

CHAPTER 1

Derivative Securities

Aims

- To explain *forward and futures* contracts, their similarities and differences.
- To examine the basic concepts behind *call and put options* and how their payoffs at maturity can provide ‘insurance’.
- To show how *interest rate swaps* can be used to alter the cash flow profile of uncertain payments or receipts, and hence reduce the risk attached to such cash flows.
- To analyse how derivative securities are used in speculation, hedging and arbitrage.
- To explain short-selling.

There are three main types of derivative securities, namely futures, options and swaps. Derivative securities are assets whose price depends on the price of some other (underlying) asset. Hence the derivatives price is *derived* from the price of this underlying asset.

For example, let's assume a futures contract on AT&T stocks is traded on the Chicago Mercantile Exchange (CME). The underlying asset in the futures contract is the stock of AT&T itself, which is traded on a different exchange, namely the New York Stock Exchange (NYSE). The price of the stock on the NYSE is for immediate delivery of the stock, and is known as the *spot or cash market price*. In contrast, today's *futures price* (on AT&T stock) quoted in Chicago is a price quote for delivery of AT&T stock (in Chicago) *at a specific date in the future*. However, we can show that the AT&T futures price (in Chicago) is (largely) determined by the stock price of AT&T (quoted on the NYSE). If AT&T's stock price changes on the NYSE by \$1 (in the next few seconds) then the AT&T futures price will also immediately change by about \$1 on the Chicago futures exchange – even though the two markets are separated by around 1,000 km. The tight link between the spot/cash market price of AT&T in New York and the AT&T futures price in Chicago is due to a process known as (risk-free) arbitrage.

Derivatives are used by hedgers, speculators and arbitrageurs. Derivatives often receive a 'bad press', in part because there have been some quite spectacular derivatives losses. For example, in 1994 Nick Leeson, who worked for Barings Bank in Singapore, lost \$1.4bn when trading futures and options on the Nikkei 225, the Japanese stock index. This led to Barings going bust. In 1998, Long Term Capital Management (LTCM), a hedge fund which leveraged its trades using derivatives, had losses of over \$4bn and had to be rescued by a consortium of banks under the imprimatur of the Federal Reserve Board. This was somewhat ironic since Myron Scholes and Robert Merton, two academics who received the Nobel Prize for their work on derivatives, were key players in the LTCM debacle. Derivatives are a bit like nuclear fission – they can be used in 'good ways' (like low cost, low carbon electricity from nuclear power) or in 'bad ways' (like nuclear bombs) – if used incorrectly they may become 'financial weapons of mass destruction' – to quote Warren Buffett (2002). Let us now examine how derivatives are used in practice, so that you can begin to make up your own mind on this issue.

1.1 FORWARDS AND FUTURES

Forward and futures contracts are analytically very similar, although the way the two contracts are traded differ in some respects. A holder of a long (short) *forward contract* has an agreement to buy (sell) an asset at a certain time in the future for a certain price which is fixed today.

The *buyer (seller or short position)* in a *forward contract*:

- acquires a legal obligation to buy (sell) an asset (*the underlying*)
- at some specific future date (*maturity/expiry date*)
- in an amount (*contract size*)
- and at a price (*the forward price*) which is fixed today.

A *forward contract* is an over-the-counter (OTC) instrument, and trades take place directly between the buyer and seller as negotiated between the two parties (usually over the phone) for a specific amount and specific delivery date.

Originally, forward (and futures) markets were introduced to eliminate risk due to changes in the spot (cash market) price of agricultural commodities. For example, a farmer might know in April that he will harvest 5,000 bushels of wheat in September. A wholesaler who purchases grain for use in the food industry might know their requirements for wheat in September, as early as April. The two participants can eliminate (or hedge) risk by negotiating a contract to supply 5,000 bushels of grain in September at a price which is agreed in April – so the *September-forward price* is agreed in April but will not be paid until September, when the grain is delivered.

The forward contract (if held to maturity) eliminates risk for each side of the bargain. Both sides of the deal are 'locked in' to the forward price (of the September contract) quoted in April and thereby remove any 'price risk'. This is a 'natural hedge' since both sides of the

deal wish to ‘lock in’ a known forward price, quoted today, for delivery of wheat at a specific date (and location) in the future. If, when we get to September, the spot/cash market price of wheat (for immediate delivery) is very high or very low, this is of no consequence, since both parties to the forward contract have agreed to exchange wheat in September at the pre-agreed forward price.

If a *futures contract* on wheat is held to maturity then delivery of the underlying asset (wheat) takes place at the pre-agreed futures price and under these circumstances the futures contract is the same as a forward contract. Theoretically the quoted forward and futures prices will be the same if they are entered into at the same time (and with the same maturity date). Although futures contracts are very similar analytically to forward contracts, they do differ in certain practical aspects.

In a forward contract the terms in the contract (e.g. delivery quantity, delivery date, etc.) are ‘tailor made’ between two traders (a buyer and seller) whereas the terms of a *futures contract* are standardised (e.g. delivery quantity, delivery point, delivery dates, etc.). Also, trading in futures contracts takes place on an organised exchange, rather than over-the-counter as with forward contracts.

Consider wheat. The physical commodity wheat can be bought and sold for (near) *immediate delivery* in the *spot (cash) market* for wheat. When you buy or sell a futures contract on wheat, it is the ‘legal right’ to the terms in the futures contract that is being purchased or sold – you do not immediately receive the physical commodity ‘wheat’ when you buy a wheat futures contract. However, as we shall see, there is a close link between the futures price of wheat and the spot price for wheat but they are not the same thing – the spot price and the futures price are quoted in two different markets.

Futures contracts are traded between market makers in a ‘pit’ on the floor of the exchange, of which the largest are the Chicago Board of Trade (CBOT) and the Chicago Mercantile Exchange (CME) – which merged to form the CME Group in 2007. However, in recent years there has been a move away from trading by ‘open outcry’ in a ‘pit’ towards electronic trading between market makers (and also over the internet). The largest ‘pit trading’ futures exchange in Europe was the London International Financial Futures Exchange (LIFFE), which has now merged and become NYSE-Euronext – an electronic trading platform. You can also trade ‘out-of-hours’ in many futures contracts using the GLOBEX electronic trading platform. Some futures contracts that are traded on US exchanges are shown in Table 1.1.

1.1.1 Market Classification

A key feature of a futures contract is that it involves *deferred delivery* of the underlying asset (e.g. wheat, AT&T stocks), whereas spot (cash market) assets are for *immediate delivery* (although in practice, there is usually a delay of a few days). A primary use of derivative securities is to minimise price uncertainty. Therefore, where the underlying assets (e.g. currencies, stocks, oil, agricultural produce) are widely traded and yet their spot prices exhibit great volatility, there is likely to be a large active derivatives market.

TABLE 1.1 Selected futures contracts

Contract	Exchange	Contract size
1. Metals and petroleum		
Gold	CME Group (COMEX)	100 troy oz
Silver	CME Group (COMEX)	5,000 troy oz
Crude oil	CME Group (NYMEX)	1,000 barrels
Natural gas	CME Group (NYMEX)	10,000 mm Btu
2. Agricultural		
Corn	CME Group (CBOT)	5,000 bu
Lean hogs	CME	40,000 lbs
Pork bellies	CME	40,000 lbs
Frozen orange juice	ICE	15,000 lbs
3. Foreign currency		
British pound	CME	£62,500
Swiss franc	CME	SFr125,000
Euro	CME	€125,000
Japanese yen	CME	¥12.5m
4. Stock indices		
S&P 500	CME Group (CBOT)	\$250 × Index
FTSE 100	NYSE-Euronext	£10 × Index
Eurotop 100	NYSE-Euronext	€20 × Index
Nikkei 225	CME Group (CBOT)	\$5 × Index
5. Interest rates		
Eurodollar – 90 days	CME Group (IMM)	\$1,000,000
US T-bills	CME Group (IMM)	\$1,000,000
US T-bonds	CME Group (CBOT)	\$100,000
UK 3-month Euro LIBOR	NYSE-Euronext	£100,000
UK Long Gilt Futures	NYSE-Euronext	€1,000,000

Note: CBOT = Chicago Board of Trade (part of CME Group), CME = Chicago Mercantile Exchange, IMM = International Money Market (Chicago, part of CME Group), NYSE-Euronext (previously London International Financial Futures Exchange, LIFFE).

Trading in derivative securities can be on a trading floor (or ‘pit’) or via an electronic network of traders, within a well-established organised market (e.g. with a clearing house, membership rules, etc.). However, many derivatives contracts – for example, all FX-forward contracts and swap contracts – are traded in OTC markets, where the contract details are not standardised but individually negotiated between clients and dealers. Options are traded widely on exchanges but the OTC market in options (particularly ‘complex’ or ‘exotic’ options) is also very large.

Today there are a large number of exchanges which deal in futures contracts. Most can be categorised as either agricultural futures contracts (where the underlying ‘asset’ is, for example, pork bellies, live hogs or wheat), energy futures (e.g. crude oil, natural gas, heating oil), metallurgical futures (e.g. silver, platinum) or financial futures contracts (where the underlying asset could be a portfolio of stocks represented by the S&P 500, currencies, T-bills, T-bonds, Eurodollar Deposits, etc.). Agricultural, energy and metallurgical futures are often generically referred to as ‘commodity futures’. There are some futures contracts that do not really fit into any of these definitions, such as weather futures – which we meet later.

Futures contracts in agricultural commodities have been traded (e.g. on the CBOT) for over 100 years. In 1972 the CME began to trade currency futures, the introduction of interest rate futures occurred in 1975 and in 1982 stock index futures (colloquially known as ‘pinstripe pork bellies’) were introduced. The CBOT introduced a clearing house in 1925, where each party to the contract had to place ‘cash deposits’ into a margin account. The latter provides insurance if one of the parties defaults on the futures contract.

Analytically, forwards and futures can be treated in a similar fashion. However, they differ in some practical details (see Table 1.2). Forward contracts (usually) involve no ‘up front’ payment and ‘cash’ only changes hands at the maturity of the contract. A forward contract is negotiated between two parties and (generally) is not marketable. In contrast, a futures contract is traded in the futures market (in Chicago)¹ and when initiated, traders have to provide a cash deposit known as the *initial margin*. However, the initial margin is merely a form of collateral to ensure both parties can fulfil the terms of the futures contract – it is not a payment for the futures contract itself and it is not the ‘futures price’. The margin

TABLE 1.2 Forward and futures contracts

Forwards	Futures
Private (non-marketable) contract between two parties	Traded on an exchange
(Large) trades are not communicated to other market participants	Trades are immediately known by other market participants
Delivery or cash settlement at expiry	Contract is usually closed out prior to maturity
Usually one delivery date	Range of maturity dates
No cash paid until expiry	Cash payments into (out of) margin account, daily
Negotiable choice of delivery dates and size of contract	Standardised contracts

¹For ease of exposition here, we assume futures and options are traded in Chicago and any delivery at maturity of the underlying asset in these derivative contracts (e.g. gold, oil, live cattle, stocks, T-bonds) is also in Chicago.

usually earns a competitive interest rate so it is not a ‘cost’. As the futures price changes then ‘payments’ (i.e. debits and credits) are made into (or out of) the margin account. Hence a futures contract is a forward contract that is ‘marked-to-market’, daily.

Because the futures contract is marketable, the contracts have to be standardised – for example, by having a set of fixed delivery dates and a fixed ‘contract size’ (e.g. 1,000 barrels of oil for the oil futures contract or \$100,000 for the US T-bond futures contract). In contrast, a forward contract can be ‘tailor made’ between the two parties, in terms of size and delivery date. Finally, forward contracts almost invariably involve actual delivery of the underlying asset (e.g. currency) whereas futures contracts can be (and usually are) ‘closed out’ prior to maturity which cancels any delivery obligations.

Forward contracts can be used for speculation. First, consider a speculator who on 1 April thinks the gold (spot) price will be high in September. On 1 April she therefore ‘buys’ (‘goes long’) a September-forward contract on gold, but does not pay any cash on 1 April. If the spot price of gold rises (falls), the speculator will make a gain (loss) on the forward contract *at the time the contract matures in September*.

For example, suppose on 1 April ($t = 0$) the quoted spot (‘cash-market’) price of gold is $S_0 = \$1,000$ per oz and the gold forward price quoted in Chicago (for delivery in September, T) is $F_0 = \$1,010$ per oz. Assume the speculator is correct and the spot (cash market) price for gold in September (T) turns out to be higher at $S_T = \$1,200$ per oz. The speculator holding the (‘long’) forward contract can take delivery of the ‘physical’ gold (in the forward contract, in Chicago) for which she pays $F_0 = \$1,010$ in September. But she can now immediately sell the gold in the spot/cash market for $S_T = \$1,200$, giving an overall profit of \$190 per contract ($= S_T - F_0$).

Now consider speculation using *futures* contracts, which can be closed out at any time before maturity. Most futures contracts are closed out prior to maturity and when they are, the clearing house (CH) in Chicago sends out a cash payment which reflects *the change* in the futures prices between the opening trade and closing out the contract (i.e. a buy followed by a sell, or vice versa). Therefore futures contracts can be used for speculation over very short time horizons. Remember that the futures price moves (approximately) dollar-for-dollar with changes in the price of the underlying spot (‘cash-market’) asset. If you think the futures price will rise (fall) then today a speculator will buy (sell) a futures contract.

Suppose on 15 June you purchased a September-futures contract on stock-XYZ at a price $F_0 = \$100$ and one week later on 22 June you closed out the contract by selling it at its new price of $F_1 = \$110$.² Then the CH ‘effectively’ sends you a cheque for \$10 – the difference between your buying price and selling price. Simplifying a little, the CH obtains this \$10 from the person who initially sold the contract to you at \$100 and is now buying it back at \$110 – if you have gained \$10 then the ‘other side of the contract’ must have lost \$10. It also follows that a

²A more accurate notation for the September-futures price would be $F_{t,T}$ where today is time $t = 0$ (15 June) and the contract matures at time T (say, 15 September), so $F_{0,T} = \$100$. As we move through time (e.g. $t = 1$ month later = 15 July) then the ‘new’ quoted futures price for the September futures on 15 July is $F_{1,T} = \$120$ (for September delivery). However, we use the simpler notation F_0 and F_1 .

speculator would earn a \$10 profit if she initially sold a contract at $F_0 = \$100$ and later closed out the contract by *buying it back* at a lower price of $F_1 = \$90$ (i.e. ‘sell high, buy low’). The different types of futures contracts that can be traded is almost limitless but only those which are useful for hedging and speculation will continue to be traded. The exchange will cease to trade any futures contracts where the trading volume is below a certain threshold.

1.2 OPTIONS

Options are a little more difficult to understand than forwards and futures and here we present a quick introductory overview. While futures markets in commodities have existed since the middle of the 1800s, options contracts have been traded for a shorter period of time. There are two types of option, calls and puts:

The holder of a call (put) option has the right (but not an obligation) to buy (sell) the ‘underlying asset’ at some time in the future (‘maturity date’) at a known fixed price (the ‘strike price’, K) but she does not have to exercise this right.

Table 1.3 provides a summary of several types of option contract and the assets underlying these contracts.

TABLE 1.3 Selected option contracts

Options contract	Exchange	Contract size
1. Individual stocks (Stock options)	CBOE, NASDAQ PHLX, NYSE-Euronext	Usually for delivery of 100 stocks
2. Stock indexes (Index options)		
S&P 500 (SPX)	CBOE	\$100 × Index
FTSE 100	NYSE-Euronext	£10 × Index
S&P 100 Index (OEX)	CBOE	\$100 × Index
3. Foreign currency		
British pound	NASDAQ PHLX	£31,250
Japanese yen	NASDAQ PHLX	¥6.25m
Canadian dollar	NASDAQ PHLX	C\$50,000
Swiss franc	NASDAQ PHLX	SFr62,500
4. Futures Options		
S&P 500 Futures Index	CME	
US T-bill Futures	CME Group (IMM)	
US T-bond Futures	CME Group (IMM)	

Note: CBOE = Chicago Board Options Exchange, CME = Chicago Mercantile Exchange, IMM = International Money Market (Chicago, part of CME Group), NYSE-Euronext (previously London International Financial Futures Exchange, LIFFE). PHLX = Philadelphia Stock Exchange (part of NASDAQ).

For the moment we consider stock option contracts, so the underlying asset in the option contract is the stock of a particular company-XYZ which is traded on the NYSE. The option contract itself, we assume is traded in Chicago.

Above we noted that the holder of a long *futures* contract on a stock-XYZ commits herself to buy the stock at a certain price at a certain time in the future and if she does nothing before the maturity date, she will *have to* take delivery of stock-XYZ, at the pre-agreed futures price. In contrast, the holder of a (European) ‘call option’ on stock-XYZ can *decide* whether to pay the known strike price and take delivery of stock-XYZ on the maturity date of the option contract – this is called ‘exercising the option contract by taking delivery’. If it is advantageous *not* to exercise the option (in Chicago) then the holder of the call option will simply do nothing. For the privilege of being able to decide whether or not to take delivery of stock-XYZ (at maturity of the option contract) the buyer of the call option must pay an upfront, non-refundable fee – the option price (or premium).

The holder of a *European* call option can ‘exercise the option’, that is, take delivery and buy the stock-XYZ in Chicago for K – only on the maturity date (expiration date) of the option contract. But the holder of an *American* call option can ‘exercise the option’ contract in Chicago on any day (up to and including the maturity date).³ Below, we deal only with European options.

Note, however, that any option contracts you hold (whether American or European) can be *sold to* a third party, at any time prior to expiration – this is known as trading and allows *closing out* the option contract. If you ‘close out’ your call (or put) option contract then delivery (to you) of the underlying asset in the option contract, will not take place.

1.2.1 Call Options

If today you buy a *European call option* and pay the *call premium/price*, then this gives you the right (but not an obligation):

- to purchase the underlying asset
- at a designated delivery point
- on a specified future date (known as the *expiration or maturity date*)
- for a fixed known price (the *exercise or strike price*)
- and in an amount (*contract size*) which is fixed in advance.

For the moment, think of a call option as a ‘piece of paper’ that contains the contract details (e.g. strike price, maturity date, amount, delivery point, type of underlying asset). You can purchase this contract today in the options market in Chicago if you pay the quoted call premium. There are always two sides to every trade – a buyer and a seller – but we will concentrate on your trade, as a buyer of the option. Note that all transactions in the option contract

³There are two basic types of options: calls and puts (which can either be American or European).

TABLE 1.4 Leverage from options

	Chicago (options market)	NYSE (cash market)
15 July	Call premium, $C = \$3$ Strike price, $K = \$80$	Spot price, $S_0 = \$80$
25 October	Payoff = $\$8 = (\$88 - \$80)$ Profit = $\$5 = (\$8 - \$3)$ Returns = $\$5/\$3 = 167\%$	Spot price, $S_T = \$88$ Profit = $\$8 = (\$88 - \$80)$ Return = $\$8/\$80 = 10\%$

are undertaken in Chicago but the underlying asset, for example a stock, is traded on another exchange (e.g. NYSE).

Suppose the current price of stock-XYZ on the NYSE on 15 July is $S_0 = \$80$. On 15 July you can pay the call premium $C = \$3$ and buy (in Chicago) an October-European call option on the stock-XYZ. The strike price in the contract is $K = \$80$,⁴ and the expiry date T is in just over 3 months' time on 25 October. Because the maturity of the call is in October, and the strike is $K = \$80$, it is known as the 'October-80 call' (Table 1.4). Assume each call option is for delivery of one stock of XYZ.

1.2.2 Long Call: Speculation

How might a speculator use this call option contract? As we shall see, the speculator will buy the call option if she thinks stock prices will increase (sufficiently) in the future and end up above the strike price, K (on the option's maturity date). If stock prices do increase (sufficiently) then the speculator will make a profit when she exercises the call option (on 25 October, its maturity date).

For example, if the stock price on 25 October (on the NYSE) turns out to be $S_T = \$88$, then the holder of the call option can 'present' (i.e. exercise) the option contract in Chicago on 25 October (the maturity date of the option), pay the strike price $K = \$80$ and receive one stock. This is exercising the option by taking delivery. She could then immediately sell the stock on the NYSE for $S_T = \$88$, making a cash profit on 25 October equal to $S_T - K = \$88 - \$80 = \$8$. Alternatively, the long call option can be 'cash settled' for $S_T - K = \$8$ which is paid via the clearing house in Chicago (and no stock is delivered). In either of these scenarios (i.e. delivery or cash settlement) the option's speculator has made \$8 on an initial outlay of 'own funds' of $C = \$3$, which is a percentage return of $[(8 - 3)/3 \times 100\%] = 167\%$ (over a 3-month period).

Had the speculator bought the stock itself (with her 'own funds') for \$80 and then sold at $S_T = \$88$, she would have made a percentage return of 10% (i.e. \$8 on an initial outlay of \$80).

⁴When the strike price chosen for the option ($K = \$80$) is the same as the *current* stock price ($S_0 = 80$), then the option is said to be 'at-the-money' (ATM). If $S_0 > K$, the (call) option is currently said to be 'in-the-money' (ITM), and if $S_0 < K$ the option is said to be 'out-of-the-money' (OTM).

The much larger *percentage* return when using the call option arises because you can purchase the option for the relatively small payment of \$3, whereas the stock costs you \$80. The higher *percentage* return from the option (relative to the percentage return from buying the stock with your ‘own funds’) is called leverage – here, a 10% increase in the stock price gives rise to a 167% return on the option strategy.

If the stock price on 25 October turns out to be $S_T = \$75$ which is less than the strike price $K = \$80$ then the option is not worth exercising – after all, why pay $K = \$80$ for delivery of stock-XYZ in Chicago, when XYZ is only worth $S_T = \$75$ on the NYSE. In this case the option on 25 October is worth zero and the speculator ‘throws it away’ (i.e. does not present/exercise the option in Chicago). Note, however, that no matter how low the stock price turns out to be on 25 October, the maximum amount the option’s speculator can lose is known in advance and is equal to the call premium $C = \$3$.

So a speculator who buys a call option has some rather nice advantages – she can benefit substantially from any upside in the stock market but can never lose more than the (rather small) option premium of \$3 she initially paid, even if stock prices fall to zero. Contrast this with buying the stock on 15 July for $S_0 = \$80$ on the NYSE – this might lead to a maximum loss of \$80, if company-XYZ entered bankruptcy before 25 October.

1.2.3 Closing Out

When a speculator buys a call option she can make a profit if the stock price increases at any time before the maturity date of the option. She does this by selling (shorting) the call option to another options trader, after the stock price has increased – this is called ‘closing out’ (or ‘reversing’) her initial long position in the option. The speculator is able to make a profit because when stock-XYZ increases in price on the NYSE then this results in a rise in the call premium (on XYZ) in Chicago. For example, if stock-XYZ increases in price by \$2 over one day then the price of the call option (quoted in Chicago) may increase from say \$3 to $C_1 = \$4$, over one day. Hence the speculator who purchased the October-call for \$3 on 15 July, can now sell the call in Chicago on 16 July (to another options trader) for \$4. The speculator actually receives her \$4 from closing out the contract, via the options clearing house in Chicago. She therefore makes a speculative profit of \$1 ($= \$4 - \3), the difference between the buying and selling price of the call – a return of 33% ($= \$1/\3) over one day.

Conversely, after the speculator purchased the October-call for $C_0 = \$3$, on 15 July, if the stock price falls by \$1 (say) on the NYSE, then the October-call premium will fall to \$2.2 (say) and when she sells it to another trader (i.e. closes out) in Chicago, the options speculator will make a loss of \$0.8 on the deal (but she will never lose more than the initial option premium of \$3). Thus a *naked (or open) position* in a long call is risky.

1.2.4 Put Options

If you *buy* a European put option (in Chicago) this gives you the right *to sell* the underlying asset (in Chicago) at some time in the future, for a price which is fixed in the contract.

If today you buy a *European put option* and pay the *put premium/price*, then this gives you the right (but not an obligation):

- to sell the underlying asset at a
- specified future date (*the expiration/maturity date*) at a
- designated delivery point
- for a known fixed price (*strike/exercise price*)
- in an amount (*contract size*) which is fixed in advance.

1.2.5 Long Put: Speculation

A put option can be used for speculation. In contrast to speculation with a long call, a speculator will buy ('go long') a put option if she expects the stock price *to fall* in the future (and end up below the strike price). Suppose on 15 July the stock price for company-XYZ is $S_0 = \$72$ on the NYSE and a speculator thinks the stock price will fall in the future. Assume the speculator is not going to gamble on the price fall by using stock-XYZ, itself. Instead, on 15 July the speculator buys (in Chicago) a European 'October-put' (expiry date is 25 October) with a strike price $K = \$70$ for a put premium paid of $P = \$2.2$.

Suppose the spot price of stock-XYZ on the NYSE on 25 October is $S_T = \$65$ (i.e. below $K = \$70$). Then on 25 October the speculator can purchase stock-XYZ on the NYSE for $S_T = \$65$ and then immediately 'deliver' stock-XYZ in Chicago along with the put contract and receive $K = \$70$, given the terms in the put contract. The options speculator makes a profit of $(K - S_T) = \$70 - \$65 = \$5$ on 25 October. Alternatively, the speculator can simply 'cash settle' the long put contract, in which case the options clearing house makes a cash payment of $(K - S_T) = \$5$ when the long put is 'cash settled' on 25 October (and the holder of the long put does not have to deliver stock-XYZ).

In either of the above cases the speculator who is long the put, receives \$5 on 25 October. The speculator's initial outlay was the put premium of $P = \$2.2$ paid on 15 July. The speculator by using the (long) put contract to speculate on a future stock price fall, has made a percentage return of 127% ($= [(5 - 2.2)/2.2]100\%$), over a 3-month period. The fall in the stock price is 9.7% ($[(S_T - S_0)/S_0 = (65 - 72)/72]$). But the *percentage* return from investing in the long put (and exercising the put at maturity) is much larger at 127%. Hence, buying the put option for $P = \$2.2$ has provided a leveraged return for the speculator.

If the spot price of stock-XYZ on the NYSE on 25 October turns out to be higher than the strike price (e.g. $S_T = \$73$, $K = \$70$) then the put option will not be exercised. Why would a speculator who holds the put, buy the stock for \$73 on the NYSE on 25 October, if she could then only obtain $K = \$70$ by delivering the stock and exercising her put contract in Chicago? The put option is therefore worth zero on 25 October and the speculator 'throws it away' (i.e. does not exercise the option). But the most the speculator with a long put can lose is the put premium of $P = \$2.2$. So a speculator who is long a put option can benefit from a sufficiently large *fall* in the price of stock-XYZ – but if she guesses wrong and the stock price rises, she can never lose more than the (rather small) put premium initially paid.

1.2.6 Long Put plus Stock: Insurance

Options can also be used to provide *insurance*. For example, suppose you run a pension fund and *already own* stocks whose current price on 15 July (on NYSE) is $S_0 = \$72$. But you are worried about a fall in price of the stocks between now and 25 October when your stocks will be sold to provide lump sum payments to pensioners. Well, you can ‘insure’ your stocks by buying an October-put option with a strike price of, say, $K = \$70$ (with maturity date 25 October). Note that in this example you hold two assets: the stock-XYZ and a put option (on stock-XYZ).

If stock prices in New York fall to $S_T = \$30$ on 25 October, then instead of selling your stocks in New York at $S_T = \$30$, you can exercise your October-put option in Chicago, which means delivering your stock-XYZ in Chicago and you will receive $K = \$70$ for each stock (from the options clearing house). By buying the put option on 15 July, you have guaranteed a minimum price of $K = \$70$ on 25 October at which you can sell the stocks-XYZ, held by the pension fund. The cost of this ‘insurance’ is the put premium $P = \$2.2$ paid on 15 July. True, the pension fund has lost \$2 per stock as the initial price of the stock was $S_0 = \$72$ in July since the pension fund can only obtain $K = \$70$ when they deliver the stock and exercise the put option in Chicago – the \$2 is the ‘deductible’ in the put insurance contract.⁵ Losing \$2 per stock because you had the foresight to take out insurance by buying a put option (with $K = \$70$), is a lot better than if you had not purchased the put, since then your stocks-XYZ would have fallen in value by \$42 ($= 72 - 30$) on the NYSE.

How does this ‘options insurance contract’ look if prices rise over the next 3 months? Suppose prices rise on the NYSE from $S_0 = \$72$ in July to $S_T = \$80$ in October. Then your long put is worthless as the pension fund would not ‘deliver’ (sell) its stocks in Chicago for $K = \$70$ (using the stocks and the put) when it can sell its stocks in New York for $S_T = \$80$. Indeed the pension fund will ‘throw away’ (i.e. not exercise) the put option in Chicago and will sell stocks-XYZ on the NYSE for \$80 – so the pension fund (and the new pensioners) will be very happy.

The insurance policy provided by the ‘stock+put’ has allowed the pension fund to fix a *minimum selling price* of $K = \$70$ at which it can sell its stock holdings on 25 October, by exercising the October-put contract in Chicago. No matter how low the stock price on the NYSE on 25 October, the pension fund – by exercising the put option – can secure a minimum price of $K = \$70$. But the ‘stock+put’ also allows the pension fund to benefit from any ‘upside’ if stock prices rise, because then the pension fund simply sells its stocks-XYZ on the NYSE at the high price. There are many types of situation that can be analysed using an options approach and some of these are discussed in Finance Blog 1.1.

⁵Given the current stock price $S_0 = \$72$, if you had purchased a put with a strike price of $K = \$72$ (i.e. an ATM put) this would guarantee a minimum selling price of \$72 on 25 October – hence you would not lose anything (other than the put premium). But a put with $K = \$72$ would cost you more than the $P = \$2$ you paid for the put with a strike of $K = \$70$ (see later chapters).

Finance Blog 1.1 Hidden Options

Aristotle in Book I of *Politics*, mentions the Greek philosopher Thales who developed a ‘financial device’ which was in fact an option. One winter he ‘read the stars’ and decided that next autumn would result in an exceptionally good olive harvest. He therefore quietly went around the owners of olive presses and paid them a small retainer (i.e. the call option premium) to secure the right to be first to use their olive presses in the autumn, for a fixed price (the strike price), if he so wished. Come autumn, the harvest was good and therefore the demand for the olive presses was high and Thales could charge a high price to the olive growers to let them use the olive presses, but Thales only paid the lower strike price to the owners of the olive presses. Even if Thales had been wrong about the harvest, the most he could have lost was the small option premium he initially paid to the owners of the olive presses.

Although some people may not be aware of it, they probably hold options. For example, consider rural bus services whose fares are often subsidised via local government taxes (e.g. sales taxes and community charges). If you live out of town, you have the option to take the bus into town by paying the known fixed fare (= strike price). You will do this if the value of your journey on that day by bus exceeds the fixed fare (strike price). Hence, if you live out of town you are holding an implicit call option and the call premium is that part of your local taxes that goes to subsidise the bus company. You may never use the bus but the option to use the bus (e.g. if your car breaks down) has a positive value to you and hence you may be willing to see the rural bus service subsidised by local taxes.

Next, suppose in January you have been offered a place at one of *several* universities, if you achieve a grade B (or above) in your examinations in June. You will make your final decision about attending a specific university or not, in September. The (implicit) option premium you pay is the time and effort you put into studying between January and June. You have nine months to decide on your choice of ‘the best’ university for you (i.e. the time to maturity of the option), which is conditional on getting appropriate grade B or above in the June exams.

In September, if you decide to go to a university, you will have to ‘pay’ the strike price (i.e. tuition and living expenses and income foregone while attending the course). In September you will choose that university with the largest net payoff $S_T - K > 0$ where S_T is the (expected) present value of your *additional* earnings after graduating from a particular university. If $S_T - K > 0$ then you will ‘take delivery’ of one of the university courses, so the option you have is a ‘call option’. Of course if $S_T < K$ then you will choose not to go to university (and instead look for a job) – that is, you will not exercise your ‘call option’, as your extra post-university earnings do not cover the costs of attending university.

The above is a type of *exotic option* since in September you are allowed to choose that university which maximises the possible payoffs $S_T - K$ across the *different* universities who

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have made you an offer. Because you can choose that university with the highest payoff (i.e. the largest value of $S_T - K$) then this is known as a *rainbow option* (or *min-max option*).

Suppose it is January so you do not yet have your June examination results. You are holding a form of exotic option known as a *barrier option*. If your intellectual prowess increases and you achieve the grade B in June, then you cross the exam barrier and the option ‘knocks in’ (i.e. comes ‘alive’) and can be exercised later (in September), if you wish.

To be even more precise you are holding a *knock-in, rainbow call option*. If you do not achieve the grade B in June, then all your university offers are void and your implicit option expires worthless in June. All that effort spent studying (i.e. the implicit option premium) will not help you get into any of your chosen ‘top’ universities in September. The option you hold is a *path dependent rainbow barrier option*, since the final payoff in September (i.e. your choice of the ‘best’ university) depends on whether you achieved at least a B-grade at an earlier date on your path to success (i.e. in your examinations in June).

Source: Adapted from Cuthbertson and Nitzsche (2001).

1.3 SWAPS

Swaps are another type of derivative contract which first appeared in the early 1980s. They are primarily used for hedging interest rate or exchange rate risk *over many future periods*.

A swap is a negotiated (OTC) agreement between two parties to exchange cash flows over a series of pre-specified future dates (‘reset dates’).

A plain vanilla interest rate swap involves a periodic exchange of interest payments. One set of future interest payments are at a fixed swap rate, $sp_0 = 3\%$ p.a. (say), which is determined when the swap is initiated. The other set of interest payments are determined by the prevailing level of some ‘floating’ interest rate (usually LIBOR). The swap will be based on a notional principal amount of \$100m, say.

For example, in July 2018 a US firm ‘BigBurger’ might have a swap-deal with JPMorgan where BigBurger has agreed to receive annual interest payments from the swap dealer based on (USD) LIBOR rates on 15 July 2019 and on 15 July 2020 (the reset dates). BigBurger also agrees to pay the swap dealer (JPMorgan) a *fixed* swap rate of $sp_0 = 3\%$ p.a., on these dates (on a notional principal amount of \$100m). BigBurger is a ‘floating-rate receiver’ and a ‘fixed-rate payer’ in the swap. The payments are based on a \$100m (notional) principal amount, but only the interest payments are exchanged (and not the \$100m principal itself). The maturity of the swap, the reset dates, notional principal, the fixed swap rate and the type of floating rate (usually LIBOR) to be used in the swap deal are set at the outset of the contract.

The agreed swap rate is $sp_0 = 3\%$ p.a. Suppose LIBOR rates turn out to be $LIBOR_1 = 5\%$ on 15 July 2019 and $LIBOR_2 = 2\%$ on 15 July 2020. Then on 15 July 2019 the swap dealer

JPMorgan owes BigBurger, \$5m in interest based on $\text{LIBOR}_1 = 5\%$ and BigBurger owes JPMorgan (the swap dealer) \$3m based on the fixed swap rate of $sp_0 = 3\%$, hence:

$$\text{Swap dealer's payoff to BigBurger} = \$100\text{m} (\text{LIBOR}_1 - sp_0) = \$2\text{m}$$

On 15 July 2020 the swap dealer owes BigBurger \$2m based on the out-turn $\text{LIBOR}_2 = 2\%$ and BigBurger owes the swap dealer \$3m (based on $sp_0 = 3\%$). So on 15 July 2020, BigBurger pays the swap dealer \$1m:

$$\text{Swap dealer's payoff to BigBurger} = \$100\text{m} (\text{LIBOR}_2 - sp_0) = -\$1\text{m}$$

The negative sign indicates that it is actually BigBurger who pays \$1m to the swap dealer (JPMorgan).⁶

Suppose BigBurger has a bank loan of \$100m (say) with Citibank with interest payments (each year) based on future values of LIBOR. If BigBurger, in July 2018, also has a 'receive-fixed, pay-float (LIBOR)' interest rate swap (with JPMorgan), at a fixed swap rate of $sp_0 = 3\%$ p.a. (say) then the 'effective cost' of the bank loan to BigBurger at any future reset date, T , is:

$$\begin{aligned} \text{Effective cost} &= \text{Loan interest} - \text{Payoff to firm-A from swap} \\ &= \$100\text{m } \text{LIBOR}_T - \$100\text{m} (\text{LIBOR} - sp_0) = \$100\text{m } sp_0 \end{aligned}$$

Hence, the net effect is that BigBurger pays the known fixed swap rate of $sp_0 = 3\%$ p.a., regardless of whether the out-turn value for LIBOR is low at 2% p.a. or high at 5% p.a. Of course, with the swap in place, this means that BigBurger cannot take advantage of low LIBOR loan rates in the future, should they occur. On the other hand, BigBurger only has to pay an effective interest rate on the loan of $sp_0 = 3\%$ p.a., even if LIBOR turns out to be high at 5% p.a. So in July 2018 if BigBurger really does want to 'lock in' an effective loan rate equal to $sp_0 = 3\%$ p.a. (on the next two loan interest rate reset dates) then it will take out a 'receive fixed-pay floating (LIBOR)' interest rate swap with JPMorgan.

The intermediaries in a swap transaction are usually large investment banks who act as swap dealers. They are usually members of the International Swaps and Derivatives Association (ISDA) who provide some standardisation in swap agreements via the *master swap agreement*, which can then be adapted where necessary to accommodate most customer requirements. Dealers make profits via the bid-ask spread (on the fixed leg of the swap) and might also charge a small brokerage fee for setting up the swap.

⁶As we see in later chapters this swap is just like two Floating Rate Agreements (FRAs). One FRA applies to the LIBOR rate on 15 July 2019 and the second FRA applies to the LIBOR rate on 15 July 2020 and both FRAs have the same 'fixed' FRA rate, equal to the swap rate of 3% p.a. Therefore the interest rate swap is analytically equivalent to two FRAs which mature on 15 July 2019 and the second on 15 July 2020.

1.4 HEDGING, SPECULATION, AND ARBITRAGE

Part of the reason for the success of both futures and options is that they provide opportunities for hedging, speculation, and arbitrage.

1.4.1 Hedgers

Examples of hedging using the *forward market* in foreign exchange are perhaps most common to the lay person. If a US exporter expects to receive £3,000 in 3 months, then the US exporter can buy dollars today in the forward market at the 3-month forward FX-rate, $F = 1.5$ (\$/£). The key feature is that today, the US company fixes the amount of USD it will receive at \$4,500, in exchange for the £3,000 it provides, in 3 months' time.

Futures contracts *if held to maturity*, are like forward contracts – they fix the price that the hedger will pay or receive at maturity of the futures contract. However, it can be shown that even if the futures contract is closed out before maturity much of the risk can be hedged, but a small amount does remain (this is known as *basis risk*).

Options contracts provide 'insurance'. Investors in options can protect themselves against adverse price movements in the future but they still retain the possibility of benefiting from any favourable price movements. To obtain this insurance, the option's purchaser ('the long') of either a call or a put has to pay the option premium, today.

For example, a US exporter to the UK can 'insure' (i.e. set a lower limit for) her future US dollar receipts in 3 months' time, if today she buys a put option on sterling at a strike price of $K = 2$ (\$/£, USD/GBP), which matures in 3 months. Suppose the put option is for 'delivery' of £3,000. The put option implies she will receive a minimum of $K = 2$ USD/GBP by exercising her put in Chicago in 3 months' time – so the minimum she will receive from exercising the put is \$6,000 (even if the quoted spot-FX rate in 3 months' time is $S_T = 1.5$ USD/GBP, say). But if in 3 months' time, the spot exchange rate is $S_T = 2.1$ USD/GBP, she can 'walk away' from the put option contract (i.e. not exercise the put) and exchange her £3,000 at the higher spot rate (and receive \$6,300 from the spot FX-dealer). For the privilege of having this 'option' to choose the best outcome in the future, she has to pay the put premium, at the outset.

1.4.2 Speculators and Leverage

We have seen that because the call option premium is small relative to the price of the underlying asset, then speculation with calls can provide a high percentage return on the 'own capital' used to purchase the option. In our above examples, buying a call option on stocks gave a return of 167%, whereas buying the stock itself only produced a return of 10% – options therefore provide leverage.

Leverage also applies to futures contracts because a speculator does not have to provide any of her own funds. Suppose on 25 January you ring up Chicago and buy a 'June-futures' contract (on stocks-ABC) at a price of $F_0 = \$90$. Assume the futures matures on 25 June. In January

you do not pay any money – here we ignore (so-called) margin requirements which are small and earn a competitive interest rate, and therefore are not a cost. Suppose on 15 March, you close out your June-futures contract in Chicago by selling at the market price of $F_1 = \$100$. You make a cash profit of $F_1 - F_0 = \$10$, on 15 March. Because the futures trade (buying then selling) does not require any ‘own funds’, the *percentage* return and hence leverage is infinite.

By using futures, speculators can make very large losses as well as very large gains. However, there is a difference between futures and options. In the case of futures the potential loss or gain can be very large. But when call or put options are purchased by speculators, the speculator’s loss is limited to the option premium, yet the upside can be very large.

1.4.3 Arbitrageurs

Arbitrage involves ‘locking in’ a riskless profit by entering into transactions in two or more markets simultaneously. Usually ‘arbitrage’ implies that the investor does not use any of his own capital when making the trades. Arbitrage plays a very important role in the determination of both futures and options prices as we shall see in later chapters. Arbitrage is often loosely referred to as the ‘law of one price’ for financial assets. Simply expressed, this implies that identical assets must sell for the same price. We consider a very simple example of arbitrage in Finance Blog 1.2.

Finance Blog 1.2 Arbitrage: Dolly the Sheep

By way of an analogy consider ‘Dolly’ the sheep. You will remember that Dolly was cloned by scientists at Edinburgh University and was an exact replica of a ‘real’ Highland sheep. Dolly and real Highland sheep are identical and indistinguishable. Dolly is a form of genetic engineering or ‘synthetic’ or ‘replication’ sheep. Assume we could engineer ‘Dolly’ in Edinburgh at a cost (in terms of wages and equipment) of £200 per Dolly. So you can purchase a Dolly in Edinburgh for £200.

Suppose the current market price of real sheep being sold in the local market in the Highlands is £220. ‘Sheep arbitrageurs’ sitting in London seeing these prices on their internet screens would (ethical issues aside) buy a ‘replication’ Dolly in Edinburgh for £200 and simultaneously they would sell Dolly in the local market in the Highlands for £220 making an arbitrage (risk-free) profit of £20. (We ignore any transportation costs of getting Dolly from Edinburgh to the Highlands.)

This increase in demand for a Dolly in Edinburgh and sale of a Dolly in the Highlands (by many arbitrageurs in London doing the same trades) would mean the price of a Dolly would be bid up in Edinburgh and the price of a Dolly in the Highlands would fall – this is ‘supply and demand’ at work. Arbitrage and ‘supply and demand’ would ensure that the price of a Dolly in Edinburgh and the Highlands would quickly move to equality at

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say £210 for each – at which point arbitrage activity would stop – since there are now no risk-free profits to be made. Economists would say that £210 is the current *equilibrium price* of a Dolly.

Arbitrage ensures that the price of real Highland sheep must eventually equal the cost of producing an identical ‘Dolly replicant’. Dolly is like a ‘synthetic’ or ‘replication’ portfolio in financial economics. As we shall see, this is how we price many derivatives – we create a ‘synthetic’ or ‘replication’ portfolio, which has identical payoffs to the derivative itself.

Larry Summers, a prominent US economist (and previous US Secretary of the Treasury) rather impishly characterised the difference between economists and traditional finance specialists with the following analogy. He said that economists are interested in why, for example, the price of a bottle of ketchup moves up and down (e.g. because of changes in incomes, relative prices, innovation in production processes, etc.), while finance specialists are only interested in whether a 16 oz bottle of ketchup sells for the same price as two 8 oz bottles. He’s only half right.

1.5 SHORT-SELLING

If an investor purchases a security (e.g. stocks) she is said to *go long* and if she sells a security *she owns*, she is said to *go short*. However, if she sells a security *that she does not own* this is known as short-selling. Hedging may involve short-selling, so we outline the main features here.

Suppose a speculator (Ms Short) thinks a particular stock will fall in price in the future but she does not own the stock. She may be able to make a profit by short-selling. Initially, she borrows the stock from her *prime broker* (e.g. Goldman’s) for an agreed time period. The prime broker may already hold the stock on behalf of another client in a custodial account or the broker has to ‘locate’ the stock, which may be borrowed from another bank (JPMorgan) or fund management company (Fidelity) or pension fund (Legal and General [L&G]), who hold stocks ‘on behalf of their customers’ in a custodial account. Suppose Ms Short sells Apple stock (which her broker has borrowed from L&G) for \$100 (and the stock is purchased by AXA insurance company). If the price falls over the next month to say \$90, then she can repurchase Apple stock in the market at \$90, return the stock to her broker, thus pocketing the difference of \$10.

If the Apple stock pays dividends over the period of the short-sale⁷ then Ms Short has to pay an equivalent cash amount to her broker (which is then passed on to L&G). Of course,

⁷This is referred to as the stock going ‘ex-dividend’ which means that AXA Insurance Company (which currently owns the stock) will receive the next dividend payment. But L&G, the initial owner of the stock is expecting to receive the dividend. Hence, Ms Short has to provide the dividend for L&G from her own funds.

if the stock price rises and Ms Short has to close out, then she will make a loss (which can increase without limit). In the US you can only short-sell on an ‘uptick’ (i.e. only if the last change in price was positive).

Short-selling is risky for the prime broker (Goldman’s), as in the future Ms Short may not ‘replace’ the stocks she has borrowed and sold in the open market. So the broker requires the cash proceeds from the short-sale to be held at the brokerage firm (e.g. Goldman’s)⁸ and will also require an additional margin payment (of say 50% of the value of the short-sale) as further ‘collateral’ (i.e. a ‘good faith’ deposit).⁹ Further margin calls may be made if the stock price subsequently rises. However, if the stock price subsequently falls, Ms Short’s short position is worth more and then she may be allowed to withdraw any surplus cash from her margin account.

The calculation of the (percent) rate of return from short-selling is often based on the initial receipts from the sale of the stocks.¹⁰ For example, suppose Ms Short short-sells 100 Apple stocks at \$2 per stock and buys them back later at \$1.50. Assume the \$200 proceeds from the short-sale cannot be used by Ms Short (and are held as collateral by the broker, who usually pays interest on these funds).

Assume the dividend yield on the stocks is $d = 5\%$ and these dividends accrue over the period Ms Short has short-sold the stocks. Any dividend payments (over the period Ms Short borrows the stocks) must be paid to L&G (via her prime broker’s account) and are equal to \$10 ($= 5\% \times \200). If we ignore the interest and commission costs of short-selling then the return on the short sale is:

$$\begin{aligned} \text{Return} &= \frac{\text{Net profit}}{\text{Proceeds from short-sale}} = \frac{\$200 - \$150 - \$10}{\$200} \\ &= \frac{\$40}{\$200} = 0.20 \text{ (20\%)} \end{aligned} \quad (1.1)$$

$$\begin{aligned} \text{Return short-sale} &= \% \text{Price fall} - \% \text{Dividend yield} = (P_0 - P_1)/P_0 - d = 25\% - 5\% = 20\% \\ &= -(\% \text{Price rise} + \% \text{Dividend yield}) \end{aligned}$$

Hence, the (simplified) return to the short-seller is simply the return to a *purchaser* of a stock, but with the sign reversed. Finally, note that the broker usually takes a small

⁸If Ms Short deposits the proceeds of the short-sale with her broker as cash, then the broker usually pays interest (at LIBOR minus a spread) on these funds, which is often referred to as ‘short interest rebate’.

⁹If the short-seller borrows funds (from a bank) to provide the margin payment, then the short will incur a ‘margin cost’ at LIBOR+spread. If the margin payment consists of other securities owned by Ms Short (e.g. T-bills) then she will earn the risk-free T-bill rate on this collateral, so it is not a ‘cost’ to Ms Short – although her broker may apply a ‘haircut’ and only allow 90% of the collateral to earn interest.

¹⁰An alternative is to use ‘own funds’ in the form of any collateral, lodged with the broker by the short-seller, as the denominator when measuring the return. We do not pursue this here.

(percentage) commission for organising the short-sale, sometimes referred to colloquially as a 'haircut' and this should also be deducted when calculating the above return.¹¹

1.6 SUMMARY

- In a *forward contract*, the forward price is agreed today, for delivery of the underlying asset in the contract (e.g. foreign exchange, stocks-XYZ, barrels of oil), at a specific place and specific date in the future (maturity date). Forward contracts are usually held to maturity, when delivery of the underlying asset takes place.
- *Forward contracts* are over-the-counter (OTC) agreements whose terms (e.g. 'size', delivery date, delivery point and forward price) are negotiated between two counterparties, today.
- *Futures contracts* if held to maturity are very similar to forward contracts. However, futures contracts are standardised (e.g. fixed contract size, delivery dates, etc.), are traded on exchanges and the futures price fluctuates and is observable continuously on the exchange (or electronic platform).
- A buyer or seller of a futures contract has to immediately provide a 'good faith deposit' which is known as the initial margin (on which interest is usually paid). The initial margin is not the 'price' of the futures contract.
- Most futures contracts are closed out before maturity. The profit from an initial long (buy) futures position is the difference between the final selling price (when the contract is closed out) and the initial price paid. The profit from an initial short (sell) futures position is the difference between the selling price and the price at which you 'buy-back' the contract. Futures contracts are 'contracts for differences'.
- Futures contracts can be used for hedging or speculation. They only require a small upfront amount of capital placed with the clearing house known as the 'margin payment'. Hence, for a speculator futures contracts provide 'leverage'.
- *Options contracts* can be used to provide 'insurance'. If you *plan* to purchase stocks in the future and are worried their price might rise, then by purchasing a call option today you can fix the *maximum* price at K (the strike price) you will have to pay for the stocks in the future. But you can also take advantage of low stock prices should they occur, by

¹¹Often speculators take a long-short position on different stocks. The total return involved to a *long-short* position involves several payments and receipts on both the long (buy) and short (sell) side of the trade. These elements combined give the total return on the long-short position which comprises: Total return = Price return to the long position + Price return to short position + Dividend income from the long position + Interest earned on any excess cash in brokerage account + 'Short' interest rebate – Commission costs ('haircut') of borrowing shares (for the short sale) – Dividend payments on the short position – Margin (interest) costs on collateral borrowed to finance the short position – Interest cost of any borrowed funds to leverage a long position.

not exercising the call option and instead purchasing the stocks at the low cash-market price on the NYSE.

- If you *already own stocks* and you are worried that their price might fall in the future, you can buy a put option which will fix the *minimum* price ($= K$) you will receive when you deliver your stocks in the futures contract and receive the strike price K at maturity of the put contract. On the other hand, if stock prices rise (above K) you do not exercise the put option but sell your stock at the high cash-market price on the NYSE.
- Options can be used for speculation without having to provide much capital (own funds) since you only pay a ‘small’ option premium (i.e. ‘small’, relative to the spot (cash-market) price of the underlying asset). So options provide *leverage*.
- Acting as a speculator, if you think stock prices will rise (fall) in the future you would buy a call (put) option, today. The most a speculator can lose when buying calls or puts are the respective option premia. But the potential upside for calls (puts) can be very large if there is a large rise (fall) in the stock price.
- An interest rate swap allows you to switch from paying an uncertain LIBOR interest rate in the future (e.g. on a bank loan) and instead to end up paying a known fixed interest rate (over the life of the swap contract).
- Short-selling stocks allows speculators to take advantage of a future fall in stock prices, even if they do not currently own the stock – they borrow the stock from their broker and sell it, hoping to buy it back at a lower price in the future.

EXERCISES

Question 1

Why are futures and options contracts generically referred to as ‘derivatives’?

Question 2

You are a US exporter (‘USam’) who will receive €10m in 6 months’ time from the sale of Barbie dolls in Euroland. How can you hedge your foreign exchange FX risk using a forward contract?

Question 3

As a speculator, how does going long a futures contract on a stock give you ‘leverage’ compared with using your own funds to buy the stock? Use $F_0 = \$101$ and $S_0 = \$100$, with out-turn values (3 months later) of $F_1 = \$111$ and $S_1 = \$110$.

Question 4

Under what circumstances would you make a profit at maturity T , from a long position in futures contract on ‘hogs’? Assume the futures price is $F_0 = \$100$ (per hog) and at maturity of the futures contract, the spot (cash market) price of hogs is $S_T = 110$.

Question 5

You are a speculator and you think stock prices will increase. Should you buy a call or a put option?

Question 6

If $K = 150$ and the put premium is $P = 5$ should you exercise the put option if the spot price at expiration is $S_T = 148$? What is the payoff and the profit?

Question 7

In what way is a call option to marry Vito Corleone's daughter (Connie, in *Godfather I*) in one year's time different from a (1-year) futures contract? Assume the strike price is K and the current price of the futures is also equal to K . Assume both contracts are held to maturity.

Question 8

You have a (mortgage) loan for \$200,000 which has been in existence for 2 years and has a further 10 years to maturity. Interest on the loan is paid every year, at whatever the (one-year) interest rate is at that time (i.e. it is a floating rate loan at LIBOR). You took out this loan when interest rates were low but now you think interest rates will be permanently higher in the future. How can you use the swaps market to effectively give you a loan with a fixed interest rate over the next 10 years? (Assume it is an 'interest only' loan, so the principal of \$200,000 remains fixed and the latter is paid off using a 'lump sum' from your pension).

Question 9

A bank, BigMoney, raises deposit funds at LIBOR (currently 10% p.a.) in the interbank market and on-lends the funds in fixed interest loans at 11% p.a. What are the risks involved and how might the bank hedge the risk using swaps?