ISMA CENTRE - THE BUSINESS SCHOOL
OF THE FINANCIAL MARKETS

UNIVERSITY OF READING
ENGLAND

IFID Certificate Programme

Rates Trading and Hedging

Option Concepts

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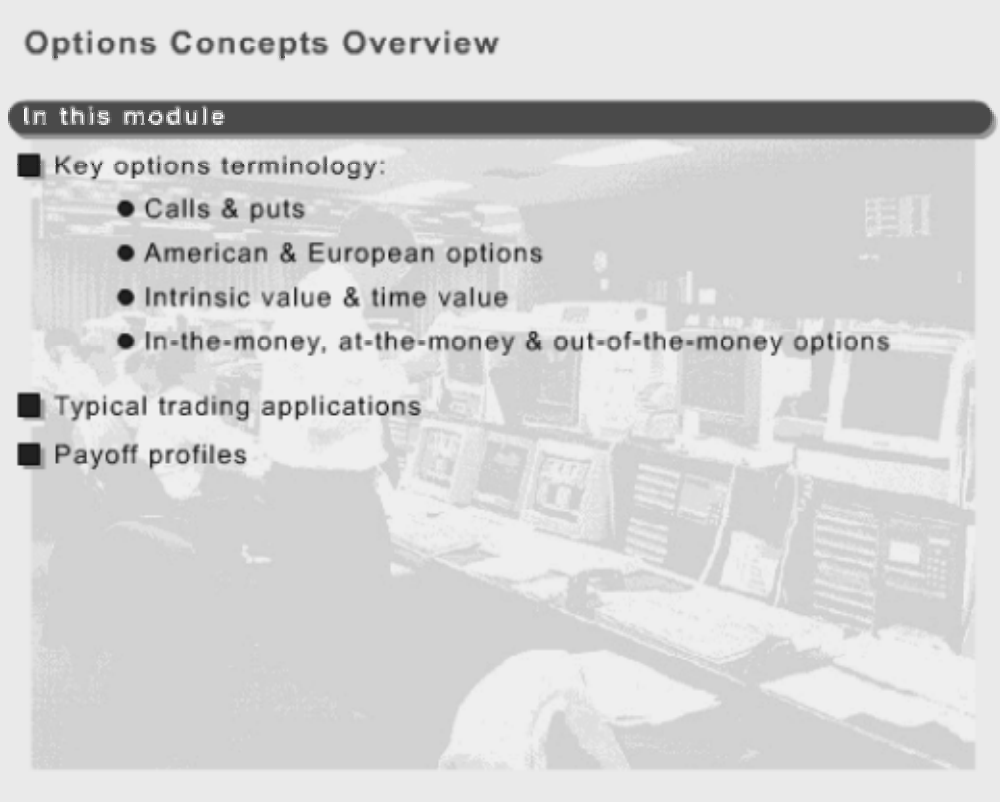
1. Overview



In this module, we introduce some key options terminology and we explain in general terms how the options work.

In the other modules we look at specific contracts and how they may be used to manage market risk.

Learning Objectives

By the end of this module, you will be able to:

1. - Compare the structural characteristics of exchange-traded bond futures options with bond options typically traded in the OTC markets
2. - Analyse the option premium in terms of:
   - Intrinsic value
   - Time value

2. Definition

An option gives the owner the right but not the obligation to buy or sell:

- An amount of a specified financial instrument (the **underlying**)
- For delivery on or before a specified date in the future (the **expiry**)
- At a price which is agreed on the trade date (the **strike**)

For the right to **exercise** the option the buyer pays a **premium**.

The definition is similar to that of a futures (or forward) contract in that it involves a transaction that may take place at some future date at a price which is agreed on the trade date.

The key difference here is that the option holder has *the right but not the obligation*. Futures commit both parties to certain obligations, as well as rights; with options one party purchases all the rights, leaving the other only with obligations. The risks and the potential returns to the option buyer are therefore very different from those to the seller. Options are widely used by fund managers, corporate treasurers and traders to create or modify market exposures.

2.1. Options Exchanges

The concept of options goes back many centuries but until the early 1970s, when the Chicago Board Options Exchange (CBOE) first opened, options markets were largely fragmented, unregulated and often plagued by financial scandal. CBOE pioneered a safe environment in which the performance of all contracts could be guaranteed.

Today it is possible to deal exchange-traded options on:

- Treasury bonds
- Treasury bills
- Three month Eurocurrency rates
- Currencies
- Equity indices
- Commodities

OTC Markets

Alongside the options exchanges, many banks and securities houses make OTC markets in conventional options on these instruments, as well as in more **exotic** ones incorporating complex payoffs. In many cases these options are embedded in **structured securities**, such as:

- Warrants
- Callable or putable bonds
- Convertible bonds
- Capped floating rate notes
- Capital protected notes
- Corridor notes
- Cliquet bonds
- PERCS

We examine these and other option-based instruments in Callable Bonds.

3. Contract Structure

	Call option	Put option
Buyer	Has the right to **BUY** (or call) the underlying	Has the right to **SELL** (or put) the underlying
Seller	Has the obligation to **SELL** the underlying, if required	Has the obligation to **BUY** the underlying, if required

The terms call and put define the potential direction of the underlying, if the option is exercised:

- Both the call buyer and the put seller are potentially long the underlying
- Both the call seller and the put buyer are potentially short the underlying

In terms of risk and return, however, there is a world of difference between buying calls and selling puts (or between selling calls and buying puts), as we shall see.

American-style option: gives the holder the right to exercise on or before expiry
European-style option: gives the holder the right to exercise on the expiry date only

Following the tradition of the early US markets most exchange-traded contracts are defined as American style, whereas in the OTC markets European-style contracts still predominate. The subtle distinction between the two styles makes some difference to the risks associated with the option, and therefore has some impact on its price.

4. Trading Application

4.1. Simple Bull Trade

Options may be used as speculative instruments, as the example below illustrates.

Example - Bull Trade

Date: 1 June
Situation: A trader for XYZ Inc. wants to profit from an anticipated rise in the price of Microsoft shares, which are currently trading at $102.00, but does not wish to take the same downside risk as owning the shares.

Strategy: Buy an option on the following terms:

Option:	Call
Style:	European
Underlying:	Microsoft Corporation common stock
Contract size:	10,000 shares
Expiry:	1 December
Strike:	$102.00
Buyer:	XYZ Inc.
Seller:	Big Bank
Premium price:	$3.00
Premium payable: (value spot)	= 10,000 x 3.00 = $30,000

In this example the option is said to be **at the money** (strictly, **at the money cash** or **at the money spot**).

A call option is:

- Out of the money (OTM): If the underlying currently trades below the strike
- At the money (ATM): If the underlying trades at the strike exactly
- In the money (ITM): If the underlying trades above the strike

For a put option with the same strike the opposite would be the case: the put would be ITM if the underlying trades below the strike, and would be OTM if the underlying traded above it.

Outcome: 1 December

Scenario A - Share price is at or below $102.00
The option buyer does not exercise his right, the option expires worthless and the buyer loses his premium.

Scenario B - Share price is higher than $102.00
The holder exercises his rights. He pays 10,000 x 102.00 = $1,020,000 (the strike) and takes delivery of the stock. If the stock was worth, say, $106 then the trader would make a profit of $10,000 or $1 per share, net of premium paid:

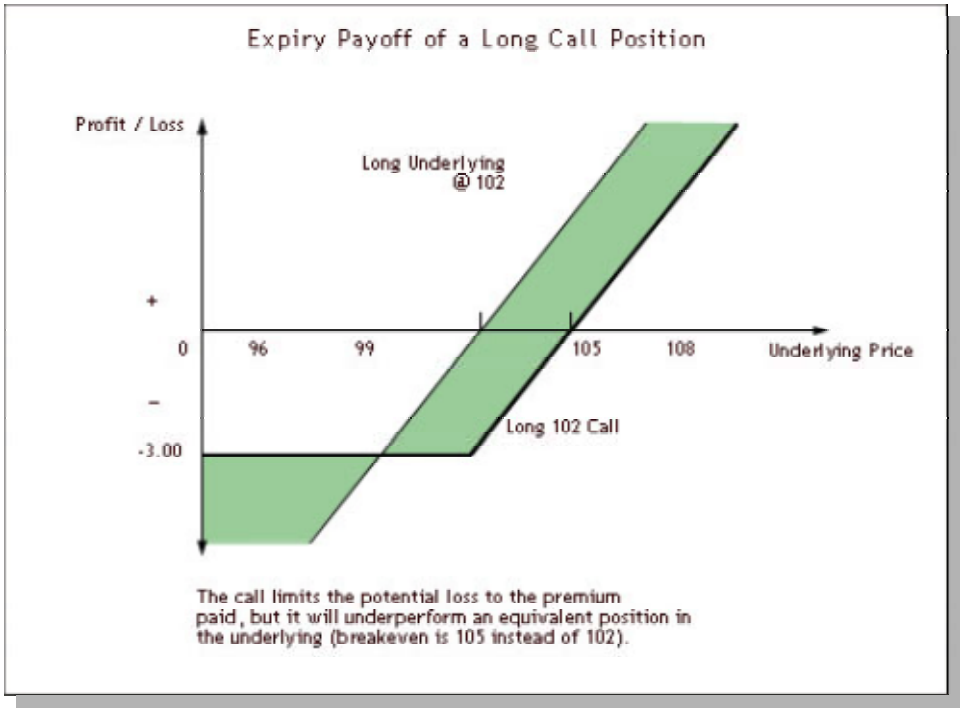
Cash flow per share ($)	(+in / -out)
Premium paid	- 3.00
Exercise of option	- 102.00
Stock resale/revaluation	+106.00
Net	**+1.00**

4.2. Expiry Payoff

Whether the trader makes a profit or loss at expiry depends on what the cash price of the stock will be. The table below shows the net profit/loss per share for different levels of the underlying at expiry.

Stock Price Scenario	Premium	Expiry Status	Expiry Payoff	Net P/L
100.00	- 3.00	OTM	0.00	**- 3.00**
101.00	- 3.00	OTM	0.00	**- 3.00**
102.00	- 3.00	ATM	0.00	**- 3.00**
103.00	- 3.00	ITM	+1.00	**- 2.00**
104.00	- 3.00	ITM	+2.00	**- 1.00**
105.00	- 3.00	ITM	+3.00	**0.00**
106.00	- 3.00	ITM	+4.00	**+1.00**
107.00	- 3.00	ITM	+5.00	**+2.00**

The profit/loss profile of this option position is plotted below.



Notice:

- Maximum downside (= $3 loss per share) if the stock price is below the strike
- The option is exercised if the stock price is higher than the strike
- The trade makes a net profit if the stock is higher than $105 (= 102 + 3)

4.3. Breakeven

At $105 the gain made from exercising into the stock (= 105 - 102) just covers the premium paid. $105 is the **breakeven** on this trade.

Expiry breakeven:
For a call = Strike + Premium
For a put = Strike - Premium

If a put on this stock with the same strike costs $1.90 then its breakeven would be $100.10 (= 102 - 1.90). At $100.10 the put holder receives $102.00 for stock which is only worth $100.10, making a $1.90 gain which is just enough to cover the premium paid.

Trading Options vs. the Underlying

The figure on the previous page also compares the cash profit/loss on the option strategy with the profit/loss on an equivalent position in the underlying stock (a **cash position**), also established at $102. Notice the trade-off:

- Option outperforms cash position if the stock trades below $99 (= $102 - 3)
- Option underperforms cash position if the stock trades above $99

$99 is the breakeven level of the option strategy relative to trading the underlying. Both strategies represent a bull position on the market, but the choice between them depends on how much downside risk the trader is prepared to take.

- **The upside to the option buyer is unlimited, but the downside is limited to the premium paid**
- **The upside to the buyer of the underlying is also unlimited, but the downside is much larger**

It follows that the downside to the seller of this call is potentially unlimited, whereas his upside is limited to the premium received. Remember the seller has no rights, only obligations. We shall explore the risk asymmetry between option buyer and seller in the section *Payoff Geometry*.

Gearing
Although in cash terms a profitable option position will under perform an equivalent position in the underlying, the premium outlay is also typically much smaller. This makes the option a highly leveraged product compared with trading the underlying. We shall discuss the option's gearing in detail in Option Risks - Delta.

5. Trading Procedures

Options trading procedures vary from one market to another, and for exchange-traded contracts they depend on whether the trader is a member of the exchange or not. In this section we outline briefly the most common procedures.

5.1. Exchange-traded Contracts

As with futures trading (see Futures Market Structure - Trading Procedures), the Clearing House guarantees the performance of all contracts by requiring both parties in a trade to place collateral. This makes options trading accessible to anyone - large or small - who can meet the collateral requirements.

Non Exchange Members

Option Buyer
Pays the premium in full up-front (**premium-paid contracts**): the maximum potential loss to the buyer is the premium paid, so if the whole premium is paid up there is no further credit risk on the buyer, hence no daily variation margin requirements. When the position is closed (or exercised) the buyer receives the value of the option, if any.

Option Seller

- **Either**: the seller leaves the premium on deposit and in addition places an initial margin in cash (when the position is closed the trader can take the balance on margin account, net of the cost of closing)

- **Or**: the seller takes the premium, but:
  - If the option is a call the seller places the full amount of the underlying as collateral
  - If it is a put the seller pays a cash amount equal to the exercise price

Example – Option buyer

Date: 1 June
Situation: A trader for XYZ Inc. wants to profit from an anticipated rise in the price of IBM shares, which are currently trading at $95.50
Strategy: Buy 10 CME $96 SEP IBM call.

Contract size:	100 IBM shares
Expiry:	16 September (third Wednesday)
Strike:	$96.00
Premium price:	$1.20

Below is a summary of the evolution of this trade. Notice that there are no variation margin calls on the option buyer.

Date	Position	Profit/loss	Cashflow Out ( ) / In +	Balance
1 June	Buy 10 SEP 96 Calls @ 1.20	0.00	Premium: 10 x 100 x 1.20 **= (1,200)**	1,200 CR
	IBM falls to $95.00 Settlement Price: $1.00	(1.00 - 1.20) x 10 x 100 = **(200)**		1,000 CR
2 June	IBM rises to $96.50 Settlement Price: $1.35	(1.35 - 1.00) x 10 x 100 **= 350**		1,350 CR
3 June	IBM rises to $96.75 Sell 10 SEP 96 Calls @ 1.45	(1.45 - 1.35) x 10 x 100 = **100**		1,450 CR
			Premium: 10 x 100 x 1.45 **= 1,450**	0.0 CR
Net (1 to 3 June)		**250**	**250**	

Exchange Members

Most exchanges operate a futures-style margining system known as **SPAN** (Statistical Portfolio Analysis).

At the end of each trading day, the entire trader's portfolio (futures as well as options) is marked to market under 16 different market scenarios. The amount of margin required is equal to the highest loss sustained on the whole portfolio in any of these scenarios, and any trader whose margin balance falls short of this worst-case scenario receives a margin call for the balance.

The SPAN system is economic on margining because it allows for the possibility of offsetting the market risks on different positions. For example, a trader who is short calls but also long futures may have less net market risk than one who is just short the calls, or just long the futures. In this case, under the SPAN system the net margin required is less than under a system where each individual position is margined separately.

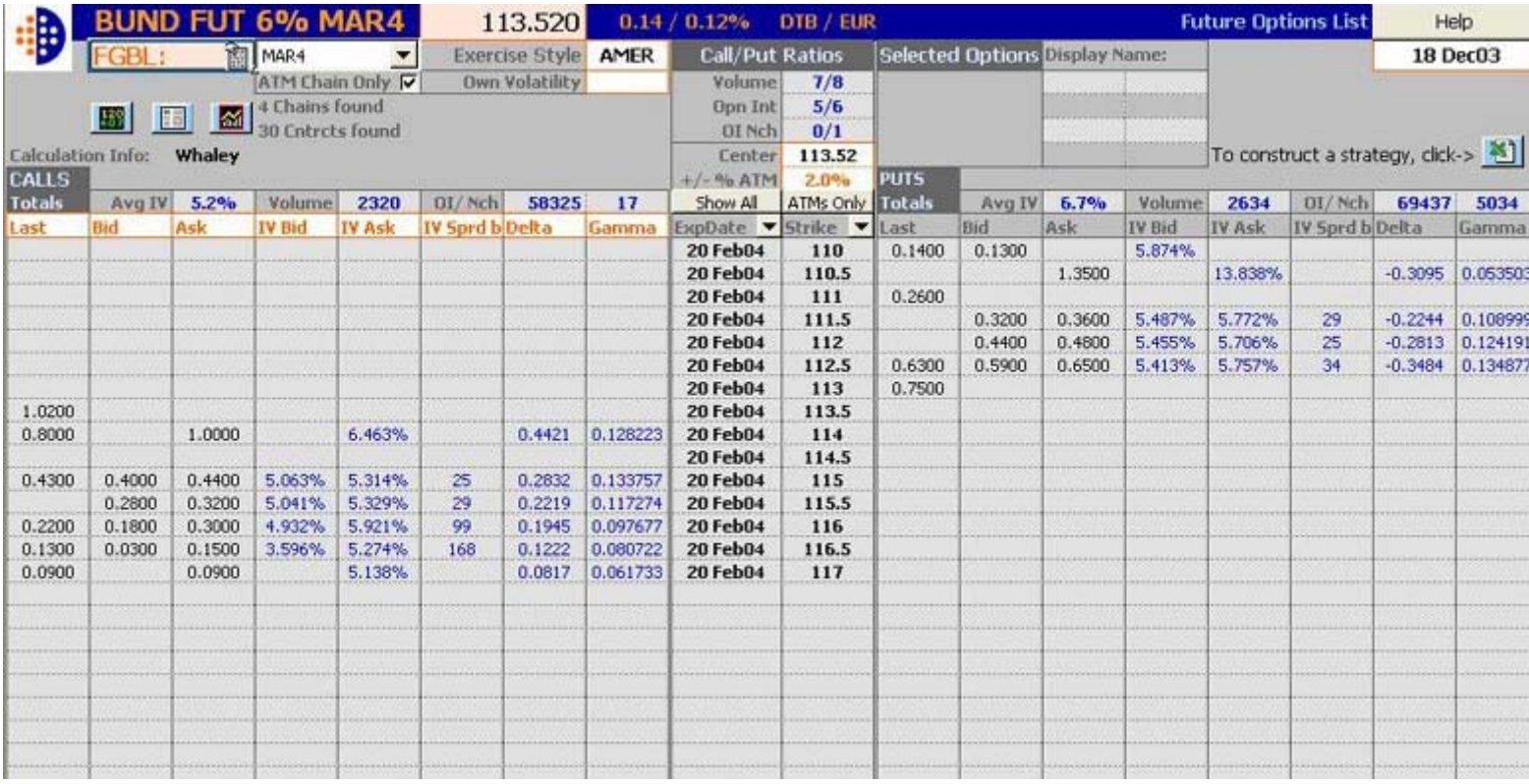
Analytic systems

Examples of Reuters bond futures options analysis functions

Below are sample screens from two widely-used providers of market information and analytics.

These examples are for illustration purposes only and do not form part of the IFID Certificate syllabus.

Reuters bond futures



BUND FUT 6% MAR4 113.520 0.14 / 0.12% DTB / EUR Future Options List Help

FGBL: MAR4 Exercise Style AMER Call/Put Ratios Selected Options Display Name: 18 Dec03

ATM Chain Only Own Volatility Volume 7/8

4 Chains found Opn Int 5/6

30 Cntrcts found OI Nch 0/1

Calculation Info: Whaley Center 113.52 To construct a strategy, click->

+/- % ATM 2.0%

CALLS										PUTS							
Totals	Avg IV	5.2%	Volume	2320	OI/ Nch	58325	17	Show All	ATMs Only	Totals	Avg IV	6.7%	Volume	2634	OI/ Nch	69437	5034
Last	Bid	Ask	IV Bid	IV Ask	IV Sprd b	Delta	Gamma	ExpDate	Strike	Last	Bid	Ask	IV Bid	IV Ask	IV Sprd b	Delta	Gamma
								20 Feb04	110	0.1400	0.1300		5.874%				
								20 Feb04	110.5			1.3500		13.838%		-0.3095	0.053503
								20 Feb04	111	0.2600							
								20 Feb04	111.5		0.3200	0.3600	5.487%	5.772%	29	-0.2244	0.108999
								20 Feb04	112		0.4400	0.4800	5.455%	5.706%	25	-0.2813	0.124191
								20 Feb04	112.5	0.6300	0.5900	0.6500	5.413%	5.757%	34	-0.3484	0.134877
								20 Feb04	113	0.7500							
1.0200								20 Feb04	113.5								
0.8000		1.0000		6.463%		0.4421	0.128223	20 Feb04	114								
								20 Feb04	114.5								
0.4300	0.4000	0.4400	5.063%	5.314%	25	0.2832	0.133757	20 Feb04	115								
	0.2800	0.3200	5.041%	5.329%	29	0.2219	0.117274	20 Feb04	115.5								
0.2200	0.1800	0.3000	4.932%	5.921%	99	0.1945	0.097677	20 Feb04	116								
0.1300	0.0300	0.1500	3.596%	5.274%	168	0.1222	0.080722	20 Feb04	116.5								
0.0900		0.0900		5.138%		0.0817	0.061733	20 Feb04	117								

Notes

- The screen shows calls and put prices for MAR 2004 Bund futures with various strikes within a 2% range of the underlying futures
- Using a pricing model, the system calculates the **implied volatilities** behind the observed bid and ask prices of these options, as well as the options' **deltas** and **gammas** (concepts that we shall discuss in more detail in module *Options Pricing and Risks – Implied Volatility*)

5.2. OTC Contracts

All terms are negotiable in the OTC markets, but in most cases:

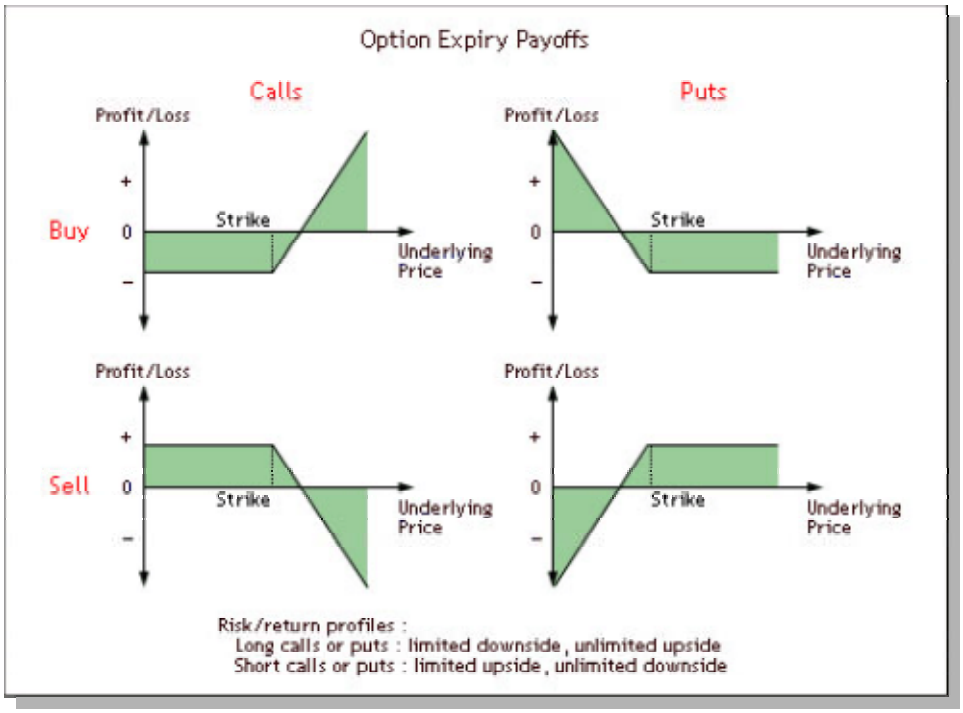
- Option buyers pay the premium up-front in full
- Option sellers may receive the premium up-front (if they have a dealing line with the buyer) but often they are required to place collateral with the buyer in the form of cash or the underlying securities.

6. Payoff Geometry

- **The downside to the option buyer is limited to the premium paid, but the upside is unlimited**

- **The upside to the option seller is limited to the premium received, but the downside is unlimited**

The risk/return profiles for options buyers and sellers at expiry are plotted in the figure below.



Explanation

- **Long a call**
  This is the type of position we analysed in detail in section *Trading Application*, where the premium paid was $3.00 per share and the strike was $102.00. The breakeven is $105.00 and the trader makes a profit if the underlying trades higher than that.

- **Short a call**
  This is the mirror image of buying a call. In our example in section *Trading Application*, the seller of the $102.00 call at $3.00 has maximum profit potential of $3.00 per share if the stock trades at or below $102.00 (i.e. the option expires ATM or OTM). Otherwise, he has potentially unlimited downside, as he has the obligation to deliver the underlying for $102.00, no matter how high is its market price.

- **Long a Put**
  We pay a premium for the right to sell the underlying at the strike.

  Example:
  Strategy: buy a $102.00 put
  Premium: $2.90 per share
  Analysis:
  - Maximum downside (= loss of $2.90) occurs if the underlying price is at or above the strike (the option expires ATM or OTM)
  - The option is exercised if the underlying price is below the strike (ITM)
  - Breakeven is $99.10 (= 102.00 - 2.90). The trade makes a net profit only if the stock trades below that level.

- **Short a Put**
  This is the mirror image of buying a put. A premium is received for the *obligation* to buy the underlying at the strike. The put seller effectively underwrites the underlying at the agreed strike.

  Example:
  Strategy: sell a $102.00 put
  Premium: $2.90 per share
  Analysis:
  - Maximum upside (= $2.90 profit) occurs if the underlying price is at or above the strike (the option expires ATM or OTM)
  - The option is exercised against the seller if the underlying price is below the strike (ITM)
  - Breakeven is $99.10 (= 102.00 - 2.90). The trade makes a net profit only if the stock is higher than $99.10.

Hedging the Risks of Selling Options

Many studies have shown that, statistically, option sellers tend to make money and option buyers tend to lose money - in other words, market prices are biased in favour of the seller.

However, short options positions expose the trader to potentially unlimited (or very large) losses, and there have been some spectacular examples of this in recent history. Professional option traders are very careful to hedge their exposure to adverse changes in the underlying price. They do so by holding compensating positions in the underlying instrument:

- **The seller of a call will go long in the underlying** in an amount such that trading losses on the short call, following a rise in the underlying price, are offset by profits on the long underlying position, and vice-versa

- **The seller of a put will go short in the underlying** in an amount such that trading losses on the short put, following a fall in the underlying price, are offset by profits on the short underlying position, and vice-versa

This technique, known as **delta-hedging**, will be explored in detail in Option Risks - Delta. An option position that is not delta-hedged is said to be a **naked position**.

7. Intrinsic Value

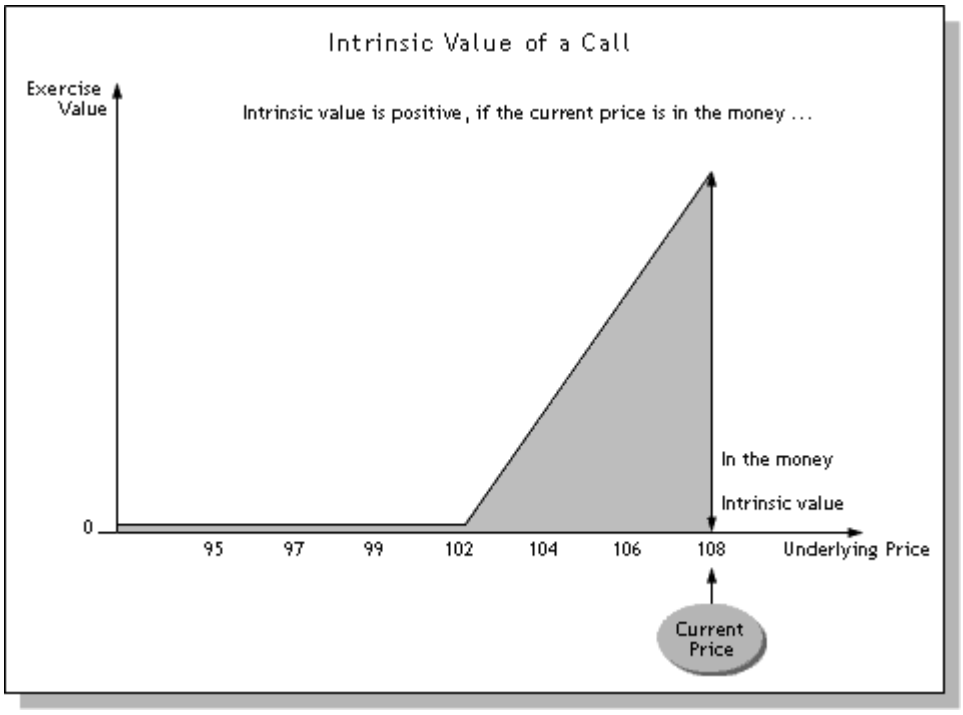
Intrinsic Value
The value that the option holder would realise if he could exercise his option immediately.

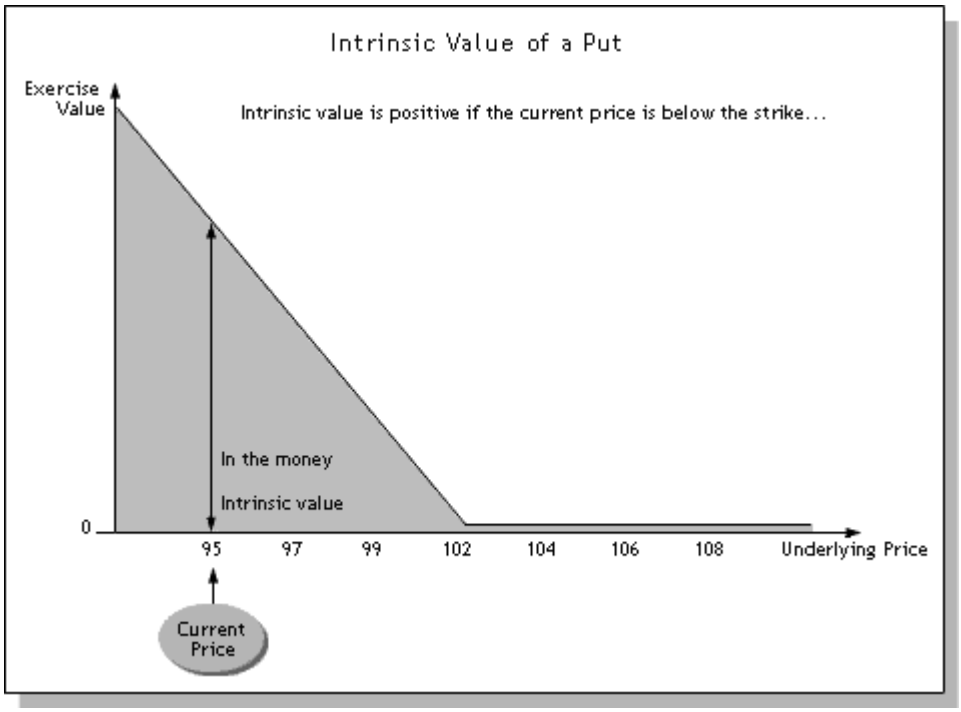
Also known as: **Expiry Value**, **Exercise Value**.

Example

Option	**Call**	**Put**
Style	American	American
Expiry	6 months	3 months
Strike	$102	$102
Intrinsic Value:		
Cash = $104	104 - 102 = $2	$0.0
Cash = $100	$0.0	102 - 100 = $2

The figures below show the intrinsic value of these options for different levels of the underlying.





- An option with positive intrinsic value is in the money (ITM)

- An option with no intrinsic value is:
  - Either at the money (ATM)
  - Or out of the money (OTM)

- Intrinsic value cannot be negative: an option either has some positive value or it has none.

Intrinsic value of American-style options:

- **Calls: MAX { Cash price of underlying - Strike, 0 }**
- **Puts: MAX { Strike - Cash price of underlying, 0 }**

Intrinsic value of European-style options:
Only holders of American-style options can realise intrinsic value before expiry. For a European-style option intrinsic value is a less straightforward concept, although in normal market parlance this is typically taken to mean the same as the intrinsic value of an American option.

We shall define the intrinsic value of European options more precisely in Option Pricing - Put Call Parity.

8. Time Value

8.1. Definition

Time Value (TV)
The amount which the buyer pays for the option, over-and-above its intrinsic value.

- TV of an ITM Option = Premium - Intrinsic value
- TV of an ATM or OTM Option = Premium

Also known as: **Extrinsic Value**

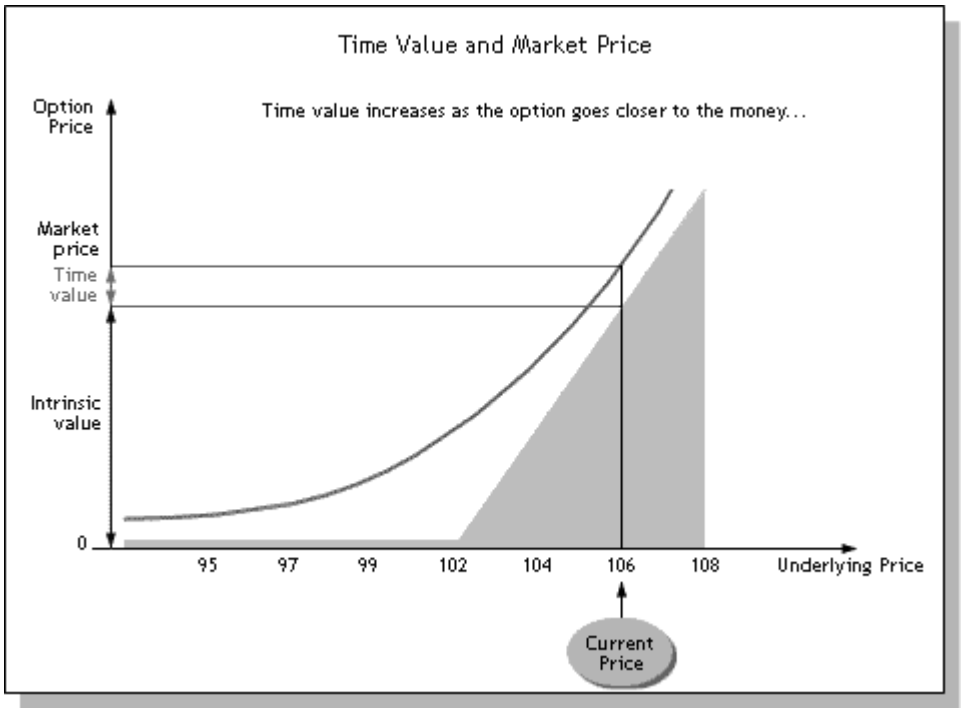
Example

Option: Call
Style: American
Strike: $102
Expiry: 6 months

The table below shows how we calculate time value given the option premiums, for different levels of the underlying.

Underlying price	**$100.00**	**$102.00**	**$104.00**
Option price	$0.80	$1.50	$2.90
Intrinsic value	$0.0	$0.0	104 - 102 = $2
Time value	$0.80	$1.50	2.90 - 2 = $0.90

We can see the pattern of the call's time value at different underlying price levels in the figure below.



In the figure, the shaded area shows the option's intrinsic value while the smooth curve, known as the **option price curve**, shows the relationship between the option price and the price of the underlying, other things being equal. The gap between the two is the option's time value.

8.2. Why do Options have Time Value?

OTM and ATM Options

The value of an option at expiry will depend on the extent to which it will be ITM, if at all. Time value is related to the probability that the option will expire ITM:

- In the example on the previous page, if the underlying trades at $100 it makes no sense to exercise the option now, but there is a chance that the market may rise above the option's strike of $102 over the next 6 months, so the market pays $0.80 for the bet

- At $102 it still makes no sense to exercise the option, but the probability of the underlying price rising above $102 is now higher, so the market pays $1.50 for the bet

The higher the volatility of the underlying price - and the longer the option has to run - the more the market will pay for these bets.

ITM Options

At $104 the option is worth at least $2 (its intrinsic value), but in fact the market pays $2.90, including $0.90 of time value. Why? For the moment consider:

1. At $104 an equivalent position in the underlying established at $102 would show a revaluation gain of $2 ($104 - $102) and would therefore be worth $2, mark to market

2. If the option is already ITM, every $1 rise in the underlying price increases its profit at expiry by a further $1 - the same as an equivalent position in the underlying

3. Likewise, every $1 fall in the underlying price reduces the profit on both positions by $1, except that:
   - For the call the losses are limited to the premium paid
   - For the underlying the losses are (virtually) unlimited

4. Therefore at $104 a call with a strike of $102 must be worth more, mark to market, than an equivalent position in the underlying.

For an ITM option time value represents an additional payment for the fact that the option is more 'disaster-proof' than an equivalent position in the underlying.

The higher the volatility of the underlying price - and the longer the option has to run - the more the market will pay for the option's disaster insurance.

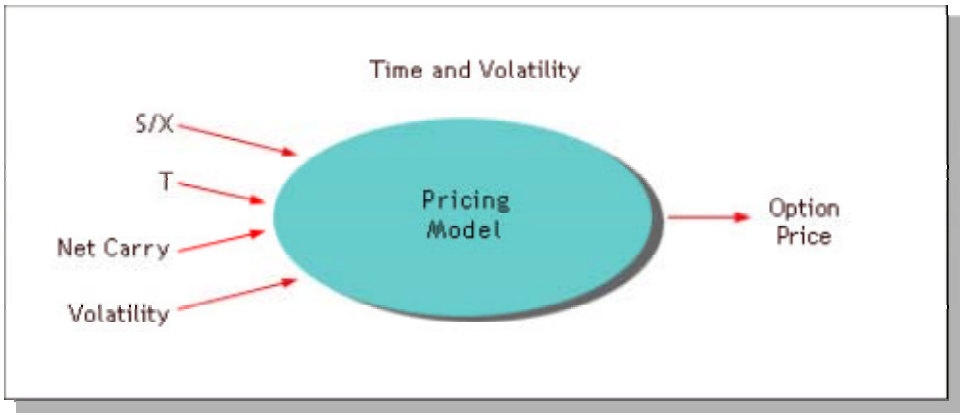
ATM Options

Time Value is highest for ATM options.

When the option is ATM the two key features of this instrument - its ‘betting’ and its ‘insurance’ value - are most prominent.

9. Summary

An option's premium price is a function of a number of market variables.



Factors affecting the option premium

- **Underlying price** (S) relative to the **strike** (X)
  Is the option ITM, ATM or OTM? This will determine its intrinsic value

- **Time to expiry** (T): shorter-dated options are cheaper than longer-dated options, because fewer things can happen to the underlying.

  Options are wasting assets!

- **Net carry**
  The option seller hedges their price risk by holding an offsetting position in the underlying (see Option Risks), so they will pass on to the buyer the net carry cost (or benefit) on that position

  Net carry = Yield on underlying – Cost of funding
  Positive carry: Yield > Funding cost
  Negative carry: Yield < Funding cost

- **Volatility**
  The more volatile the price of the underlying, the higher the chance that:
  - OTM options will expire ITM
  - ITM options will expire OTM - (so disaster protection is more valuable).

The higher the volatility, the higher is the time value of the option, hence its premium price.

All securities and derivatives give traders some exposure to market direction, to net carry and therefore to time. However, only options offer traders an additional exposure to market volatility. In Option Pricing we define this key concept rigorously, and in Options Strategies we explain how you can trade volatility.

10. Exercise

10.1. Question 1

Question 1

Below are premium prices for options on IBM stock, which currently trades at USD 65.00.

CME - IBM Options (USD per share)

	Calls		Puts	
Strike	MAR	JUN	MAR	JUN
60.00	7.80	8.30	2.25	2.50
70.00	3.30	4.20	6.75	7.10

a) Complete the table below: type your answer in each box and validate. Enter 'U' where the potential loss is unlimited or very large.

Strategy	**Max. Loss/ (U)nlimited**	**Max. Profit/ (U)nlimited**	**Breakeven**	**Intrinsic Value**	**Time Value**
Long MAR 60 call					
Long MAR 70 call					
Long JUN 70 call					
Short JUN 70 call					
Long MAR 60 put					
Short MAR 60 put					
Short MAR 70 put					

10.2. Question 2

Question 2

Below are premium prices for options on IBM stock, which currently trades at USD 65.00.

CME - IBM Options (USD per share)

	Calls		Puts	
Strike	MAR	JUN	MAR	JUN
60.00	7.80	8.30	2.25	2.50
70.00	3.30	4.20	6.75	7.10

Which one or more factors should someone who is bullish on IBM take into account when comparing the performance of:

a) The MAR 60 call with the MAR 70 call?

- ☐ The MAR 70 call has more downside risk
- ☐ The MAR 70 call has less downside risk
- ☐ The MAR 70 call has a lower breakeven
- ☐ The MAR 70 call has a higher breakeven

b) The MAR 70 call with the JUN 70 call?

- ☐ The JUN 70 call has less downside risk
- ☐ The JUN 70 call has a lower chance of expiring ITM
- ☐ The JUN 70 call has a better chance of expiring ITM
- ☐ The JUN 70 call has more downside risk

c) Which one or more of the strategies below would be appropriate to someone who is bearish on a market?

- ☐ Sell calls
- ☐ Sell puts
- ☐ Buy calls
- ☐ Buy puts