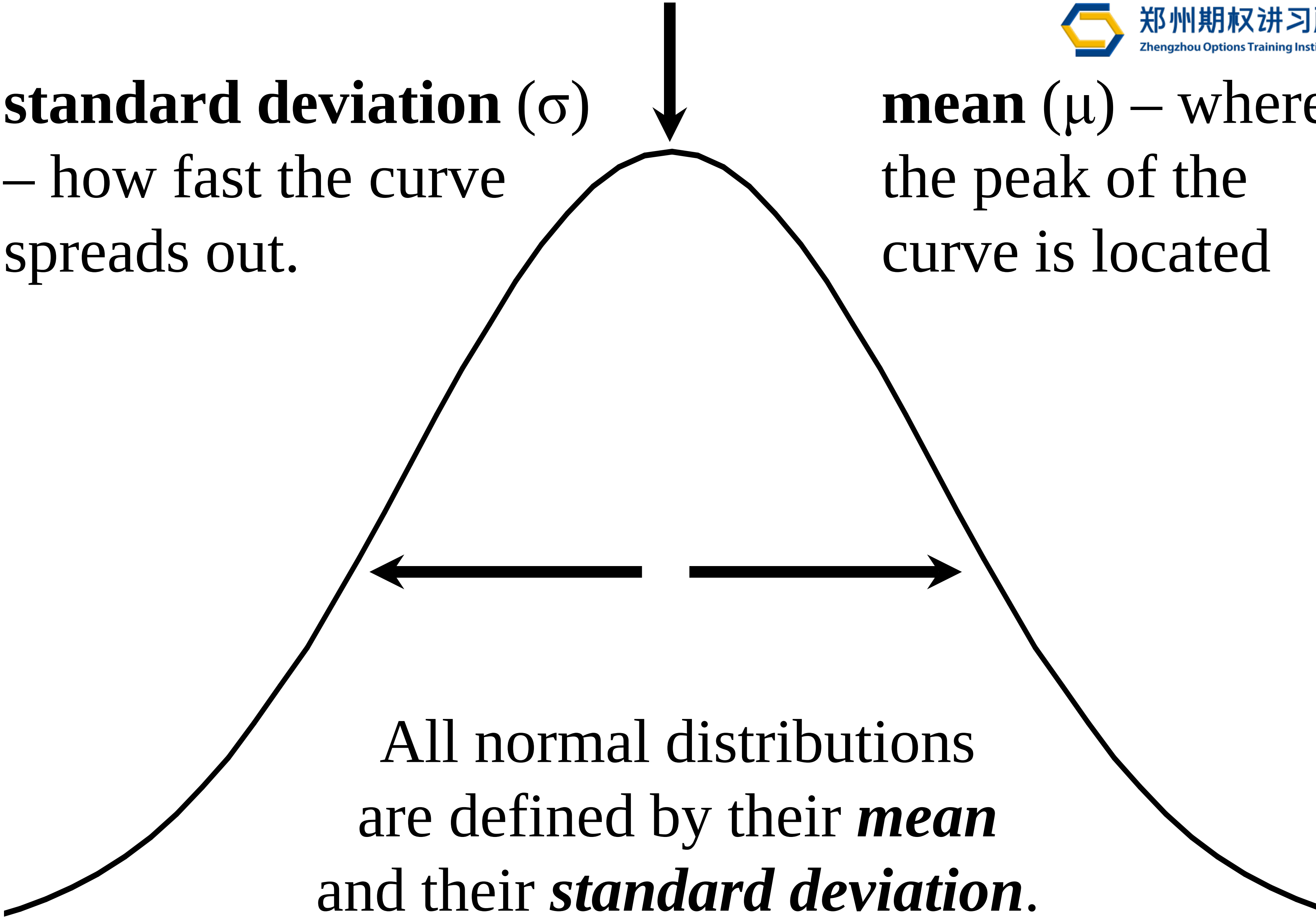


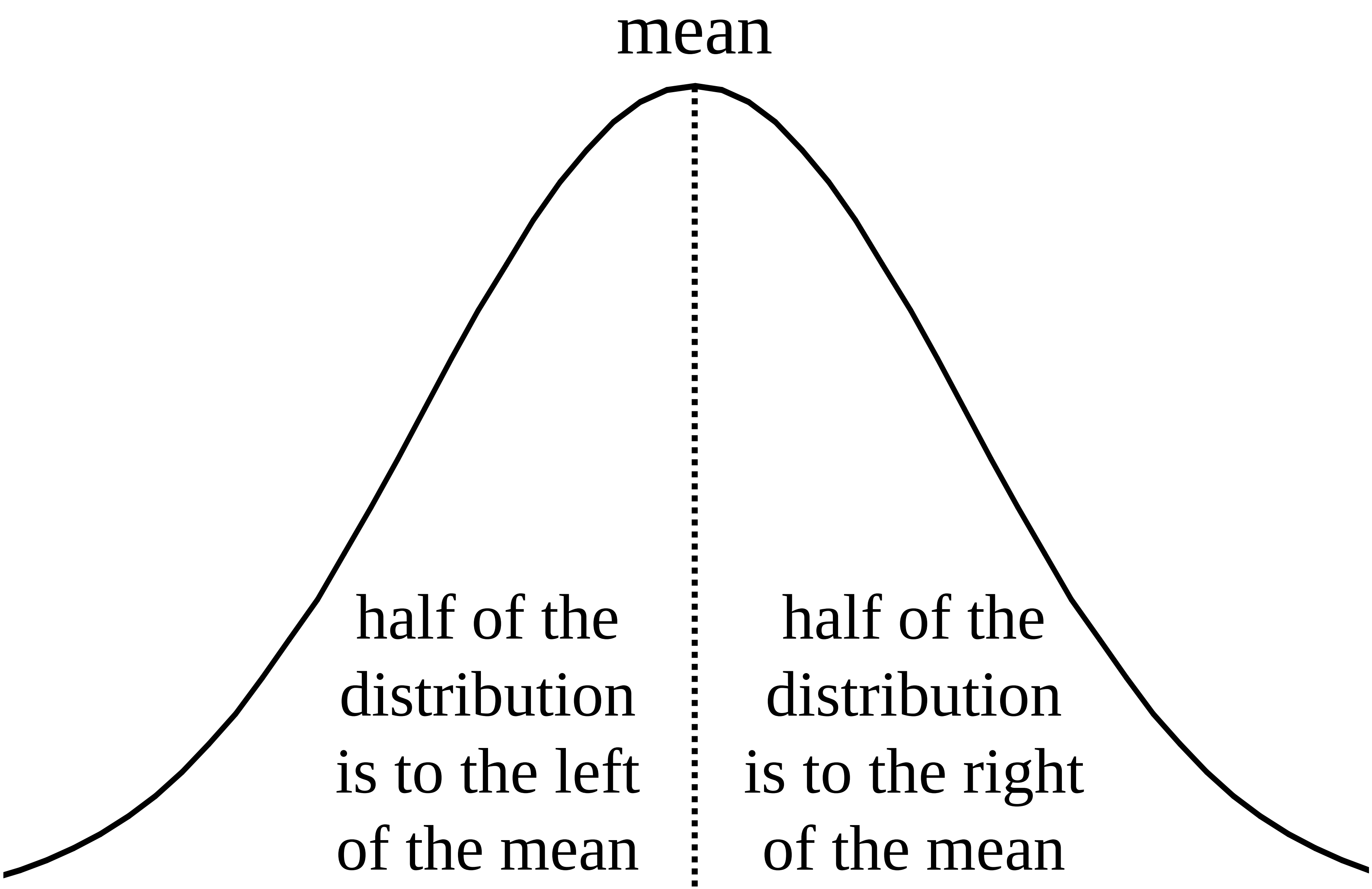
underlying prices

normal distribution



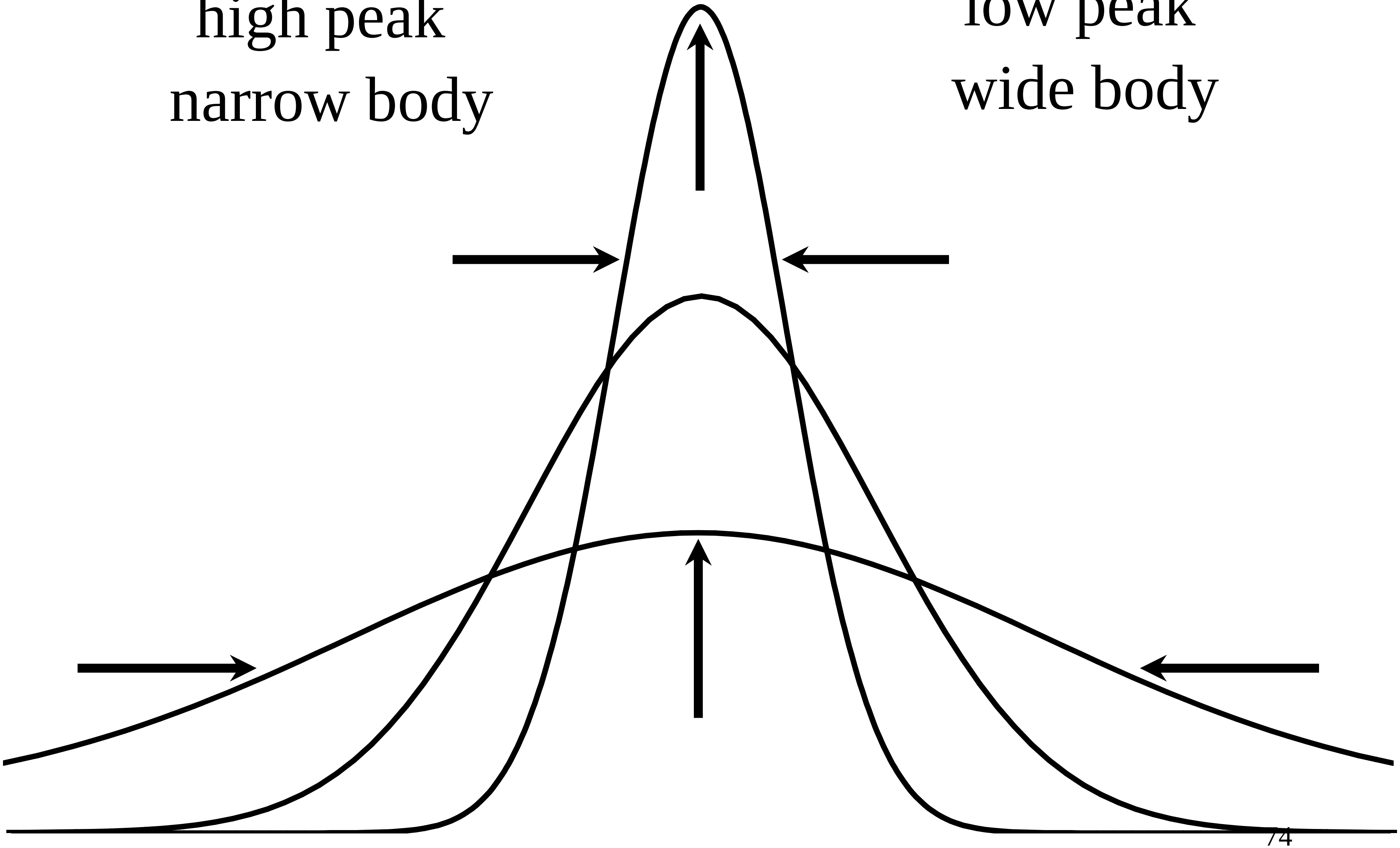
underlying prices

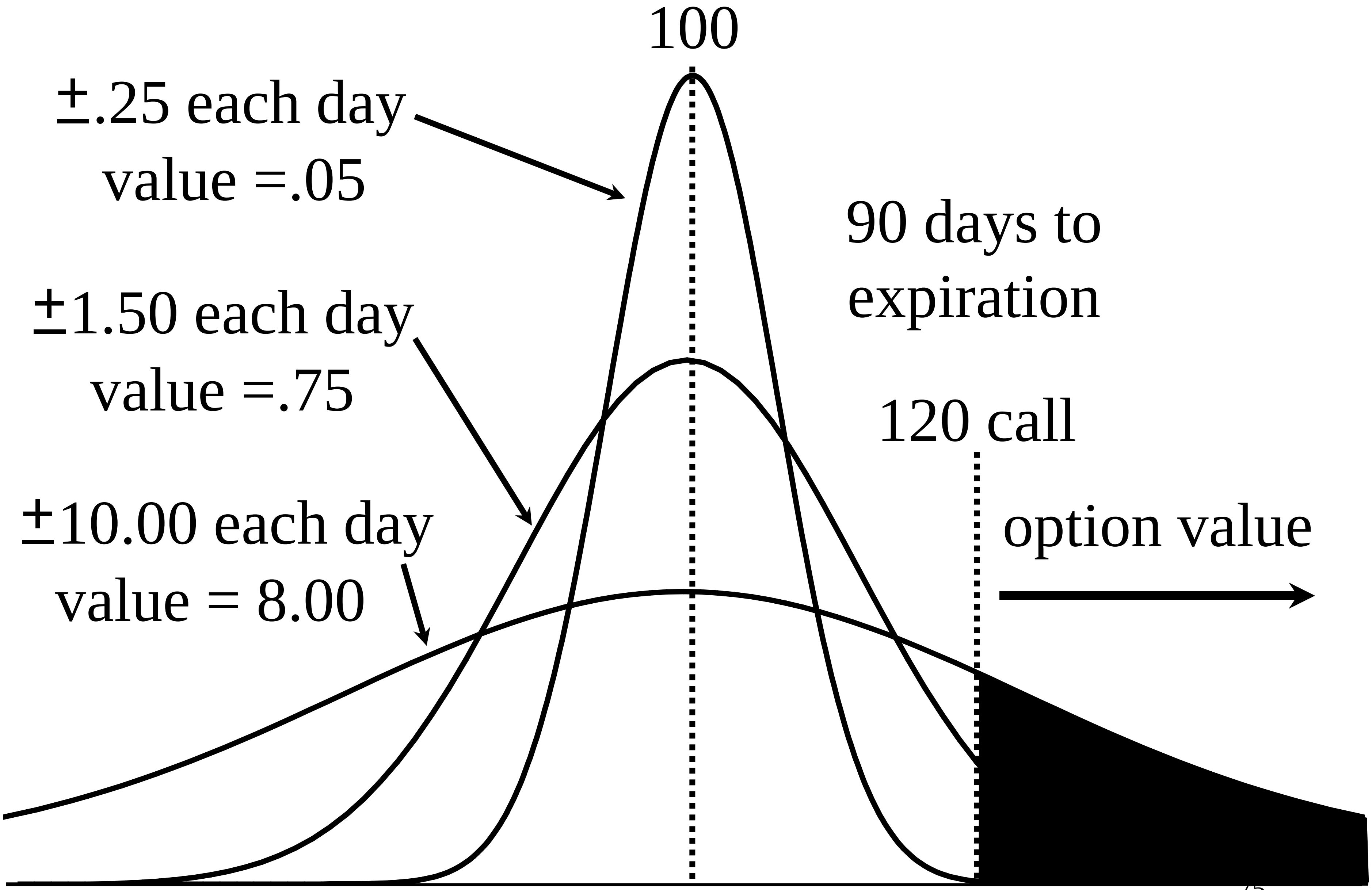

standard deviation (σ) – how fast the curve spreads out.
mean (μ) – where the peak of the curve is located
All normal distributions are defined by their ***mean*** and their ***standard deviation***.

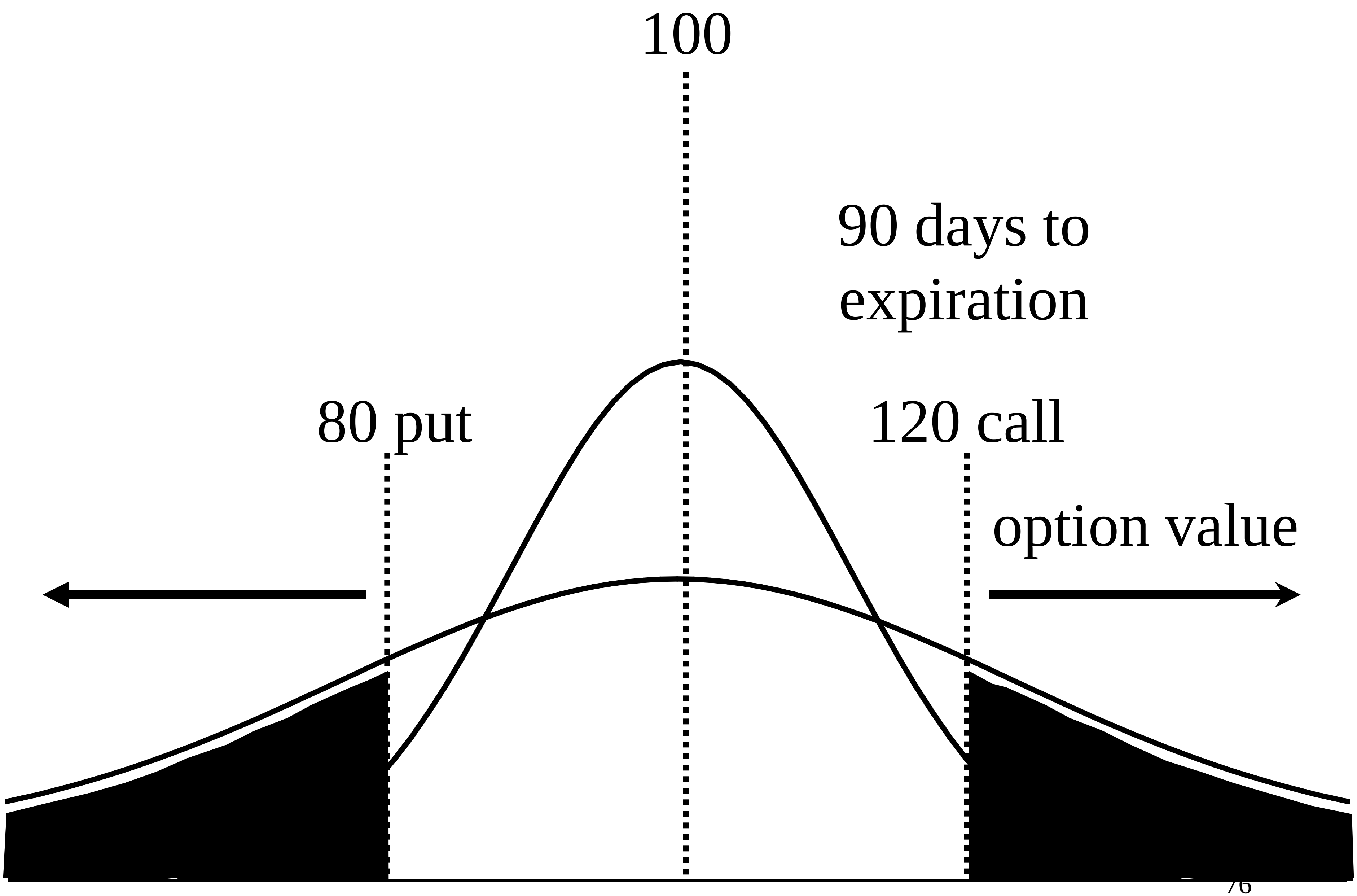

mean
half of the distribution is to the left of the mean
half of the distribution is to the right of the mean

low standard deviation
high peak
narrow body

high standard deviation
low peak
wide body




100
±.25 each day
value =.05
90 days to
expiration
±1.50 each day
value =.75
120 call
±10.00 each day
value = 8.00
option value

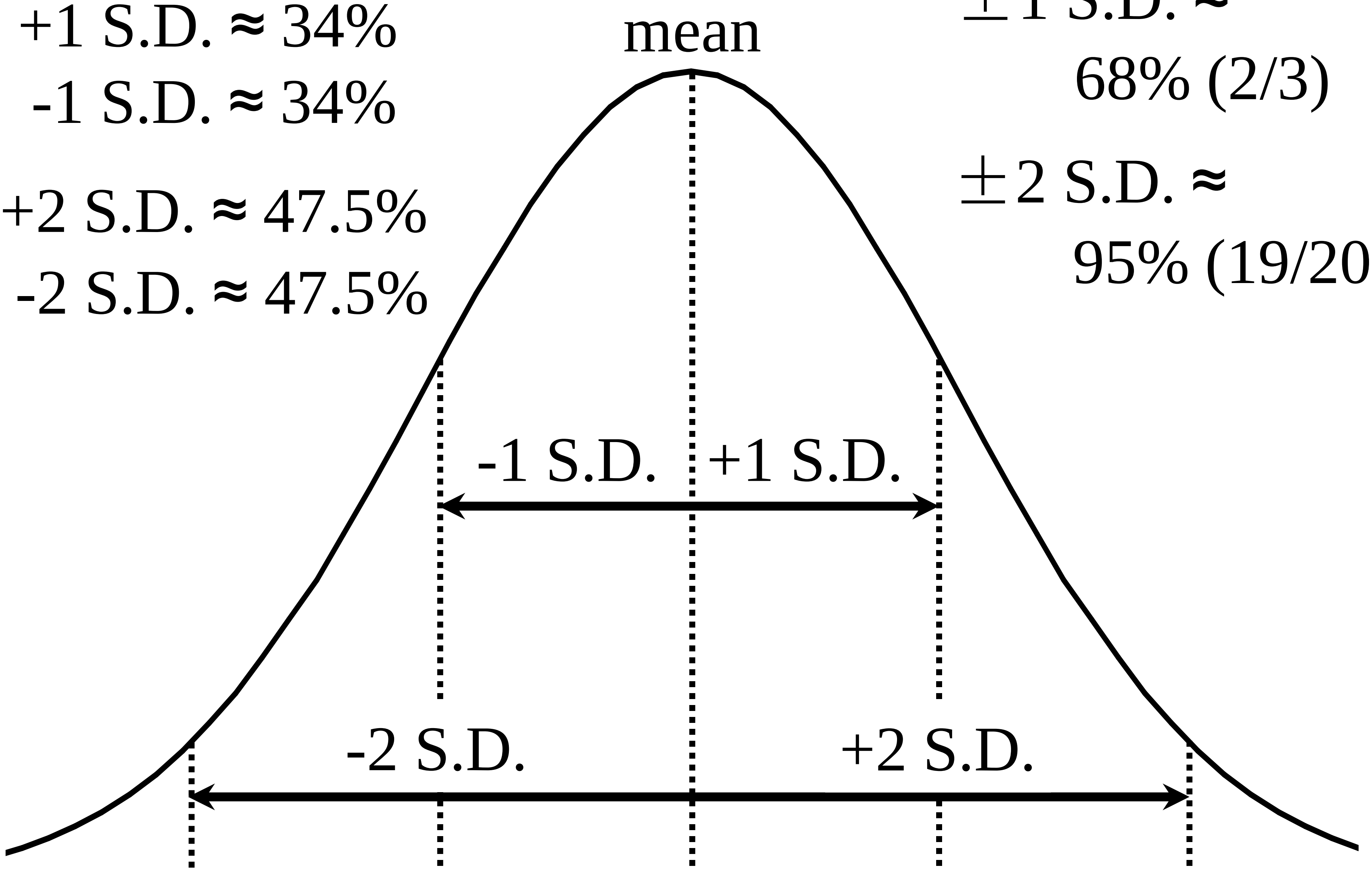

100
90 days to
expiration
80 put
120 call
option value

+1 S.D. ≈ 34%
-1 S.D. ≈ 34%

+2 S.D. ≈ 47.5%
-2 S.D. ≈ 47.5%

±1 S.D. ≈ 68% (2/3)

±2 S.D. ≈ 95% (19/20)



We would expect to see an occurrence

- within 1 standard deviation

  approx. 2 times out of 3

- within 2 standard deviations

  approx. 19 times out of 20

- greater than 1 standard deviation

  approx. 1 time in 3

- greater than 2 standard deviations

  approx. 1 time in 20

exercise price

time to expiration

underlying price

interest rate

volatility

(dividends)

mean?

standard deviation?

Mean – forward price

(underlying price, time to expiration, interest rates, dividends)

Standard deviation – volatility

Volatility: one standard deviation, in percent, over a one year period.

1-year forward price = 100.00

volatility = 20%

One year from now:

- 2/3 chance the contract will be between 80 and 120 (100 ± 20%)
- 19/20 chance the contract will be between 60 to 140 (100 ± 2*20%)
- 1/20 chance the contract will be less than 60 or more than 140

What does an annual volatility tell us about movement over some other time period?

monthly price movement?

weekly price movement?

daily price movement?

$$\text{Volatility}_t = \text{Volatility}_{\text{annual}} * \sqrt{t}$$

Daily volatility (standard deviation)

Trading days in a year? 250 – 260

Assume 256 trading days

$t = 1/256 \qquad \sqrt{t} = \sqrt{1/256} = 1/16$

$\text{Volatility}_{\text{daily}} = \text{Volatility}_{\text{annual}} / 16$

current price = 100.00

volatility$_{daily}$ ≈ 20% / 16 = 1¼%

One trading day from now:

- 2/3 chance the contract will be between 98.75 and 101.25

  (100 ± 1¼%)

- 19/20 chance the contract will be between 97.50 and 102.50

  (100 ± 2*1¼%)

Weekly volatility:

$$t = 1/52 \qquad \sqrt{t} = \sqrt{1/52} \approx 1/7.2$$

$$\text{Volatility}_{\text{weekly}} \approx \text{Volatility}_{\text{annual}} / 7.2$$

Monthly volatility:

$$t = 1/12 \qquad \sqrt{t} = \sqrt{1/12} \approx 1/3.5$$

$$\text{Volatility}_{\text{monthly}} \approx \text{Volatility}_{\text{annual}} / 3.5$$

Volatility Exercise I

For each contract and volatility below, what would be an approximate daily and weekly standard deviation:

Sugar futures trading at 5140

	10%	12%	14%	16%
daily				
weekly				

Glass futures trading at 1465

	15%	20%	25%	30%
daily				
weekly				

Volatility Exercise II

For each contract, volatility, and time interval below, what would be an an approximate one standard deviation price change:

Cotton futures trading at 19,600

volatility = 7.5%, time = 22 days

volatility = 11.25%, time = 86 days

Wheat futures trading at 2625.00

volatility = 14%, time = 9 weeks

volatility = 9.75%, time = 27 weeks

futures price = 2628; volatility = 14%

daily standard deviation

$\approx$ 2628 * 14% / 16

= 2628 * .875% $\approx$ **23**

weekly standard deviation

$\approx$ 2628 * 14% / 7.2

= 2628 * 1.94% $\approx$ **51**

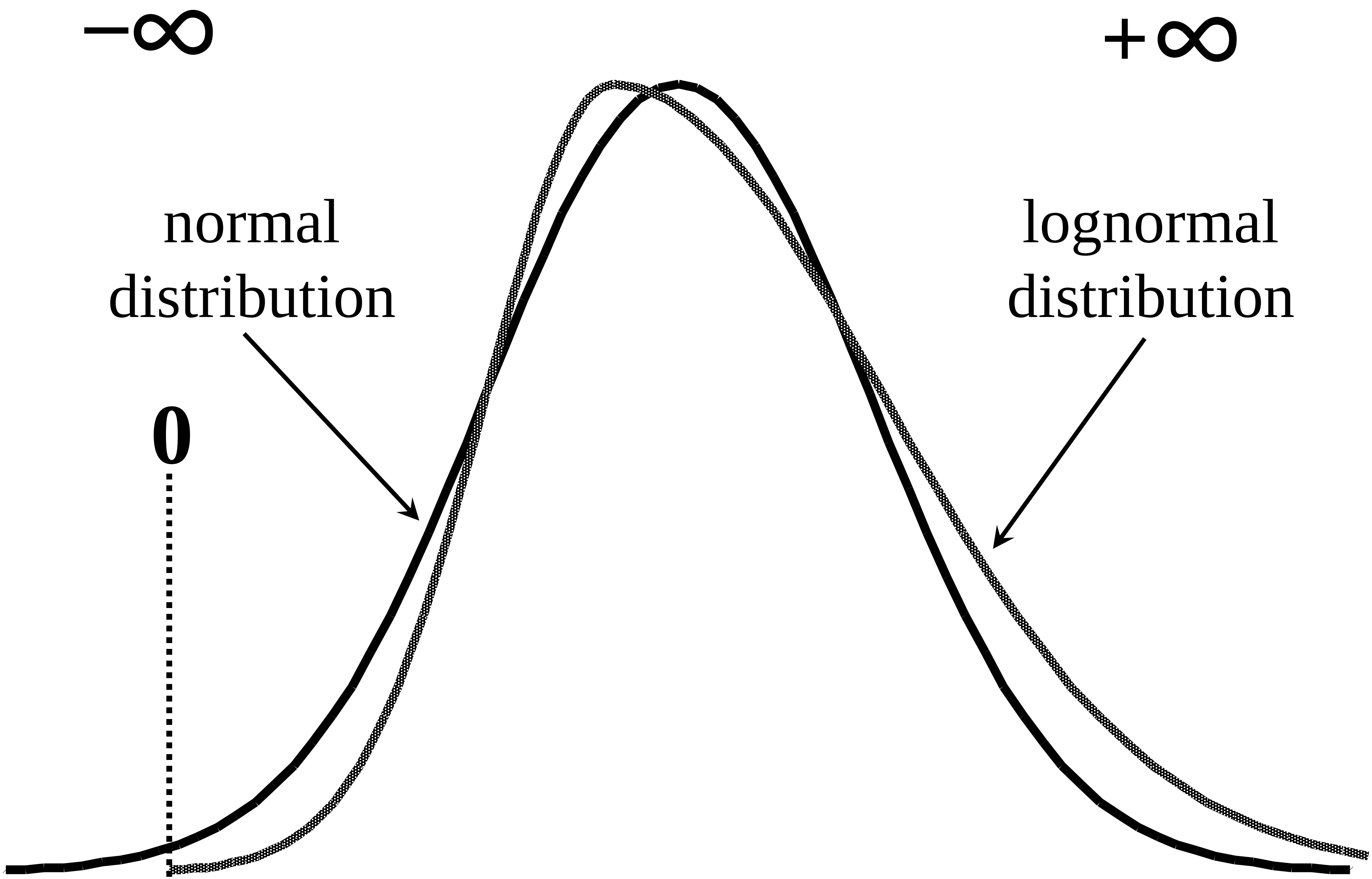
futures price = 2628; volatility = 14%

daily standard deviation = 23

+8 +19 -12 -21 +16

Is 14% a reasonable volatility estimate?

How often do you expect to see an occurrence greater than one standard deviation?


−∞
+∞
normal distribution
lognormal distribution
0

forward price = 100

	normal distribution	lognormal distribution	price
110 call	3.00	3.20	2.90
90 put	3.00	2.80	3.10

Are the options mispriced?

Maybe the marketplace thinks the model is wrong.

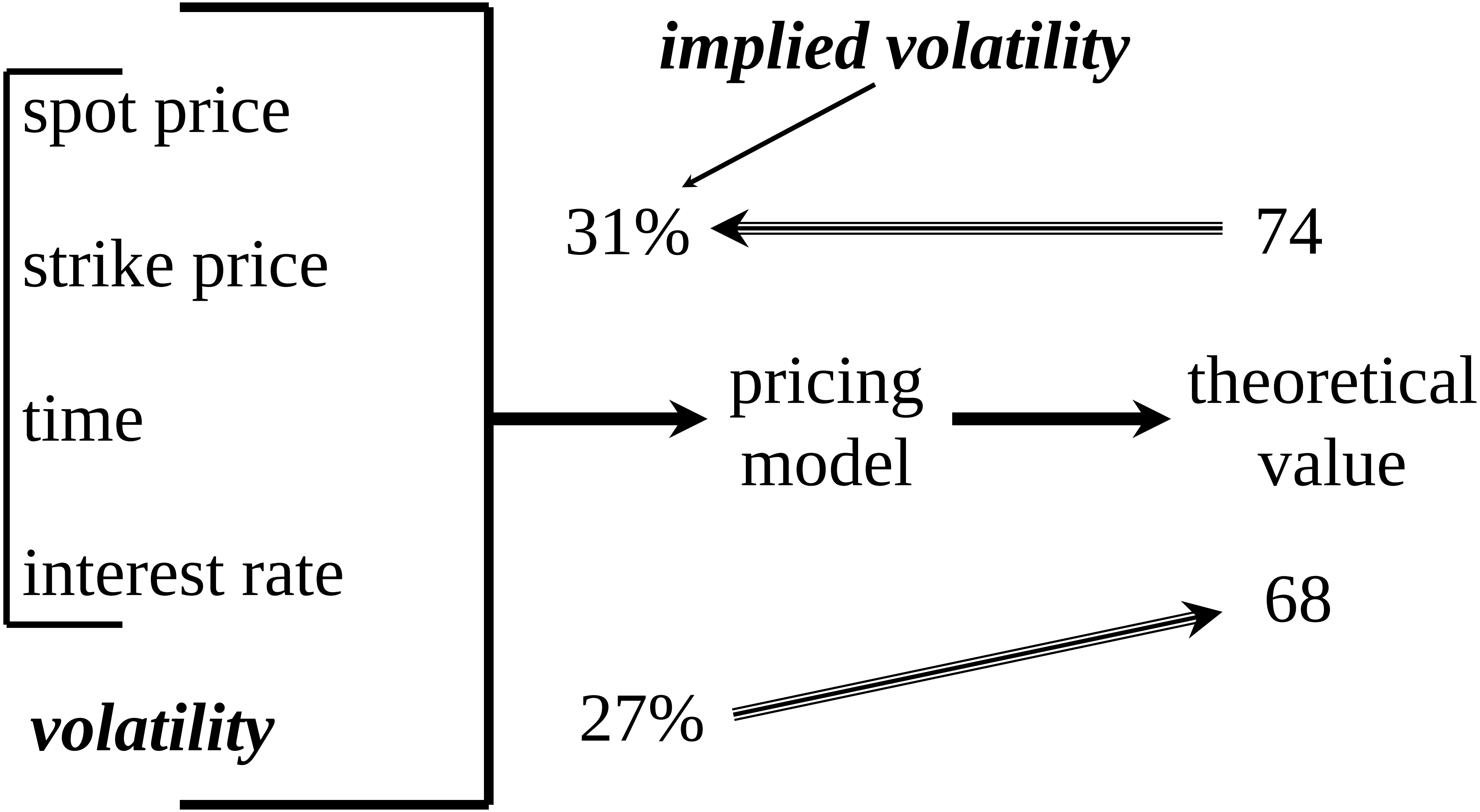
Maybe the marketplace is right.

realized volatility: The volatility of the underlying contract over some period of time (historical, future)

implied volatility:

derived from the prices of options in the marketplace

the marketplace's consensus forecast of future volatility


spot price
strike price
time
interest rate
volatility
implied volatility
31%
74
pricing model
theoretical value
27%
68

today

realized volatility	implied volatility
backward looking	forward looking
(what ***has*** occurred)	(what the marketplace thinks ***will*** occur)

implied volatility = price

realized volatility = value

(historical, future)

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Risk Measurement

Trade an underlying futures contract:

risk

Trade an option:

directional

volatility

risk

time

interest rate

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Delta (Δ) –

The number of underlying contracts required to establish a neutral hedge

The directional risk of a position in terms of an equivalent position in the underlying contract

The sensitivity of an option's theoretical value to a change in the price of the underlying contract

calls have positive deltas / puts have negative deltas

$\Delta = 50\ (.50)$

underlying price	up 1.20	down 1.70
option value	up .60	down .85

calls have positive delta values

puts have negative delta values

If….

underlying price ↑	call values ↑
	put values ↓
underlying price ↓	call values ↓
	put values ↑

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Delta: approximately the probability that an option will finish in-the-money

10 (-10)	10% chance of finishing in-the-money
90 (-90)	90% chance of finishing in-the-money
50 (-50)	50% chance of finishing in-the-money

less than 50 (-50):	out-of-the-money
greater than 50 (-50):	in-the-money
equal to 50 (-50):	at-the-money

Option delta = 10

Probability that the option will finish in-the-money: 10%

Probability that the option will finish out-of-the-money: 90%

Sell option at 1.00

out-of-the-money	9 * +1.00
in-the-money	1 * -20.00
total expected P&L	-11.00

Gamma or ***curvature (Γ)*** –

The rate of change in an option's delta with respect to movement in the price of the underlying contract

Usually expressed as the change in the delta per one point change in the price of the underlying contract

All options have positive gamma values

Underlying price = 100

110 call: delta = 30 gamma = 2

100	30	99	28
101	32	98	26
102	34	97	24

Underlying price falls to 75 New delta of 110 call?

30 - 25*2 = -~~20~~ The gamma must be changing

All options have positive gamma values

underlying price = 100 ⟶ 101

⟶ 99

100 call		100 put	
delta = +50		delta = -50	
gamma = +5		gamma = +5	
+50	+50	-50	-50
+5	-5	+5	-5
+55	+45	-45	-55

Delta = speed

rate of change in the option value

(first derivative)

Gamma = acceleration

rate of change in the delta value

(second derivative)

Theta (Θ):

The sensitivity of an option’s value to the passage of time

Usually expressed as the change in value per one day’s passage of time

Option value = 5.00 theta = .05

+1 day	4.95
+2 days	4.90
+3 days	4.85

Often written with a negative sign to represent a loss in value as time passes. Using this notation all options have negative theta values.

Vega or ***Kappa (K)*** –

The sensitivity of an option’s theoretical value to a change in volatility

Usually expressed as the change in value per one percentage point change in volatility

Often interpreted as the change in price with respect to a change in implied volatility

All options have positive vega values

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Volatility = 25%

Option value = 5.00

Vega = .20

25%	5.00	24%	4.80
26%	5.20	23%	4.60
27%	5.40	22%	4.40
28%	5.60		

All options have positive vega values: they become more valuable as volatility rises and less valuable as volatility falls

Rho (P) –

The sensitivity of an option's theoretical value to a change in interest rates

Usually expressed as the change in value per one percentage point change in interest rates

The rho of an option may be either positive, negative, or zero depending on the type of option, the underlying contract, and the settlement procedure.

measure	calls	puts	underlying
delta	positive	negative	positive
gamma	positive	positive	zero
theta	negative	negative	zero
vega	positive	positive	zero
rho (futures)	zero	zero	zero

Risk Measurement Exercise

For each option on the following page:

1. If we assume that the delta is constant what will be the new theoretical value if the underlying contract moves by the given amount?

2. What will be the new delta if the underlying contract moves by the given amount?

3. If the underlying contract moves by the given amount what will be the approximate theoretical value if you also include the gamma? (Hint: What is the average delta?)

4. What will be the approximate theoretical value if ten days pass with no movement in the underlying contract?

5. What will be the approximate theoretical value if volatility changes by the given amount?

Risk Measurement Exercise

	theoretical value	delta	gamma	daily theta	vega	underlying movement	change in volatility
a)	8.04	65	3.7	-.036	.24	↑ 3.00	↓ 3%
b)	1.88	-28	2.3	-.021	.30	↑ 2.50	↑ 7%
c)	3.76	50	4.9	-.012	.80	↓ 1.44	↑ 3.5%
d)	17.12	-87	2.9	-.060	.75	↓ 2.68	↓ 9%
e)	.95	11	1.9	-.002	.06	↑ .66	↓ 2.5%
f)	14.56	-44	8.8	-.045	.92	↓ 10.00	↑ 6%

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Risk Measurement Exercise

	original delta	new theoretical value using a constant delta	new delta	average delta	new theoretical value using the average delta	if ten days pass	if volatility changes
a)	**65**						
b)	**-28**						
c)	**50**						
d)	**-87**						
e)	**11**						
f)	**-44**						

Futures Price = 99.75 | Time to November Expiration = 3 months | Volatility = 20.00%

	CALLS						PUTS					
exercise price	price	theoretical value	delta	gamma	theta	vega	price	theoretical value	delta	gamma	theta	vega
90	10.74	10.49	86	2.2	-.0122	.111	.97	.74	-14	2.2	-.0122	.111
95	6.90	6.71	70	3.5	-.0189	.172	2.18	1.96	-30	3.5	-.0189	.172
100	3.94	3.85	51	4.0	-.0218	.199	4.17	4.10	-49	4.0	-.0218	.199
105	1.92	1.98	32	3.6	-.0196	.178	7.16	7.23	-68	3.6	-.0196	.178
110	.84	.91	18	2.6	-.0142	.129	11.11	11.16	-82	2.6	-.0142	.129

position	theoretical edge	delta position	gamma position	theta position	vega position
long 7 futures contracts	0	+7 x +100	0	0	0
short 10 November 95 calls	10 x +.19	-10 x +70	-10 x +3.5	-10 x -.0189	-10 x +.172
	+1.90	0	-35.0	+.1890	-1.720
long 20 November 105 calls	20 x +.06	+20 x +32	+20 x +3.6	+20 x -.0196	+20 x +.178
short 10 November 100 calls	10 x +.09	-10 x +51	-10 x +4.0	-10 x -.0218	-10 x +.199
	+2.10	+130	+325.0	-.2380	+1.570
long 10 November 110 calls	10 x +.07	+10 x +18	+10 x +2.6	+10 x -.0142	+10 x +.129
long 10 November 90 puts	10 x -.23	+10 x -14	+10 x +2.2	+10 x -.0122	+10 x +.111
	-1.60	+40	+48.0	-.2640	+2.400
short 20 November 90 calls	20 x +.25	-20 x +86	-20 x +2.2	-20 x -.0122	-20 x +.111
long 20 November 95 calls	20 x -.19	+20 x +70	+20 x +3.5	+20 x +.0189	+20 x +.172
	+1.20	-320	+26.0	-.1340	+1.220
long 10 November 90 puts	10 x -.23	+10 x -14	+10 x +2.2	+10 x -.0122	+10 x +.111
short 20 November 95 puts	20 x +.22	-20 x -30	-20 x +3.5	-20 x -.0189	-20 x +.172
long 10 November 100 puts	10 x -.07	+10 x -49	+10 x +4.0	+10 x -.0218	+10 x +.199
	+1.40	-30	-8.0	+.0380	-.340

Sell 10 November 95 calls – 6.90 (theoretical value = 6.71)
Buy 7 futures contracts

theoretical edge	delta	gamma
0	+7 x 100	0
+10 x .19	-10 x 70	-10 x 3.5
+1.90	0	-35.0

theta	vega
+7 x 0	+7 x 0
-10 x -.0387	-10 x .134
+.387	-1.34

Positive Delta: You want the underlying price to rise

Negative Delta: You want the underlying price to fall

Positive Gamma: You want the underlying contract to make a big move, or move very quickly

Negative Gamma: You want the underlying contract to sit still, or move very slowly

Positive Theta: The passage of time will help

Negative Theta: The passage of time will hurt

Positive Vega: You want implied volatility to rise

Negative Vega: You want implied volatility to fall

positive delta

slow
upward movement

negative gamma

(positive theta)

rising
implied volatility

positive vega

Risk Interpretation Exercise

Match each position with the corresponding market conditions which will most help the position.

position	market conditions
+delta / +gamma / -vega	no price movement; rising implied volatility
-delta / -gamma / -vega	upward price movement; falling implied volatility
0 delta / -gamma / +vega	price movement in either direction; rising implied volatility
0 delta / +gamma / +vega	swift upward price movement; falling implied volatility
+delta / -gamma / +vega	downward price movement
0 delta / +gamma / -vega	price movement in either direction; falling implied volatility
-delta / 0 gamma / 0 vega	slow upward price movement; rising implied volatility
+delta / 0 gamma / -vega	slow downward price movement; falling implied volatility

	in-the-money	at-the-money	out-of-the-money
gamma		✓	
theta		✓	
vega		✓	

An at-the-money option always has a greater gamma, theta, and vega than an equivalent in-the-money or out-of-the-money option.

A long-term option always has a greater vega than an equivalent short-term option.

Theta values (time decay)

As time passes the theta of an ***at-the-money*** option increases.

3 months to expiration	-.03
3 weeks to expiration	-.06
3 days to expiration	-.16

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Dynamic Hedging

futures price = 99.75

time to November expiration = 10 weeks

volatility = 16.85%

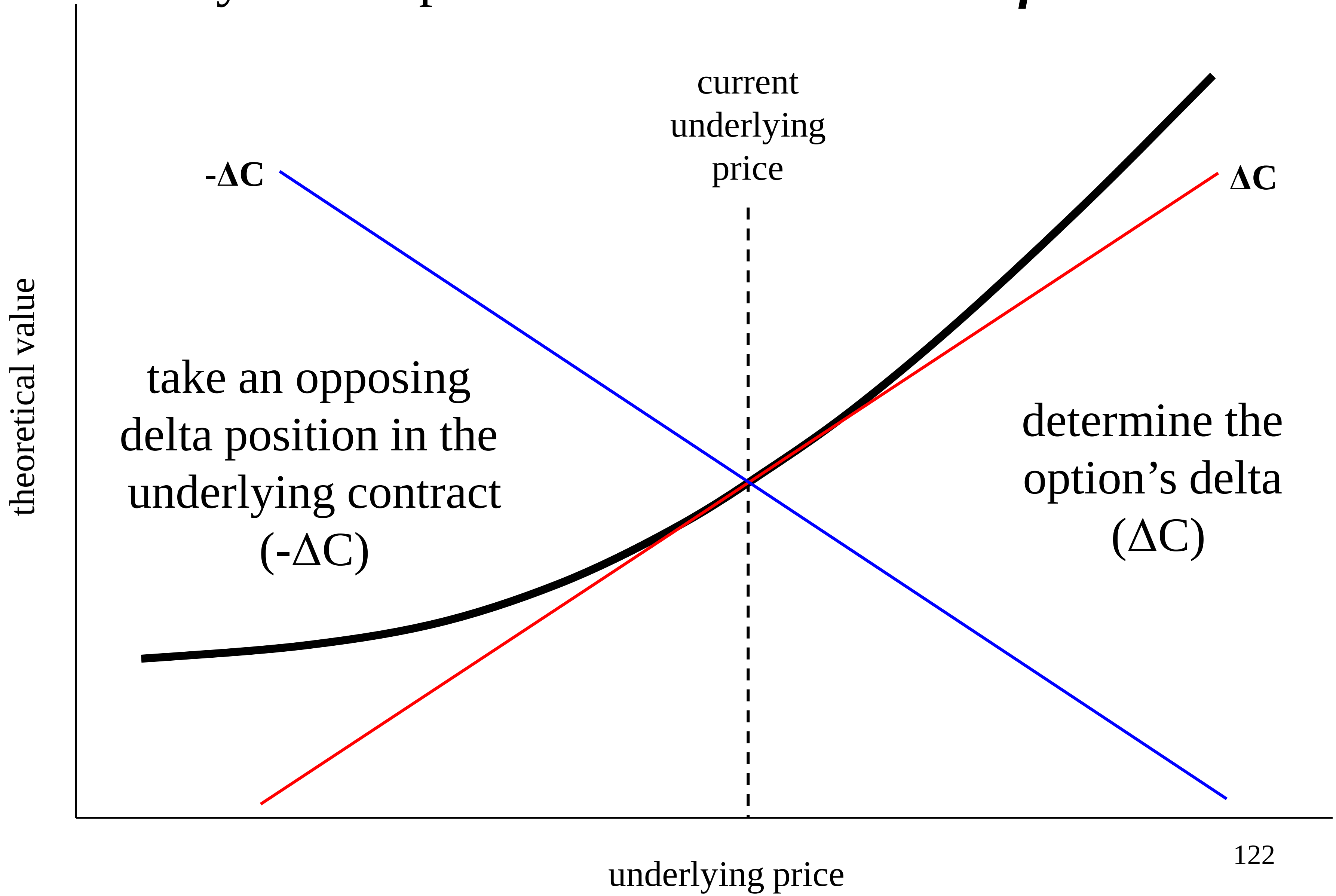
November 100 call ??

theoretical value = 2.82

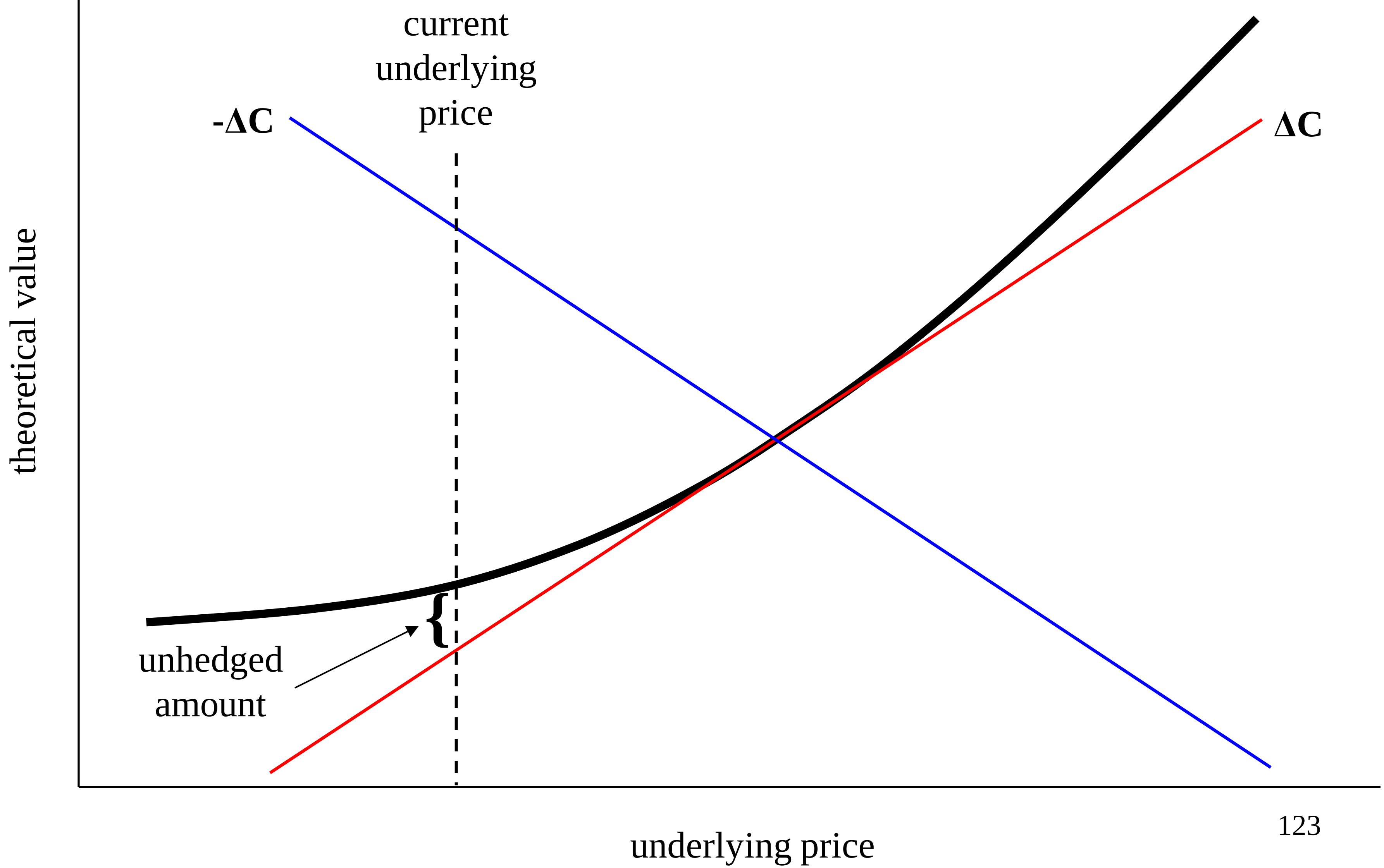
price = 2.60

How can we capture the difference between the option’s price and its theoretical value?

buy a call option *delta neutral* or *flat*

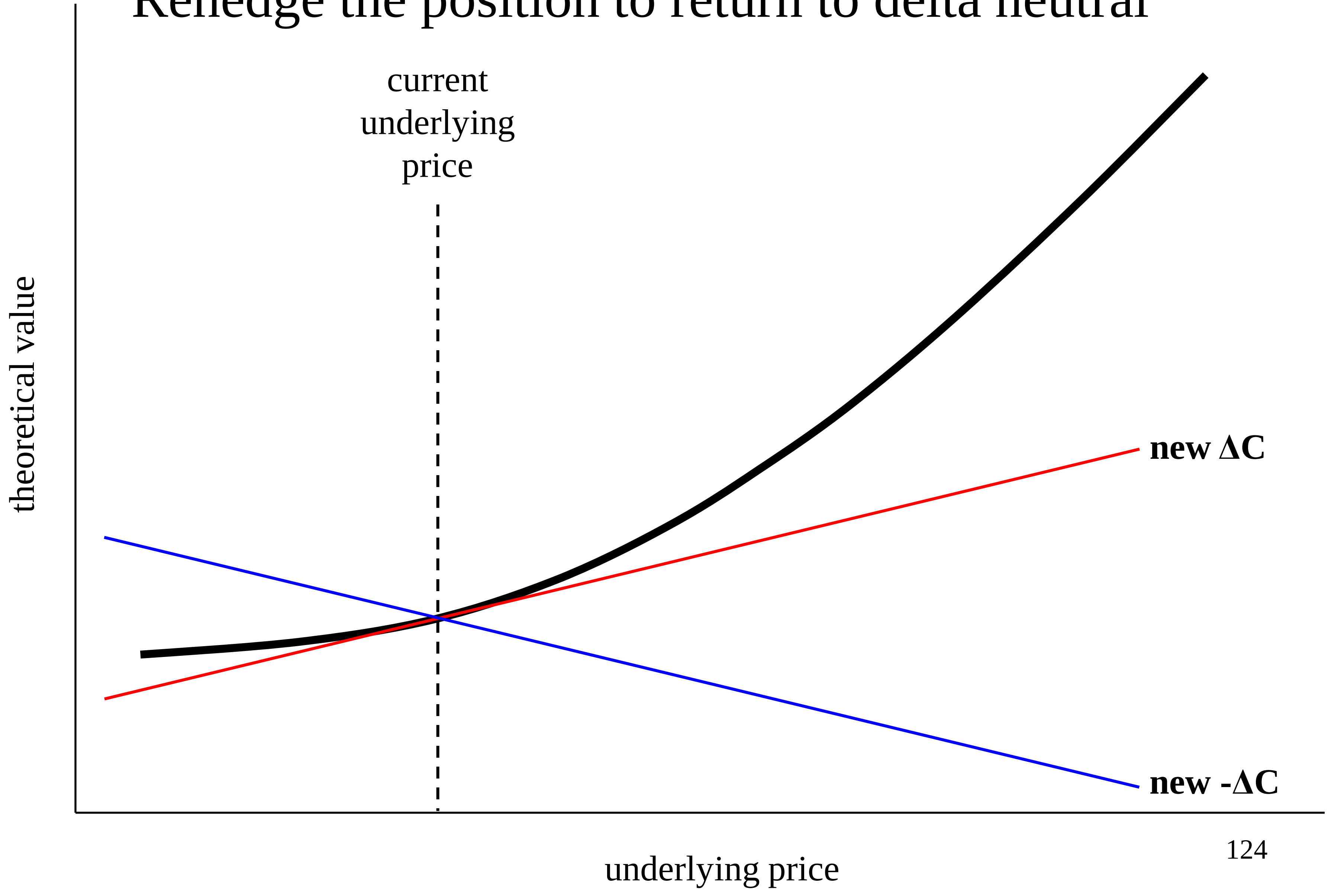


Due to the option's ***curvature***, as market conditions change the position will become unhedged.

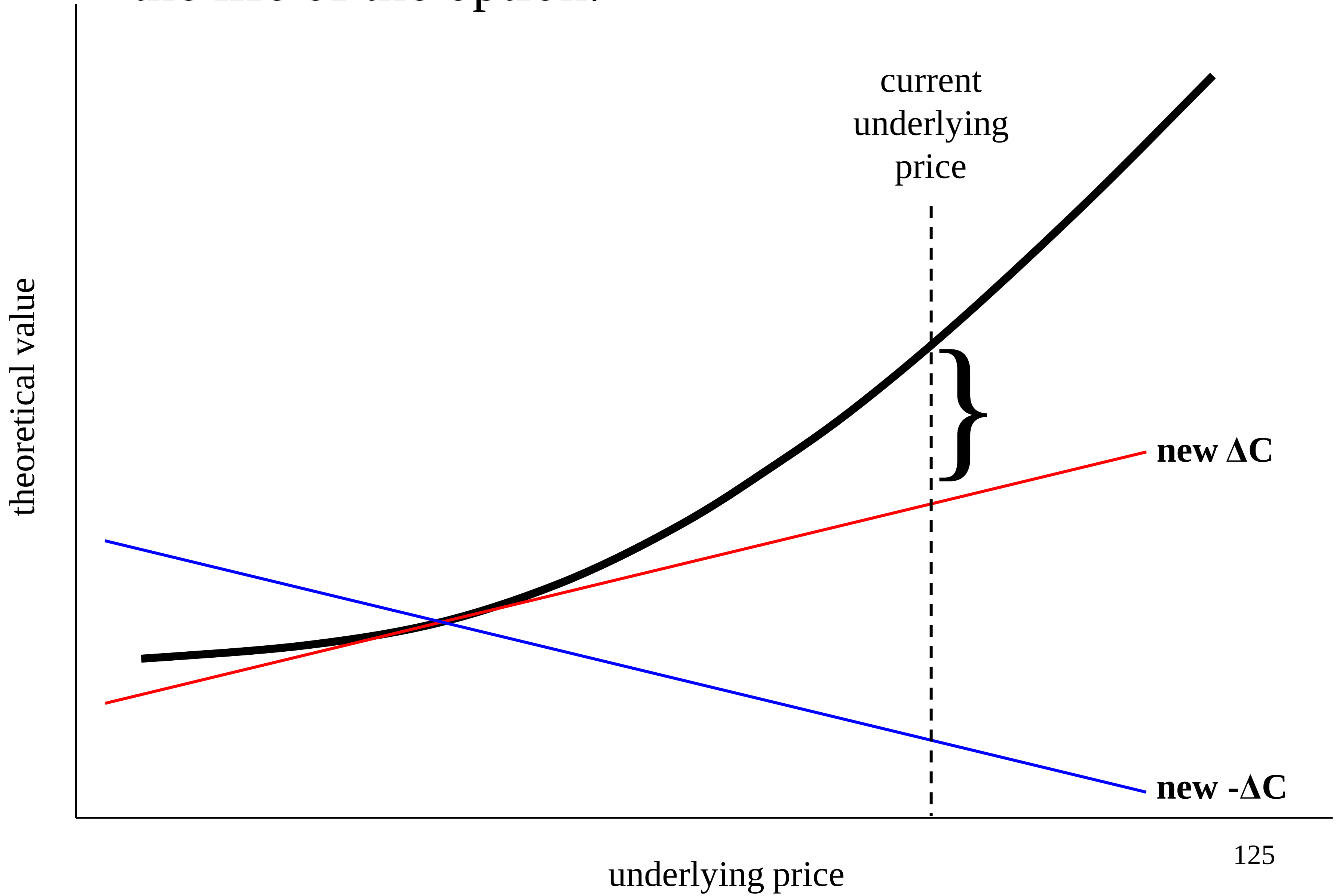


Determine the new delta of the option.

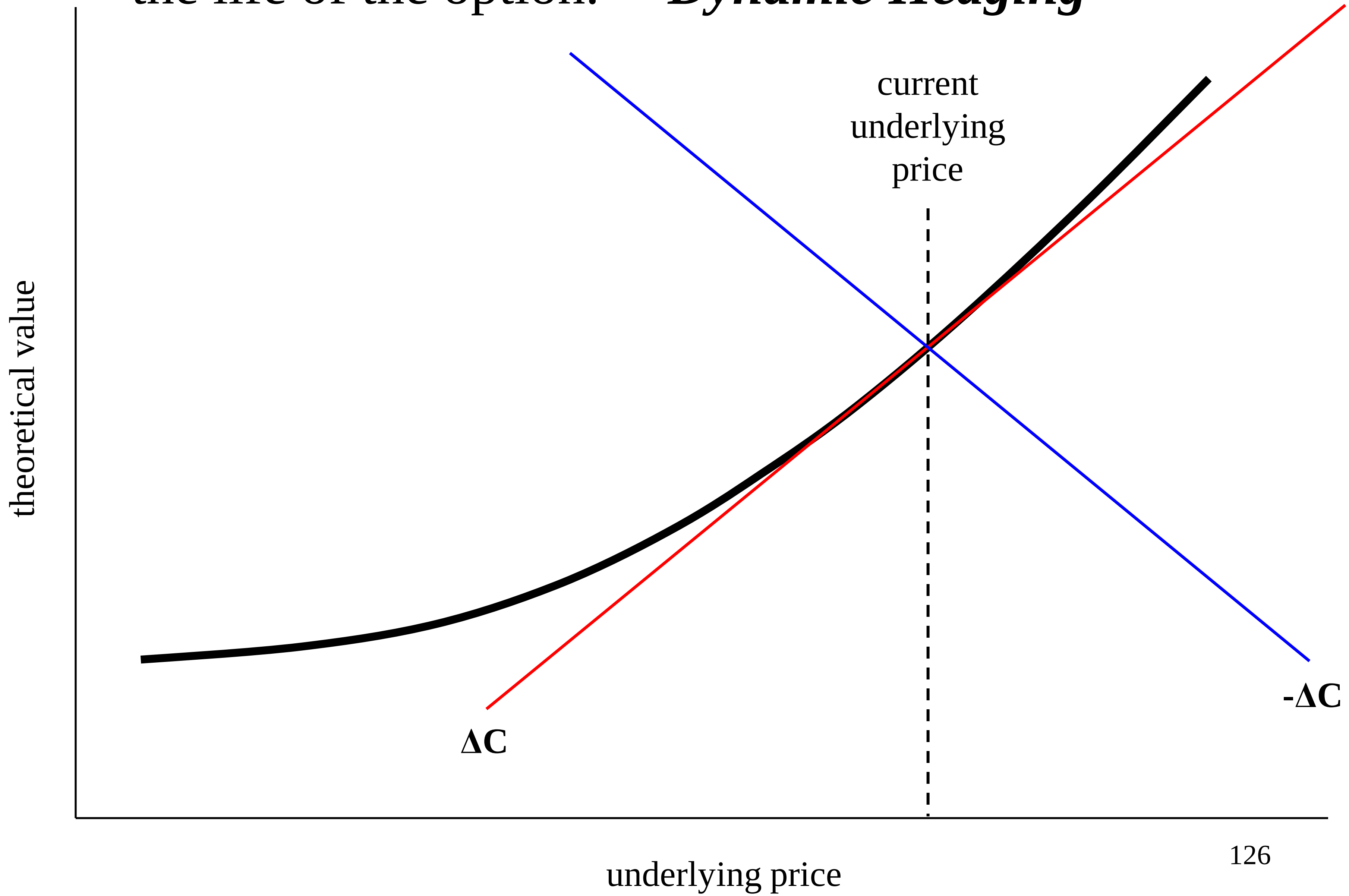
Rehedge the position to return to delta neutral



Continue the rehedging process throughout the life of the option.



Continue the rehedging process throughout the life of the option. ***Dynamic Hedging***



Each time the position becomes unhedged there is a potential profit opportunity. We can capture this profit by rehedging the position.

Suppose we add up all the profit opportunities over the life of the option which result from the rehedging process. What should this equal?

the option's ***theoretical value***

The rehedging process is a type of ***statistical arbitrage.***

Delta of the November 100 call = 50 (.50)

For each November 100 call we buy, we must sell .50 of an underlying contract

Buy 100 November 100 calls

call delta = +100 * 50 = +5000

Sell 50 futures contracts

futures delta = -50 * 100 = -5000

Total position delta = +5000 -5000 = **0**

Delta Neutral: Within a small range, no preference as to whether the underlying market moves up or down

Positive delta: Preference for upward movement

Negative delta: Preference for downward movement

One week later:

futures price = 100.21 (previously 99.75)

time to November expiration = 9 weeks

volatility = 16.85%

Delta of November 100 call = 53

total delta position =

+100*53 -50*100 =

+5300 -5000 = +300

Adjustment: A trade made with the primary objective of returning the position to delta neutral

Previous delta position: +300

Adjustment: sell 3 futures contracts

New delta position: +300 -3*100 = 0

Another week passes:

futures price = 98.86 (previously 100.21)

time to November expiration = 8 weeks

volatility = 16.85%

Delta of November 100 call = 44

total delta position =

+100*44 -50*100 -300 =

+4400 -5000 -300 = -900

Previous delta position: -900

Adjustment: buy 9 futures contracts

New delta position: -900 +9*100 = 0

Dynamic Hedging: the process of periodically adjusting a position in order to remain delta neutral

At expiration: close out the entire position at fair value

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week	futures price	delta of November 100 call	current delta position	adjustment	total adjustments
0	99.75	50	0		
1	100.21	53	+300	sell 3	-3
2	98.86	44	-900	buy 9	+6
3	97.12	33	-1100	buy 11	+17
4	98.72	42	+900	sell 9	+8
5	101.01	59	+1700	sell 17	-9
6	96.88	26	-3300	buy 33	+24
7	98.69	38	+1200	sell 12	+12
8	97.33	21	-1700	buy 17	+29
9	100.62	61	+4000	sell 40	-11
10	102.28			buy 11	

Original position

Futures price at November expiration = 102.28

Value of the November 100 call at expiration

102.28 - 100 = 2.28

Option P&L = 100*(2.28 - 2.60)

= 100*-.32 = -32.00

Futures P&L = 50*(99.75 - 102.28)

= 50*-2.53 = -126.50

Total P&L on original position

= -32.00 -126.50 = ***-158.50***

Adjustment process

week 1 – sell 3 futures contracts at 101.21

week 2 – buy 9 futures contracts at 98.86

week 3 – sell 11 futures contracts at 97.12

⋮

week 9 – sell 40 futures contracts at 100.62

week 10 – buy 11 futures contracts at 102.28

Total adjustment P&L: ***+180.57***

	P&L
Original position	-158.50
Adjustment process	+180.57
Total P&L	***+22.07***

Predicted P&L: 100*(2.82 - 2.60) = 100*.22

= ***22.00***

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Real-world considerations:

- transaction costs
- trading restrictions
- interest rates
- we don’t know the future volatility

Option trading based on theoretical evaluation can be thought of as a race between….

the cash flow generated by the dynamic hedging process

the decay in the option's value as time passes

If the option is trading at a price greater than its value the decay wins the race.

If the option is trading at a price less than its value dynamic hedging wins the race.

If the option is trading at a price equal to its value the race is a tie.

Volatility = 16.85%

theoretical value = 2.82

If volatility turns out to be higher than 16.85% ……

the option is worth more than 2.82

If volatility turns out to be lower than 16.85% ……

the option is worth less than 2.82

As volatility declines the option’s theoretical value declines.

Price of the November 100 call = 2.60

At what volatility will the theoretical value of the November 100 call exactly equal its price?

At a volatility of 15.60%, the value of the November 100 call = 2.60

break-even volatility = 15.60%

implied volatility = 15.60%

Delta Hedging Exercise

For this question use the following table of delta values:

	June 70	June 75	June 80	June 85	June 90
call delta	87	72	52	34	19
put delta	-13	-28	-48	-66	-81

You buy 25 June 80 calls. What do you need to do (buy? sell? how many?) to hedge your position as close to delta neutral as possible with each of the following contracts:

underlying contract   June 85 call   June 75 put

You sell 80 June 75 puts. What do you need to do (buy? sell? how many?) to hedge your position as close to delta neutral as possible with each of the following contracts:

June 70 call   June 80 put   June 90 call

You sell 15 underlying contracts. You would like to hedge half your delta position with June 70 puts and half your delta position with June 90 calls. As close as possible, how many of each contract do you need to buy or sell?

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Introduction to Spreading

Spread – a position in one contract, or group of contracts, and an opposing position in a different contract, or group of contracts

Position?

directional	delta
volatility	gamma / vega
interest rate	rho

buy calls directional position?

positive delta

How might you spread off your directional risk?

sell underlying contracts

sell different calls

buy puts

buy puts gamma position?

How might you spread off your gamma position?

sell different puts

sell calls

Why spread?

You believe there is a relative mispricing between contracts.

You want to construct a position which reflects a particular view of market conditions.

You need to manage the risk of your position.

Roulette bet

value = 95¢ price = $1.00

One player would like to bet $2,000 on one number. What can happen?

Player loses: +$2,000

Player wins: -$70,000

Roulette bet

value = 95¢ price = $1.00

Two players would like to bet $1,000 each, but on different numbers.

Both players lose: +$2,000

One player wins: -$34,000

Roulette bet

value = 95¢ price = $1.00

Situation 1: One player betting $2,000 on one number

Situation 2: Two players betting $1,000 each on different numbers

In the ***long run*** which situation is better for the casino?

Roulette bet

value = 95¢ price = $1.00

Situation 1: One player betting $2,000 on one number 5% x $2,000 = $100

Situation 2: Two players betting $1,000 each on different numbers

5% x (2 x $1,000) = $100

Roulette bet

value = 95¢ price = $1.00

Situation 1: One player betting $2,000 on one number

Situation 2: Two players betting $1,000 each on different numbers

In the ***short run*** which situation is riskier for the casino?

Roulette bet

value = 95¢ price = $1.00

What is a perfect spread for the casino?

38 players betting $1,000 each on all 38 numbers

One player must win: -$36,000

Amount of money on the table: +$38,000

Casino wins $2,000

Spreading helps us ….

maintain the theoretical edge

while reducing the risk

Market-making:

get an edge	manage the risk
get an edge	manage the risk
get an edge	manage the risk

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Volatility Strategies

Volatility Spread

A spread, usually delta neutral, which is sensitive to either the volatility of the underlying contract (gamma), or to changes in implied volatility (vega)

Long Straddle

+1 September 100 call

+1 September 100 put

Short Straddle

-1 September 100 call

-1 September 100 put

Long Straddle

underlying price = 100.00	delta
+1 September 100 call	+50
+1 September 100 put	-50
	0

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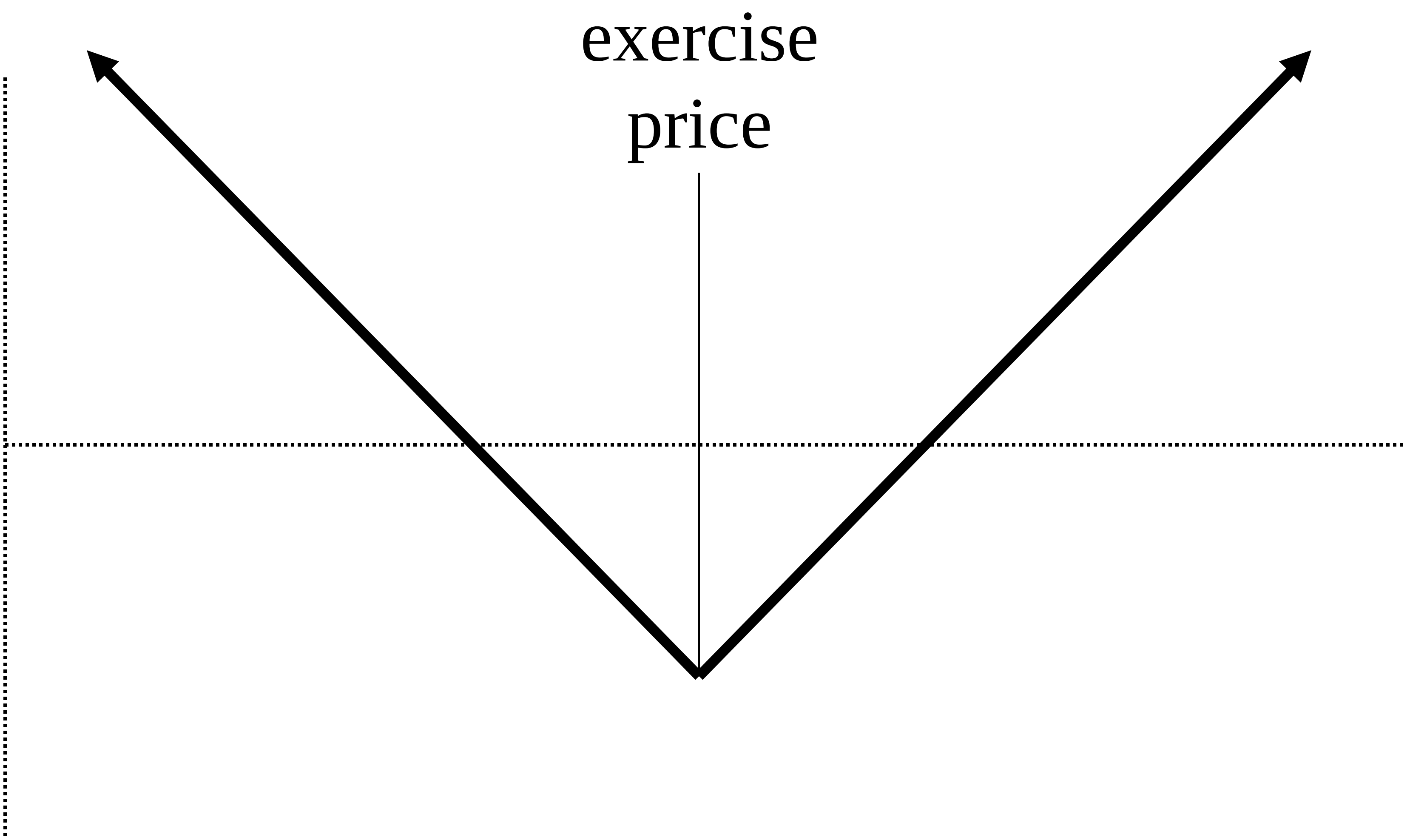
Long Straddle

underlying price = 105.00	delta
+1 September 100 call	+75
+3 September 100 put	-25
	0

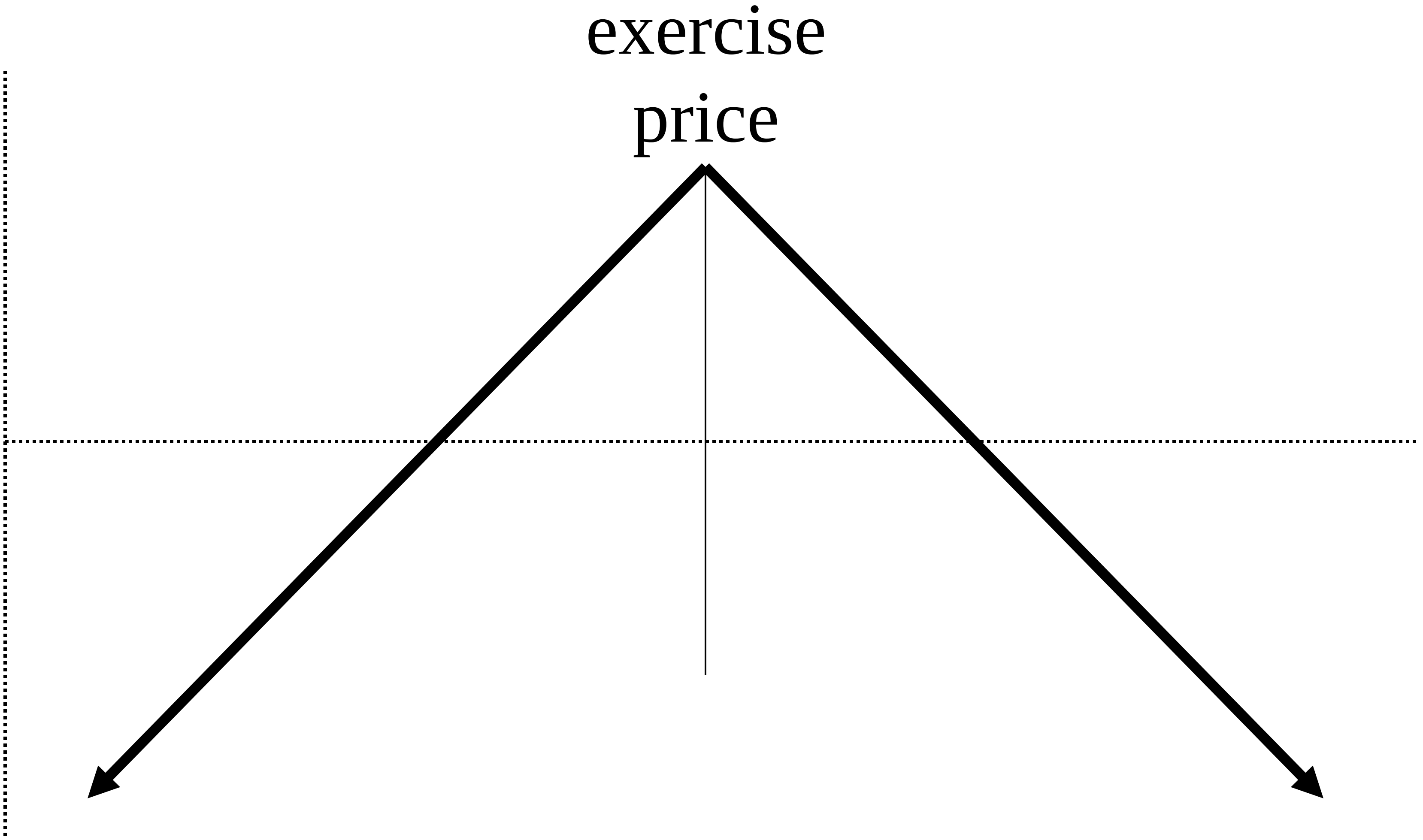
Ratio Spread

Any spread where the number long market contracts and short market contracts are unequal

Long Straddle



Short Straddle



Long Straddle

delta	gamma	theta	vega
0	+	–	+

Short Straddle

delta	gamma	theta	vega
0	–	+	–

Long Strangle

+1 September 95 put

+1 September 105 call

Short Strangle

-1 September 95 put

-1 September 105 call

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Long Strangle

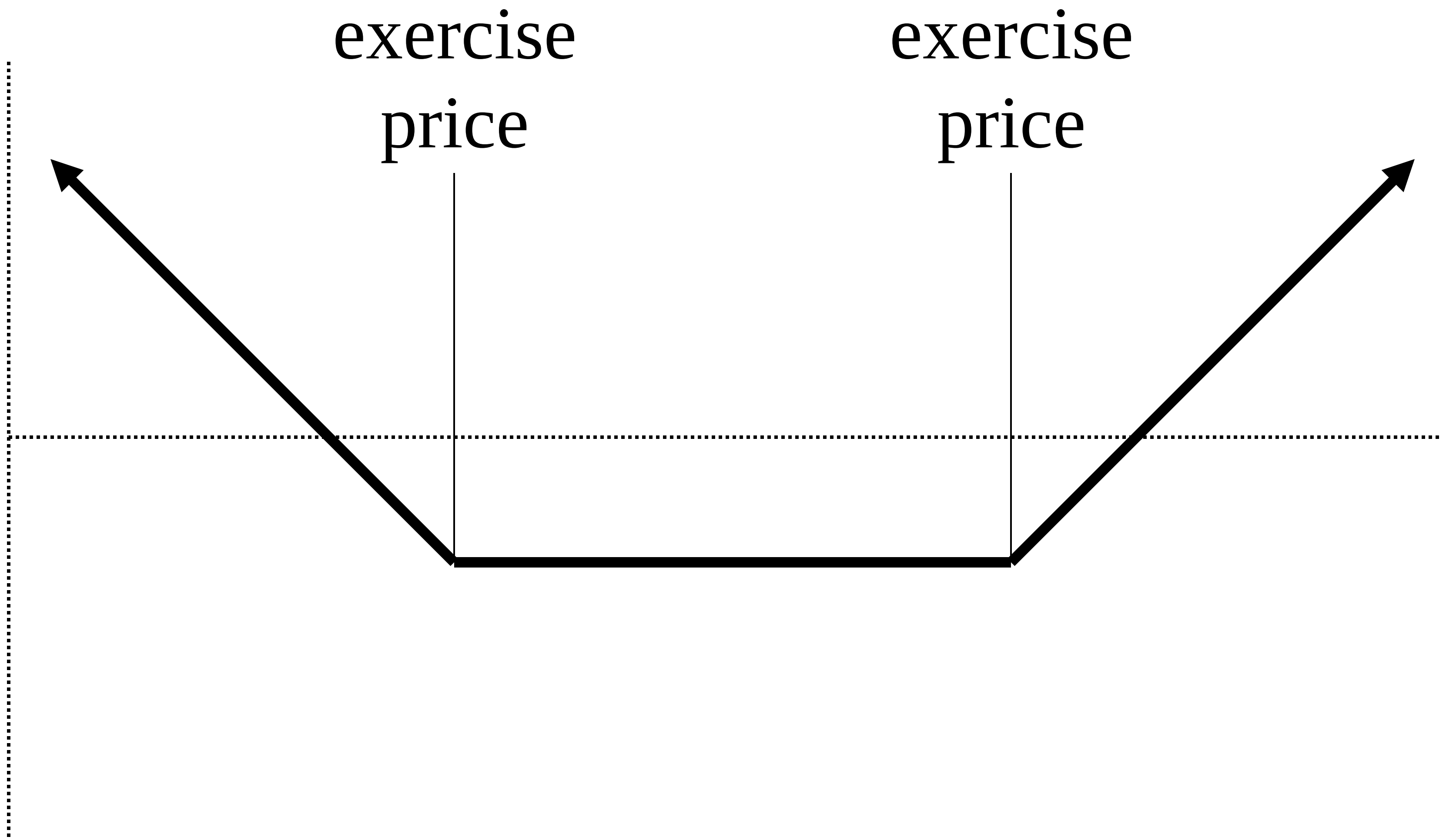
futures price = 100

	delta
+1 September 105 put	-75
+1 September 95 call	+75
	0

Guts

A strangle where both options are in-the-money

Long Strangle



Short Strangle

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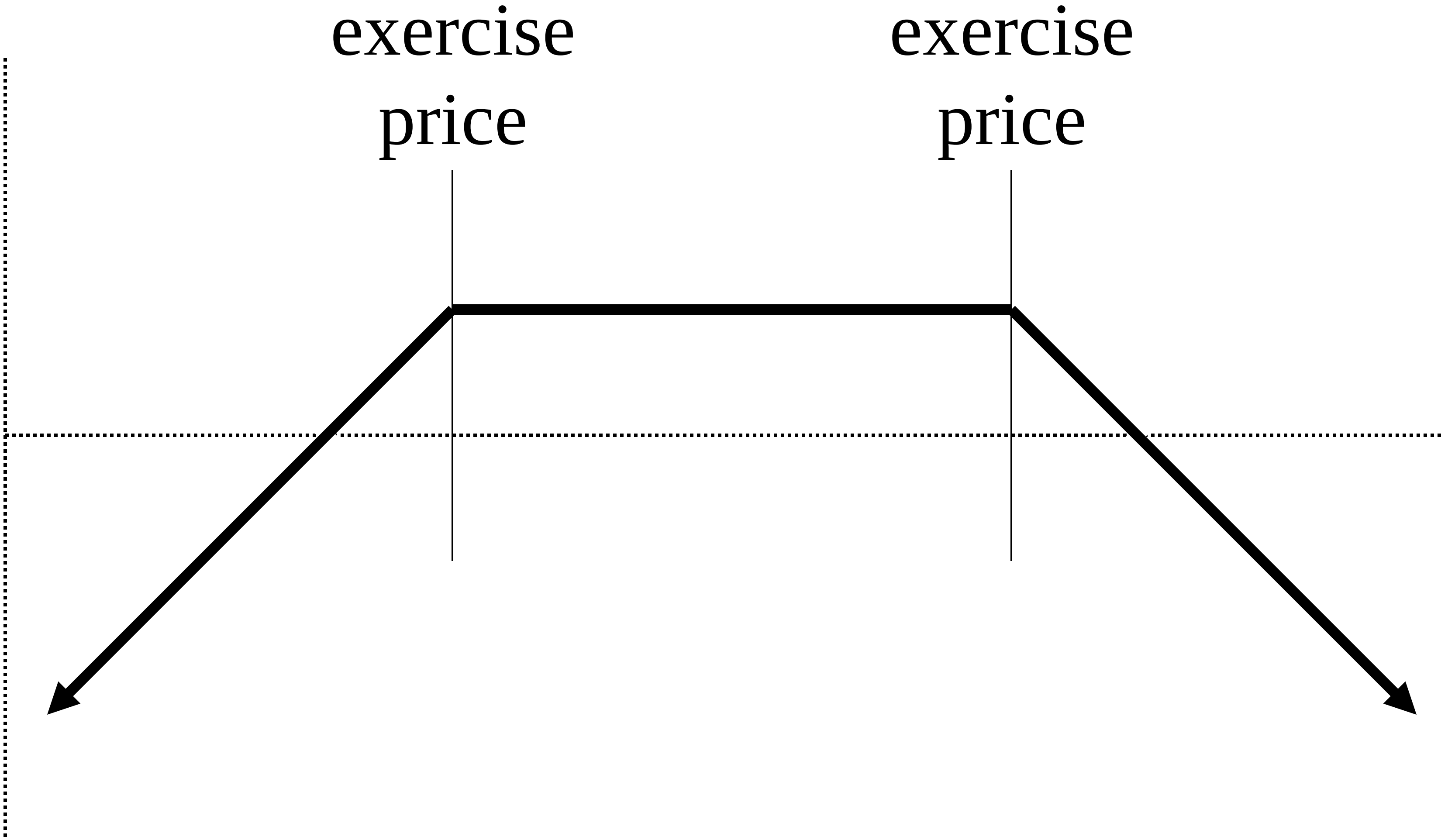


Long Strangle

delta	gamma	theta	vega
0	+	–	+

Short Strangle

delta	gamma	theta	vega
0	–	+	–

Long Butterfly

+1 September 95 call

-2 September 100 calls

+1 September 105 call

+1 November 90 put

-2 November 100 puts

+1 November 110 put

Short Butterfly

-1 September 95 call	***wing***
+2 September 100 calls	***body***
-1 September 105 call	***wing***
-1 November 90 put	***wing***
+2 November 100 puts	***body***
-1 November 110 put	***wing***

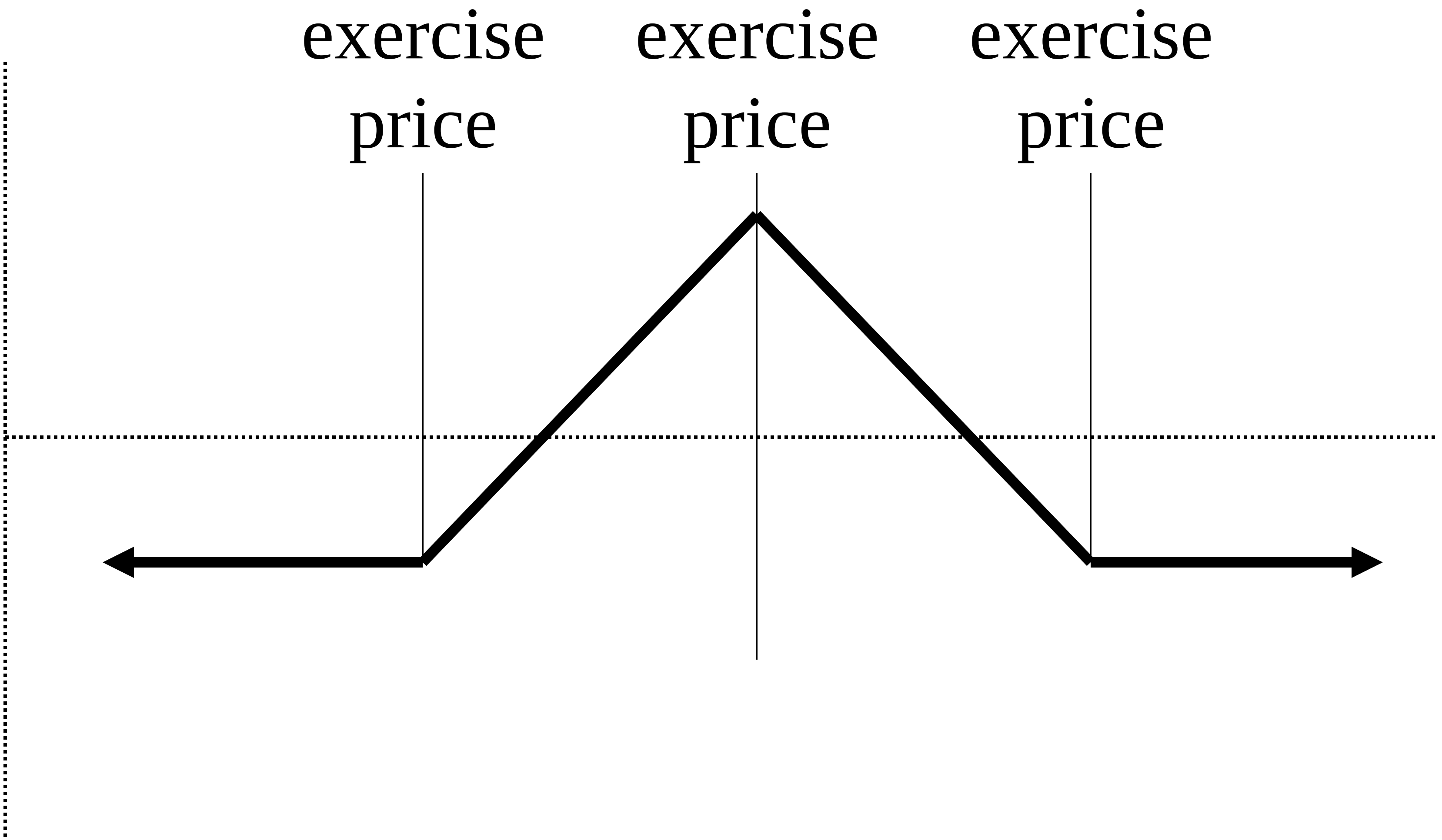
Long Butterfly

	90	110	100
+1 September 95 call	0	+15	+5
-2 September 100 calls	0	-20	0
+1 September 105 call	0	+5	0
	0	0	+5

minimum value = 0

maximum value = amount between exercise prices

Long Butterfly



Short Butterfly

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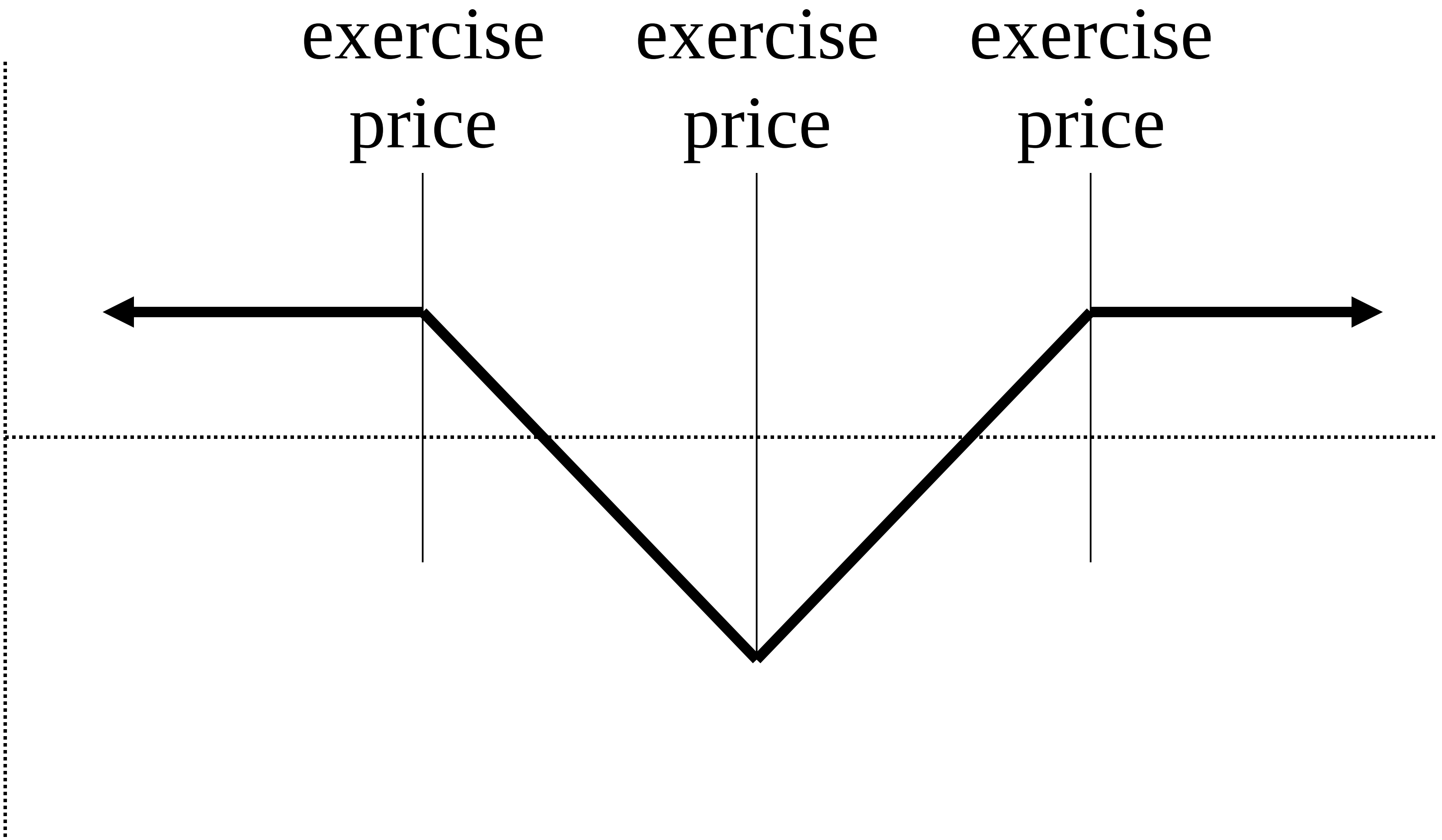
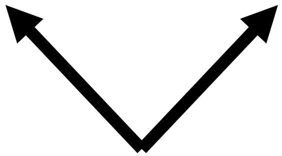


Long Butterfly

<u>delta</u>	<u>gamma</u>	<u>theta</u>	<u>vega</u>
0	–	+	–

Short Butterfly

<u>delta</u>	<u>gamma</u>	<u>theta</u>	<u>vega</u>
0	+	–	+

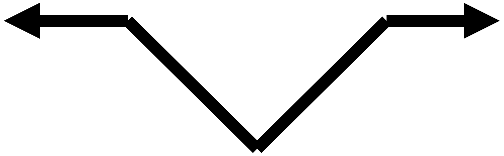


long
straddle

+gamma / +vega

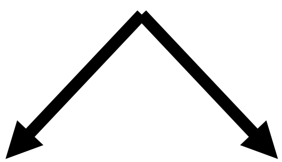
long
strangle

+gamma / +vega



short
butterfly

+gamma / +vega

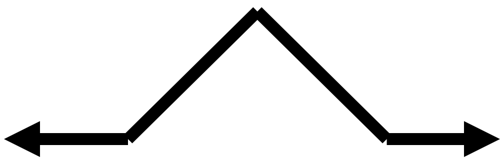


short
straddle

-gamma / -vega

short
strangle

-gamma / -vega



long
butterfly

-gamma / -vega

Ratio Spread (buy more than sell)

futures price = 100

		delta
+3	September 105 call	25
-1	September 95 call	75
		0
+2	November 95 put	-25
-1	November 100 put	-50
		0

Ratio Spread (sell more than buy)

futures price = 100

		delta
-3	September 105 call	25
+1	September 95 call	75
		0
-2	November 95 put	-25
+1	November 100 put	-50
		0

futures price = 100

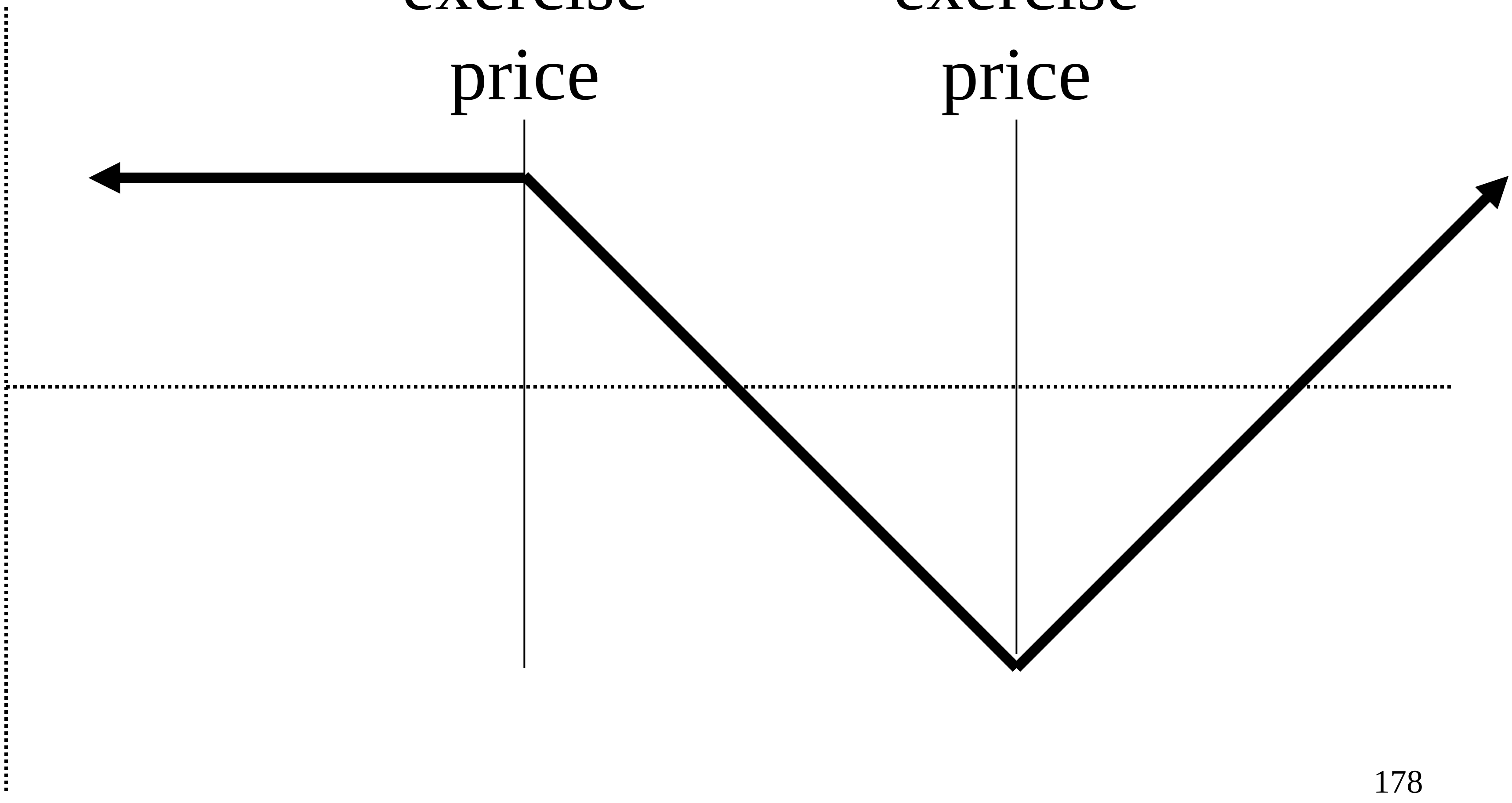
	price
+3 September 105 call	1.00
-1 September 95 call	6.00

120	+3 * 14.00	-1 * 19.00	=	+23.00
80	-3 * 1.00	+1 * 6.00	=	+3.00
100	-3 * 1.00	+1 * 1.00	=	-2.00

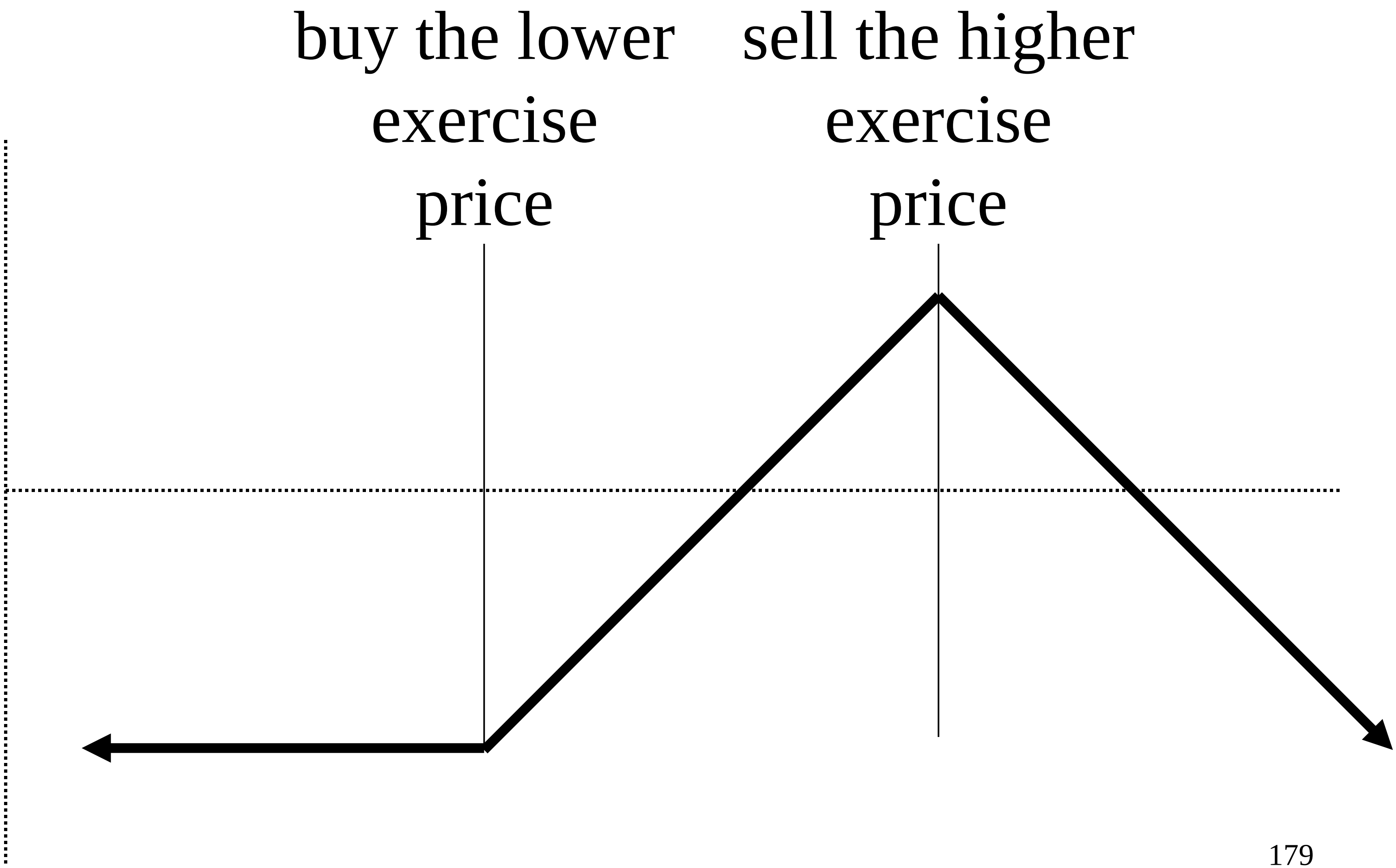
Call Ratio Spread (buy more than sell)

sell the lower exercise price

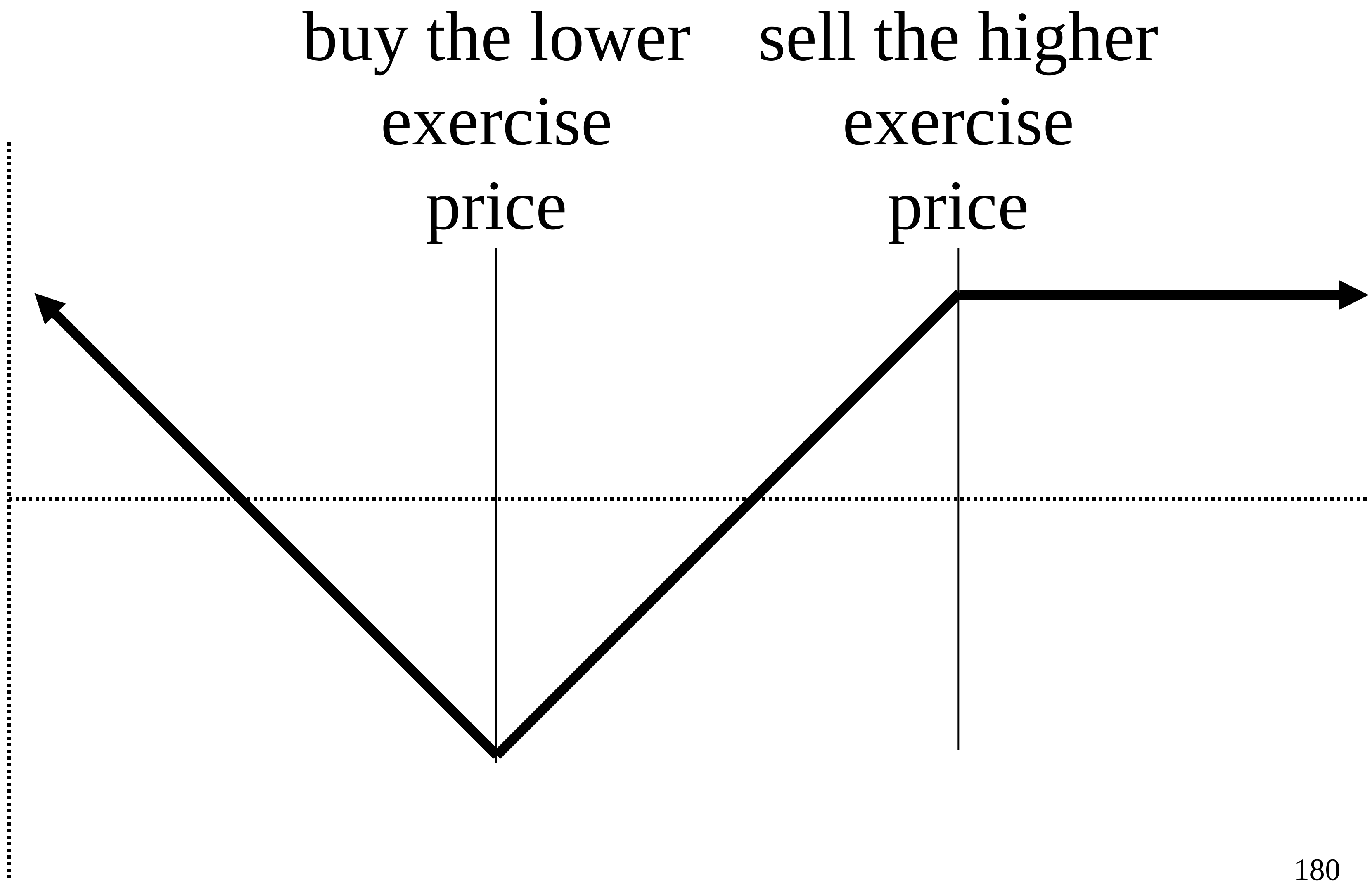
buy the higher exercise price



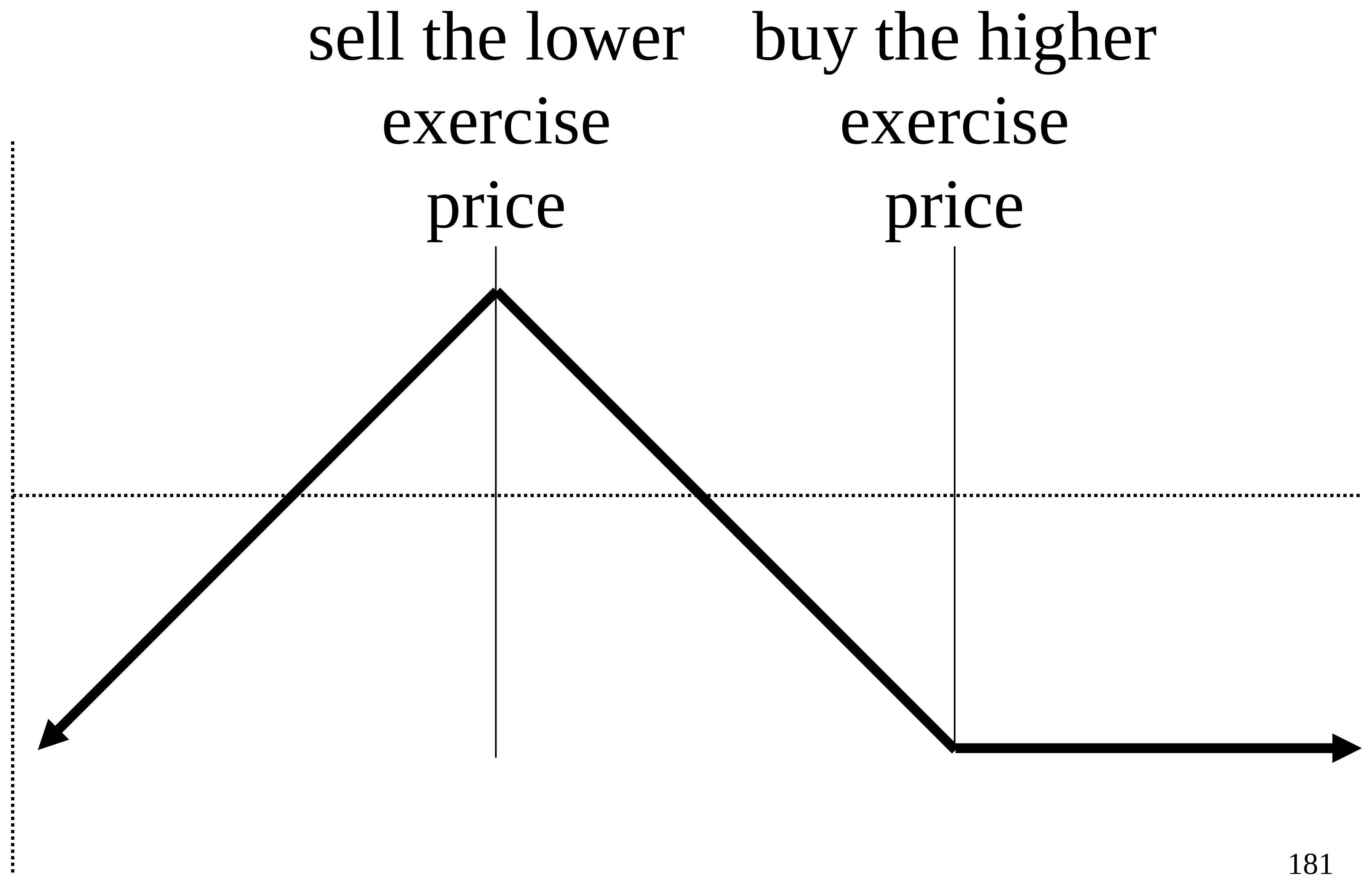
Call Ratio Spread (sell more than buy)



Put Ratio Spread (buy more than sell)



Put Ratio Spread (sell more than buy)



Ratio Spread – buy more than sell

delta	gamma	theta	vega
0	**+**	**–**	**+**

Ratio Spread – sell more than buy

delta	gamma	theta	vega
0	**–**	**+**	**–**

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	downside risk / reward	upside risk / reward
long straddle / strangle	unlimited reward	unlimited reward
short straddle / strangle	unlimited risk	unlimited risk
long butterfly	limited risk	limited risk
short butterfly	limited reward	limited reward

	downside risk / reward	upside risk / reward
call ratio spread (buy more than sell)	limited reward	unlimited reward
put ratio spread (buy more than sell)	unlimited reward	limited reward
call ratio spread (sell more than buy)	limited risk	unlimited risk
put ratio spread (sell more than buy)	unlimited risk	limited risk

Long Calendar Spread

(Time Spread, Horizontal Spread)

+1 November 100 call

-1 September 100 call

+1 May 95 put

-1 January 95 put

Short Calendar Spread

(Time Spread, Horizontal Spread)

-1 November 100 call

+1 September 100 call

-1 May 95 put

+1 January 95 put

+1 November 100 call

-1 September 100 call

futures price = 100

November	4 months	3 months	2 months
September	2 months	1 month	0 months

November	3.00	2.60	2.10
September	2.10	1.30	0
	.90	1.30	2.10

+1 November 100 call

-1 September 100 call

	100	150	50
November	3.00	50.05	.05
September	2.10	50.00	0
	.90	.05	.05

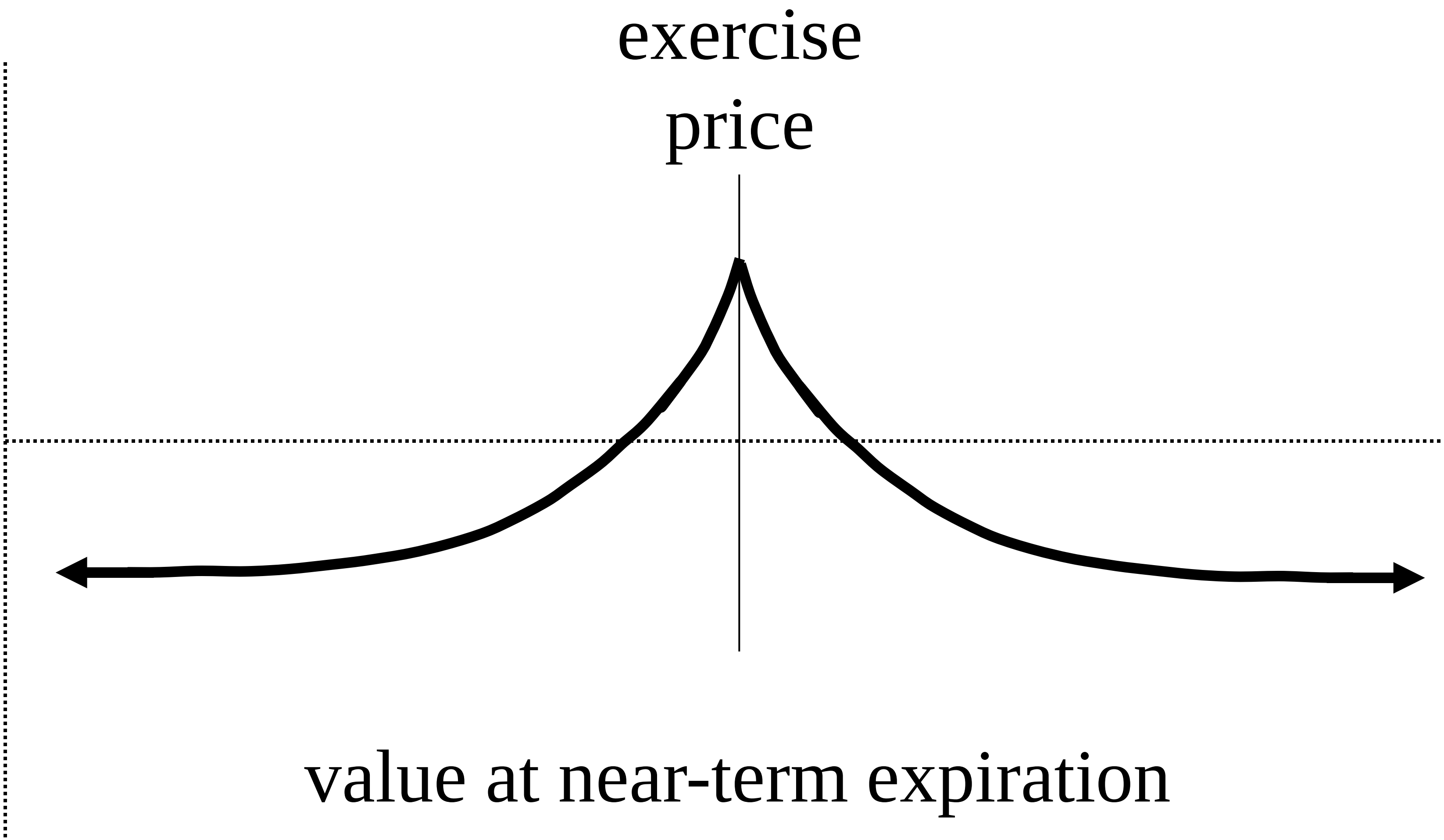
+1 November 100 call

-1 September 100 call

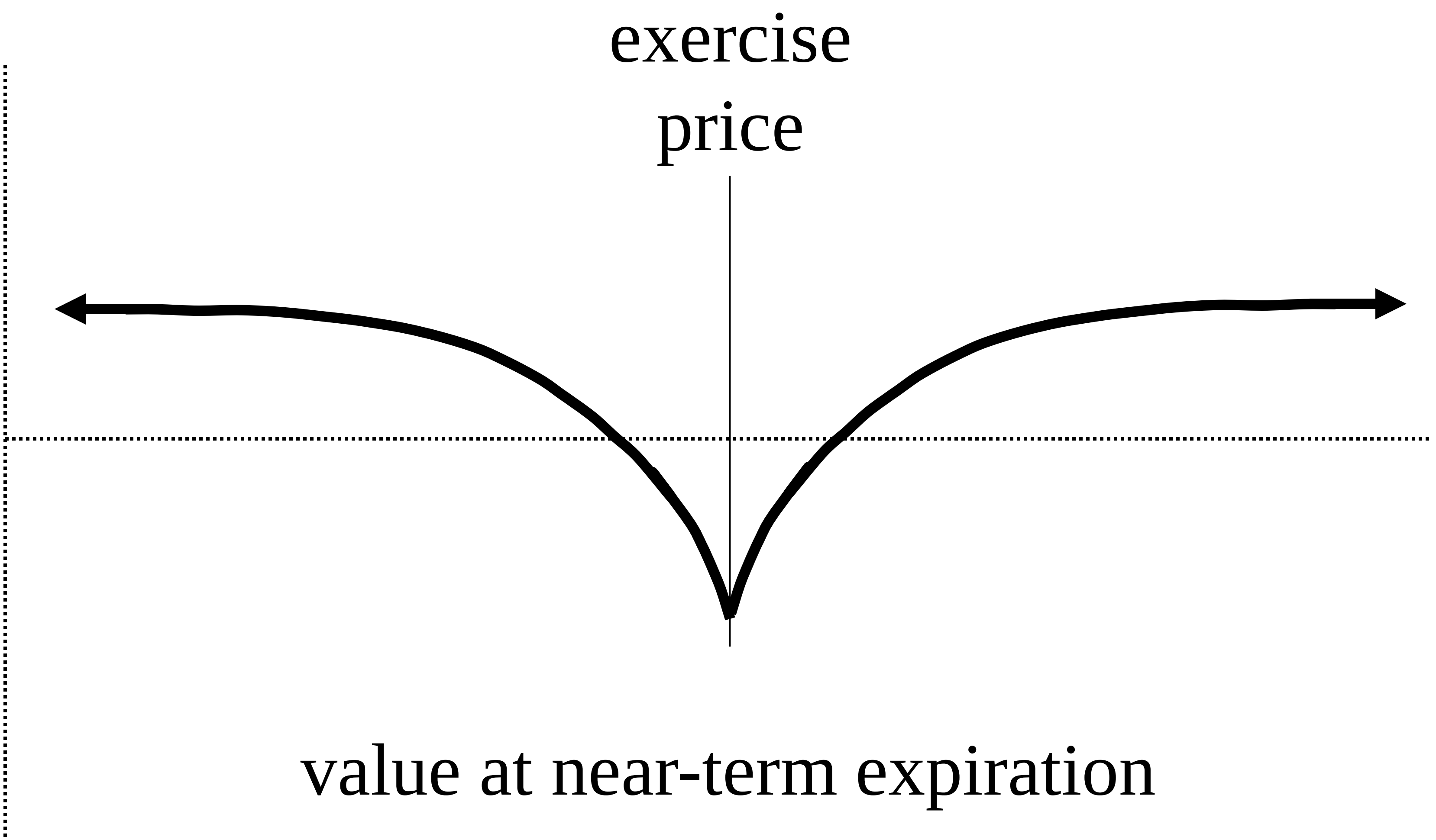
	25%	30%	20%
November	3.00	3.90	2.10
September	2.10	2.50	1.70
	.90	1.40	.40

negative gamma / positive vega

Long Calendar Spread



Short Calendar Spread



Long Calendar Spread

delta	gamma	theta	vega
0	–	+	+

Short Calendar Spread

delta	gamma	theta	vega
0	+	–	–

Volatility Spreads

delta	gamma	theta	vega
0	+	↓	+
↓	−	↓	−
↓	−	↓	+
↓	+	↓	−

Volatility Spreads

gamma	vega	
+	+	long straddle, long strangle, short butterfly, ratio spread (buy more than sell)
–	–	short straddle, short strangle, long butterfly, ratio spread (sell more than buy)
–	+	long calendar spread
+	–	short calendar spread

Volatility Strategy Exercise

On this and the following pages are several different volatility strategies with some possible changes in market conditions. If the underlying futures contract is currently trading at 80, for each change in market conditions is the strategy making money (+) or losing money (–). Assume all positions are initially delta neutral.

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility falls
+1 June 80 call +1 June 80 put			

	the underlying price falls sharply	time passes with no change in the underlying	implied volatility rises
+2 August 75 puts -1 August 85 put			

	the underlying price falls sharply	time passes with no change in the underlying	implied volatility rises
-1 March 80 call +1 January 80 call			

Volatility Strategy Exercise

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility rises
-1 September 75 put +2 September 80 puts -1 September 85 put			

	the underlying price falls sharply	time passes with no change in the underlying	implied volatility falls
+3 July 85 calls -1 July 75 call			

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility rises
+1 December 80 put -1 September 80 put			

	the underlying price falls sharply	time passes with no change in the underlying	implied volatility falls
-4 October 70 puts +1 October 85 put			

Volatility Strategy Exercise

	the underlying price falls sharply	time passes with no change in the underlying	implied volatility falls
+1 August 75 call -2 August 85 calls			

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility rises
-1 May 85 call -1 May 75 put			

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility falls
+1 November 80 call -1 October 80 call			

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility rises
-1 April 80 call -1 April 80 put			

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Bull & Bear Strategies

Futures price = 100

Long Straddle

+1 December 100 call
+1 December 100 put

delta neutral

+1 December 95 call
+1 December 95 put

Bull Straddle

+1 December 100 call

-1 December 110 call

bull spread

-1 December 100 call

+1 December 110 call

bear spread

minimum value = 0

maximum value = X_h - X_l

+1 December 100 ***put***

-1 December 110 ***put***

bull spread

-1 December 100 ***put***

+1 December 110 ***put***

bear spread

minimum value = 0

maximum value = X_h - X_l

Bull (Vertical) Spread

Buy an option at a lower exercise price

Sell an option at a higher exercise price

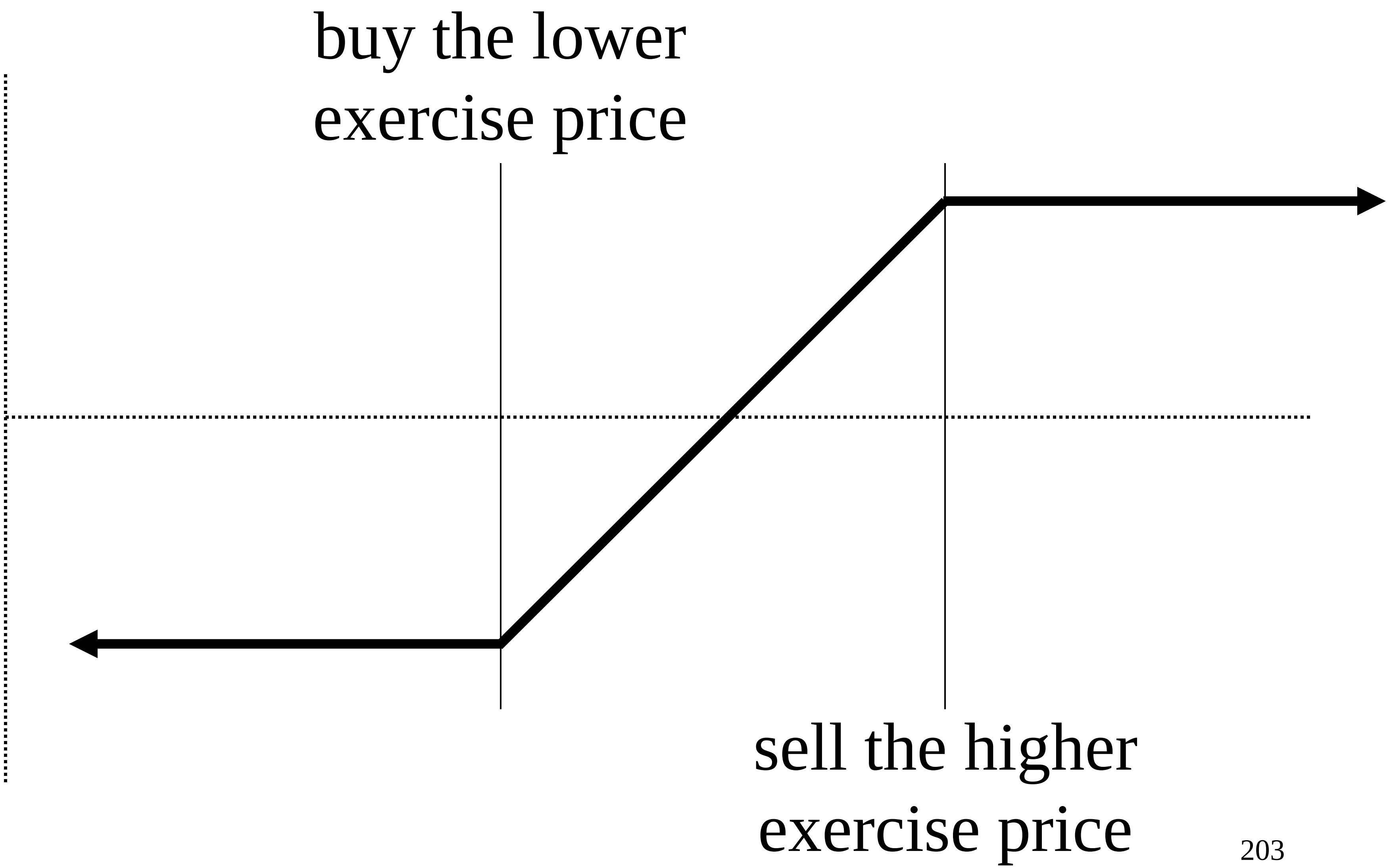
Bear (Vertical) Spread

Buy an option at a higher exercise price

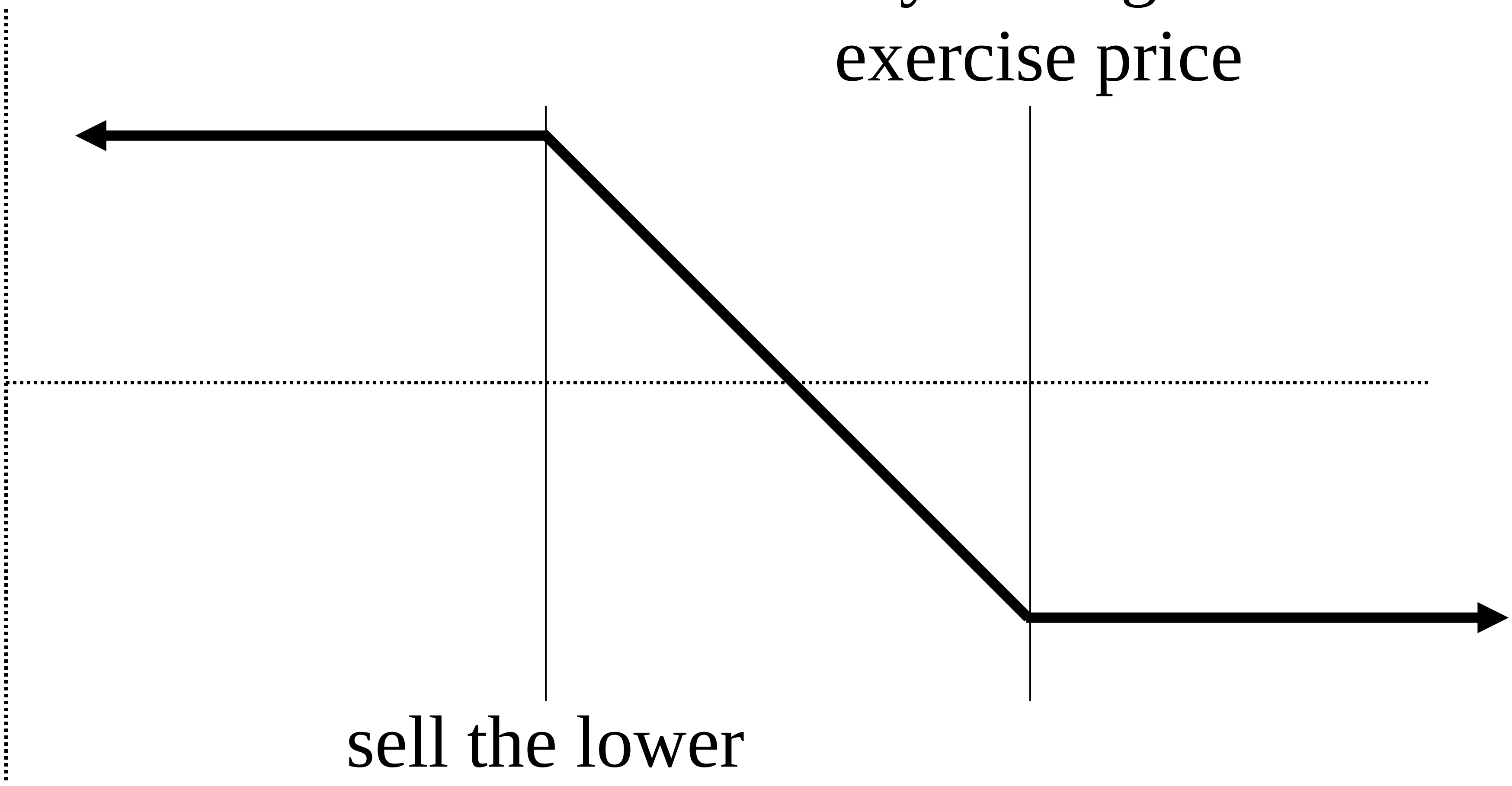
Sell an option at a lower exercise price

Both options must be the same type (both calls or both puts) and expire at the same time.

Bull (Vertical) Spread



Bear (Vertical) Spread



Futures price = 100
Time to expiration = 6 weeks

Volatility	20%	
95 call	5.86	(78)
95 / 100 spread	3.15	(27)
100 call	2.71	(51)
100 / 105 spread	1.75	(27)
105 call	.96	(24)

Futures price = 100

Time to expiration = 6 weeks

Volatility	20%	15%	25%
95 call	5.86	5.41	6.38
95 / 100 spread	3.15	3.38	3.00
100 call	2.71	2.03	3.38
100 / 105 spread	1.75	1.56	1.86
105 call	.96	.47	1.52

Futures price = 100
Time to expiration = 6 weeks

Volatility	20%	110	90	100
95 call	5.86			
95 / 100 spread	3.15	+	−	⊕
100 call	2.71			
100 / 105 spread	1.75	⊕	⊖	−
105 call	.96			

Futures price = 100
Time to expiration = 6 weeks

Volatility	20%	15%	25%
95 put	.86	.41	1.38
95 / 100 spread	1.85	1.62	2.00
100 put	2.71	2.03	3.38
100 / 105 spread	3.25	3.44	3.14
105 put	5.96	5.47	6.52

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Bull and Bear Strategy Exercise

For each spread on this and the following page you are given an outlook for the underlying futures market (either bullish or bearish) and an opinion about implied volatility (you believe it is either unreasonably high or unreasonably low). Given this information, from the four suggested spreads choose the spread which you think is best.

	underlying price	directional outlook	implied volatility
long 50 call / short 45 call long 45 call / short 50 call long 40 put / short 35 put long 55 put / short 50 put	50	bearish	too high
long 70 call / short 75 call long 70 put / short 75 put long 70 call / short 65 call long 65 call / short 70 call	71	bearish	too low

Bull and Bear Strategy Exercise

	underlying price	directional outlook	implied volatility
long 40 put / short 45 put long 35 put / short 40 put long 45 put / short 40 put long 45 call / short 4 call	39	bullish	too low
long 80 call / short 75 call long 80 put / short 75 put long 75 call / short 80 call long 85 call / short 90 call	82	bullish	too high
long 1900 put / short 1600 put long 1800 call / short 1700 call long 1700 call / short 1500 call long 1800 put / short 2000 put	1700	bearish	too high

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Synthetics

+1 December 100 call

-1 December 100 put

above 100

put is worthless / exercise call

buy underlying at 100

below 100

call is worthless / assigned on put

buy underlying at 100

+1 December 100 call

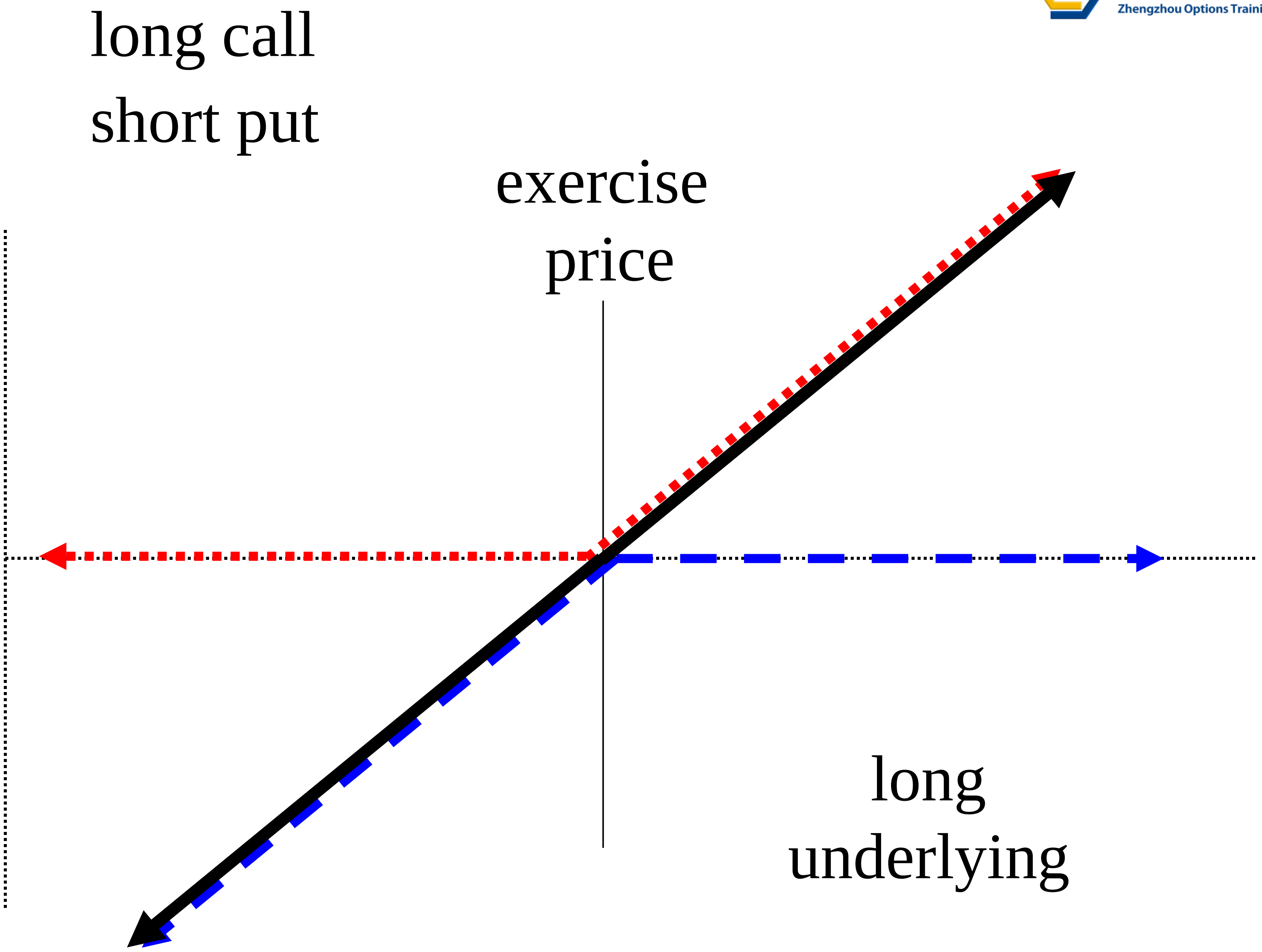
-1 December 100 put

Regardless of whether the underlying is above or below the exercise price at expiration

buy underlying at 100

Synthetic Long Underlying

(Synthetic Long Forward)


long call
short put
exercise
price
long
underlying

long call + short put ≈

synthetic long underlying

short call + long put ≈

synthetic short underlying

delta of an underlying contract? 100

+1 December 100 call	+30	+80
-1 December 100 put	-70	-20

long call + short put ≈

synthetic long underlying

short call + long put ≈

synthetic short underlying

gamma of an underlying contract? 0

+1 December 100 call	5	2
-1 December 100 put	5	2

long call + short put ≈

synthetic long underlying

short call + long put ≈

synthetic short underlying

vega of an underlying contract? 0

+1 December 100 call	.15	.40
-1 December 100 put	.15	.40

long put + long underlying ≈

synthetic long call

short put + short underlying ≈

synthetic short call

long call + short underlying ≈

synthetic long put

short call + long underlying ≈

synthetic short put

Buy December 100 straddle:

+1 December 100 call

+1 December 100 put

+2 December 100 calls

-1 futures contract

+2 December 100 puts

+1 futures contract

Bull spread:

buy a lower exercise price

sell a higher exercise price

+1 December 90 call

-1 December 100 call

+1 December 90 put

-1 December 100 put

Synthetic Equivalent Exercise

What is the strategy or synthetic equivalent for each combination below?

long a Jan 75 put / long a futures contract

short a Feb 85 call / long a futures contract

long a Mar 65 call / long a Mar 65 put

short a Apr 70 call / long a Apr 70 put

long a May 75 put / short a May 85 put

long a Jun 85 call / short a futures contract

short a Jul 70 call / short a Jul 70 put

long an Aug 90 call / short an Aug 90 put

long a Sep 70 call / short a Sep 75 call

short an Oct 65 put / short a futures contract

short a Nov 90 call / short a Nov 65 put

-1 December 100 call

+1 December 100 put

+1 underlying contract

Arbitrage – buying and selling the same or closely related products in different markets in order to take advantage of a price discrepancy

Conversion

long underlying + synthetic short underlying

long underlying + short call long put

The call and put have the same exercise price and expiration date.

Reverse Conversion (Reversal)

short underlying	+	synthetic long underlying
short underlying	+	long call short put

The call and put have the same exercise price and expiration date.

Conversion

buy the underlying / **buy** the put

Reverse Conversion

sell the underlying / **sell** the put

Conversion

-1 December 100 call	6.00
+1 December 100 put	2.00
+1 futures contract	104.00

Cash flow: +6 -2 +100 = 104

C - P = S - X ***Put-Call Parity***

Conversion / Reverse Conversion

buy -1 December 100 call 6.00

sell +1 December 100 put 2.00

sell +1 futures contract ~~104.00~~ 104.50

Cash flow: +6 -2 +100 = 104

$C - P = S - X$ $6 - 2 = 104.50 - 100$

$4 \neq 4.50$

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When fixing settlement prices, exchanges try to maintain put-call parity.

QWV3 s489.10 +9.30 488.60 /489.30 1x2 Prev 479.80
At 12:35 d Vol 4961 Op 480.90 Hi 489.80 Lo 480.50 OpenInt 31061

QWV3 Comdty | 95) Templates | 96) Actions | 97) Expiry | Option Monitor: Option Monitor

WHITE SUGAR (LIF) Oct1 489.10 9.30 1.9383% 488.60 / 489.30 Hi 489.80 Lo 480.50 Volm 4961 HV 16.18 91) News (CN)

Calc Mode Center 489.10 Strikes 9 Exch

295) Center Strike | 296) Calls/Puts | 297) Calls | 298) Puts | 299) Term Structure

	Calls							Puts					
	Strike	Ticker	Bid	Ask	Last	Volm		Strike	Ticker	Bid	Ask	Last	Volm
	Oct 13 (35d 9/2/13); CSize 50; QWV3 489.10							Oct 13 (35d 9/2/13); CSize 50; QWV3 489.10					
1)	450	QWV3C			40.00s		55)	450	QWV3P			.90s	
2)	460	QWV3C			31.10s		56)	460	QWV3P			2.00s	
3)	470	QWV3C			23.10s		57)	470	QWV3P			4.00s	
4)	480	QWV3C			16.30s		58)	480	QWV3P			7.20s	
5)	490	QWV3C			10.85s		59)	490	QWV3P			11.75s	
6)	500	QWV3C			6.85s		60)	500	QWV3P			17.75s	
7)	510	QWV3C			4.10s		61)	510	QWV3P			25.00s	
8)	520	QWV3C			2.90s		62)	520	QWV3P			33.80s	
9)	530	QWV3C			2.30s		63)	530	QWV3P			43.20s	
	Dec 13 (95d 11/1/13); CSize 50; QWZ3 479.50							Dec 13 (95d 11/1/13); CSize 50; QWZ3 479.50					
10)	440	QWZ3C			43.45s		64)	440	QWZ3P			3.95s	
11)	450	QWZ3C			35.65s		65)	450	QWZ3P			6.15s	
12)	460	QWZ3C			28.60s		66)	460	QWZ3P			9.10s	
13)	470	QWZ3C			22.40s		67)	470	QWZ3P			12.90s	
14)	480	QWZ3C			17.10s		68)	480	QWZ3P			17.60s	
15)	490	QWZ3C			12.70s		69)	490	QWZ3P			23.20s	
16)	500	QWZ3C			9.25s		70)	500	QWZ3P			29.75s	
17)	510	QWZ3C			6.60s		71)	510	QWZ3P			37.10s	
18)	520	QWZ3C			4.60s		72)	520	QWZ3P			45.10s	

93) Default color legend Zoom 100%

Synthetic Pricing Exercise - Futures

For each set of futures options below, fill in the missing value

futures price	exercise price	call price	put price
19560	19000	325	
2803		205	252
	1375	125	62
9838	9800		27
	8600	133	133
2319	2350	97	
5225		311	236
3890	3800		0

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Hedging Strategies

Options as “insurance”

Practical considerations

How much protection do I need?

How much risk am I willing to accept?

Theoretical considerations

What is the cost of the insurance?

Does the premium I receive fairly compensate me for the lost opportunity?

Options as "insurance"

Buy a protective option

long an underlying contract – buy a put

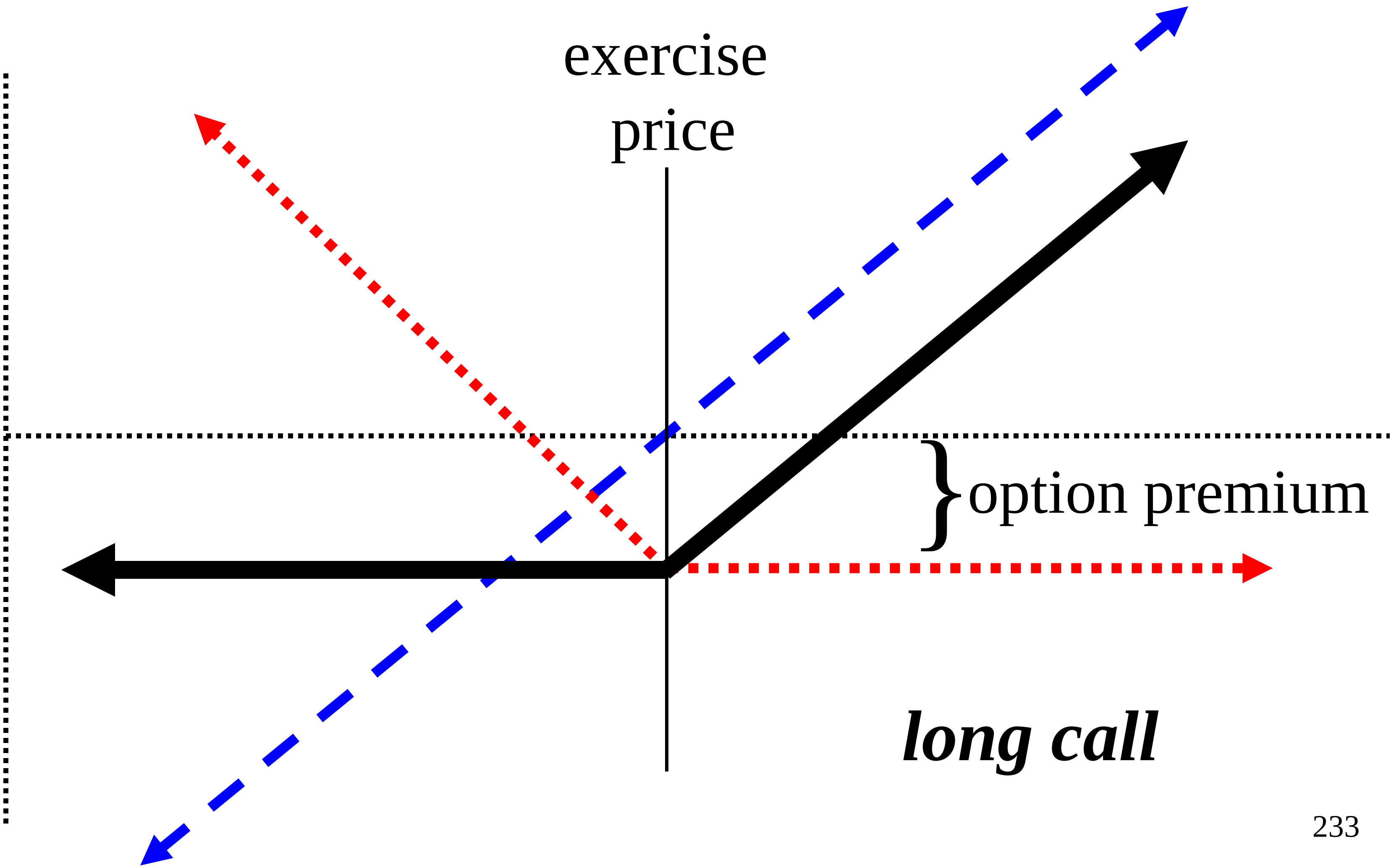
short an underlying contract – buy a call

Advantage – absolute, well-defined protection; unlimited potential profit

Disadvantage – cost of option; loss of premium

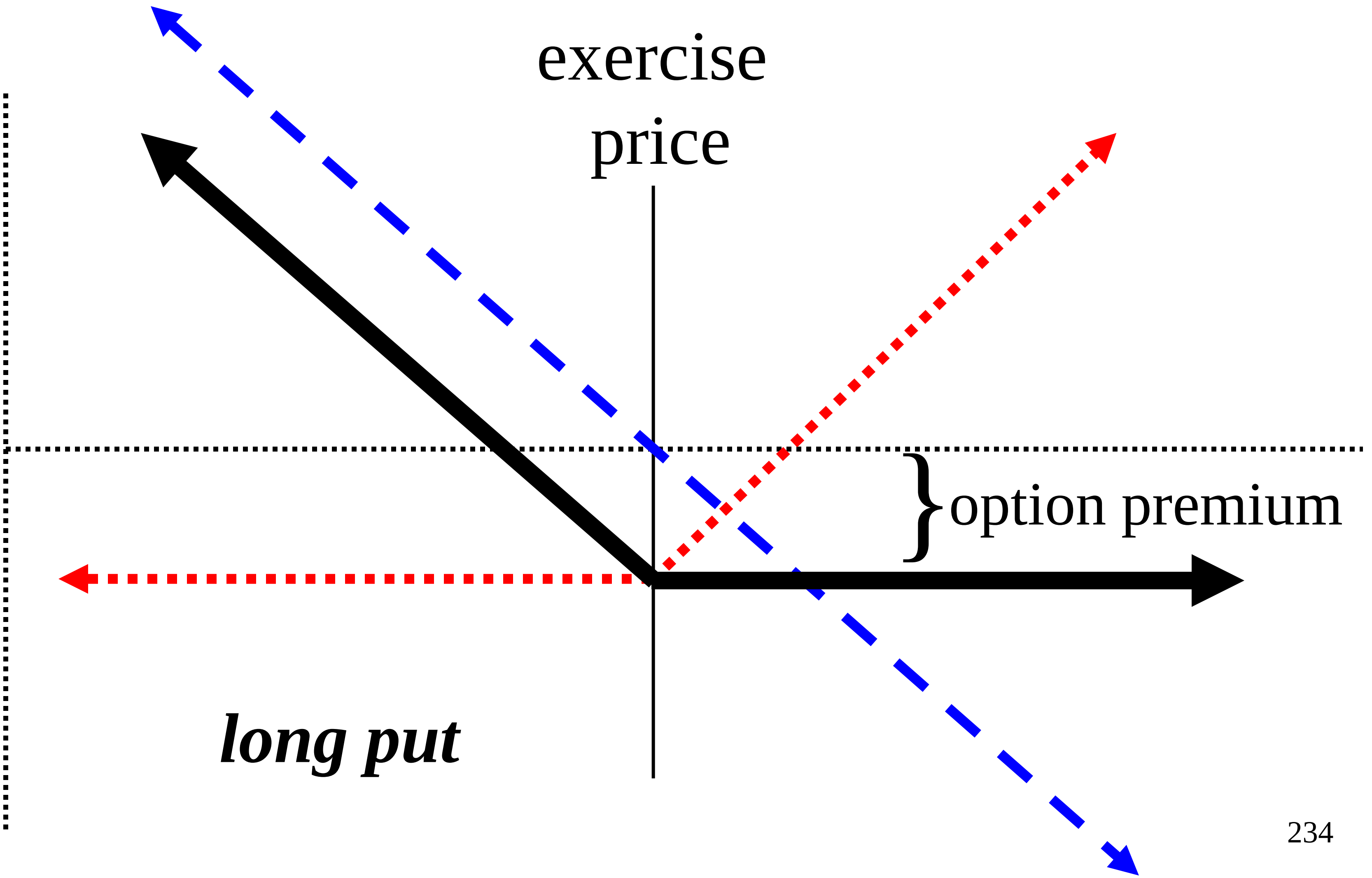
long an underlying contract

long a protective put



short an underlying contract

long a protective call



Options as insurance

Sell a covered option

long an underlying contract – sell a call

short an underlying contract – sell a put

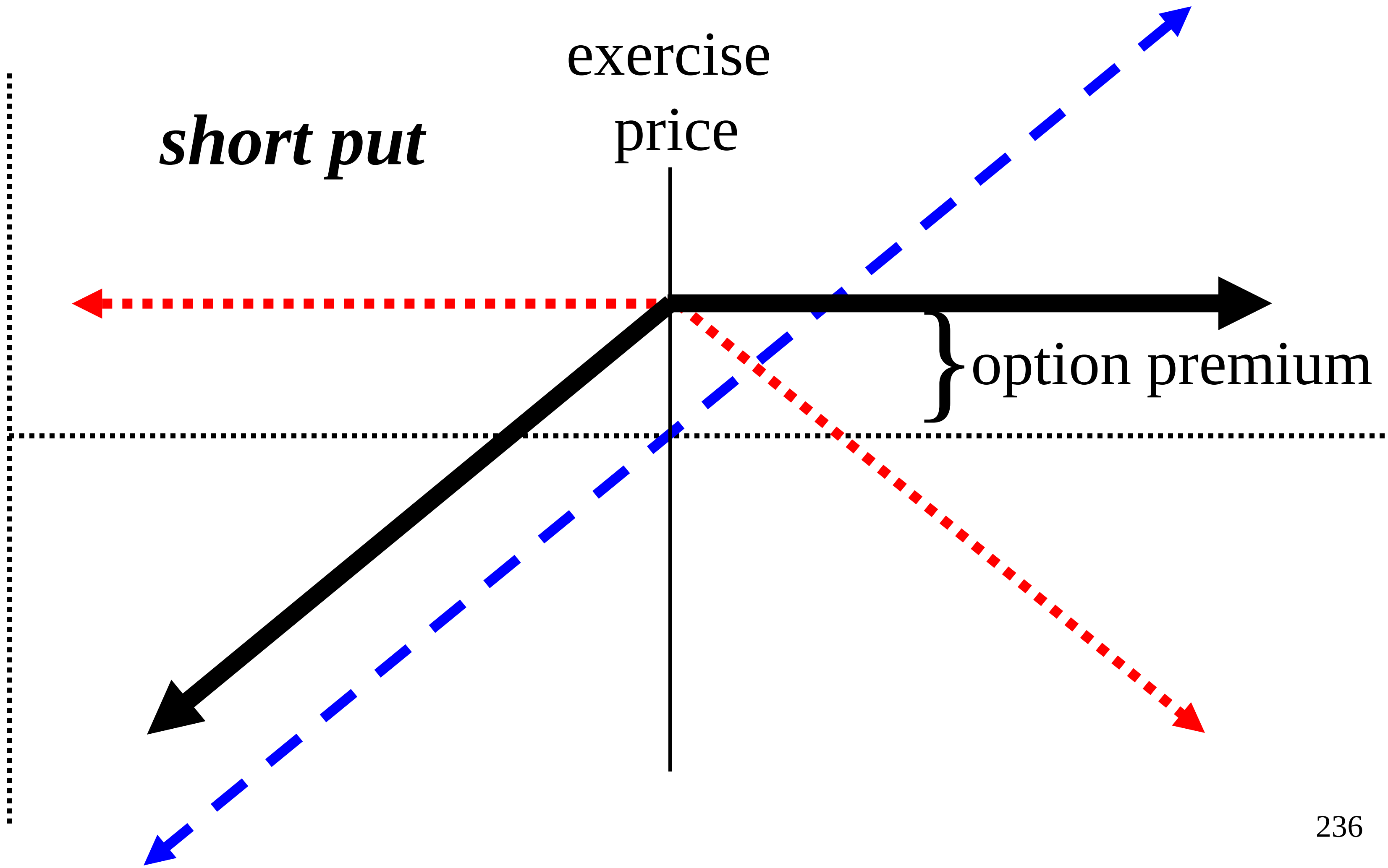
Advantage – receive premium

Disadvantage – sold option offers only partial protection; limited profit potential

long an underlying contract

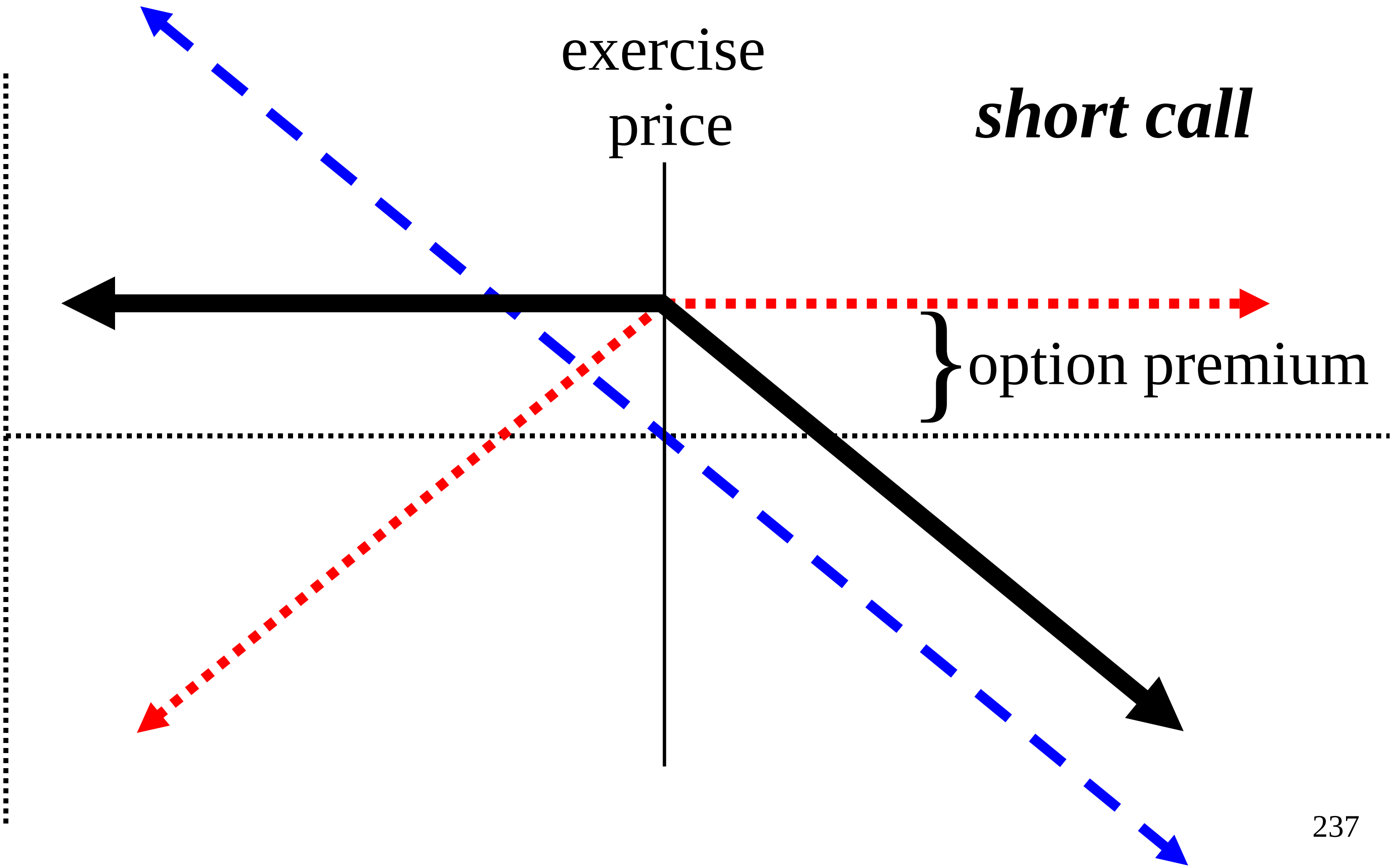
short a covered call

buy / write



short an underlying contract

short a covered put



Options as insurance

Simultaneously buy a protective option and sell a covered option

long an underlying contract

– buy a put / sell a call (***long collar***)

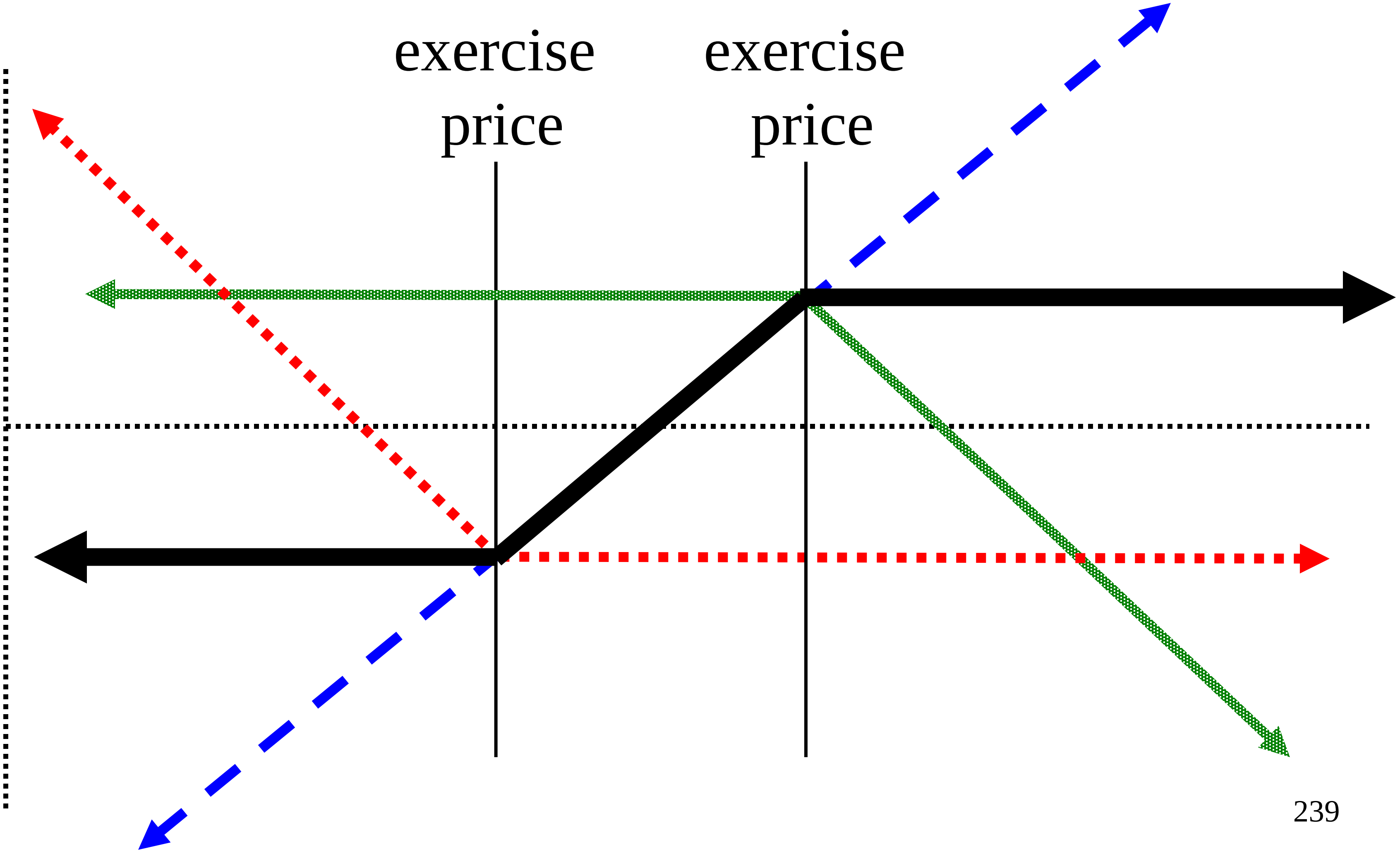
short an underlying contract

– buy a call / sell a put (***short collar***)

Zero-cost collar – the price of the bought and sold options are the same

long an underlying contract
long put
short call

bull spread

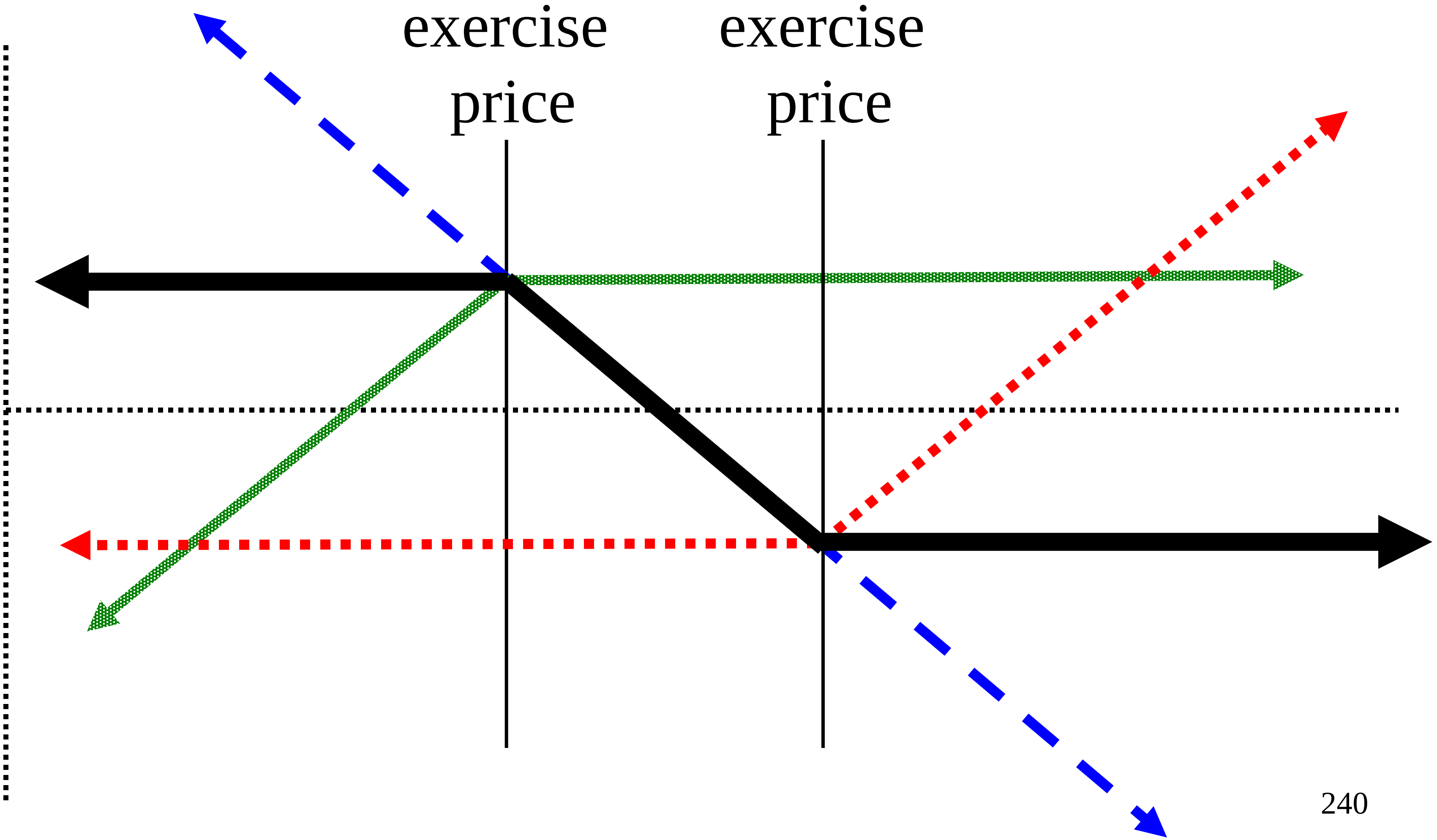


short an underlying contract

long call

bear spread

short put



Hedging strategies tend to reduce the volatility of a portfolio.

Is that desirable?

year 1 returns	year 2 returns	year 3 returns	average return	total return
+25%	-20%	+25%	+10%	+25%
+29%	-34%	+44%	+13%	+22.6%
+16%	-6%	+17%	+9%	+27.6%
+8.5%	+8.5%	+8.5%	+8.5%	+27.7%

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Answers to Exercises

Expected Value Exercise (answers)

124	126	128	130	132	134	136
4%	12%	19%	22%	21%	16%	6%

Using the above prices and probabilities for an underlying contract, what are the expected values for the following contracts:

underlying	126 call	130 call	133 call
130.32	**4.40**	**1.42**	**.34**
	126 put	130 put	133 put
	.08	**1.10**	**3.02**

What do you notice about the difference between the values of calls and puts at the same exercise price? **They differ by intrinsic value.**

Volatility Exercise I (answers)

For each contract and volatility below, what would be an approximate daily and weekly standard deviation:

Sugar futures trading at 5140

	10%	12%	14%	16%
daily	**32**	**39**	**45**	**51**
weekly	**71**	**86**	**100**	**114**

Glass futures trading at 1465

	15%	20%	25%	30%
daily	**14**	**18**	**23**	**27**
weekly	**31**	**41**	**51**	**61**

<u>**Volatility Exercise II**</u> (answers)

For each contract, volatility, and time interval below, what would be an an approximate one standard deviation price change:

Cotton futures trading at 19,600

volatility = 7.5%, time = 22 days $19600*.075*\sqrt{22/365}$ = **361**

volatility = 11.25%, time = 86 days $19600*.1125*\sqrt{86/365}$ = **1070**

Wheat futures trading at 2625.00

volatility = 14%, time = 9 weeks $2625*.14*\sqrt{9/52}$ = **153**

volatility = 9.75%, time = 27 weeks $2625*.0975*\sqrt{27/52}$ = **184**

Risk Measurement Exercise (answers)

	original delta	new theoretical value using a constant delta	new delta	average delta	new theoretical value using the average delta	if ten days pass	if volatility changes
a)	**65**	**9.99**	**76.1**	**70.6**	**10.16**	**7.68**	**7.32**
b)	**-28**	**1.18**	**-22.3**	**-25.1**	**1.25**	**1.67**	**3.98**
c)	**50**	**3.04**	**42.9**	**46.5**	**3.09**	**3.64**	**6.56**
d)	**-87**	**19.45**	**-94.8**	**-90.9**	**19.56**	**16.52**	**10.37**
e)	**11**	**1.02**	**12.3**	**11.6**	**1.03**	**.93**	**.80**
f)	**-44**	**18.96**	**-100**	**-72.0**	**21.76**	**14.11**	**20.08**

Risk Interpretation Exercise (answers)

Match each position with the corresponding market conditions which will most help the position.

position		market conditions
+delta / +gamma / -vega	—	swift upward price movement; falling implied volatility
-delta / -gamma / -vega	—	slow downward price movement; falling implied volatility
0 delta / -gamma / +vega	—	no price movement; rising implied volatility
0 delta / +gamma / +vega	—	price movement in either direction; rising implied volatility
+delta / -gamma / +vega	—	slow upward price movement; rising implied volatility
0 delta / +gamma / -vega	—	price movement in either direction; falling implied volatility
-delta / 0 gamma / 0 vega	—	downward price movement
+delta / 0 gamma / -vega	—	upward price movement; falling implied volatility

Delta Hedging Exercise (answers)

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For this question use the following table of delta values:

	June 70	June 75	June 80	June 85	June 90
call delta	87	72	52	34	19
put delta	-13	-28	-48	-66	-81

You buy 25 June 80 calls. What do you need to do (buy? sell? how many?) to hedge your position as close to delta neutral as possible with each of the following contracts:

underlying contract	June 85 call	June 75 put
sell 13	**sell 38**	**buy 46**

You sell 80 June 75 puts. What do you need to do (buy? sell? how many?) to hedge your position as close to delta neutral as possible with each of the following contracts:

June 70 call	June 80 put	June 90 call
sell 26	**buy 47**	**sell 118**

You sell 15 underlying contracts. You would like to hedge half your delta position with June 70 puts and half your delta position with June 90 calls. As close as possible, how many of each contract do you need to buy or sell?

sell 58 June 70 puts **buy 39 June 90 calls**

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Volatility Strategy Exercise (answers)

On this and the following pages are several different volatility strategies with some possible changes in market conditions. If the underlying futures contract is currently trading at 80, for each change in market conditions is the strategy making money (+) or losing money (–). Assume all positions are initially delta neutral.

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility falls
+1 June 80 call +1 June 80 put	+	—	—

	the underlying price falls sharply	time passes with no change in the underlying	implied volatility rises
+2 August 75 puts -1 August 85 put	+	—	+

	the underlying price falls sharply	time passes with no change in the underlying	implied volatility rises
-1 March 80 call +1 January 80 call	—	+	+

Volatility Strategy Exercise (answers)

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility rises
-1 September 75 put +2 September 80 puts -1 September 85 put	+	—	+

	the underlying price falls sharply	time passes with no change in the underlying	implied volatility falls
+3 July 85 calls -1 July 75 call	+	—	—

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility rises
+1 December 80 put -1 September 80 put	+	—	—

	the underlying price falls sharply	time passes with no change in the underlying	implied volatility falls
-4 October 70 puts +1 October 85 put	—	+	+

Volatility Strategy Exercise (answers)

	the underlying price falls sharply	time passes with no change in the underlying	implied volatility falls
+1 August 75 call -2 August 85 calls	–	+	+

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility rises
-1 May 85 call -1 May 75 put	–	+	–

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility falls
+1 November 80 call -1 October 80 call	+	+	–

	the underlying price rises sharply	time passes with no change in the underlying	implied volatility rises
-1 April 80 call -1 April 80 put	–	+	–

Bull and Bear Strategy Exercise (answers)

For each spread on this and the following slide you are given an outlook for the underlying market (either bullish or bearish) and an opinion about implied volatility (you believe it is either unreasonably high or unreasonably low). Given this information, from the four suggested spreads choose the spread which you think is best.

	underlying price	directional outlook	implied volatility
long 50 call / short 45 call long 45 call / short 50 call long 40 put / short 35 put **long 55 put / short 50 put**	50	bearish	too high
long 70 call / short 75 call long 70 put / short 75 put **long 70 call / short 65 call** long 65 call / short 70 call	71	bearish	too low

Bull and Bear Strategy Exercise (answers)

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	underlying price	directional outlook	implied volatility
long 40 put / short 45 put long 35 put / short 40 put long 45 put / short 40 put long 45 call / short 4 call	39	bullish	too low
long 80 call / short 75 call long 80 put / short 75 put **long 75 call / short 80 call** long 85 call / short 90 call	82	bullish	too high
long 1900 put / short 1600 put **long 1800 call / short 1700 call** long 1700 call / short 1500 call long 1800 put / short 2000 put	1700	bearish	too high

Synthetic Equivalent Exercise (answers)

What is the strategy or synthetic equivalent for each combination below?

long a Jan 75 put / long a futures contract	**long a Jan 75 call**
short a Feb 85 call / long a futures contract	**short a Feb 85 put**
long a Mar 65 call / long a Mar 65 put	**long straddle**
short a Apr 70 call / long a Apr 70 put	**short futures contract**
long a May 75 put / short a May 85 put	**bull put spread**
long a Jun 85 call / short a futures contract	**long a Jun 85 put**
short a Jul 70 call / short a Jul 70 put	**short straddle**
long an Aug 90 call / short an Aug 90 put	**long futures contract**
long a Sep 70 call / short a Sep 75 call	**bull call spread**
short an Oct 65 put / short a futures contract	**short an Oct 65 call**
short a Nov 90 call / short a Nov 65 put	**short strangle**

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<u>**Synthetic Pricing Exercise - Futures**</u> (answers)

For each set of futures options below, fill in the missing value

futures price	exercise price	call price	put price
19560	19000	325	**235**
2803	**2850**	205	252
1438	1375	125	62
9838	9800	**65**	27
8600	8600	133	133
2319	2350	97	**166**
5225	**5150**	311	236
3890	3800	**90**	0