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Derivative Markets: An Introduction

Prof. Dr AP Faure

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AP Faure

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Derivative Markets: An Introduction
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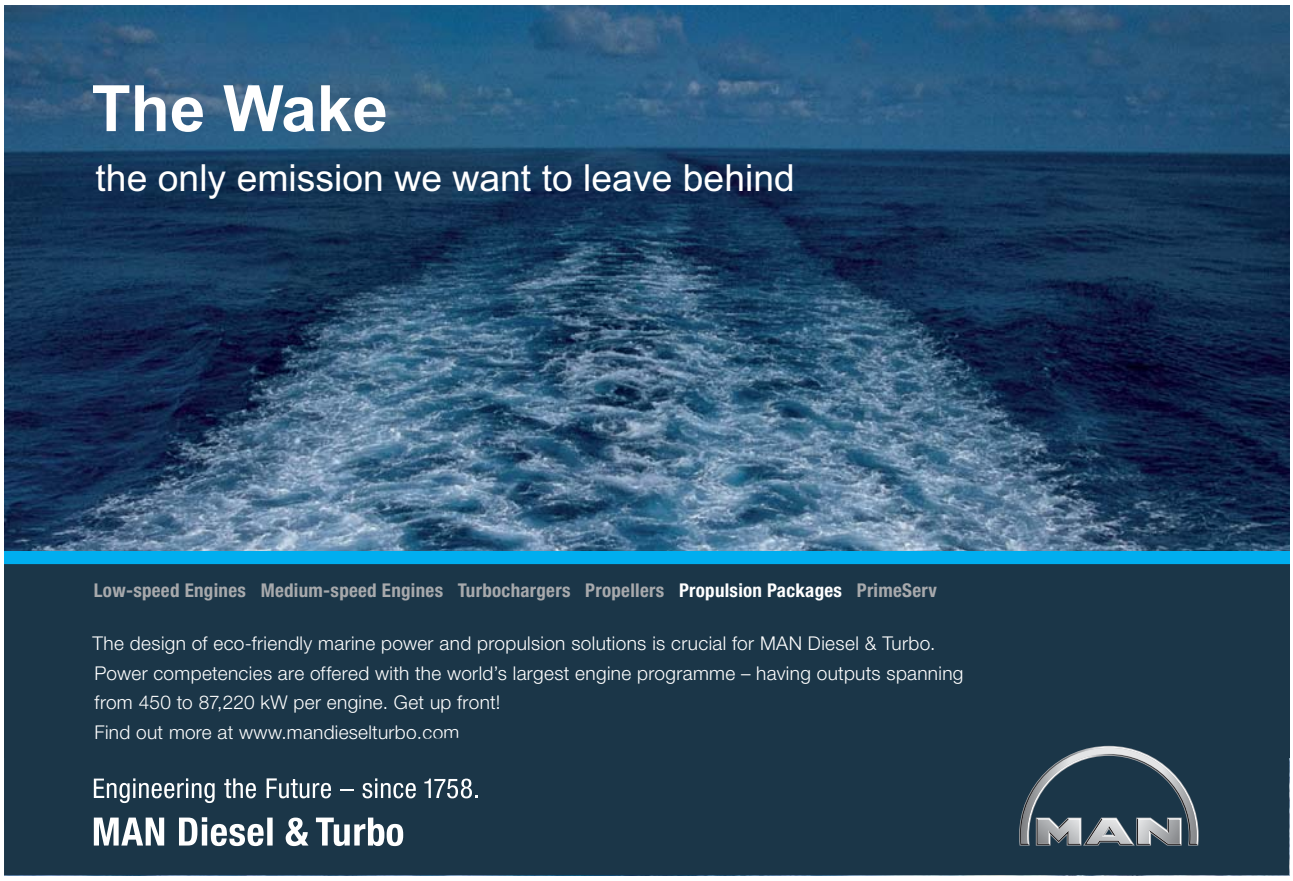

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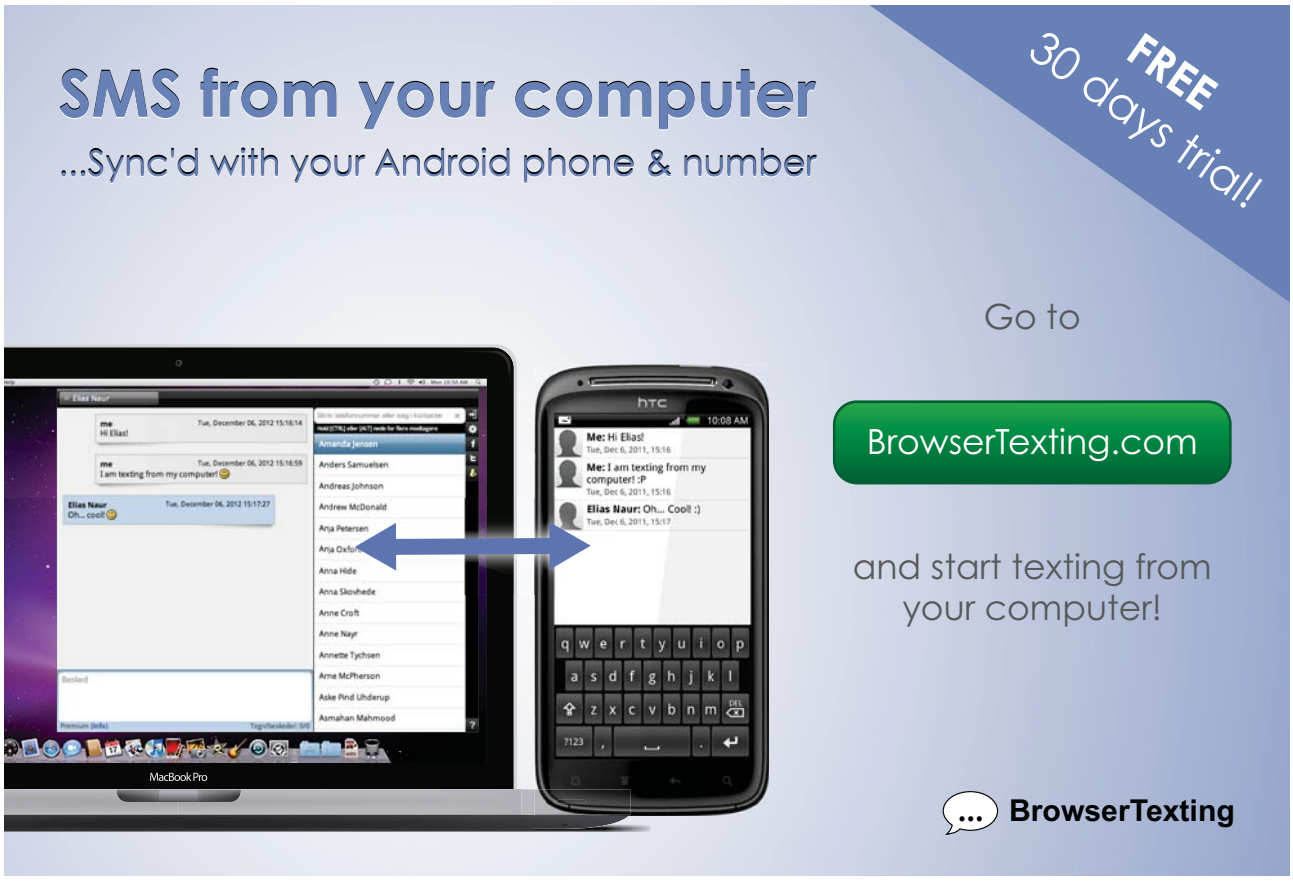

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1 Context

1.1 Learning outcomes

After studying this text the learner should / should be able to:

1. Understand the context of the derivative markets.
2. Describe the basic fundamentals of the derivative markets.

1.2 Introduction

The purpose of this section is to provide the context of the derivative markets, which is the financial system and its financial markets, and the commodities markets. The following are the subsections:

- The financial system in brief.
- Ultimate lenders and borrowers.
- Financial intermediaries.
- Financial instruments.
- Spot financial markets.
- Interest rates.
- The derivative markets.

1.3 The financial system in brief

The financial system is essentially concerned with borrowing and lending and may be depicted simply as in Figure 1.

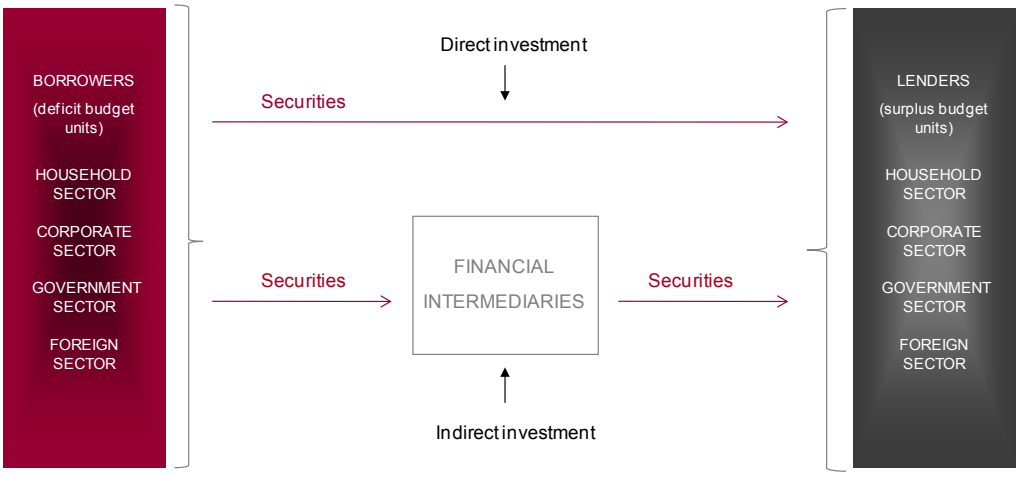

Figure 1: financial system (simplified)

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The financial system has six essential elements:

- First: *ultimate lenders* (surplus economic units) and *borrowers* (deficit economic units), i.e. the non-financial economic units that undertake the lending and borrowing process.
- Second: *financial intermediaries* which intermediate the lending and borrowing process; they interpose themselves between the lenders and borrowers.
- Third: *financial instruments*, which are created to satisfy the financial requirements of the various participants; these instruments may be marketable (e.g. treasury bills) or non-marketable (e.g. retirement annuity).
- Fourth: the *creation of money (= deposits)* when banks loans are demanded and satisfied; banks have the unique ability to create money by simply lending because the general public accepts bank deposits as a medium of exchange.
- Fifth: *financial markets*, i.e. the institutional arrangements and conventions that exist for the issue and trading (dealing) of the financial instruments;
- Sixth: *price discovery*, i.e. the price of shares / equity and the price of money / debt (the *rate of interest*) are "discovered" (made and determined) in the financial markets. Prices have an allocation of funds function.

We touch upon these elements of the financial system below, because they serve as the context and foundation of the derivative markets.

1.4 Ultimate lenders and borrowers

The ultimate lenders can be split into the four broad categories of the economy: the *household sector*, the *corporate (or business) sector*, the *government sector* and the *foreign sector*. Exactly the same non-financial economic units also appear on the other side of the financial system as *ultimate borrowers*. This is because the members of the four categories may be either surplus or deficit units or both at the same time. An example of the latter is government: the governments of most countries are permanent borrowers (usually long-term), while at the same time having short-term funds in their accounts at the central bank and/or the private banks, pending spending.

1.5 Financial intermediaries

Financial intermediaries exist because there is a conflict between lenders and borrowers in terms of their financial requirements (term, risk, volume, etc.). They solve this divergence of requirements and perform many other functions such as lessening risk, creating a payments system, monetary policy, etc.

Financial intermediaries may be classified in many ways. A list of the financial intermediaries found in most financial systems, according to our categorisation preference, is as shown in Box 1.

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The main financial intermediaries (or categories) and their relationship to one another may be depicted as in Figure 2.

MAINSTREAM FINANCIAL INTERMEDIARIES

DEPOSIT INTERMEDIARIES

Central bank (CB)
Private sector banks

NON-DEPOSIT INTERMEDIARIES

Contractual intermediaries (CIs)

Insurers
Retirement funds (pension funds, provident funds, retirement annuities)

Collective investment schemes (CISs)

Securities unit trusts (SUTs)
Property unit trusts (PUTs)
Exchange traded funds (ETFs)

Alternative investments (AIs)

Hedge funds (HFs)
Private equity funds (PEFs)

QUASI-FINANCIAL INTERMEDIARIES (QFIs)

Development finance institutions (DFIs)
Special purpose vehicles (SPVs)
Finance companies
Investment trusts / companies
Micro lenders
Buying associations

BOX 1: Financial intermediaries

1.6 Financial instruments

As a result of the process of financial intermediation, and in order to satisfy the investment requirements of the ultimate lenders and the financial intermediaries (in their capacity as borrowers and lenders), a wide array of financial instruments exist. They can be split into three categories:

- Equity / share instruments.
- Debt instruments, which can be split into:
  - Short-term debt instruments (= money market).
  - Long-term debt instruments (of which the bond market is a part).
- Deposit instruments (which can be seen as a form of debt instrument; the majority of which are short-term).

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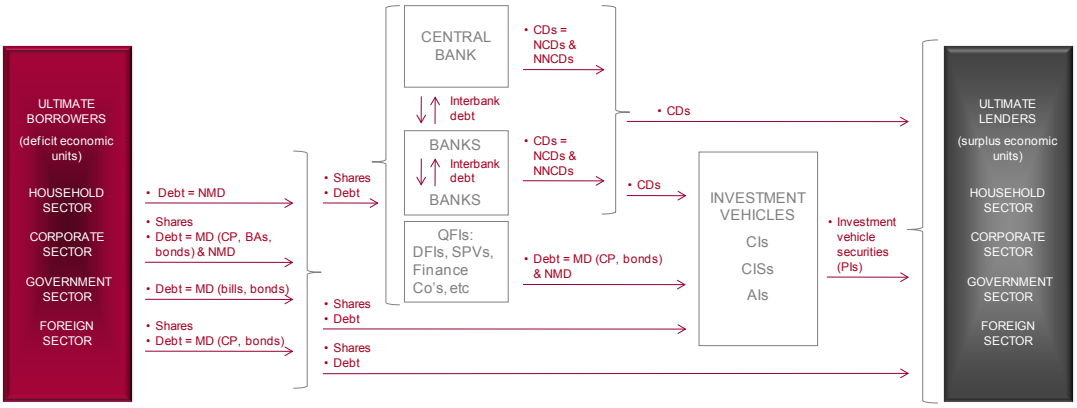
The instruments are either non-marketable (e.g. bank overdraft, bank mortgage advance) (called non-marketable debt or NMD), which means that their markets are only primary markets (see next section), or marketable debt (MD), e.g. treasury bills, which means that they are issued in their primary markets and traded in their secondary markets (see next section). The financial instruments (also called securities) that exist in the Local Country's[1] financial markets (defined in the next section) are revealed in Figure 2.



MD = marketable debt; NMD = non-marketable debt; CP = commercial paper; BAs= bankers' acceptances; CDs = certificates of deposit (= deposits); NCDs = negotiable certificates of deposit; NNCDs = non-negotiable certificates of deposit; foreign sector issues foreign shares and foreign MD (foreign CP & foreign bonds); PI = participation interest (units)

Figure 2: financial intermediaries & instruments / securities

1.7 Spot financial markets

1.7.1 Introduction

Spot (also called cash) markets are distinguishable from the derivative markets. *Spot* means to settle the deal as soon as possible and there are different conventions for the debt, share and forex markets as shown in Figure 3. The derivative markets settle (obligation or option) the underlying (described later) instruments in the future.

This section covers the spot markets under the following headings:

- Primary and secondary markets.
- Debt markets.
- Share / equity market.
- Foreign exchange market.

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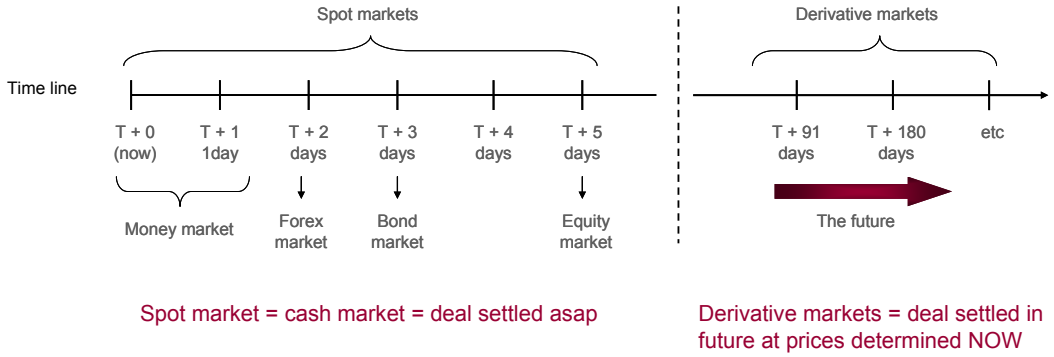

Figure 3: financial markets: spot & derivatives

1.7.2 Primary and secondary markets

As noted, there exist primary and secondary markets. The former are the markets that exist for the issue of new securities (marketable and non-marketable), while the latter are the markets that exist for the trading (i.e. exchange) of existing marketable securities. It should be evident that in the primary markets the issuers (borrowers) receive money from the lenders (investors), while in the secondary markets the issuers do not; money flows from the buyers to the sellers. This is depicted in Figure 4 and Figure 5 (shares used as example).

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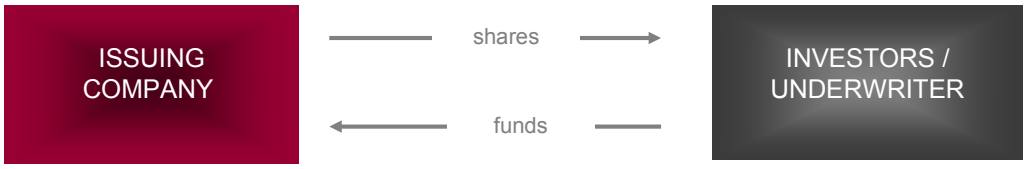

Figure 4: exchange of value in primary equity market

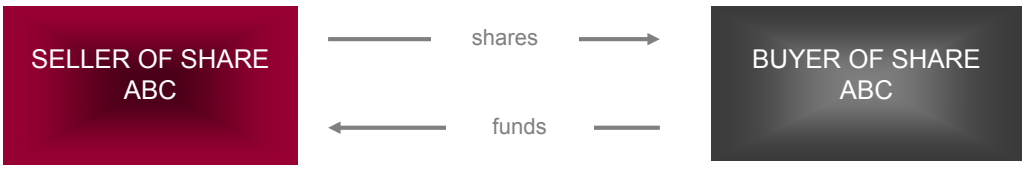

Figure 5: exchange of value in secondary equity market

The secondary financial markets evolved to satisfy the needs of lenders (investors) to buy and sell (exchange) securities when the need arose. Some markets naturally exist in a safe (i.e. low risk) environment, while for others a safe environment has been created. The former markets are called over-the-counter (OTC) markets, and the latter the formalised (or exchange-driven) markets. The OTC markets are the foreign exchange and money markets (in some countries partly exchange-driven), which essentially are the domain of the well-capitalised banks, while the exchange-driven markets are the equity / share and bond markets (the latter in some cases). These markets may be depicted as in Figure 6.

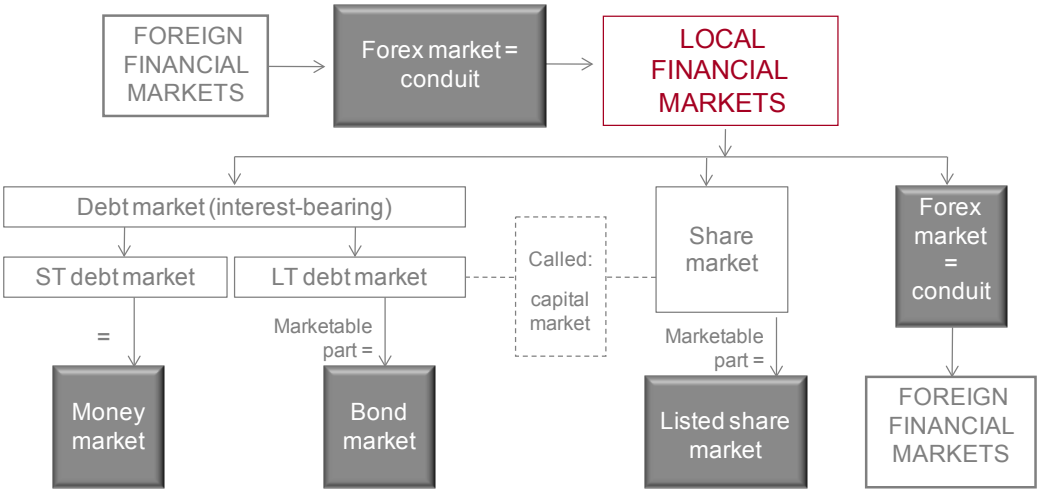

Figure 6: financial markets

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1.7.3 Debt market

There are two financial markets: the share market and the debt market. The debt market is the market in which debt instruments are issued (primary market) and exchanged (secondary market). Interest is paid on debt instruments (hence the other name: interest-bearing market), as opposed to dividends that are paid on shares / equities. The debt markets are also called the fixed-interest markets, but this is a misnomer because interest may be floating, i.e. reset at intervals, during the life of the instruments.

The debt market and it can be split into the short-term debt market (STDM) and the long-term debt market (LTDM). The money market can be defined as the short-term marketable securities market or as the market for all short-term debt, marketable and non-marketable. Some scholars also term the market as the market for wholesale debt. Our preference is to define the money market as the market for *all* short-term debt, marketable and non-marketable – and the reason is that in this market the volume of non-marketable debt (ST-NMD) far outstrips the volume of marketable debt (ST-MD). Also the genesis of money market interest rates takes place in the ST-NMD (specifically the interbank markets – there are three interbank "markets", but we will not cover this detail here).

As seen, the other part of the debt market is the LTDM, which is (obviously) the market for the issue and trading of long-term debt instruments. The trading of long-term debt only applies to the MD securities of the LTDM, and this applies to bonds. Thus the bond market is the market for the issue (primary market) and trading (secondary market) of marketable long-term debt securities.

The money and bond markets are differentiated according to term to maturity: the cut-off maturity is arbitrarily set at one year. Thus, the money market is usually defined as the issue and trading of securities with maturities of less than one year and the bond market as the issue and trading of securities with maturities of longer than one year (called bonds). The bond market is part of the LTDM (the marketable part).

The definition of the bond market is acceptable but the money market is much more than the issue and trading of securities of less than one year. It encompasses:

- The primary markets that bring together the supply of retail and wholesale short-term funds and the demand for wholesale and retail short-term funds.
- The secondary market in which existing marketable short-term instruments are traded.
- The creation of new money (deposits) and the financial assets that lead to this (loans in the form of NMD and MD securities).
- The central bank-to-bank interbank market (cb2b IBM) and the bank-to- central bank interbank market (b2cb IBM) where monetary policy is played out and interest rates have their genesis (i.e. where interest rate policy is implemented).
- The b2b IBM where the central bank's key lending interest rate (KIR[2]) has its secondary impact, i.e. on the interbank rate.
- The money market derivative markets (= an addendum).

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It is in the money market that money (= bank deposits of the non-bank private sector[3]) is created by the banks by simply lending (= bank assets). It does not appear proper that the banks are able to do so, but *it is so* because the general public accepts bank deposits as a means of payment (= the definition of money apart from bank notes and coins), assuming a low inflation environment.

Because of this unique ability of the banks, a referee is required to ensure that the money stock does not grow too rapidly (since high money growth is related to inflation). The referee is the central bank and its weapon is the KIR.

The central bank operates in the debt and foreign exchange (forex) markets through buying and selling debt instruments and forex (called open market operations) with a specific purpose: to ensure that the banks borrow from it at all times. This is called the "liquidity shortage" but it is simply loans to the banks at a rate of interest called the KIR. (This happens in the so-called interbank market.)

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The ultimate outcome of the level of the KIR is the level of bank lending rates. This is monetary policy which can be summarised as follows:

- Borrowings from the central bank at all times means that the KIR affects the banks' deposit rates.
- The banks endeavour to maintain a healthy margin (because they are profit-maximisers) between what they pay for deposits and what they charge for loans (the high profile loan rate is the prime rate).
- Thus if the KIR affects the banks' deposit rates it affects the banks' lending rates via a "static" margin.
- The level of the banks' prime rates (which are the same) (and their other lending rates which are benchmarked on prime rate) affects the demand for bank loans (= bank credit).
- The demand for credit by the household sector, the corporate sector and the government sector, when satisfied by the banks (which they happily do if the creditworthiness of the borrower is sound), "creates" bank deposits.[4]
- Bank deposit growth is money stock growth, and the "cause" is bank loan growth.[5]
- The money stock growth rate generally reflects the demand for goods and services.
- If the demand for goods (as largely reflected in the bank credit / money stock growth rate) is high and the economy cannot expand quickly enough to satisfy the demand, inflation makes its menacing appearance.
- Thus the job of the central bank is to ensure that the money stock (bank deposits) does not grow beyond the economy's capacity to satisfy the demand (that underlies it).
- This it executes via the one weapon it has: the KIR and the ability to ensure that the banks borrow from it at all times.
- Inflation, if high and sustained, ultimately impairs economic growth because economic agents (individuals and business – the household and corporate sector) devote their attention to hedging their wealth. The foreign sector's involvement in the local economy is also affected.
- A change in money market rates has an almost immediate impact on the pricing / valuation of assets (bonds, equities and property), and therefore on the perception of wealth (which has an effect on expenditure, the main driver of economic growth).

The reason for this exposition is the significance *interest rates*. They have their genesis in the money market in the form of the KIR. This rate (essentially one-day rate) should be seen as having a direct effect on the one-day interbank rate and therefore on the one-day deposit rate; this rate radiates to all other longer-term rates (deposit and borrowing). *The money market rates are a vital input in the pricing of derivative instruments.*

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1.7.4 Share / equity market

The share market is the market for the issue and trading of shares. The term *equity* refers to the capital of a company; it is made up of three parts:

- Ordinary shares. These shares are permanent capital in the sense that they represent a share in the ownership of a company
- Preference shares. These shares are long-term capital if they have a maturity date (they usually do), or permanent capital if they are perpetual, i.e. have no maturity date.
- Retained profits.

Ordinary and preferences shares are marketable, whereas retained profits are not. Preference shareholders have preference over ordinary shareholders, and creditors (e.g. bonds, bank loans) enjoy preference over preference shares, in the event of the liquidation of the company.

1.7.5 Foreign exchange market

The forex market, strictly speaking, is not a financial market.[6] However, since residents (ignoring exchange controls for a moment) are able to borrow or lend offshore, and foreigners are able to lend to or borrow from local institutions, the forex market (which allows these transactions to take place) has a domestic and foreign lending or borrowing dimension, and can be viewed as being closely allied to the domestic financial market.

When we focus on the ultimate lenders and borrowers in our depiction of the financial system shown earlier, we observe that these sectors include the *foreign sector*. This is where the foreign exchange market fits in. The foreign sector is able to supply funds locally, domestic institutions are able to lend to the foreign sector, and the foreign sector is able to borrow funds in the local market (i.e. issue securities in the local market). The unbound forex markets of the world allow this to take place. As indicated above, the forex market should be seen as a conduit for foreigners to the local financial and goods / services markets and for locals to the foreign financial and goods / services markets.

It will be apparent that in order for a forex market to function there needs to be a demand for and a supply of forex. *Demand* is the demand for, say, US dollars, the counterpart of which is the *supply* of rand. This cannot be satisfied without a *supply* of forex (say US dollars), the counterpart of which is a *demand* for rand. The forex market brings these *demanders* and *suppliers* together.

1.8 Interest rates

As we have seen, interest rates have their genesis in the money market, starting with the KIR. The KIR is made effective by the existence of a borrowed reserves condition (also called "money market shortage" and "liquidity shortage"), which in most countries is a permanent feature of the financial landscape. The KIR has an almost direct influence on the bottom end of the yield curve, which may be depicted as in Figure 7.

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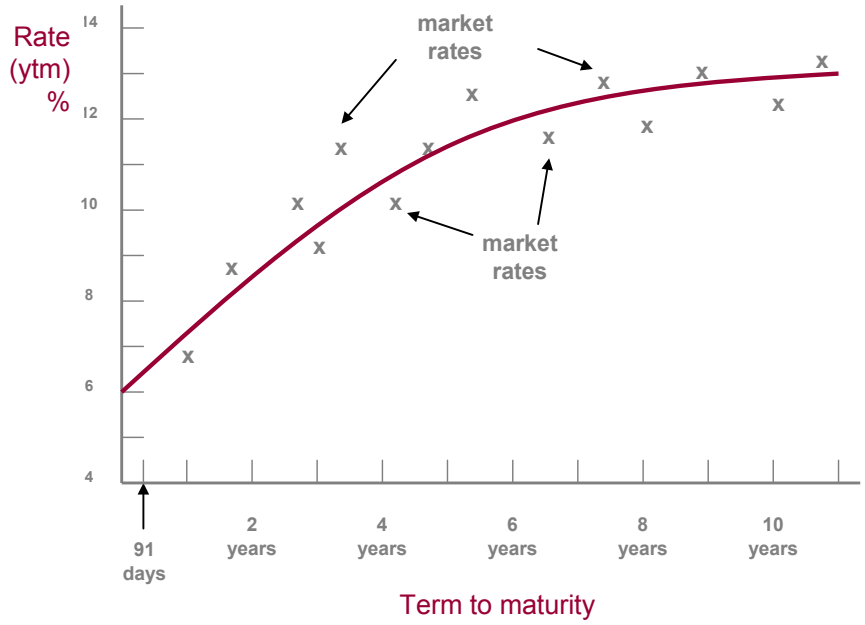

Figure 7: market rates and constructed yield curve

The yield curve is a representation of the relationship between interest rates and term to maturity. The money market is represented in the lower end of the yield curve and the bond market the part after one year to maturity. In this respect the bond market can be seen to be an extension of the money market.

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1.9 The derivative markets

The word "derivative" means that the product that it describes is "derived" from something. The "something/s" are financial market instruments and the indices (i.e. indices of prices and interest rates) of financial instruments. The latter are debt instruments, share market instruments and forex.

This means that the derivatives cannot exist on their own, i.e. they piggyback on the ordinary financial market instruments or indices. However, it must be rapidly added that there are derivatives that piggyback on other derivatives. Examples are options on futures and options on swaps.

Derivatives are contracts between two parties to buy, sell or exchange (optional or obligatory) a standard or non-standard quantity and quality of an asset or cash flow at a pre-determined price on or before a specified date in the future. The value of the underlying security or index (the spot market instrument that underlies the derivative) changes continuously, and this means that the value of the derivative almost always also changes. For example, the value of a future on a share index changes as the index changes in value. Also, the value of an option on a bond changes because the rate on the bond changes in the secondary market.

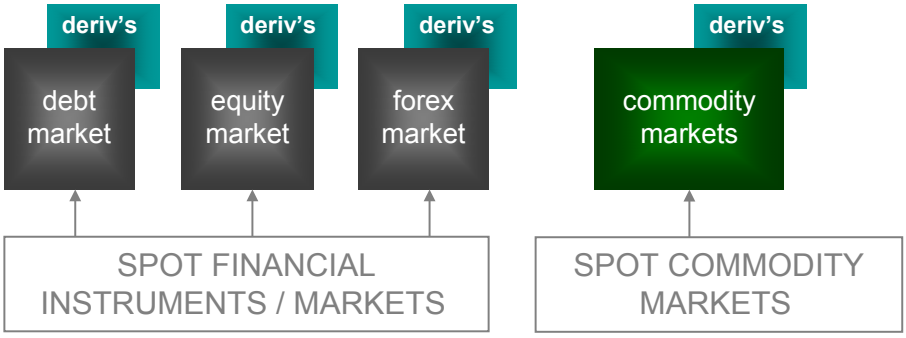

Figure 8: derivative markets

The terminology of the derivative markets can be confusing (caps, floors, collars, options, futures, options on futures, FRAs, repos, swaps, swaptions, and the like) and this leads to the need to categorise these markets in a sensible fashion. The derivative markets may be broadly categorised according to:

- Commodity derivative markets.
- Financial derivative markets.

The term *financial* or *financial markets* refer to the debt, share and forex markets. Thus we can depict the derivative markets as shown in Figure 8.

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This broad categorisation makes sense because there is a fundamental difference between these markets in terms of underlying assets and market turnover. The underlying assets in the commodities derivative markets are various, such as gold, maize, oil, etc., which are fundamentally different to the financial assets or notional financial assets that underlie financial derivatives. Turnover on the latter market dwarfs the turnover on the former.

However, there is much overlap in terms of the types of derivatives that are found in both markets. For example, in both market types forwards, futures, options, and swaps are to be found.

It may also make sense to categorise these markets according to whether they are:

- formalised derivative markets (i.e. exchange-traded), as opposed to
- informal derivative markets (i.e. OTC).

For example, there are *formalised markets* in futures and options on futures; and there are *informal OTC markets* in forwards, interest rate caps and floors, forward rate agreements, interest rate and currency swaps, etc. However, this is not the ideal categorisation because there are derivatives that have feet in both the formal and the OTC markets (for example forward rate agreements).

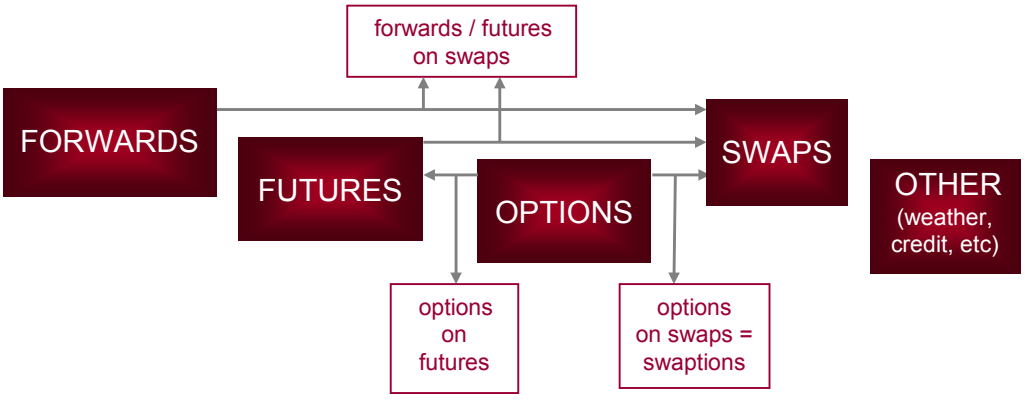

Figure 8: derivative instruments / markets

Another way in which one may categorise derivatives is according to the broad types of derivatives: *forwards, futures* (which are similar), *options* (which include options on futures and swaps), *swaps*, and *other* (such as credit and weather derivatives). This classification may be depicted as in Figure 8.

However, this is not ideal because there is a need to relate them to the spot (cash) markets. This is shown in Figure 9. This illustration is also not ideal because it cannot capture the finer distinctions of the derivative markets (for example forwards actually do not apply to all the markets). Table 1 provides the detail of the derivative markets and how they relate to the spot markets.

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Even the classification offered in Table 1 is not foolproof, because further explanation is required in some cases to make it absolutely clear. This type of information cannot be captured in an illustration or a table; it requires explanation.

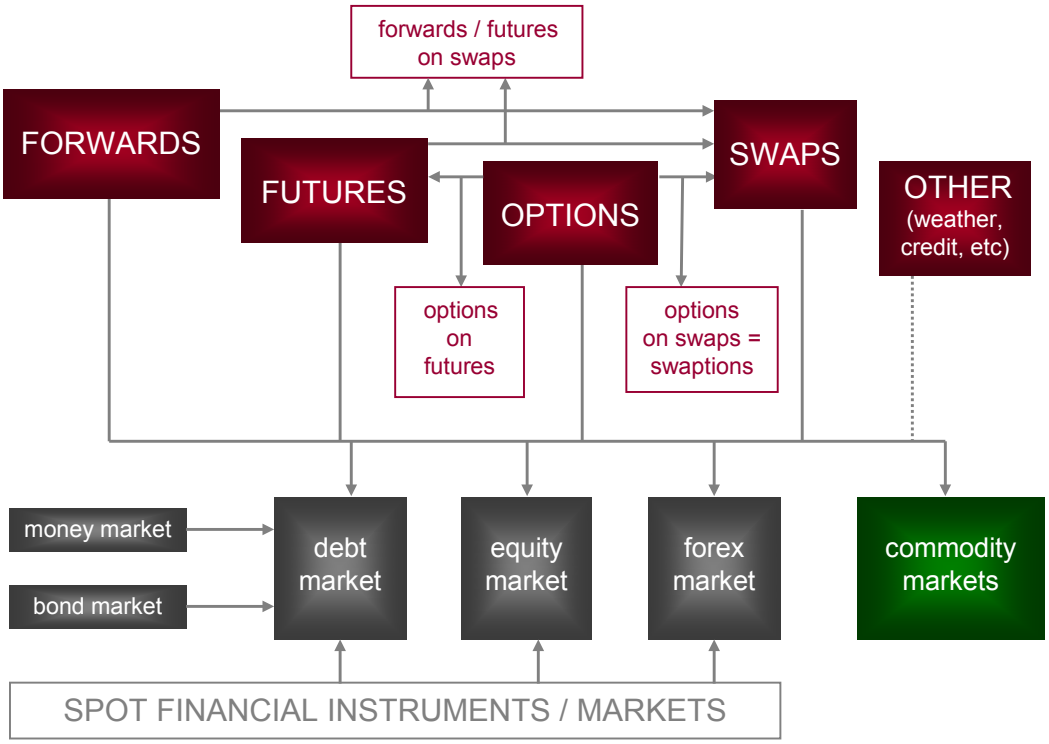

Figure 9: derivatives and relationship with spot markets

However, Figure 9 and Table 1 do provide an overarching view of the types of derivative instruments and provides a logical framework for discussion. Taking the above as a cue it makes sense to categorise and discuss derivative instruments in the following order:

- Forwards.
- Futures.
- Swaps
- Options.
- Other derivatives.

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Derivatives	Debt market	Share market	Forex market	Commodities market
Forwards	Yes	Yes	Yes	Yes
Futures	Yes	Yes	Yes	Yes
Options:				
Options on "physicals"[1]	Yes	Yes	Yes	Yes
Options on futures	Yes	Yes	Yes	Yes
Options on swaps	Yes	Yes	Yes	Yes
Warrants[2]	Yes	Yes		
Caps and floors	Yes			Yes
Swaps[2]	Yes	Yes	Yes	Yes
Other:				
Credit derivatives[3]	Yes			
Weather derivatives[3]				
1. The actual spot market instruments and indices. 2. Requires explanation (done later). 3. Do not apply to specific financial or commodity markets.				

Table 1: Spot markets and derivative instruments

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1.10 Summary

The financial system provides the context of the derivatives markets. The instruments and their rates, prices and indices underlie the derivative instruments. The most important input in derivatives' pricing is the rate of interest (which has its genesis in the money market).

The sound classification of derivatives is forwards, futures, swaps, options and other derivatives (and hybrids).

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2 Derivative markets: forwards

2.1 Learning outcomes

After studying this text the learner should / should be able to:

1. Describe the characteristics of forward markets.
2. Explain the essence and mechanics of forward contracts / instruments.
3. Understand the mathematics of the forward markets.
4. Calculate a forward price.
5. Distinguish the advantages and disadvantages of forward markets vis-à-vis futures markets.
6. Portray the organisational structure of the forward markets.

2.2 Introduction

Forward markets / instruments are the forerunners of the futures markets / instruments. However, not all forwards transmuted into futures markets. The *forward foreign exchange market*, for example, is a gargantuan market in terms of turnover and liquidity. There are also a number of other formidable forward markets such as forward markets in interest rate products (e.g. forward rate contracts). This significant derivative market is covered under the following headings:

- Spot market.
- Introduction to forward markets.
- A simple example.
- Forward markets.
- Forwards in the debt markets.
- Forwards in the foreign exchange market.
- Forwards in the commodities markets.
- Forwards on derivatives.
- Organisation of forward markets.

2.3 Spot market: defintion

As we saw earlier, the spot market is also called the "cash market", and it refers to transactions or deals (which are contracts) that are settled at the earliest opportunity possible. For example (see Figure 1), in the money market a spot deal is where securities are exchanged for payment (also called *delivery versus payment*) on the day the deal is struck / transacted (T+0) or the following day. In many bond markets a spot deal is a deal done now (day T+0) for settlement in 3 days' time (T+3). In most share / equity markets spot means T+5. In the money market, deals are usually settled on the day of the transaction (T+0) or the following day (T+1).

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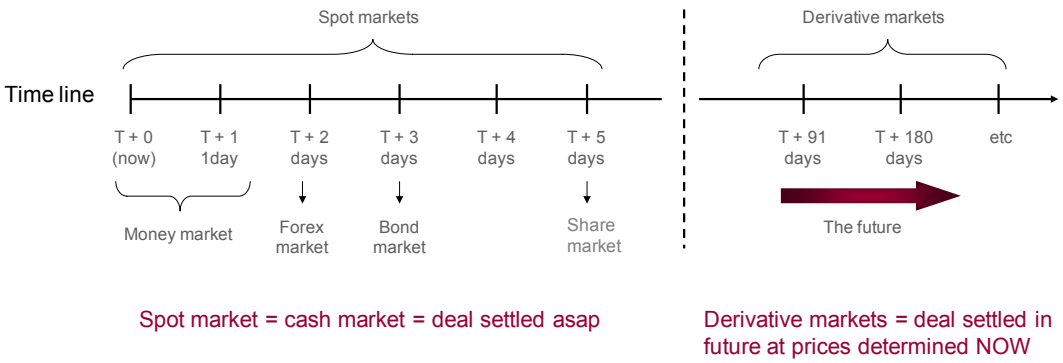

Figure 1: spot & forward settlement (derivative markets)

The issue that determines the number after the "+" sign is essentially convenience. In the money market it is convenient to settle now or tomorrow, because the market is of a wholesale nature and the securities are kept in safe custody by banks in large metropolitan areas (or in a securities depository or are dematerialised). In the share market many individuals are involved that are spread across the county and, therefore, it takes time for the securities to be posted / sent to the exchange. This of course changes with dematerialisation / immobilisation[7].

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A spot deal may thus be defined as a contract between buyer and seller, undertaken on T+0, for the delivery of a security by the seller to the buyer and payment by the buyer to the seller in order to complete settlement of the deal at time T+0 or T+ a few days, depending on convenience / convention.

2.4 Forward market: defintion

Like a spot deal, a forward deal is a deal done now (T+0) at a price agreed now. However (and this is the difference), the settlement date is *not* a few days after T+0 as in the case of spot transactions, but usually a month or a few months after T+0 (see Figure 2.1). The motivation for such a deal is usually that the *spot price* that will prevail in the future is uncertain. A forward deal removes the spot price uncertainty.

The best way to describe a forward deal is with an example. Consider a wheat farmer. He plants his crop now and expects to reap the harvest in 3 months' time. He knows the input cost, but he does not know what spot price he will get for his harvested wheat in 3 months' time. Thus, he is faced with (spot) price risk (uncertainty). The solution to his risk is a forward (or futures) market that will enable him to sell his wheat forward, in other words he would like to deal now (T+0) at a price agreed now (T+0) for delivery of the wheat in 3 months' time (T+ 3 months) when he will be paid.

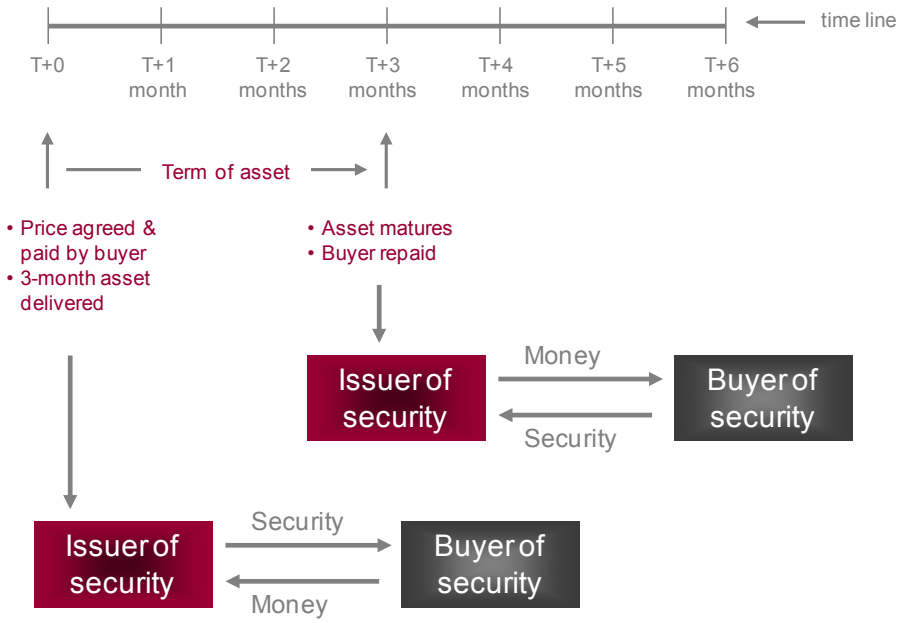

Figure 2: spot deal on T+0 on 3-month asset

A forward deal in the financial markets is the same except that the instrument dealt in:

- has a term to maturity and
- may have an income (dividend on a share / interest on a bond).

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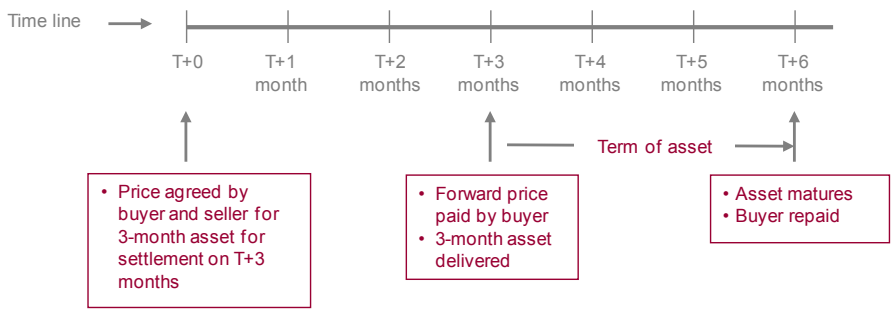

Figure 3: forward deal on 3-month asset (settlement in T+3 months)

A spot deal on a 3-month financial asset is portrayed as in Figure 3. A forward deal is where the price or rate on an asset is determined now for settlement at some stage in the future. *Some stage* means *other that spot*. A 3-month forward deal on a 3-month asset is shown in Figure 3.

Thus a forward is a contract between a buyer and a seller that obliges the seller to deliver, and the buyer to accept delivery of, an agreed quantity and quality of an asset at a specified price (now) on a stipulated date in the future. A simple example will clarify this definition further see Figure 4).

2.5 An example

Figure 4: example of forward deal

A forward transaction is effected on 18 September (T+0). On this day the spot price of a basket of maize (corn) is LCC100. A consumer (buyer) believes that the price of maize (his favourite food) will be much higher in three months' time (because of an anticipated drought). He would thus like to secure a price now for a basket of maize he would like to purchase in three months' time.

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The farmer (producer and seller), on the other hand, believes that the price of maize will decline (because he anticipates plenty of rain). The farmer quotes the buyer a price of LCC103.74, i.e. he undertakes to supply the buyer with one basket of maize on 18 December (after 91 days) for a consideration (price) of LCC103.74. This figure the farmer arrived at by taking into account the interest rate he is paying the bank for a loan used to produce the mielies. Assuming the interest rate to be 15.0% pa, he calculates the forward price according to the following formula (= cost of carry model):

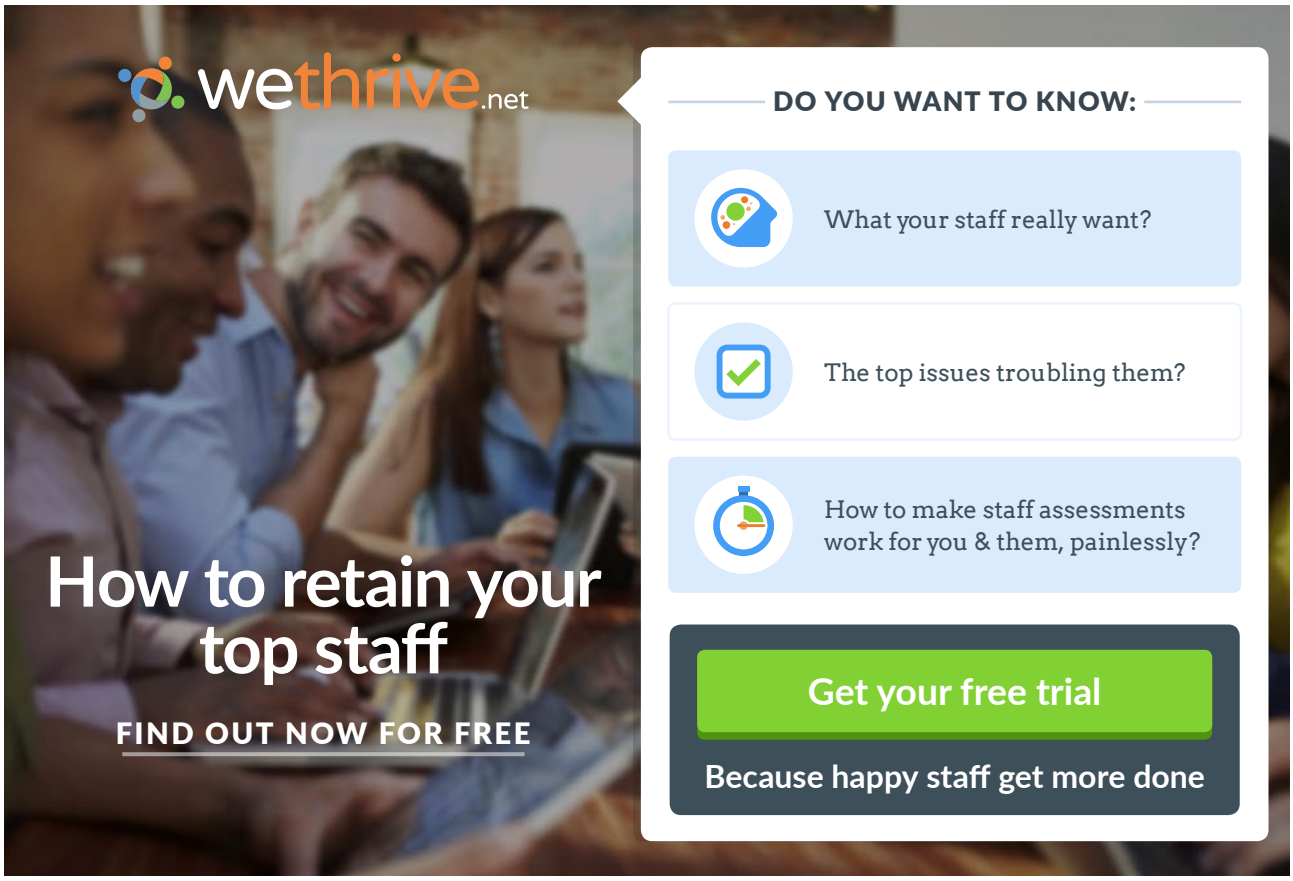
$$FP = SP \times [1 + (ir \times t)]$$

where

FP = forward price
SP = spot price
ir = interest rate per annum for the term (expressed as a unit of 1)[8]
t = term, expressed as number of days / 365

$$FP = LCC100 \times [1 + (0.15 \times 91 / 365)]$$
$$= LCC100 \times (1.037397)$$
$$= LCC103.74.$$

The buyer draws up a contract, which both Mr Farmer and he (Mr Consumer) sign (see Box 1).



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Forward Contract

18 September 2010

Mr Consumer hereby undertakes to take delivery of, and Mr Farmer hereby undertakes to deliver, one basket of maize on 18 December 2010 at a price of LCC103.74.

Signed

…… ……..
Mr Farmer Mr Consumer

Box 1: Example of forward contract

On 18 December (after a drought) the price for a basket of maize (i.e. the spot price) has risen to LCC120. The consumer pays the farmer LCC103.74 and takes delivery of the basket of maize. What is the financial position of each party to the forward contract?

- *The buyer* pays LCC103.74. Had he waited until 18 December to purchase his basket of maize, he would have had to pay the spot price of LCC120. If, in the 91-day period, he had "gone off" maize, he will still be happy to purchase the basket at LCC103.74, and this is because he will sell the same basket at LCC120 (the spot price now on 18 December). He thus profits to the extent of LCC16.26 (LCC120 – LCC103.74) (and is annoyed with himself that he did not take a larger "position").
- *The farmer* is thin-lipped because he could have sold the basket of maize on 18 December for LCC120. This does not mean that he made a loss. His production cost, including his carry cost, could only have been, say, LCC95. He thus makes a profit of LCC8.74 (LCC103.74 – LCC95), but it is smaller than he would have made (LCC120 – LCC95.00 = LCC25) in the absence of the forward contract.

Had it rained and the supply of maize increased, the price would most likely have fallen. If we assume the spot price had fallen to LCC90 per basket on 18 December, the farmer is better off (received LCC103.74 as opposed to LCC90), whereas the buyer is worse off (paid LCC103.74 as opposed to LCC90 had he not done the forward deal).

It is important at this stage to attempt to analyse the *advantages and disadvantages* of forward markets. The main *advantages* that can be identified are:

- Flexibility with regard to delivery dates.
- Flexibility with regard to size of contract.

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The disadvantages are:

- The transaction rests on the *integrity of the two parties*, i.e. there is a risk of non-performance.
- Both parties are "*locked in*" to the deal for the duration of the transaction, i.e. they cannot reverse their exposures.
- *Delivery* of the underlying asset took place, i.e. there was no option of settling in cash.
- The *quality of the asset* may vary.
- *Transaction costs are high* (for example, the consumer visits the farmer at least twice, has a lawyer to draw up the contract, etc.).

2.6 Forward markets

Futures markets developed out of forward markets because of the disadvantages of forward deals. However, forward markets do still exist, and this is because of their advantages as mentioned above and the *lack of the disadvantages mentioned above in some markets*. The following will make this clear:

- Flexibility with regard to delivery dates.
- Flexibility with regard to size of contract.
- The transaction rests on the integrity of the two parties, but this is not a problem in certain markets where the participants are substantive in terms of capital and expertise (e.g. the forex market).
- Both parties are "locked in" to the deal for the duration of the transaction, but in certain markets they are able to reverse their exposures with other instruments (e.g. futures in the forex market).
- Delivery of the underlying asset is the purpose of doing a forward deal in most cases (i.e. the client does not want the option of settling in cash) (e.g. forex market).
- The quality of the asset does not vary in many cases (e.g. forex market).
- Transaction costs are not high in certain markets (e.g. forex market because of high degree of liquidity).

As will have been guessed, the largest forward market is the forward foreign exchange market. In addition, forward markets exist in the debt market, the share market and in the commodities market. This means that there are forward markets in all the financial markets.

In addition to the forwards that exist in all the financial markets there are also forwards on one of the derivatives, i.e. swaps. The forward markets are discussed under the following sections:

- Forwards in the debt markets.
- Forwards in the share / equity market.
- Forwards in the foreign exchange market.
- Forwards in the commodity markets.
- Forwards on derivatives.

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2.7 Forwards in the debt markets

2.7.1 Introduction

The forward market contracts that are found in the debt markets are:

- Forward interest rate contracts.
- Repurchase agreements.
- Forward rate agreements.

2.7.2 Forward interest rate contracts

2.7.2.1 Introduction

A forward interest rate contract (FIRC) is the sale of a debt instrument on a pre-specified future date at a pre-specified rate of interest. This category includes forwards on indices of interest rate instruments (such as forwards on the GOVI index). Below we provide examples of FIRCs in the OTC market and the exchange-traded markets:

- Example: OTC market.
- Examples: exchange-traded markets.

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2.7.2.2 Example: OTC market

An example is probably the best way to describe the forward market in interest rate products, i.e. forward interest rate contracts. As noted, these contracts involve the *sale of a debt instrument on a pre-specified future date at a pre-specified rate of interest*, and contain details on the following:

- The debt instrument/s.
- Amount of the instrument that will be delivered.
- Due date of the debt instruments.
- Forward date (i.e. due date of the contract).
- Rate of interest on the debt instrument to be delivered.

An insurance company requires a LCC100 million (plus) 206-day negotiable certificate of deposit (NCD) investment in 100 days' time when it receives a large interest payment. It wants to secure the rate now because it believes that rates on that section of the yield curve are about to start declining, and it cannot find a futures contract that matches its requirement in terms of the exact date of the investment (100 days from now) and its due date (306 days from now).

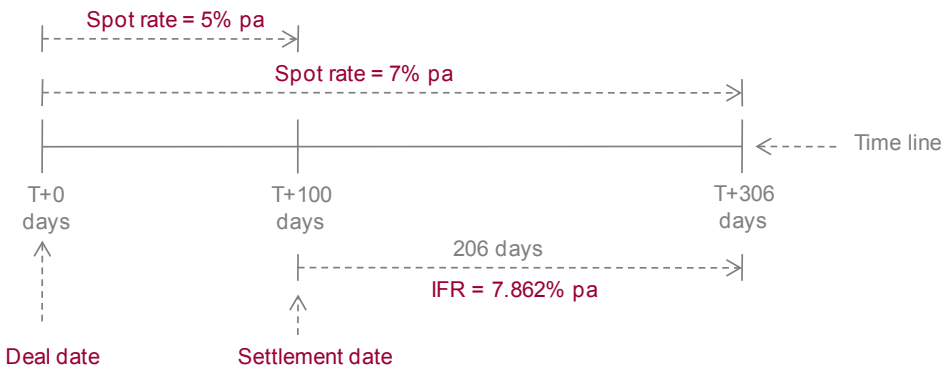

Figure 5: example of forward interest rate contract

It approaches a dealing bank and asks for a forward rate on LCC100 million (plus) 206-day NCDs for settlement 100 days from now. The spot rate (current market rate) on a 306-day NCD is 7.0% pa and the spot rate on a 100-day NCD is 5% pa. It will be evident that the dealing bank has to calculate the rate to be offered to the insurer from the existing rates. This involves the calculation of the rate *implied* in the existing spot rates, i.e. the *implied forward rate* (IFR) (see Figure 5):

$$IFR = \{[1 + (ir_L \times t_L)] / [1 + (ir_S \times t_S)] - 1\} \times [365 / (t_L - t_S)]$$

where

ir_L = spot interest rate for the longer period (306 days)
ir_S = spot interest rate for shorter period (100 days)
t_L = longer period, expressed in days / 365) (306 / 365)
t_S = shorter period, expressed in days / 365) (100 / 365)

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$$
\begin{aligned}
\text{IFR} &= \{[1 + (0.07 \times 306 / 365)] / [1 + (0.05 \times 100 / 365)] - 1\} \times 365 / 206 \\
&= [(1.05868 / 1.01370) - 1] \times 365 / 206 \\
&= (1.04437 - 1) \times 365 / 206 \\
&= 0.07862 \\
&= 7.862\% \text{ pa.}
\end{aligned}
$$

The bank will quote a rate lower than this rate in order to make a profit. However, we assume here, for the sake of explication, that the bank takes no profit on the client. It undertakes to sell the NCDs to the insurer at 7.862% pa after 100 days.

The financial logic is as follows[9]: the dealing bank could buy a 306-day NCD from another bank and sell it under repo (have it "carried") for 100 days; the repo buyer will earn 5.0% pa for 100 days and the ultimate buyer, the insurer (the forward buyer) will earn the IFR of 7.862% pa for 206 days. The calculations follow:

1. The dealing bank buys LCC100 million 306 day NCDs at the spot rate of 7.0% pa. The interest = 7.0 / 100 × LCC100 000 000 × 306 / 365 = LCC5 868 493.15.
2. The maturity value (MV) of the investment = cash outlay + interest for the period = LCC100 000 000 + LCC5 868 493.15 = LCC105 868 493.15.
3. The bank has the NCDs "carried" for 100 days at the spot rate for the period of 5.0% pa. This means it sells the LCC100 million NCDs at market value (LCC100 million) for a period of 100 days at the market rate of interest for money for 100 days.
4. After 100 days, the bank pays the "carrier" of the NCDs interest for 100 days at 5.0% pa on LCC100 million = LCC100 000 000 × 5.0 / 100 × 100 / 365 = LCC1 369 863.01.
5. The bank now sells the NCDs to the insurer at the IFR of 7.862% pa. The calculation is: MV / [1 + (IFR / 100 × days remaining to maturity / 365)] = LCC105 868 493.15 / [1 + (7.862 / 100 × 206 / 365)] = LCC101 370 498.00.
6. The insurer earns MV – cash outlay for the NCDs = LCC105 868 493.15 – LCC101 370 498.00 = LCC4 497 995.10 for the period.
7. Converting this to a pa interest rate: [(interest amount to be earned / cash outlay) × (365 / period in days)] = [(LCC4 497 995.10 / LCC101 370 498.00) × (365 / 206)] = 7.862% pa, i.e. the agreed rate in the forward contract.

Essentially what the dealing bank has done here is to hedge itself on the forward rate quoted to the insurer. It will be evident, however, that the bank, while hedged, makes no profit on the deal. As noted, in real life the bank would quote a forward rate lower than the break-even rate of 7.862% pa (e.g. 7.7% pa.)

The principle involved here, i.e. "carry cost" (or "net carry cost" in the case of income earning securities), is applied in all forward and futures markets. This will become clearer as we advance through this text.

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The above is a typical example of a forward deal in the debt market. It will be apparent that the deal is a private agreement between two parties and that the deal is not negotiable (marketable). The market is not formalised and the risk lies between the two parties. It is for this reason that the forward interest rate contract market is the *domain of the large players*, and these are the large banks, and the institutions[10].

Numbers in respect of OTC FIRCs are not available.

2.7.3 Repurchase agreements

2.7.3.1 Introduction

A knowledgeable student will have noted that the above deal (the OTC FIRC) could have been executed by the insurer by way of the celebrated *repurchase agreement* (repo). The insurer could have bought the NCDs outright and sold them to some other holder of funds under repo for 100 days. Similarly the bank could have bought the NCDs outright, sold them under repo for 100 days and then sold them outright to the insurer.

In most international textbooks, the repo is not covered under derivative instruments, but is rather regarded as a money market instrument. We regard the repo as a derivative because it is *derived* from money or bond market instruments, and its value (i.e. the rate on it) is *derived* from another part of the money market (the price of money for the duration of the repo).

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The repo may also be seen as a combination of a spot and a forward transaction, specifically a spot sale and a simultaneous forward purchase of the same instrument (from the point of view of the seller / maker). The buyer of the repo does a simultaneous spot purchase and forward sale.

The repo may also be regarded as a short-term loan secured by the assets sold to the lender. Another way of putting this is that the repo is similar to a collateralised loan in that the purchaser of the securities under repo is providing funds to the seller and its loan is backed by the securities for the period of the agreement; the lender receives a return based on the fixed price of the agreement when it is reversed.

The repo is discussed in much detail here because it is a versatile instrument and the market in this instrument is vast. The sections we cover here are:

- Definition
- Terminology
- Example
- Purpose of effecting repurchase agreements
- Participants in the repurchase agreement market
- Types of repurchase agreements
- Securities that underlie repurchase agreements
- Size of repurchase agreement market
- Mathematics of repurchase agreements
- Repos and the banking sector
- Listed repurchase agreements.

2.7.3.2 Definition

A repurchase agreement (repo) is a contractual transaction in terms of which an existing security is sold at its market value (or lower) at an agreed rate of interest, coupled with an agreement to repurchase the same security on a specified, or unspecified, date. This definition perhaps requires further elaboration.

Agreement

The transaction note confirming the sale of the security can contain a note stipulating the agreement to repurchase. Alternatively, two transaction notes can be issued, i.e. a sale note together with a purchase note dated for the agreed repurchase date. It is market practice that underlying all repurchase agreements is the TBMA / ISMA Global Master Repurchase Agreement, (GMRA), i.e. an internationally recognised repo contract.

Existing security

The maker of the repo sells a security already in issue to the buyer of the agreement.

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Market value

The security is sold at its market value (and sometimes at better, i.e. lower, than market value), in order to protect the buyer of the repo against default of the maker. If the seller fails to repurchase the security at termination of the repo, the holder acquires title to it and has the right to sell it in the market. For example, if the value of the securities sold is LCC9 500 000, the repo is done at a value of LCC9 450 000, and the interest factor for the period of the repo is LCC35 000 (total = LCC9 485 000), the buyer is protected should the maker default.

Agreed rate of interest

The agreed rate for the term of the agreement is the interest rate payable on the repo by the seller for the relevant period. This applies in the case where the maturity date of the agreement is specified. A small number of repos are "open repos", i.e. both the buyer and the seller have the right to terminate the agreement at any time. The rate payable on these open repos is a rate agreed between the two parties to the deal; the rate may be benchmarked or it may be agreed daily.

Specified maturity date

The specified maturity date is the date when the agreement is terminated. The buyer sells the security / securities underlying the repo back to the maker for the original consideration plus the amount of the interest agreed.

Unspecified maturity date

In the case of an agreement where the maturity date is not specified (the *open* repo), the termination price (original consideration plus interest) cannot be agreed at the outset of the agreement. The rate at which interest is calculated can be fixed or floating, but is usually the latter. In the case of a floating rate, as noted, the rate would be an agreed differential below or above a benchmark rate.

2.7.3.3 Terminology

The terminology related to repo is often confusing to those not involved in the money market. The term *repurchase agreement* applies to the seller of the agreement. He agrees to *repurchase* the security. The buyer of the agreement, on the other hand, is doing a *resale agreement*. He agrees to *resell* the security to the maker of the agreement.

Synonyms for the repurchase agreement are *buy-back agreement* (point of view of the maker) and *sell-back agreement* (point of view of the buyer). Repurchase agreements are also frequently referred to *warehousing transactions*. The seller is doing a *warehousing transaction* and the buyer is *warehousing* an asset.

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Terminology also used by some participants is *repo-in* and *repo-out*. The former is a *resale agreement* and the latter a *repurchase or buy-back agreement*. Both makers and buyers, however, sometimes use the word *carry*. The maker would say he is having securities *carried*, while the buyer would say he is *carrying* securities.

The terminology used by the many central banks in their accommodation procedures and open market operations is also a challenge. They generally accommodate the banks by doing *repos* at the *KIR*. What the central banks are actually doing are *resale agreements* with the banks. The banks are doing *repurchase agreements* with the central banks.

At times central banks sell securities to the banks to "mop up" liquidity, i.e. to increase the money market shortage. They refer to these as *reverse repos*. In fact, they are not reverse repos from the central bank's point of view; they are *repos*.

Similarly, when the central bank sells foreign exchange to the banks in order to "mop up" liquidity, it says it does *forex swaps* with the banks. This is true, but the transactions may be seen to be repurchase agreements with the banks in foreign exchange at the money market rate, less the relevant foreign interest rate for the term of the repo. This is discussed in detail later.

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The majority of participants and certainly the central bank mainly use the term repo, and we will acquiesce in this regard, but use the correct terminology where appropriate to avoid confusion.

2.7.3.4 Example

Figure 6 provides an example of a repo deal. A bank has in portfolio a LCC10 million NCD of another bank that it is holding in order to make a capital profit when rates fall. The NCD had 360 days to maturity when it was purchased. It is now day 30 in the life of the NCD (i.e. it has 330 days to run), and the bank needs funding for a particular deal that has 70 days to run. The bank sells the NCD to a party that has funds available for 70 days under agreement to repurchase the same NCD after 70 days. The rate agreed is the market interest rate for 70 days.

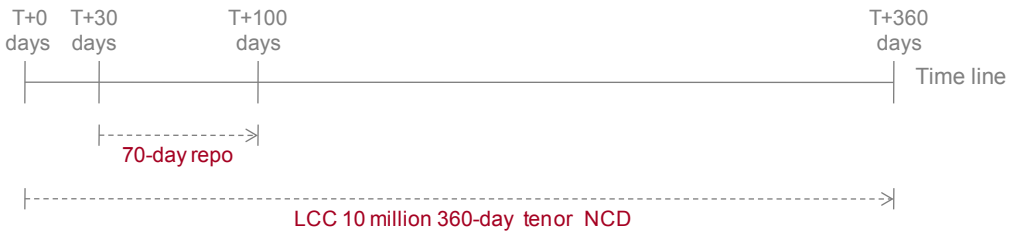

Figure 6: example of 70-day repo in NCDs

2.7.3.5 Motivation for repos

One of the main reasons which give rise to repos is best described by way of an example. A client of a broker-dealer may wish to invest LCC50 million for a 7-day period. If the broker-dealer cannot find a seller of securities with a term of 7 days, he will endeavour to find a holder of securities who requires funds for this period. If the rate for the repurchase agreement can be agreed, the broker would effect a *resale agreement* with the seller of the securities and a *repurchase agreement* with the buyer.

Another way of putting this is that the seller is having the broker *carry* his securities for a period, while the broker is having these same securities *carried* by the buyer for the same period. Another reason which gives rise to repurchase agreements is holders of securities requiring funds for short-term periods.

Yet another transaction that gives rise to a repo is the taking of a *position* in a security. For example, a speculator who believes that bond rates are about to fall (say in the next week) would buy, say, a 5-year bond to the value of, say, LCC5 million at the spot rate of, say, 9.5% (the consideration of course will not be a nice round amount). He does not have the funds to undertake this transaction, but has the creditworthiness to borrow this amount in the view of a broker-dealer. The speculator would thus immediately sell the bond to the broker-dealer (who is involved in the repo market) for 7 days at 10.2% pa (the rate for 7-day money). The broker-dealer in turn would on-sell the bond to, say, a pension fund for 7 days at, say, 10.0% pa.

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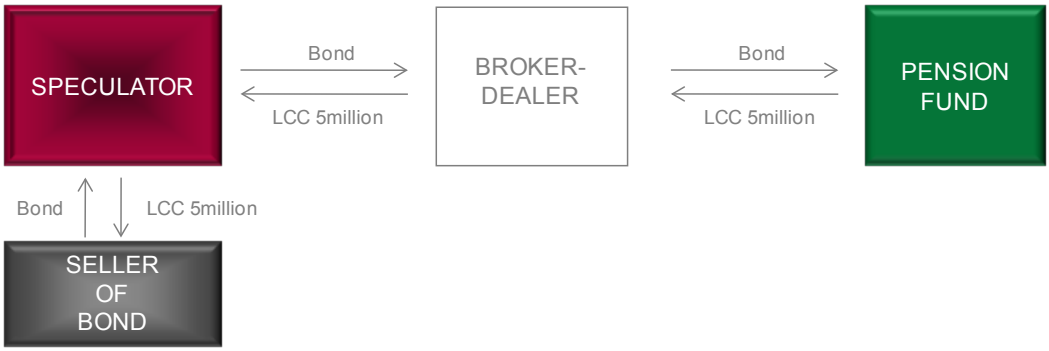

Figure 7: cash and security flows at onset of repo

Assume now that the 5-year bond rate falls to 9.4% on day seven. The broker-dealer unwinds the repo deal and pays the pension fund LCC5 million plus interest at 10% for 7 days (LCC5 000 000 × 7 / 365 × 0.10 = LCC9 589.04). The broker-dealer then sells the bond back to the speculator for LCC5 million plus interest at 10.2% (LCC5 000 000 × 7 / 365 × 0.102 = LCC9 780.82). The broker's profit is 0.2% on LCC5 million for 7 days (i.e. the difference between the two above amounts (LCC191.78). The speculator sells the bond in the bond market at 9.4% (remember he bought it at 9.5%). His profit on the 5-year-less-7-days bond is 0.1% (which is probably around LCC50 000 – we assume this), i.e. the consideration on the bond is LCC5 000 000 + LCC50 000 = LCC5 050 000. His overall profit is thus LCC50 000 minus the cost of the *carry* (LCC9 780.82), i.e. LCC40 219.18.

This deal may be depicted as in Figures 7–8.

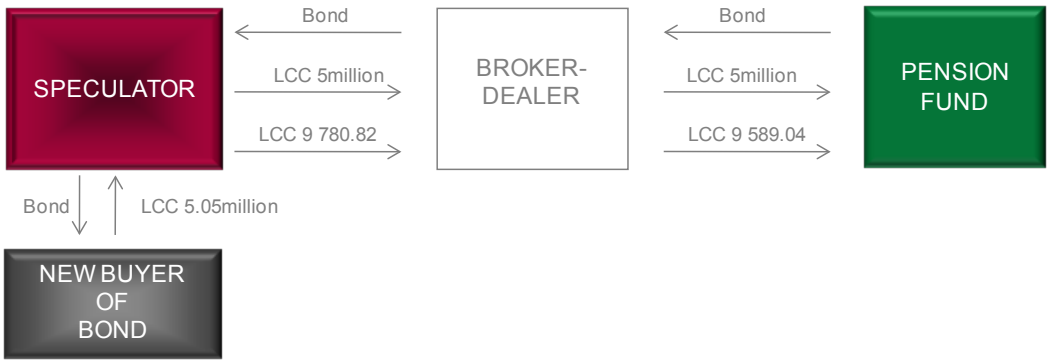

Figure 8: cash and security flows on termination of repo

It will be evident that the speculator sold his bond position to the broker under *repurchase agreement* for 7 days (or had them *carried* for this period). The broker did a *resale agreement* for 7 days with the speculator (or *carried* the bonds), and a *repurchase agreement* with the pension fund (or had the bonds *carried* by the pension fund). The pension fund did a *resale agreement* with the broker, or *carried* the bonds for 7 days.

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Another rationale for the repo market is the interbank market. This is covered in the following section.

2.7.3.6 Institutions involved in the repo market

The above are the main reasons that give rise to repurchase agreements, i.e. a party wishing to acquire funds for a period and a party with a matching investment requirement. And there are many strategies that underlie these agreements.

In Local Country (LC) the parties involved in this market are the money market broker-dealers, the banks, corporate entities, pension funds, insurance companies, money market funds, the central bank, foreign investors, speculators in the bond market, etc.

Of all these institutions, the central bank and the banks are usually the largest participants, because the *repo* is the method used by the central bank to provide accommodation to the banks (in most countries) (see below).

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2.7.3.7 Types of repurchase agreements

As noted earlier, there are two main types of repurchase agreements, i.e. the *open repurchase agreement* and the *fixed term repurchase agreement*. The former agreement is where there is no agreed termination date. Both parties have the option to terminate the agreement without notice. The rate on these agreements is usually a floating rate, the basis of which is agreed in advance.

Fixed term repurchase agreements are repurchase agreements where the rate and the term are agreed at the outset of the agreement. The term of repos usually range from a day to a few months.

2.7.3.8 Securities that underlie repos

Only prime marketable securities are used in repos, and this includes money market and bond market securities. Repos are usually done at market value of the underlying securities or lower than market value, and the securities are *rendered negotiable*. Securities are rendered negotiable to protect the investor against the maker of the repo, i.e. in the event of the maker reneging on a deal, the investor has the right to sell the underlying securities (in terms of the ISDA Master Repurchase Agreement).

What is meant by *rendered negotiable* is that the underlying securities are prepared in negotiable form. For example, a bank acceptance made payable to a particular investor is endorsed in blank. In the case of bond certificates this means that a signed securities transfer form accompanies each certificate.[11]

2.7.3.9 Mathematics of the repurchase agreement market

Repurchase agreements are dealt on a yield basis, i.e. the interest rate is paid on an add-on basis. The amount of interest is calculated in terms of the following formula:

$$IA = C \times ir \times t$$

where

IA = interest amount
C = consideration (i.e. the market value or lower of the securities)
ir = agreed interest rate per annum expressed as a unit of 1
t = term of the agreement, expressed in days / 365

If, for example, LCC10 million (nominal value) NCDs with a maturity value of LCC10 985 000, and a market value of LCC10 300 000, were sold for seven days at a repo rate of 12.0% pa, the interest payable would be as follows:

$$\begin{aligned} IA &= C \times ir \times t \\ &= \text{LCC10 } 300\,000 \times 0.12 \times 7 / 365 \\ &= \text{LCC23 } 704.11. \end{aligned}$$

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It should be clear that the buyer would pay LCC10 300 000 for the repo and receive LCC10 323 704.11 upon termination of the agreement.

The mathematics of repos in the case of bonds is similar to that of bond forwards (remember a repo is a *combination of a spot sale and a forward purchase*). The carry rate is applied to the all-in price at the first settlement date of the deal (called reference price) to determine the price at termination (second settlement date).

2.7.3.10 Repos and the banking sector

Because the banks are the largest initiators of repos, and a large slice of the market takes place between banks, it is necessary to afford this sector a separate section.

Because repos are one method through which banks are able to acquire funding, many central banks require banks to report *on balance sheet* all their repos, for purposes of their capital adequacy requirement, i.e. banks are required to allocate capital to this activity (because the asset has to be bought back). It will be evident that if a bank brings back on balance sheet securities sold, it has to create a liability, and this liability item is termed "loans under repurchase agreements".

There are many reasons for banks engaging in the repo market. Perhaps the most prominent is that the repo instrument is a convenient method to satisfy wholesale clients' needs (retail clients do not feature in this market).

All the major banks have Treasury Departments, and this department is the hub of these banks. All wholesale transactions and portfolio planning take place in the Treasury Department. If a large mining house client, for example, would like to purchase LCC100 million securities that have 63 days to run (because it need the funds for an acquisition in 63 days' time and is "full"[12] in terms of its limit for the bank), the bank is able to satisfy the client's investment requirement by selling LCC100 million of its strategic holding of government bonds to the client for 63 days.

Another example is a small bank losing a LCC100 million deposit at the end of the trading day, and not being able to negotiate a deposit to fund the shortfall with the non-bank sector. Assuming a large bank has a LCC100 million surplus, and that this bank does not want to be exposed to the small banks, it may offer the LCC100 million to the small bank against a repo, i.e. the small bank will sell securities to the value of LCC100 million to the large bank for a day or two (at the rate for this period). Clearly, if the small bank fails in this period, the large bank has claim to the repo securities.

In most countries banks are accommodated by the central bank effecting repos with them, i.e. the banking sector sells eligible securities to the central bank under repo. The style of monetary policy adopted in most countries is ensuring that the banks are indebted to the central bank at all times (i.e. borrow cash reserves on a permanent basis), in order to "make the KIR effective".

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2.7.3.11 Listed repurchase agreements

Generally speaking, the repo market is an OTC market. However, in many countries repos on bonds are widely-used instruments; thus listed repos do exist.

2.7.4 Forward rate agreements

General

A *forward rate agreement* (FRA) is an agreement that enables a user to hedge itself against unfavourable movements in interest rates by fixing a rate on a notional amount that is (usually) of the same size and term as its exposure that starts sometime in the future. It is akin to a foreign exchange forward contract in terms of which an exchange rate for a future date is determined upfront.

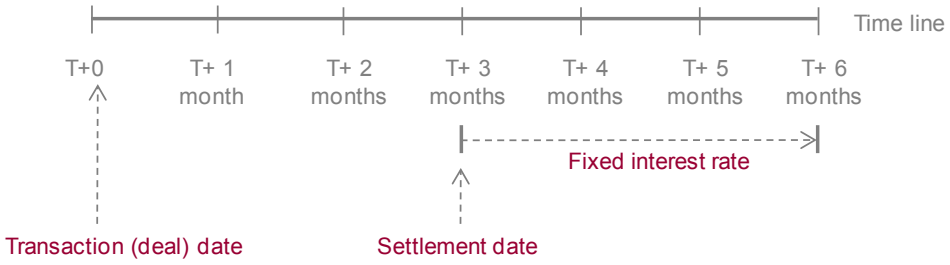

Figure 9: 3 × 6 FRA

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An example is a 3 × 6 FRA (3-month into 6-month): the 3 in the 3 × 6 refers to 3 months' time when settlement takes place, and the 6 to the expiry date of the FRA from deal date, i.e. the rate quoted for the FRA is a 3-month rate at the time of settlement. This may be depicted as in Figure 9.

This type of instrument is particularly useful for the company treasurer who is of the opinion that the central bank is about to increase the KIR and that the interest rates on commercial paper (his borrowing habitat) will rise sharply. He needs to borrow LCC20 million in three months' time for a period of three months. He approaches a dealing bank that he normally deals with on 4 March and obtains quotes on a series of FRAs as shown in Table 1[13].

FRA	Bid (% pa)	Offer (% pa)	Explanation
3 × 6	10.00	10.10	3-month rate in 3 months' time
6 × 9	10.20	10.30	3-month rate in 6 months' time
9 × 12	10.40	10.50	3-month rate in 9 months' time

Table 1: fictional fra quotes

The treasurer verifies these rates against the quoted FRA rates of another two banks (i.e. to ensure that he is getting a good deal), finds that they are fair and decides to deal at the 10.10% pa offer rate for the 3 × 6 FRA for an amount of LCC20 million, which matches the company's requirement perfectly. The applicable future dates are 4 June and 3 September (91 days).

The transaction means that the dealing bank undertakes to fix the 3-month borrowing rate in three months' time at 10.10% for the company. The transaction is based on a *notional amount* of LCC20 million. The notional amount is not exchanged; it merely acts as the amount upon which the calculation is made.

The rate fixed in the FRA is some *benchmark* (also called *reference*) rate, or a rate referenced on a benchmark rate, i.e. some rate that is readily accepted by market participants to represent the 3-month rate. We assume this is the 3-month JIBAR[14] rate, which is a yield rate.

On settlement date, i.e. 4 June, the 3-month JIBAR rate is 10.50% pa. On this day the 3-month (91-day) commercial paper rate is also 10.50% pa (which it should be because the JIBAR rate is representative of the 3-month rate). The company borrows the LCC20 million required at 10.50% through the issue of commercial paper for 91 days. According to the FRA the dealing bank now owes the company an amount of money equal to the difference between the spot market rate (i.e. 3-month JIBAR = 10.50% pa) and the agreed FRA rate (i.e. 10.10% pa) times the notional amount. This is calculated as follows:

$$SA = NA \times ird \times t$$

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where

SA = settlement amount
NA = notional amount
ird = interest rate differential (10.50% pa – 10.10% pa = 0.40% pa)
t = term (forward period), expressed as number of days / 365
SA = LCC20 000 000 × 0.004 × (91 / 365)
= LCC19 945.21.

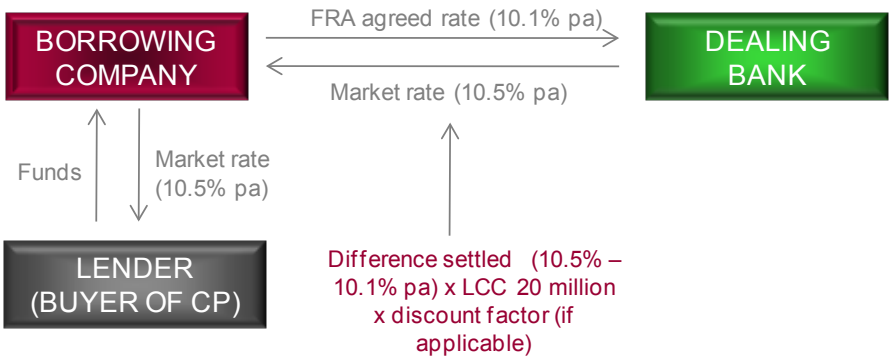

Figure 10: example of FRA: bank settles difference

Note that this formula applies in the case where settlement of this amount is made in arrears at month 6 (= 3 September). If the amount is settled at month 3 (= 4 June) it has to be discounted to present value (PV). The discount factor is:

df = 1 / [1 + (rr × t)]

where

rr = reference rate (= JIBAR rate)
t = term of agreement (number of days / 365)

df = 1 / [1 + (rr × t)]
= 1 / [1 + (0.105 × 91 / 365)]
= 0.97449.

Therefore (PVSA = present value of settlement amount):

PVSA = SA × df
= LCC19 945.21 × 0.97449
= LCC19 436.41

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This transaction may be illustrated as in Figure 10. It will be evident that the exchange of interest on LCC20 million does not take place; the dealing bank only settles the difference.

Implied forward rate

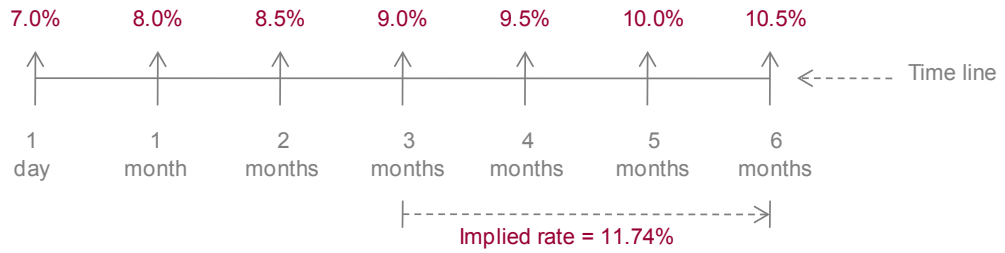
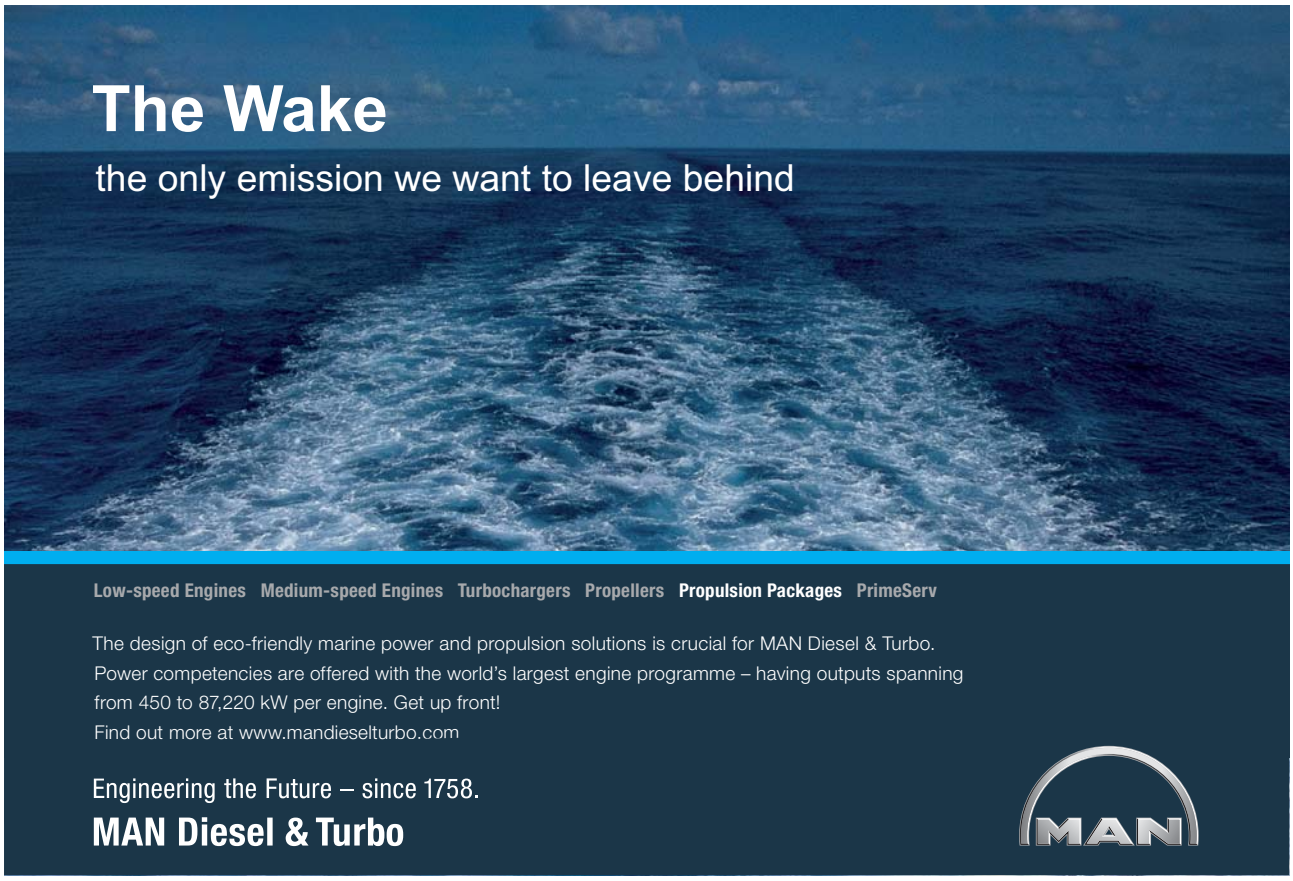


Figure 11: money market yield curve

The dealing bank would of course not have sucked the rates quoted out of thin air. It would have based its forward rates on the rates implicit in the spot market rates. An example is required (see Figure 11).

Shown here are the spot rates for various periods at a point in time[15]. This may also be called a money market yield curve (as opposed to a long-term yield curve which stretches for a number of years). This notional yield curve may also be depicted as in Figure 12 (this is an unrealistic yield curve, because the yield curve does not usually follow straight lines).



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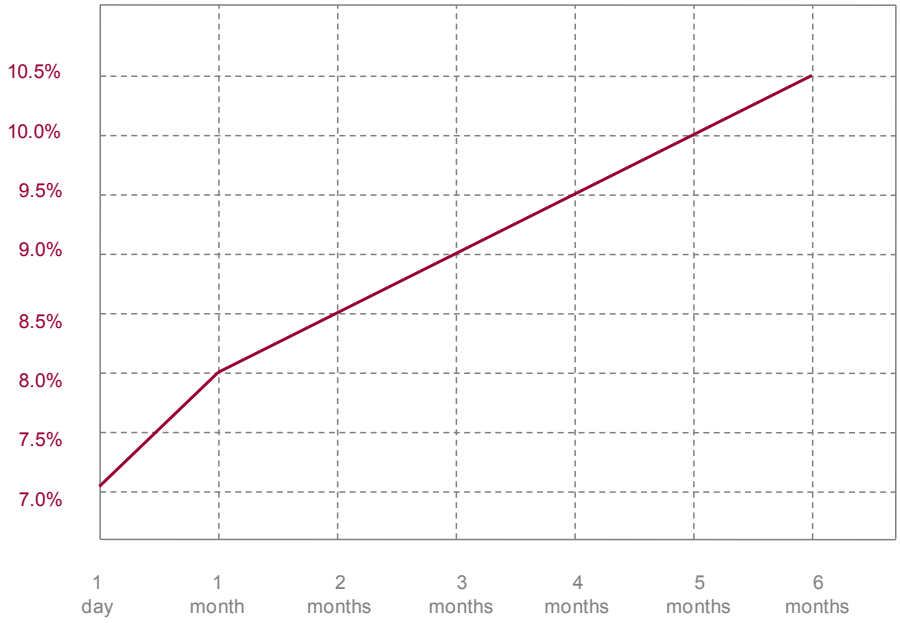

Figure 12: fabricated money market yield curve

The rate now (spot rate) for three months is 9.0% pa and the rate now (spot rate) for six months is 10.5% pa, and we know that the latter rate covers the period of the first rate. The rate of interest for the three-month period *beyond the three-month period* can be calculated by knowing the two spot rates mentioned. This is the forward rate of interest, or the *implied forward rate*. This is done as follows (assumption 3-month period: 91 days; 6-month period: 182 days):

$$IFR = \{[1 + (ir_L \times t_L)] / [1 + (ir_S \times t_S)] - 1\} \times [365 / (t_L - t_S)]$$

where

IFR = implied forward rate
ir_L = spot interest rate for the longer period (i.e. 6-month period)
ir_S = spot interest rate for shorter period (i.e. 3-month period)
t_L = longer period, expressed in days / 365) (i.e. the 6-month period – 182 days)
t_S = shorter period, expressed in days / 365) (i.e. 3-month period – 91 days)

$$\begin{aligned} IFR &= \{[1 + (0.105 \times 182/365)] / [1 + (0.09 \times 91/365)] - 1\} \times 365/91 \\ &= [(1.0524 / 1.0224) - 1] \times 365/91 \\ &= (1.0293 - 1) \times 365/91 \\ &= 0.1174 \\ &= 11.74\% \text{ pa.} \end{aligned}$$

The bank, in the case of a 3 × 6 FRA, will quote a rate that is *below* the implied 3-month forward interest rate, i.e. below 11.74%.

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2.8 Forwards in the share / equity market

There is only one type of forward contract in the share market, and this is the outright forward. An outright forward is simply the sale of shares at some date in the future at a price agreed at the time of doing the deal. The mathematics is straightforward (= cost of carry model):

$$FP = SP \times [1 + (ir \times t)]$$

where

FP = forward price
SP = spot price
t = term, expressed as number of days / 365
ir = interest rate per annum for the term (expressed as a unit of 1).

An example is required: a pension fund believes the price of Company XYZ shares will increase over the next 85 days when its cash flow allows the purchase of these shares. It requires 100 000 shares of the company and approaches a broker-dealer to do an 85-day forward deal. The broker-dealer buys the 100 000 shares now at the spot price of LCC94 per share and finances them by borrowing the funds from its banker at the prime rate of 12.0% pa for 85 days. It offers the pension fund a forward deal based on the following (assumption: non-dividend paying share):

SP = 100 000 shares of Company XYZ at LCC94.0 per share = LCC9 400 000
t = 85 days
ir = 12.5% = 0.125 (note that the it includes a margin of 0.5%)
FP = LCC9 400 000 × [1 + (0.125 × 85 / 365)]
= LCC9 400 000 × 1.029110
= LCC9 673 634.00.

After 85 days the pension funds pays the broker-dealer this amount for the 100 000 Company XYZ shares, and the broker-dealer repays the bank:

Consideration = LCC9 400 000 × [1 + (0.12 × 85 / 365)]
= LCC9 400 000 × 1.027945
= LCC9 662 684.92.

The broker-dealer makes a profit of LCC10 949.07 (LCC9 673 634.00 – LCC9 662 684.92).

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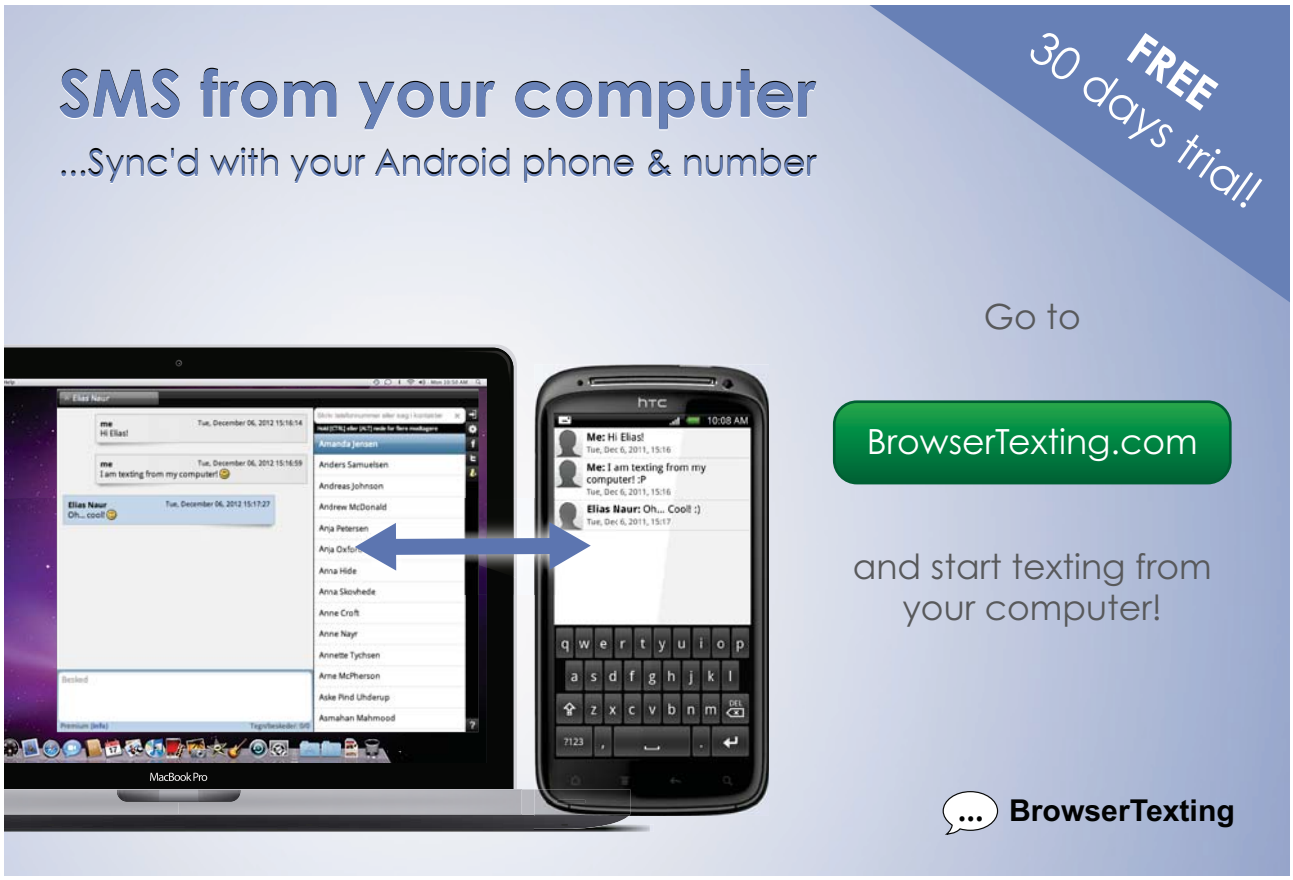
Clearly, the pension fund at the start of the deal is of the opinion that the price of the shares will increase by more than the price of money for the period. Pension funds mainly do outright forward share transactions and this is because they are not permitted to incur borrowings. The pension fund would also "shop around" to find the best deal.

2.9 Forwards in the foreign exchange market

2.9.1 Introduction

Foreign exchange is deposits and securities in a currency other than the domestic currency, and an exchange rate is an expression of units of a currency in terms of one unit of another currency. An example is USD / LCC 7.5125, which means that LCC 7.5125 is required to buy USD 1.0[16]. The 1.0 is left out of the expression because it is known to be 1.0. The one unit currency is called the *base currency* and the other the *variable currency*.



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There are two broad types of deals in foreign exchange, spot and forward, and there are four types of forwards. The five deal types in foreign exchange are:

- Spot foreign exchange transactions.
- Forward foreign exchange transactions:
  - Outright forwards
  - Foreign exchange swaps (not to be confused with "proper" currency swaps)
  - Forward-forwards
  - Time options (not to be confused with "normal" options).

A *spot foreign exchange transaction* is a deal done now (on T+0) for settlement on T+2 (an international convention), and essentially amounts to the exchange of bank deposits in two different countries. Investments or the purchase of goods then occur as a second phase, i.e. the foreign bank deposit is used to buy the foreign investment or goods. A *forward foreign exchange transaction* is a transaction that takes place (i.e. is settled) on a date in the future other than the spot settlement date of T+2, but the price and amount is agreed on the deal date (i.e. now = T+0). This transaction is called an outright forward. This type of forward foreign exchange transaction and the other slight variations on the main theme are discussed next.[17]

2.9.2 Outright forwards

2.9.2.1 Introduction

As noted, *outright forwards* are forward foreign exchange contracts, i.e. contracts between the market making banks[18] and clients, and may be defined as contracts in terms of which the banks undertake to deliver a currency or purchase a currency on a specified date in the future other than the spot date, at an exchange rate agreed upfront. The formula is:

$$\text{Outright forward} = SP \times \{[1 + (ir_{vc} \times t)] / [1 + (ir_{bc} \times t)]\}$$

where

SP = spot exchange rate
ir_{vc} = interest rate on variable currency
ir_{bc} = interest rate on base currency
t = term, expressed as number of days / 365.

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The above is the standard formula, because the vast majority of forwards are done for standard periods of less than a year (30-days, 60-days, 90-days, 180-days, etc). When the period is longer than a year, the formula becomes:

Outright forward $= SP \times [(1 + ir_{vc})^n / (1 + ir_{bc})^n]$
where n = number of years

(where the period is broken years, for example 430 days, then n = 430 / 365).

It will have been noted that the principal here is the PV / FV concept, with the difference being that there are two interest rates that are to be taken into account. If the rate on the variable currency is higher than the rate on the base currency, then the units of the variable currency will be higher, i.e. it takes more LCC to buy one USD on a forward date. Conversely, it takes less USD to buy one LCC on the forward date. An example is called for.

2.9.2.2 Example one

Forward period = 60 days
Spot rate = USD / LCC 7.50
ir_{bc} = 5.0%pa
ir_{vc} = 10.0% pa

Outright forward rate[19]

$$= SP \times \{[1 + (ir_{vc} \times t)] / [1 + (ir_{bc} \times t)]\}$$
$$= 7.50 \times \{[1 + (0.10 \times 60/365)] / [1 + (0.05 \times 60/365)]\}$$
$$= 7.50 \times (1.01643836 / 1.00821918)$$
$$= 7.56114134$$
$$= \text{USD / LCC } 7.56114134.$$

Let us test the logic. An investor has the choice of investing in a LCC 60-day deposit at 10.0% pa or in a USD 60-day deposit at 5.0% pa. In the former case the investor will earn (assuming LCC 10 000 000 is available to invest):

Forward consideration $= \text{present consideration} \times [1 + (ir_{vc} \times 60/365)]$
$= \text{LCC } 10\,000\,000 \times [1 + (0.10 \times 60/365)]$
$= \text{LCC } 10\,000\,000 \times 1.01643836$
$= \text{LCC } 10\,164\,383.60$

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In the latter case the investor buys the USD equivalent of LCC 10 000 000 = USD 1 333 333.33 [LCC 10 000 000 × (1 / 7.5)]. The investor immediately deposits this amount for 60 days at 5.0% pa, and sells the USD forward consideration forward for LCC at the forward rate of USD / LCC 7.56114134:

$$\begin{aligned}\text{Forward consideration} &= \text{present consideration} \times [1 + (ir_{bc} \times 60/365)] \\ &= \text{USD } 1\,333\,333.33 \times [1 + (0.05 \times 60/365)] \\ &= \text{USD } 1\,333\,333.33 \times 1.00821918 \\ &= \text{USD } 1\,344\,292.23.\end{aligned}$$

LCC equivalent at forward exchange rate:

$$\begin{aligned}&= \text{USD } 1\,344\,292.23 \times 7.56114134 \\ &= \text{LCC } 10\,164\,383.60.\end{aligned}$$

It should be evident that the forward exchange rate may be calculated by dividing the LCC forward consideration by the USD forward consideration:

$$\text{LCC } 10\,164\,383.60 \,/\, \text{USD } 1\,344\,292.23 = 7.5611.$$

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Conclusion: the investor earns the same return in both countries, and this is so because of the principle of *interest rate parity*:

The net rate of return from an investment offshore should be equal to the interest earned minus or plus the forward discount or forward premium on the price of the foreign currency involved in the transaction.

This says that the interest differential between two currencies is related to the forward discount or premium, and that *interest rate parity* is reached when the interest rate differential is equal to the discount or premium on one of the currencies. In this example USDs are selling at a premium in the forward market (think: *more LCC per USD in the forward market*).

This condition in the forward market is brought about by arbitrage. The many participants in the foreign exchange market seek out arbitrage opportunities in this regard (mispricing) and drive the forward exchange rate to reflect the condition of *interest rate parity.*

In the above example the spot exchange rate was USD / LCC 7.5 and the forward exchange rate USD / LCC 7.5611 (rounded). Thus the *forward points* (or forward *swap* points) are 611 (or LCC 0.0611). This is clarified in the following section on foreign exchange swaps.

2.9.2.3 Example two

It will be useful to provide another example in order to clarify the PV/FV concept:

A citizen of Local Country borrows funds for 6 months from a Local Country bank, buys USD at the spot rate, invests immediately in a 60-day USD deposit, and converts the USD forward consideration into LCC at the forward rate. The elements of the transactions are:

Amount borrowed	= LCC 10 000 000 at 10% pa
LCC borrowing rate	= 10.0%pa
Spot exchange rate	= USD / LCC 7.5
USD 6-month deposit rate	= 5% pa
Forward exchange rate	= 7.56114134.

LCC 10 000 000 at spot rate = USD 1 333 333.33 (LCC 10 000 000 / 7.5)

USD 1 333 333.33 at 5% for 60 days

= USD 1 333 333.33 × (1 + 0.05 × 60 / 365)

= USD 1 333 333.33 × 1.0082192

= USD 1 344 292.26

USD 1 344 292.26 sold for LCC at forward rate

= USD 1 344 292.26 × 7.56114134

= LCC 10 164 384

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LCC owed to bank after 60 days

$$= \text{LCC } 10\,000\,000 \times (1 + 0.10 \times 60 / 365)$$
$$= \text{LCC } 10\,000\,000 \times 1.01643834$$
$$= \text{LCC } 10\,164\,384.$$

It will be clear that the Local Country LCC borrower / USD investor did not benefit from the deal; he is at break-even. Had he benefited the forward rate would have been out of line, allowing an arbitrage deal to be undertaken.

From this example it will have been established that if the cost of borrowing is higher than the gain from lending the forward rate will have to be at a premium to compensate for the interest rate differential. It may also be explained as follows:

If LCC invested increases by more than USD invested (because of the higher LCC interest rate), the numerator (LCC) will increase by more than the denominator (USD) and thus result in a forward rate that is higher than the spot rate.

The numerator and denominator referred to are of course from the formula presented above and repeated here:

$$\text{Outright forward exchange rate} = SP \times \{[1 + (ir_{vc} \times t)] / [1 + (ir_{bc} \times t)]\}.$$

2.9.3 Foreign exchange swaps

Foreign exchange swaps (called *forex swaps* or just *swaps*) are not to be confused with "proper" currency swaps, which will be covered later. Forex swaps are forward deals done on a different basis, and are the deal type done by the market maker banks in the vast majority of cases.

A forex swap is the exchange of two currencies now (i.e. spot) at a *specified* exchange rate (which does not have to be the current exchange rate but usually is a rate close to the current rate – it is a benchmark rate on which the "points" are based) coupled with an agreement to exchange the same two currencies at a specified future date at *the specified* exchange rate *plus or minus the swap points*. *Swaps points* are also called *forward points* and are quoted, for example, as 590 / 600. This quote is interpreted as follows:

- the left side (specified exchange rate + 590 points) is the rate at which the quoting bank will buy USD in 60 days for USD sold spot now (client buys spot and sells forward)
- the right side (specified exchange rate + 600 points) is the rate at which the quoting bank will sell USD after 60 days for USD bought spot now (client sells spot and buys forward).

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It is important to note that the points run from the second decimal and are in terms of price (of the variable currency). The following should be clear:

Forward swap	= outright forward – SP
Outright forward	= SP + forward swap

Using the earlier numbers:

Forward swap	= outright forward – SP
	= 7.5611 – 7.5
	= 0.0611
Outright forward	= SP + forward swap
	= 7.5 + 0.0611
	= 7.5611.

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An example is called for: a number of years ago the Local Country central bank encouraged the inflow of foreign exchange by offering the banks cheap swap rates. This means that the local banks were "encouraged" to borrow offshore and swap USD for LCC, which is unwound on the forward date, giving them a virtually risk-free profit. The following are the numbers (utilising some of the numbers used earlier):

Specified rate (= spot rate = SP)	= USD / LCC 7.5
Period of forward deal	= 60 days
Interest rate parity forward rate	= USD / 7.5611 (i.e. "fair value" rate)
USD rate (assume borrowing in US) (ir_{bc})	= 5.0% pa
LCC rate (assume lending in LC) (ir_{vc})	= 10.0% pa
Forward points offered	= 550.

A local bank borrows USD 1 000 000 at 5.0% from a US bank and sells this to the Local Country central bank. The central bank credits the bank's current account in its books (i.e. excess cash reserves) by LCC 7 500 000 (USD 1 000 000 × 7.5). This of course amounts to the *exchange of currencies in the first round of the swap*. The central bank undertakes to exchange USD 1 000 000 plus interest at 5% for LCC in 60 days' time (the second exchange) at the forward rate of:

Forward rate = specified rate (the benchmark rate) + forward swap points
= 7.50 + 550 (i.e. 0.0550)
= 7.555

Forward consideration (USD) = borrowing × [1 + (ir_{bc} × 60/365)]
= USD 1 000 000 × [1 + (0.05 × 60/365)]
= USD 1 000 000 × 1.008219
= USD 1 008 219.

This means that the central bank will supply USD 1 008 219 at an exchange rate of USD / LCC 7.555 at the conclusion of the swap after 60 days.

The bank withdraws the *created*[20] LCC7 500 000 from the central bank and invests this in a local bank (other bank most likely) NCD at 10.0%. The proceeds at the end of the forward period are:

Forward consideration (LCC) = deposit × [1 + (ir_{vc} × 60/365)]
= LCC 7 500 000 × [1 + (0.10 × 60/365)]
= LCC 7 500 000 × 1.01643836
= LCC 7 623 288.

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On the due date of the swap, the central bank supplies USD 1 008 219 to the local bank for a LCC 7 617 095 (USD 1 008 219 × 7.555)[21]. This of course amounts to the *exchange of currencies in the opposite direction, ie it is the second round of the swap*. The local bank fulfils its obligation to the US bank (USD 1 008 219 = borrowing plus interest), and pockets the profit on the swap of LCC 6 193. This amount is the difference between the amount paid by the bank that issued the NCD and the amount paid by the bank to the cin terms of the swap contract (LCC 7 623 288 – LCC 7 617 095).

2.9.4 Forward-forwards

A forward-forward is a swap deal between two forward dates as opposed to an outright forward that runs from a spot to a forward date. An example is to sell USD 30 days forward and buy them back in 90 days time. The swap is for the 60-day period *between* 30 days from deal date (now = T) and 90 days from deal date. The backdrop to this deal may be that the client (company) previously bought USD forward (30 days' ago for the date 30 days from now) but wishes to defer the transaction by a further 60 days because it will not need the USD until then. This deal[22] is illustrated Figure 13.

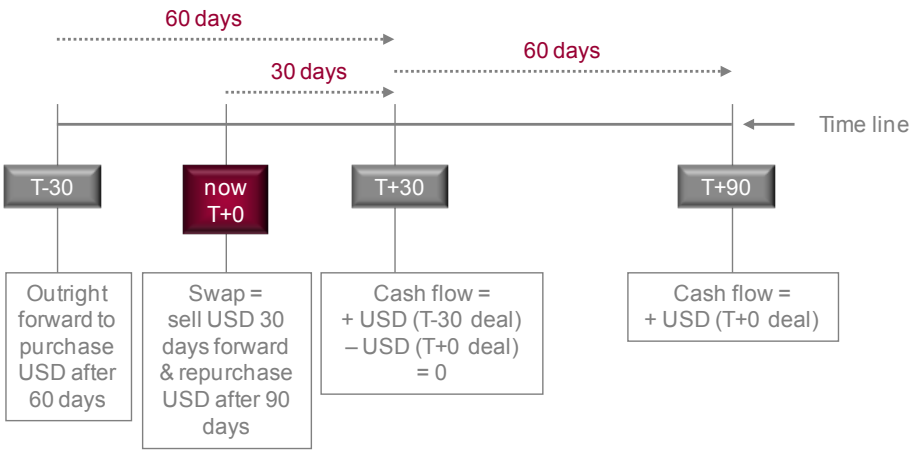

Figure 13: example of a forward-forward deal

Variations of forward-forwards are *foreign exchange agreements* (FXAs) and *exchange rate agreements* (ERAs). Together they are referred to as *synthetic agreements for forward exchange* (SAFEs). The FXA is the same as a forward-forward as explained above, but on the first settlement date, T+30 in our example, the settlement takes place as in the case of a FRA, i.e. in *cash* reflecting the *difference* between the exchange rate set in the outright forward contracted on T-30 and the exchange rate set in the swap on T+0. The difference may be a profit or a loss for the client, which of course will be the reverse for the bank. An ERA is the same as a FXA, but takes no account of the movement in spot rates between T-30 and T+0.[23]

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2.9.5 Time options

As noted above, when a bank does an *outright forward* it is undertaking to buy or sell a specified currency on a future date at an exchange rate specified at the outset. This type of contract does not suit every non-bank client. A client may have a requirement for a hedge but is not sure exactly when forex is required (e.g. an importer), or to be sold (e.g. an exporter). In these cases *forex time options* are appropriate instruments. This instrument is the same as an outright forward with the maturity date specified, but the client has the option to settle at any time within a specified period. The *specified period* may be anytime during the period of the contract, or anytime between a future date and the expiry date of the contract.

A forex time option is not to be confused with a *currency option* in terms of which the holder has the option but not the obligation to buy (call) or sell (put) a specified currency at a specified strike rate before or on the expiry date. An option premium is payable, which is not the case with a time option. In the case of a time option, the *holder has the obligation to settle* but has *flexibility in terms of the settlement date*.

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2.9.6 Functions/uses of the forward foreign exchange market

There are many reasons for the existence of the forward foreign exchange market, but it is essentially used to cover a number of risks that are encountered by investors and commercial companies that are engaged in importing and exporting. The four main uses of the forward market are:

- Commercial covering.
- Hedging an investment.
- Speculation.
- Covered interest arbitrage.

2.10 Forwards in the commodities market

Above we have discussed the forward markets in the debt market and the foreign exchange market. There are also forward markets in many commodities, but they will not be discussed here, because the principle remains the same. Only the maths is slightly different because other costs, such as storage (which usually includes insurance), is taken into account:

$$FP = \{SP \times [1 + (ir \times t)]\} + (SC \times dte)$$

where

FP = forward price
SP = spot price
ir = interest rate for period, i.e. period from now to the forward deal date
dte = days to expiry (of forward contract, i.e. until forward deal date)
t = dte / 365
SC = storage costs.

It will be evident that this is a "carry cost" (CC) model, where there are two costs, interest and storage, and no income on the asset is forthcoming (if income were forthcoming the model becomes a "net carry cost" (NCC) model.

Example: forward grain market: one ton of grain will be delivered to a buyer 91 days from today:

SP (of grain) = LCC1 200 per ton
ir = 12.0% pa
dte = 91
t = 91 / 365
SC = 35 cents per ton per day
FP = {LCC1 200 × [1 + (0.12 × 91 / 365)]} + (0.35 × 91)
= (LCC1 200 × 1.0299) + LCC31.85
= LCC1 267.75 per ton.

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2.11 Forwards on derivatives

In addition to the forwards that are found in the four financial markets, there are also forwards on swaps.

The specific swaps on which forwards are written are interest rate swaps (IRSs). The forward IRS is an agreement to enter into a swap at some stage in the future at terms agreed upfront. It differs from a swaption (discussed later) in terms of which the holder has the right to allow the option to lapse. In the case of a forward swap, the *holder is obliged to undertake the swap* at the future agreed date (swaps are discussed in some detail later).

2.12 Organisational structure of forward markets

Figure 14 is one way of depicting the organisational structure of the spot financial markets.

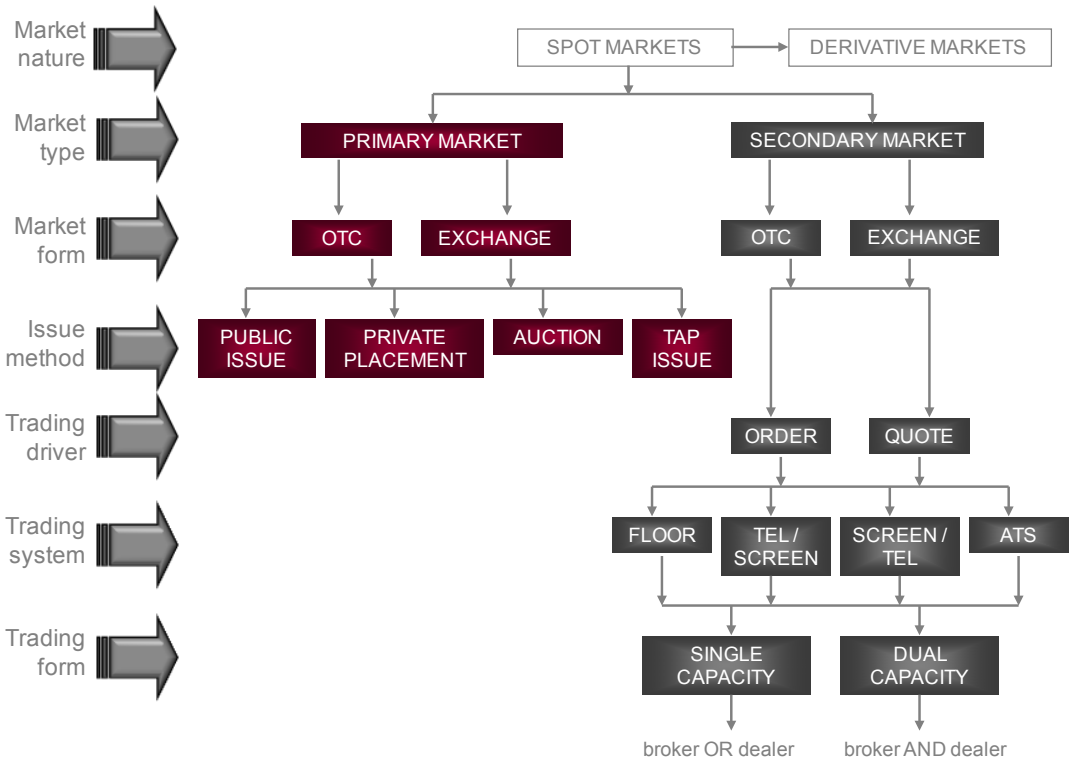

Figure 14: organisationalstructure of spot financial markets

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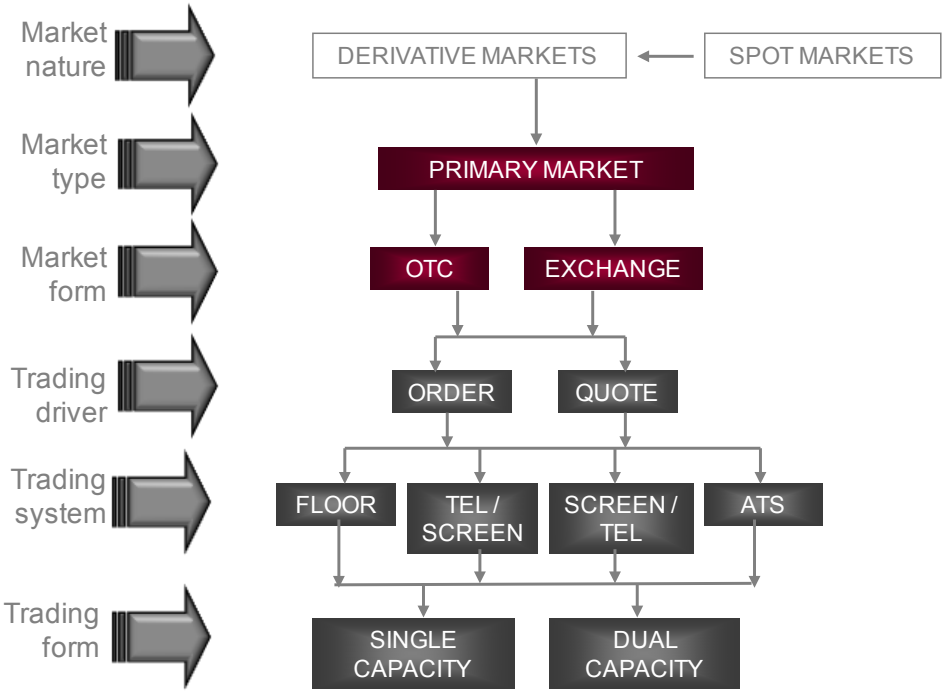

Figure 15: organisationalstructure of derivative financial markets

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However, this applies to the "normal" financial markets, i.e. the money, bond and share markets. It is not well suited to the foreign exchange and derivative markets. Figure 15 is an attempt to visualise the derivative markets.

The derivative markets in the form of the OTC forward markets are entirely primary markets (there are minor exceptions such as repos that are marketable, but trading in them is rare); thus, generally, one cannot talk of a secondary OTC derivatives market (in the normal sense of the term). The reason for this situation is that the forward market instruments are usually custom made for clients. However, this does not mean that the holder of a forward transaction is "stuck" with the deal until maturity; the instruments are "marketable" in the sense that the positions created by them may be "closed out" quite easily by the purchase / sale of an opposite deal. The "closing out" will result a net loss or profit, as in the case of a spot instrument sale.

The same applies in the case of listed (on an exchange) forwards, but with a difference. A secondary market in these listed instruments also does not exist in the normal sense of the term. However, the contracts are standardised and can therefore be "closed out" by doing an equal but opposite transaction. In the case of the OTC forward markets it is not always possible to do the exact opposite transaction, leaving thus a measure of risk.

This brings us to the trading driver: quote or order. Participants are able to get quotes from the banks or place an order with a broker-dealer. "Quote" means that the banks provide quotes (as in market making – explained earlier). This leads to the trading system. In the Local Country's derivative markets, all the trading systems apply (except "floor"; it does however still apply in some international markets).

The trading system "telephone / screen" means applies where broker-dealers quote indication prices on the screen (for example, the Reuters Monitor System) and clients phone in and ask for firm prices. "Screen / telephone" is where prices quoted on screen are firm for a certain size deal and the deal is consummated on the telephone. ATS stands for "automated trading system" and here deals in the form of orders are inputted into the ATS and are matched by it if there is an opposite order. The various types of forward transactions fit into one of these three trading systems.

Single and dual capacity trading means that the broker-dealers either act as brokers *and* dealers (dual) or as brokers *or* dealers (single).

2.13 Summary

Forward contracts are to settle assets / securities on dates in the future other than spot settlement dates. Some markets are suited for forward contracts such as the forex market and the FRA market. There are forwards in all the markets: debt, share, forex and commodities. The pricing of forwards rests on the cost of carry model, i.e. the rate of interest for the relevant period less income (if applicable).

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3 Derivative markets: futures

3.1 Learning outcomes

After studying this text the learner should / should be able to:

- Define a futures contract.
- Understand the constituents of the definition of futures contracts.
- Understand the payoff (risk) profile of futures contracts.
- Understand the characteristics of the futures market, such as getting out of a position in futures, and cash settlement versus physical settlement.
- Understand the concepts of margins, marking to market and open interest.
- Comprehend the principles applied in the pricing of futures contracts (fair value).
- Calculate the fair value prices of futures contracts.
- Understand the concepts of convergence, basis and carry cost in relation to basis.
- Understand the motivation for undertaking deals in futures, particularly hedging, and the participants in the futures market.
- Comprehend basis and spread trading.

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3.2 Introduction

In the previous section on forwards, we defined a forward market as *a market where a transaction (buy or sell) on an asset is concluded now (at T+0) for settlement on a date in the future at a price determined now.* A forward contract may therefore be defined as *a contract between a buyer and a seller at time T+0 to buy or sell a specified asset on a future date at a price set at time T+0*. We also identified the advantages and disadvantages of forward markets. We also covered variations on this main theme, such as FRAs, FIRCs and repos.

Essentially, futures contracts are standardised forward contracts, and they developed because forward contracts have some disadvantages, the most obvious one being that forward contracts are difficult (usually impossible) to reverse. There is also a need for efficient price discovery which means that liquidity needs to be enhanced, and this only comes about when activity in the market increases, and in pursuance of this contracts need to be standardised in terms of quality, quantity and expiry date. Once this need is satisfied an exchange is an appropriate market form, and an exchange mitigates risk, which further enhances the breadth and depth of the market.

This does not mean that all forward markets are destined to become futures markets. In some markets reversibility of deals is not crucial and customisation in terms of quantity and expiry is required. The best example is the outright forward forex market where commercial transactions (importing and exporting) require customisation and rarely require reversal.

Futures are discussed in the following sections:

- Futures defined.
- An example.
- Trading price versus spot price.
- Types of futures contracts.
- Organisation of futures markets.
- Clearing house.
- Margining and marking to market.
- Open interest.
- Cash settlement versus physical settlement.
- Payoff with futures (risk profile).
- Pricing of futures (fair value versus trading price).
- Fair value pricing of specific futures.
- Basis.
- Participants in the futures market.
- Hedging with futures.
- Basis trading.

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- Spread trading.
- Futures market contracts.
- Risk management by a futures exchange.
- Mechanics of dealing in futures.
- Economic significance of futures market.

3.3 Futures defined

3.3.1 Introduction

A futures contract may be defined as *a contractual obligation in terms of which one party to the deal undertakes on T+0 to sell an asset at a price (determined on T+0) on a future date, and the other party undertakes to buy the same asset at the same price on the same future date*. This sounds pretty similar to the forward contract. It is, but the differences are that the contracts are *standardised*, the underlying assets are *standardised*, and the *contracts are exchange-traded*, because these qualities render the contracts marketable (sort of – later we will see that futures are marketable in the sense that they can be "closed out" by undertaking an equal and opposite transaction).

As noted, essentially the futures markets of the world developed to overcome the disadvantages of forward markets. By their very nature, forward markets are OTC markets (mostly), whereas futures markets are all formalised in the form of financial exchanges, the members of which effect all trading, and the exchange guarantees all transactions by interposing itself between buyer and seller.

The definition of a future may now be extended: *a standardised contract which obligates the buyer to accept delivery of, and the seller to deliver, a standardised quantity and quality of an asset at a pre-specified price on a pre-stipulated date in the future*.

It may be useful to break up this definition into its constituents:

- Standardised contract between two parties.
- Buyer and seller.
- Delivery.
- Standardised quantity.
- Standardised quality.
- Asset.
- Price.
- Expiry date.
- Market price.

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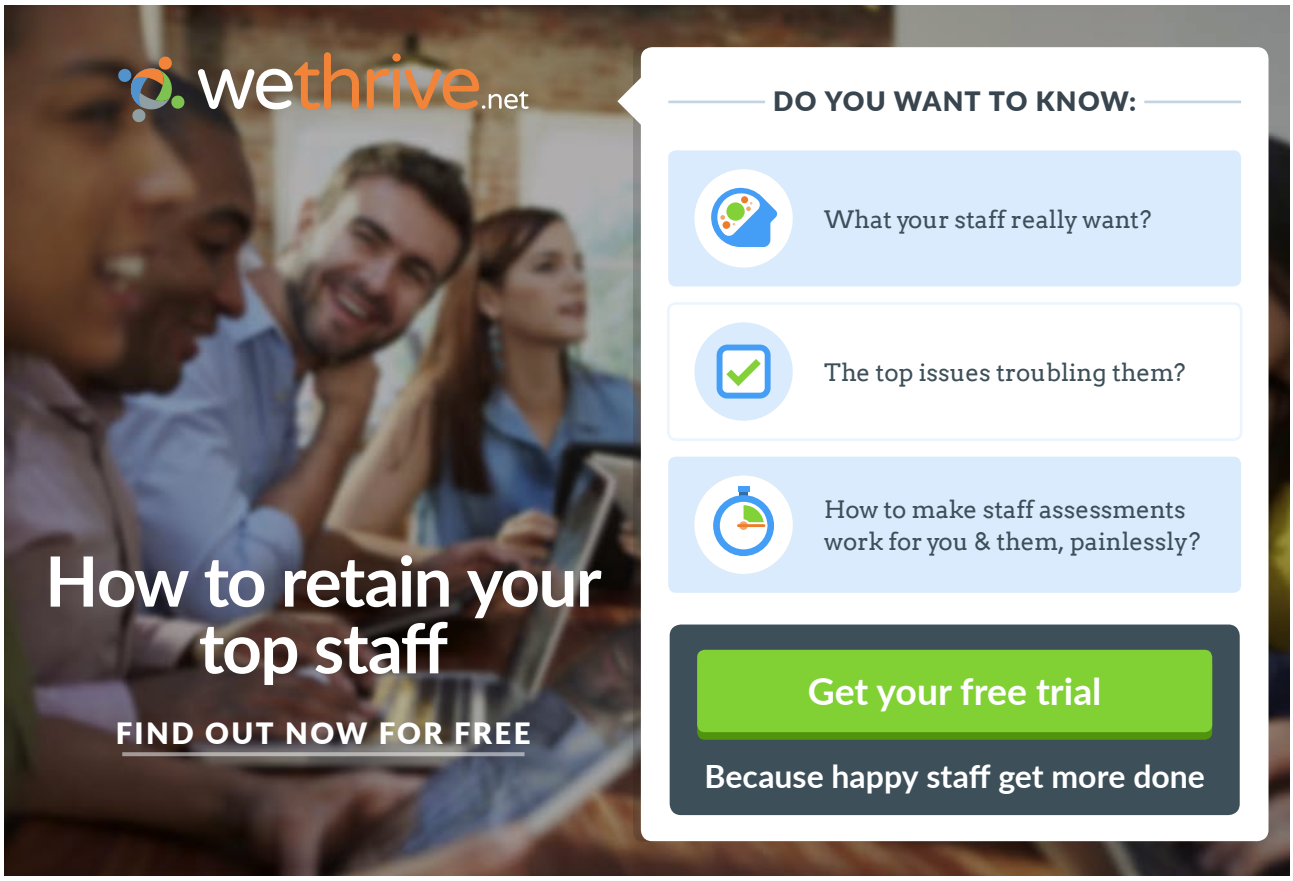
3.3.2 Standardised contract between two parties

Figure 1: participants in futures deal

All futures contracts in all international futures markets are standardised. A future is a legal contract between two parties setting out the details: price, expiry date, etc. At least one party to the contract must be a member of the exchange. As noted, even though a client may buy a future from, or sell a future to, a member of the exchange, the transaction is guaranteed by the exchange, i.e. the exchange acts as the seller for each buyer, and as the buyer for each seller: it interposes itself in each futures deal. This may be illustrated simply as in Figure 1.

3.3.3 Buyer and seller

It should be evident that the futures market is a typical example of a "zero sum game", i.e. for every buyer of a contract there is a seller. Consequently, if the buyer makes a loss, the seller gains by the same amount. The converse is obviously also true. As noted earlier, the buyer and the seller deal with a member of the exchange, unless the buyer and seller are members of the exchange.



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3.3.4 Delivery

Even though the standard definition of a future emphasises delivery, in practice this is rare, particularly in the *financial* futures markets. The reason for this is simply that the participants in the futures markets prefer settlement of the profit or loss on expiry date. Even if they wanted delivery, in many cases this is not possible. In the case of a future on an equity index, for example, it is impossible to deliver the index. Nowadays, delivery takes place in only a few financial and commodity futures contracts.

3.3.5 Standardised quantity

Every futures contract obviously has a specific size, as opposed to a forward contract where size is negotiated between buyer and seller. For example, in the case of the equity / share index futures contracts in South Africa, the size of each contract is ZAR10 × the index value. In the commodities futures markets the contract sizes are usually multiples of standard units, for example, tons, ounces, barrels, bushels, etc.

3.3.6 Standardised quality

This is important in the commodities futures markets, particularly in the case of perishable assets. Quality is obviously not an issue in the case of financial futures markets. In these markets contracts are based on underlying specific assets or notional assets the qualities of which do not vary.

3.3.7 Asset

A futures contract is a derivative instrument, i.e. it and its value are derived from an underlying asset and it cannot exist in the absence of this asset. The underlying assets of futures contracts can be divided into two broad categories, i.e. specific assets and notional assets, and there are various subcategories under each, such as storable assets, perishable assets, income-producing assets, etc. Specific (also called "physical") assets include the specific bonds and equities, pork bellies, etc, while notional assets include the industrial index, the all share index, the gold index, etc. One may also categorise futures broadly into financial futures and commodity futures, and then split them further into sub-categories as follows:

- Financial futures:
  - Interest rates (for example, future on a specific bond, future on a bond index).
  - Shares / equities (for example, future on an individual share, future on equity / share index).
  - Currencies (for example, future on the USD/GBP exchange rate, future on currency index).
- Commodity futures:
  - Agricultural (for example, future on livestock, future on maize).
  - Metals and energy (for example, future on gold price, future on crude oil).

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3.3.8 Price

Price is the core of a future. Essentially, futures market participants are fixing a price now for settlement in the future. Clearly therefore, the price of the future is related to the price of the underlying instrument. As the price of the underlying instrument varies, so does the price of the future (but not always to the same extent).

3.3.9 Expiry date

The other vital feature of futures contracts is the expiry date, i.e. the date when delivery or cash settlement takes place. Needless to say, the price of the future at the expiry time on the expiry date is equivalent to the spot price. It will therefore be clear that the futures price moves closer to the spot price as time goes by (i.e. it converges on the spot price).

3.3.10 Market price

The contract trades (in the sense that it can be reversed = "closed out") because it has a value, and this value is largely influenced by the spot price of the underlying asset, but also by expectations. Price is the only feature of the future that varies. Each contract has a minimum movement size or "tick size", for example LCC1.

3.4 An example

The above definitional section may be rendered more meaningful if an example of a futures transaction is introduced at this stage (see Box 1). This is an actual deal supplied by an exchange [the Johannesburg Securities Exchange (JSE); hence the use of the currency ZAR, reduced to "R", in the example] (names are fictitious in the interests of confidentiality).

Member (of the exchange) ABCM bought one Dec 2012 ALSI futures contract at the price 29490. It is a notional contract with the underlying "asset" being the ALSI index, and it expires at 12 noon on 1 December 2012. It can therefore not be delivered by the seller to the buyer and will be settled in cash. The counterparty (seller) to the deal is member (of the exchange) PQRM: he sold the contract at price 29490. Both parties dealt 29490, i.e. the agreed price (i.e. the *price at which willing buyer and willing seller were prepared to deal*), which is the "trading" (or market) price of the ALSI at the time (let's assume 10 am) on the date of purchase / sale (let's assume 3 January 2012). (Note that the trading / market price is different, but related, to the actual index value.) If these were naked positions (i.e. not hedged), they indicated:

- The buyer expected the ALSI to increase.
- The seller expected the ALSI to decline.

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Entry trade

ABCM buys 1 DEC12 ALSI @ 29490 (Long)
PQRM sells 1 DEC12 ALSI @ 29490 (Short)

Ref no	Member	Dealer	Buy / Sell	Qty	Contract	Price	Counter-party
000003993	ABCM	IMR	B	1	DEC 12 ALSI	29490	PQRM
000003993	PQRM	DRC	S	1	DEC 12 ALSI	29490	ABCM

Close-out trade

ABCM sells 1 DEC12 ALSI @ 29510 (closes out) (Profit: 29510 – 29490 = R20)
PQRM buys 1 DEC12 ALSI @ 29510 (closes out) (Loss: 29490 - 29510 = - R20)

Ref no	Member	Dealer	Buy / Sell	Qty	Contract	Price	Counter-party
000003995	ABCM	IMR	S	1	DEC 12 ALSI	29510	PQRM
000003995	PQRM	DRC	B	1	DEC 12 ALSI	29510	ABCM

Profit/loss equals the difference in the buy price and the sell price multiplied by the nominal multiplied by the number of contracts. The example above assumes the nominal is 1.

Box 1: example of futures deal

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At 3 pm on 3 January 2012 both parties "closed out" their positions at the trading price of the future: 29510. Members ABCM and PQRM each did an *equal and opposite* trade to their original trade, and therefore made a profit or a loss. This indicates an important point on the nature of the futures market (and indeed of the derivatives market in general): it is a zero-sum market: for every buyer there is a seller (in equal amounts) and for every profit there is an equal-sized loss.

Thus, in the above example member ABCM made a profit of R20, while member PQRM made a loss of R20. Note that this assumes the "nominal" is 1 (we did this to keep it simple). In reality the nominal is 10, i.e. the contract size / value = 10 × the market prices dealt at. Thus, when the trade was opened, both parties had an exposure to the ALSI market of 10 × R29 490 = R290 490, and when the trade was closed out the profit / loss was R200.

It is a feature of futures markets that no money changes hands when a deal is struck. However, both buyer and seller are required to make a "good faith" deposit – termed the "margin" (note: this was the origin of the margin, but it is now part of the risk management procedures of the exchange). This deposit is made with the broker who, in turn, passes it on to the exchange.

In conclusion, it is important to again point out that the exchange interposes itself between the buyer and the seller and guarantees the transaction. For each buy-deal the exchange creates a sell-deal, and for the opposite deal (the sell-deal) the exchange creates a buy-deal. Thus, the counterparty to each leg of a deal is the exchange.

3.5 Futures trading price versus spot price

It should be clear at this stage that buyers and sellers of futures contracts trade at the *market prices* for the relevant futures, i.e. at the prices established in the market by the interplay of supply of and demand for the futures contracts. It is also apparent that these prices are different from the spot prices of the underlying assets, but that the prices of futures are closely related to the spot prices of the underlying assets. An example is required.

The example in the Figure 2 depicts the life of a three-month future (assume it is a share index future) created on 31 March and expiring on 30 June. It will be evident that the buyer of the future on 31 March who holds it to expiry on 30 June profits (and the seller loses of course). She bought the future at 110 when the spot price was 100 and it "closed out" at 132. Similarly, the buyer of the future on 30 April at 122 (when the spot price was 112) also profits, but to a lesser extent. The buyer of the future on 31 May at 138 (when the spot price was 124), held to expiry, however, makes a loss because the futures price declined to 132 on expiry date (= spot price).

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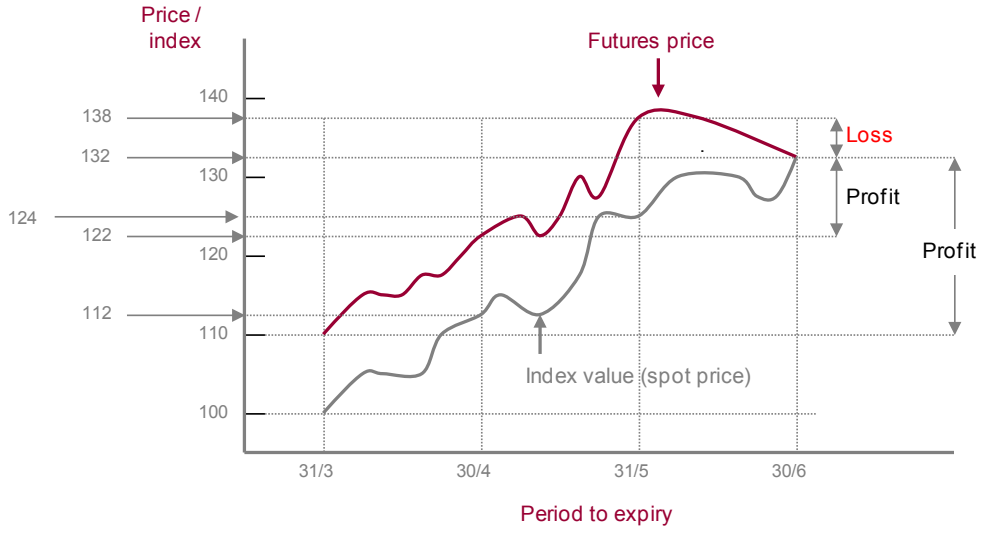

Figure 2: example of a 3-month future (index)

As noted earlier, the price of a future always converges upon the spot (cash market) price as the expiry date gets closer. The reason is that the so-called *basis* (which is similar to net carry cost – see below) becomes smaller with the passage of time. On expiry date the basis (and net carry cost) is zero.

Table 1 tracks the life of a fictitious March 2011 All Share Index (ALSI) future as at month-ends. As noted above, "spot" refers to the *value of the index* on the particular dates, while market rate refers to the *price for the future* established in the market, i.e. the price at which the future traded on the relevant dates. This is also illustrated in the Figure 3.

It can be seen that the future traded above the spot price for the entire life of the contract. This is not always the case, however. At times the future can trade at a discount to the spot price. Also clear from the above is that the difference between the two prices is not consistent. This is because expectations play a major role in the determination of the futures price.

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Year	Month	Value of index (spot rate)	Market rate (price / value) of future (mark-to-market)
2009	March	13535	13665
	April	13733	**13860**
	May	13992	14120
	June	14054	14223
	July	14177	14525
	August	14011	14282
	September	13792	14030
	October	13916	14252
	November	14183	14425
	December	14889	15415
2010	January	14754	15262
	February	14846	15235
	March	14939	15185
	April	15357	15870
	May	15396	15865
	June	15404	15515
	July	15651	**15865**
	August	15833	15948
	September	15676	15712
	October	15724	15862
	November	15756	15840
2011	December	15860	15965
	January	15054	15165
	February	15147	15173
	March (15th)	**15277**	**15277**

Table 1: March 2011 all share index futures contract

Two examples may be useful (the numbers are from the Table 1):

- A buyer of 10 contracts (one contract = LCC10 × market price) of the March 2011 ALSI on 30 April 2009 would have "bought" an exposure in the share market (ALSI) to the value of LCC1 386 000 (10 × LCC10 × 13860). If this position were held until "close out", i.e. 15 March 2011, the buyer would have profited to the extent of LCC141 700 [LCC1 527 700 (10 × LCC10 × 15277) – LCC1 386 000]. The seller of the contract would of course have lost this amount (if she held the contract until expiry).
- A buyer of the 10 contracts on 30 July 2010 would have bought exposure to the ALSI of LCC1 586 500 (10 × LCC10 × 15865). If she held the future until expiry, she would have made a loss LCC58 800 [LCC1 527 700 (10 × LCC10 × 15277) – LCC1 586 500].

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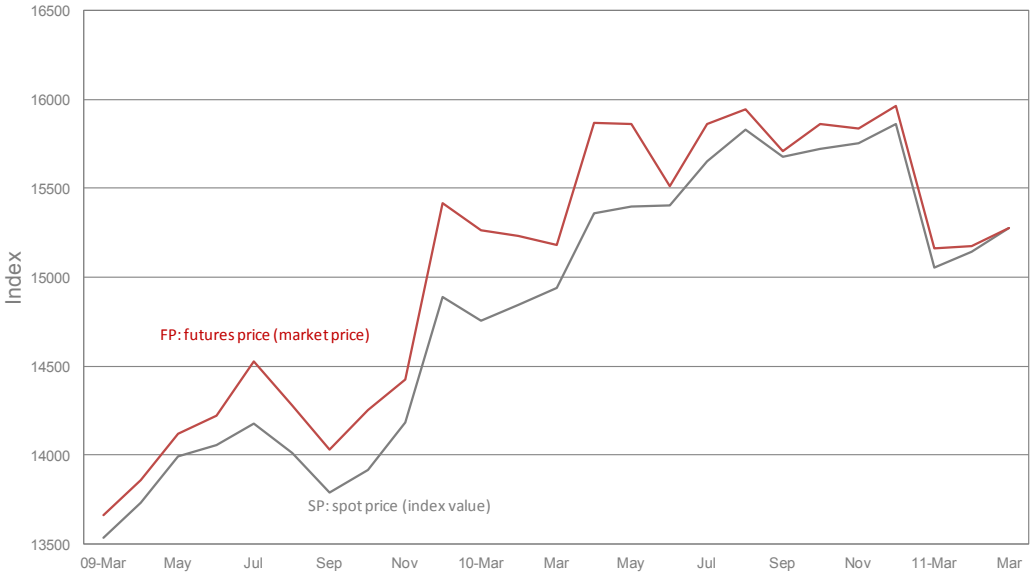

Figure 3: March 2011 all share index (ALSI) future

3.6 Types of futures contracts

There are many futures exchanges around the world, and the variety of contracts is vast. Table 2 shows an excerpt of the contracts that are listed (from Wall Street Journal).

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FINANCIAL			COMMODITIES	
Interest rate	Equity / share	Foreign currencies	Agricultural	Metals and energy
Physical Treasury bonds Treasury notes Treasury bills Federal funds Canadian govt bond Eurodollar Euromark Euroyen Eurobond **Index (notional)** Short sterling bond index Long sterling bond index Municipal bond index	**Physical** Various specific shares **Index (notional)** DJ Industrial S&P 500 NASDAQ 100 CAC-40 DAX-30 FTSE 100 Toronto 35 Nikkei 225 NYSE	**Physical** Japanese yen DM British pound Swiss franc French franc Australian dollar Brazilian real Mexican peso Sterling/mark cross rate **Index (notional)** US dollar index	**Grains and oilseeds** Wheat Soybeans Corn (maize) **Livestock and meat** Cattle – live Hogs – lean Pork bellies **Food and fibre** Cocoa Coffee Sugar Cotton Orange juice	**Physical -Metals** Gold Platinum Silver Copper Aluminium Palladium **Physical -Energy** Crude oil – light sweet Natural gas Brent crude Propane **Index (notional)** CRB index
Physical = the actual instrument, currency, commodity. Index = indices of exchanges, etc. CRB index = Commodity Research Bureau.				

Table 2: Examples of futures contracts

There are various contracts under each of these names, i.e. contracts that have different expiry dates. For example, there may be four S&P 40 contracts running simultaneously – the 15 March, the 16 June, the 15 September, and the 15 December. It is to be noted that The Wall Street Journal's futures contract complete list is about three times the above list provided.

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3.7 Organisational structure of futures markets

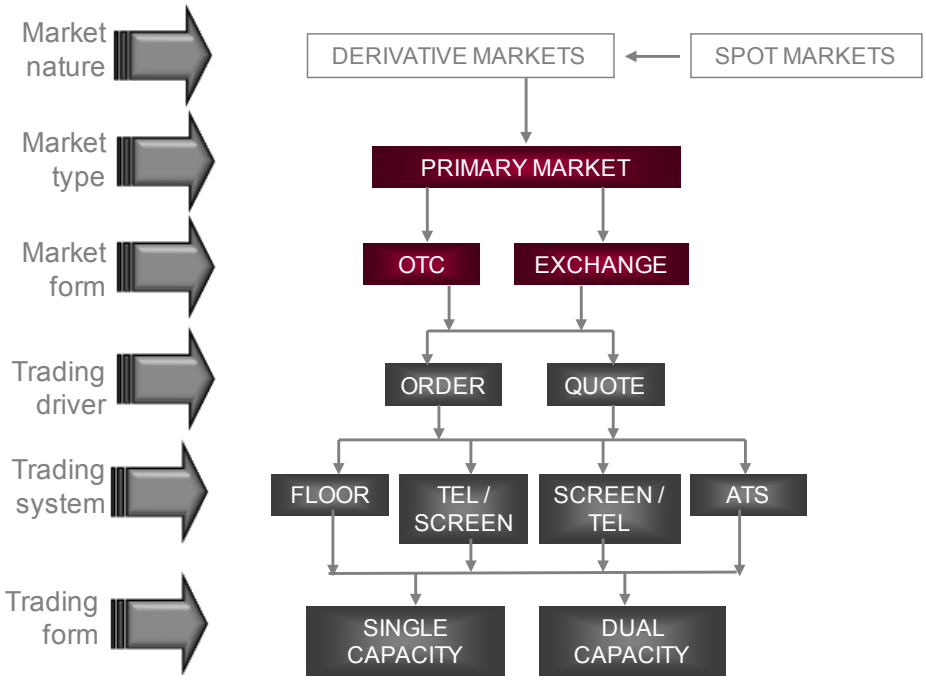

Figure 4: organisational structure of derivative financial markets

Financial markets have many aspects to them. One way of depicting the organisational structure of financial markets is as in Figure 4.

Does the futures market have both *primary markets* and *secondary markets*? The answer is that the market type is primary market; however, while futures cannot be sold, they can be "closed out" at any time by dealing in the opposite direction. The "closing out" results a loss or profit as in the case of a spot instrument sale (or purchase in the case of a "short" sale[24]) in the secondary market.

The *market form* of the futures market is formal in the shape of an exchange. There are many futures exchanges in the world or futures divisions of exchanges as in the case of South Africa.

As regards *trading driver* and the *trading system,* the futures market in South Africa is *order* and *ATS* (automated trading system), i.e. an *order-matching method* on an ATS is followed. This requires some elucidation:

- The broking members of the exchange register their clients with the exchange. This is in fact unique in that most futures exchanges do not know who the clients of the members are.
- The members we refer to by the generic term *broker-dealers*, because they may deal as principals or agents and the capacity of trading is disclosed to the client. The broker-dealers at times deal in dual capacity in a single deal (see last bullet point).

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- Some broker-dealers do not have clients and only deal as principals, and some broker-dealers deal only as agents with clients (both are called single capacity).
- The ATS is constructed in such a way that broker-dealers input their orders into the system (directly onto a computer). An example is buy 300 December ALSI contracts at 9020 (this is an index value). Sellers do so also. The system places on the screen the best buy and sell orders for all the different contracts, and has a drop-down facility where the non-best buy and sell orders appear (to show the depth of the market).
- Because the buyers and sellers are ultimately to deal with the exchange, the identities of the broker-dealers are not displayed.
- When two opposite orders match, the deal is automatically consummated by the ATS, and the two members are informed via the system. The clients (if applicable) are informed in turn by their broker-dealers.
- A broker-dealer, as noted, can deal in dual capacity, meaning that a single order can be split between principal and agent. For example, the buy example mentioned earlier can be 100 contracts as principal and 200 contracts as agent.

Because large deals (defined as for example over 500 contracts) may affect prices unduly, the rules of the exchange allow for *off-ATS trading*. These deals are negotiated between members and then reported on the ATS. However, most futures deals are done via the ATS.

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The above is the organisation of the South African futures market. In some futures markets, the open outcry floor method of trading is preferred. This is also an order driven trading system, which is highly transparent because the broker-dealers face each other in a "trading pit", i.e. ensuring that clients' orders (and broker-dealers' own orders) are transacted at the best prices. An ATS may be seen as *imitating the transparency of floor trading*.

As regards delivery, in the futures markets delivery of the underlying asset usually does not take place. This is discussed in the later section "cash settlement versus physical settlement". However, unlike as in the case of forwards (the unsophisticated future) margin is required. This is discussed after the following section on clearing.

3.8 Clearing house

All deals are cleared through a clearing house that is usually separate from the exchange. The clearing house may be regarded as being responsible for the management of the market.

We noted earlier that as soon as a deal is struck, the exchange interposes itself between the two principals that concluded the deal. This means that it takes on the opposite side of each leg of each deal. Most exchanges are backed by a Fidelity and Guarantee funds.

3.9 Margining and marking to market

The exchange requires that for each transaction the client is obliged to place with it a "good faith deposit', which is called the *margin deposit*. At the start of a deal this is called the *initial margin*, and this is set by the exchange (see contracts below). It is usually 5–8% of the value of the contract. The initial margin may be defined as *a deposit required on futures deals that will ensure that the obligations under the contracts will be fulfilled*.

The initial margin essentially protects the exchange from default because it is extremely unlikely that losses on positions will exceed the initial margin. At the end of each day the margin account is topped up, where required (i.e. in the case of losses). Each contact is *marked to market* every day, meaning that at a point in time each contract is "valued". This takes place at the end of the trading day and it is based on the *last settlement price.*

The purpose of the marking to market is to ensure that the *margin account is kept funded*. If the mark to market price is lower that the purchase price, i.e. if the holder of a future is making a loss, she has to top up the margin account to the proportionate level it was. This amount is called the *variation margin*. If a holder makes a profit, a credit to the margin account is made. The ultimate purpose is to ensure that the exchange, which has taken on the risk of guaranteeing the trades, is protected.

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From this it follows that if a holder of a future makes a loss and is unable to top up the margin account, the exchange will "close the member out". This means that the exchange takes an offsetting contract. The loss in then deducted from the client's margin account balance, and he is paid out.

3.10 Open interest

A term that often crops up in the futures market is "open interest". This is the term for the number of outstanding contracts of a particular contract, i.e. the number of contracts that are still open and obligated to delivery (physical or cash settlement). Double counting is avoided in the number. If broker-dealer A takes a position in a future and B takes the opposite position, open interest is equal to 1. Open interest on a particular contract may be depicted as in Figure 5 (daily from start of contract to its expiry date).

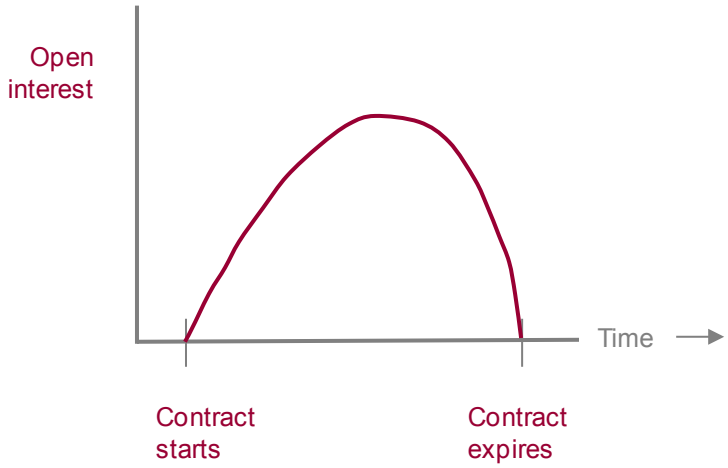

Figure 5: open interest

When a contract is launched by an exchange, open interest is zero. As participants begin to trade, open interest rises, and this continues until the maturity date approaches. On maturity date the future is "closed out" and open interest is again zero (because the contract is replaced with another that has a new maturity date).

3.11 Cash settlement versus physical settlement

In many of the commodities markets physical settlement takes place. This means that the commodities that underlie futures contracts are delivered at expiry of the contract. In the financial futures markets, physical delivery also takes place in some cases (for example, certain of the bond contracts), but in the majority of cases settlement takes place in the form of cash settlement.

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Many traders in futures markets where delivery is required resort to *trade reversing* prior to expiry of the contract, and the reason for doing so is that they do not want to deliver or receive the physical goods/metals etc. These traders are involved in the market for speculative or hedging reasons, and take an opposite position to the one they hold prior to maturity, in so doing liquidate their position at the clearing house.

3.12 Payoff with futures (risk profile)

The gains and losses on futures are symmetrical around the difference between the spot price on expiry of the futures contract and the futures price at which the contract was purchased. A simple example may be useful (see Figure 6): one futures contract = one share of ABC Corporation Limited.

On the vertical axis we have the profit or loss scale of the future. On the horizontal axis we have the price of the future at expiry (= spot price). If the long future is bought at LCC70 and the price at expiry is LCC71, the profit is LCC1, i.e. for each LCC1 increase in the price of the future, the profit is LCC1. Thus, if the spot price on maturity is LCC90, the profit is LCC20 (LCC90 – LCC70).

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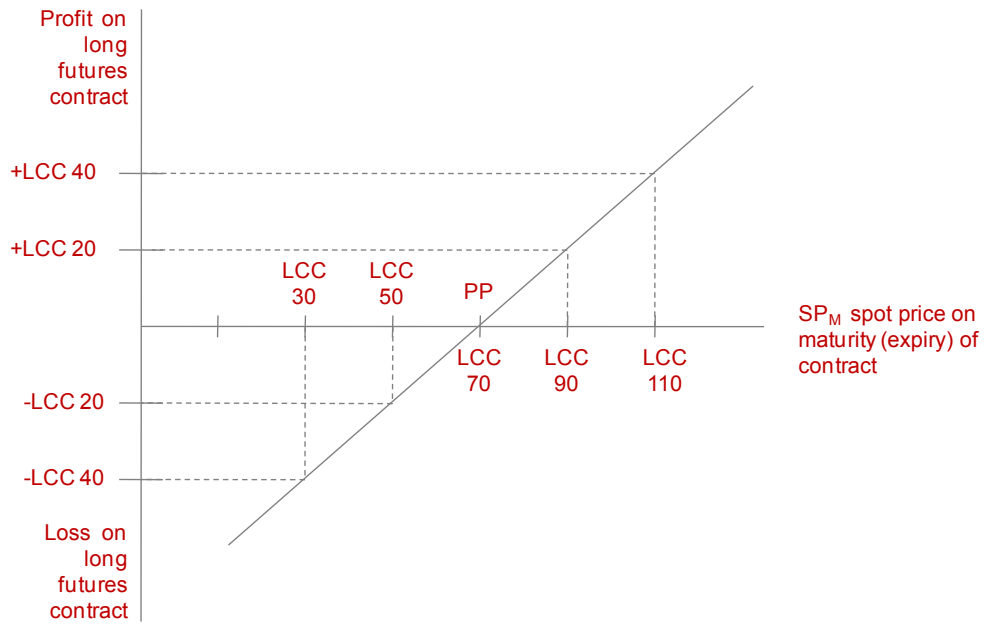

Figure 6: payoff with long futures contract (risk profile)

It will be apparent that if the spot price on maturity is SP_m, and the purchase price is PP, then the payoff on a *long* position per one unit of the asset is:

$$SP_m - PP.$$

It follows that the payoff in the case of a *short* future (see Figure 7) is:

$$PP - SP_{m.}$$

It will also be clear that the payoff on a future is a *total payoff* because nothing was paid for the contract (remember: the margin is a deposit that earns interest and is repayable in full).

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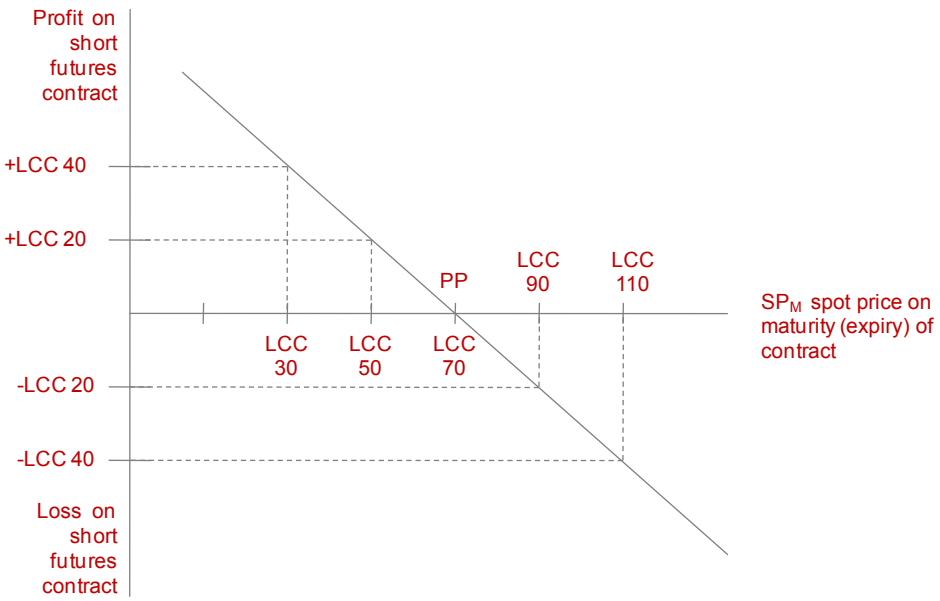

Figure 7: payoff with short futures contract (risk profile)

3.13 Pricing of futures (fair value versus trading price)

The reader should at this stage already have a good idea of the principle involved in the pricing of futures contracts. Some elaboration, however, will be useful. All or some of the following factors influences the *theoretical price* of a future, which is also termed the *fair value price* (FVP):

- Current (or "spot") price of the underlying asset.
- Financing (interest) costs involved.
- Cash flows (income) generated by the underlying asset.
- Other costs such as storage and transport costs and insurance.

The theoretical price / FVP of a future is determined according to the the *cost-of-carry model* (CCM): the FVP is equal to the spot price (SP) of the underlying asset, plus the cost-of-carry (CC) of the underlying asset to expiry of the contract. Thus:

$$FVP = SP + CC.$$
$$CC = \{SP \times [(rfr - I) \times t]\} + OC$$

where:

rfr = risk free rate[25] (i.e. the financing cost for the period)
I = income earned during the period (dividends or interest)
t = days to expiry (dte) of the contract / 365
OC = other costs (which apply in the case of commodities: usually transport, insurance and storage).

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Thus, in the case of financial futures:

$$\begin{aligned} FVP &= SP + CC \\ &= SP + \{SP \times [(rfr - I) \times t]\} \\ &= SP \times \{1 + [(rfr - I) \times t]\}. \end{aligned}$$

An example may be handy. The table and graph shown earlier (Table 1 and Figure 3) are expanded to include the fair value prices (FVPs) at the end of each month[26] (see Table 3 and Figure 8). Taking April 2010 as an example, we have the following:

SP (index value)	= 15357
rfr (assumed)	= 8.0% pa
I (assumed dividend yield)	= 2.0% pa
t = dte / 365	= 319 / 365

$$\begin{aligned} FVP &= SP + CC \\ &= SP + \{SP \times [(rfr - I) \times t]\} \\ &= SP \times \{1 + [(rfr - I) \times t]\} \\ &= 15357 \times \{1 + [(0.08 - 0.02) \times (319 / 365)]\} \\ &= 15357 \times [1 + (0.06 \times 0.873973)] \\ &= 15357 \times 1.052438 \\ &= 16162. \end{aligned}$$

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As can be seen from Table 3, the March 2011 future traded (15870) at lower than its FVP (16162).

Year	Month	Value of index (spot rate)	Market rate (price / value) of future (mark-to-market)	Fair value price
2009	March	13535	13665	15124
	April	13733	**13860**	15277
	May	13992	14120	15494
	June	14054	14223	15493
	July	14177	14525	15557
	August	14011	14282	15303
	September	13792	14030	14996
	October	13916	14252	15060
	November	14183	14425	15279
	December	14889	15415	15963
2010	January	14754	15262	15744
	February	14846	15235	15773
	March	14939	15185	15796
	April	**15357**	**15870**	**16162**
	May	15396	15865	16125
	June	15404	15515	16057
	July	15651	15865	16235
	August	15833	15948	16343
	September	15676	15712	16104
	October	15724	15862	16073
	November	15756	15840	16028
2011	December	15860	15965	16053
	January	15054	15165	15160
	February	15147	15173	15184
	March (15th)	**15277**	**15277**	**15277**

Table 3: March 2011 all share index futures contract

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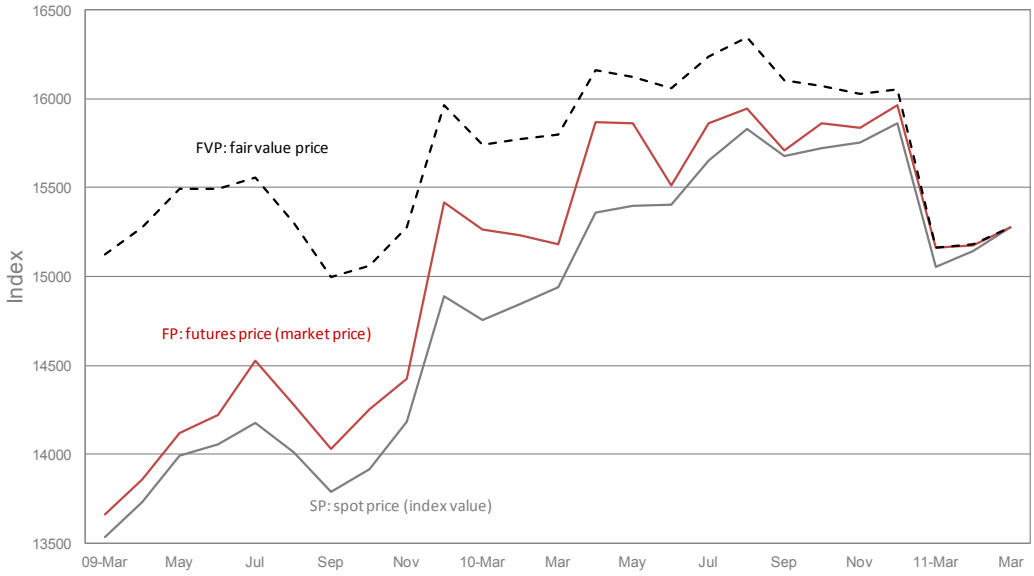

Figure 8: March 2011 all share index (ALSI) future

It will be apparent that in the above use was made of simple interest. In the case of *compound interest*, the formula changes to:

$$FVP = SP \times [1 + (rfr - I)]^t$$

Using the above example:

$$\begin{aligned} FVP &= SP \times [1 + (rfr - I)]^t \\ &= 15357 \times 1.06^{0.87397} \\ &= 15357 \times 1.052244 \\ &= 16159. \end{aligned}$$

It is clear that compounding makes little difference in the case of short-term contracts.

3.14 Fair value pricing of specific futures

3.14.1 Introduction

In the previous section we covered the basic principle (formula) for valuing futures. However, there are a number of variations on the theme, because there are different types of futures contract traded.

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The (valuation) mathematics pertaining to the different futures is illustrated with the following futures:

- Short-term interest rate futures.
- Individual bond futures.
- Equity / share index futures.
- Individual equity / share futures (aka single stock futures).
- Commodity futures.
- Currency futures.
- Futures on other derivatives.
- Other futures.

3.14.2 Short-term interest rate futures

In the case of short-term interest rate futures, the theoretical price or fair value price (FVP) is determined from the calculated *forward-forward rate* (which is also called the *implied forward rate*). An example is required here: the South African 3-month JIBAR[27] future, the specifications of which are shown in Table 4.

UNDERLYING INSTRUMENT (CONTRACT BASE)	The 3-month Johannesburg Interbank Agreed Rate (JIBAR)
CONTRACT SIZE (NOTIONAL)	R100 000 nominal
QUOTATION STYLE	Effective interest rate
CONTRACT MONTHS	March, June, September and December
EXPIRY DATES & TIMES	11h00 on third Wednesday of the contract month (or previous business day)
MINIMUM TICK SIZE	0.001% (1/10 of a basis point)
BASIS POINT VALUE	ZAR 2.50 per basis point (rate change = 0.01% pa)
MARK-TO-MARKET (MTM)	Explicit daily fixing
SETTLEMENT	Cash
SETTLEMENT YIELD (DAILY MTM)	Closing MTM yield
SETTLEMENT YIELD (ON EXPIRY)	3-month JIBAR on expiry
INITIAL MARGIN	R100 per contract
Source: JSE (2010).	

Table 4: Specifications of the 3-month jibar future

A note on how the basis point value (ZAR 2.50 per basis point) is arrived at is required. A basis point = 0.01% *per annum*. Because there are four 3-month periods in a year, 3 months is taken to be 91.25 days (365 / 4). Therefore, if the 3-month JIBAR rate changes from 7.81% pa to 7.80% pa (i.e. by 1 basis point), the profit on a 91.25-day asset = (0.01 / 100) × (91.25 / 365) × ZAR 100 000 = ZAR 2.50.

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The theoretical price or fair value price (FVP) of a 3-month JIBAR future is arrived at by calculating the implied forward rate from the current spot rates. An example is required: shown in Figure 9 are the JIBAR rates quoted on the day a client wishes to buy a 3-month JIBAR futures contract (i.e. a 3-month rate in 3 months' time).

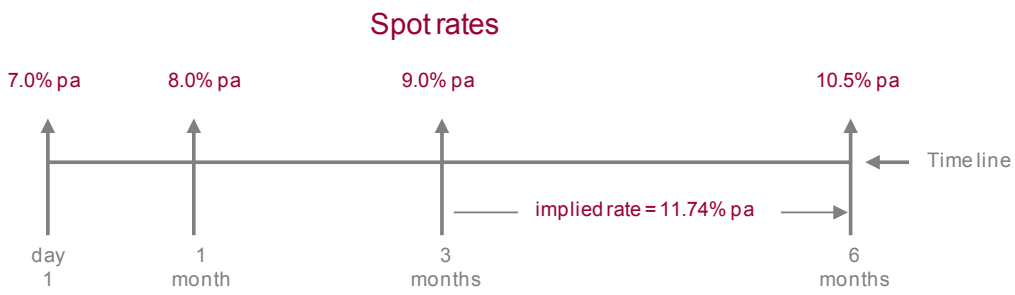

Figure 9: JIBAR spot rates and implied rate

The rate now (spot rate) for three months is 9.0% pa and the rate now (spot rate) for six months is 10.5% pa, and the period of the latter rate covers the period of the first rate. The rate of interest for the three-month period *beyond the first three-month period* can be calculated by knowing the two spot rates mentioned. This is called the *forward rate of interest,* or the *implied forward rate*, or the *forward-forward rate*. This is calculated as follows (assumption 3-month period = 91 days; 6-month period = 182 days):

$$\text{IFR} = \{[1 + (ir_L \times t_L)] / [1 + (ir_S \times t_S)] - 1\} \times [365 / (t_L - t_S)]$$

where

IFR = implied forward rate
ir_L = spot interest rate for 6-month (i.e. long) period
ir_S = spot interest rate for 3-month (i.e. short) period
t_L = 6-month (i.e. long) period, expressed as number of days / 365 (= 182 / 365)
t_S = 3-month (i.e. short) period, expressed as number of days / 365 (= 91 / 365)

$$\begin{aligned}\text{IFR} &= \{[1 + (0.105 \times 182/365)] / [1 + (0.09 \times 91/365)] - 1\} \times [365 / (182 - 91)] \\ &= [(1.05235616 / 1.02243836) - 1] \times (365 / 91) \\ &= 0.02926123 \times 4.010989 \\ &= 0.11736647 \\ &= 11.736647\% \text{ pa.}\end{aligned}$$

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This derived interest rate may be tested as follows: if R1 million (present value, PV) is placed on deposit for 6 months (182 days) at the abovementioned 6-month rate of 10.5% pa, the future value ($FV_{6\text{-}m}$) amount would be:

$$\begin{aligned} FV_{6\text{-}m} &= PV \times [1 + (0.105 \times 182 / 365)] \\ &= R1\ 000\ 000 \times 1.05235616 \\ &= R1\ 052\ 356.16. \end{aligned}$$

Alternatively, if an investment were made for 91 days, the following would be the total:

$$\begin{aligned} FV_{3\text{-}m} &= PV \times [1 + (0.09 \times 91 / 365)] \\ &= R1\ 000\ 000 \times 1.02243836 \\ &= R1\ 022\ 438.36. \end{aligned}$$

If this amount (R1 022 438.36) is invested for another 91 days at the implied forward rate of 11.736647%, the $FV_{6\text{-}m}$:

$$\begin{aligned} FV_{6\text{-}m} &= PV \times [1 + (0.11736647 \times 91 / 365)] \\ &= R1\ 022\ 438.36 \times 1.02926123 \\ &= R1\ 052\ 356.16. \end{aligned}$$

As expected, this number is identical to the FV of the six-month investment calculated above.

As seen, the implied forward rate is 11.736647% pa. This is the fair value price / rate, i.e. the rate that should apply to the future.

Keep in mind that the fair value is not necessarily equal to the market value (= MTM value as determined by the exchange). It will also be apparent that the forward-forward pricing of futures is the same as the pricing of an FRA. An FRA can thus be seen as the OTC equivalent of the interest rate future. This calculation also applies to the forward-forward foreign exchange swap.

3.14.3 Individual bond futures[28]

The principle that underlies the fair value price of a bond future is the CCM as discussed. However, the calculation is more elaborate because of the existence of coupon payments, clean and dirty (all-in) prices, ex and cum interest and so on. The fair value price (FVP) of an individual bond future is made up of:

Bond spot price (i.e. all-in price) + carry cost (i.e. rfr) – income.

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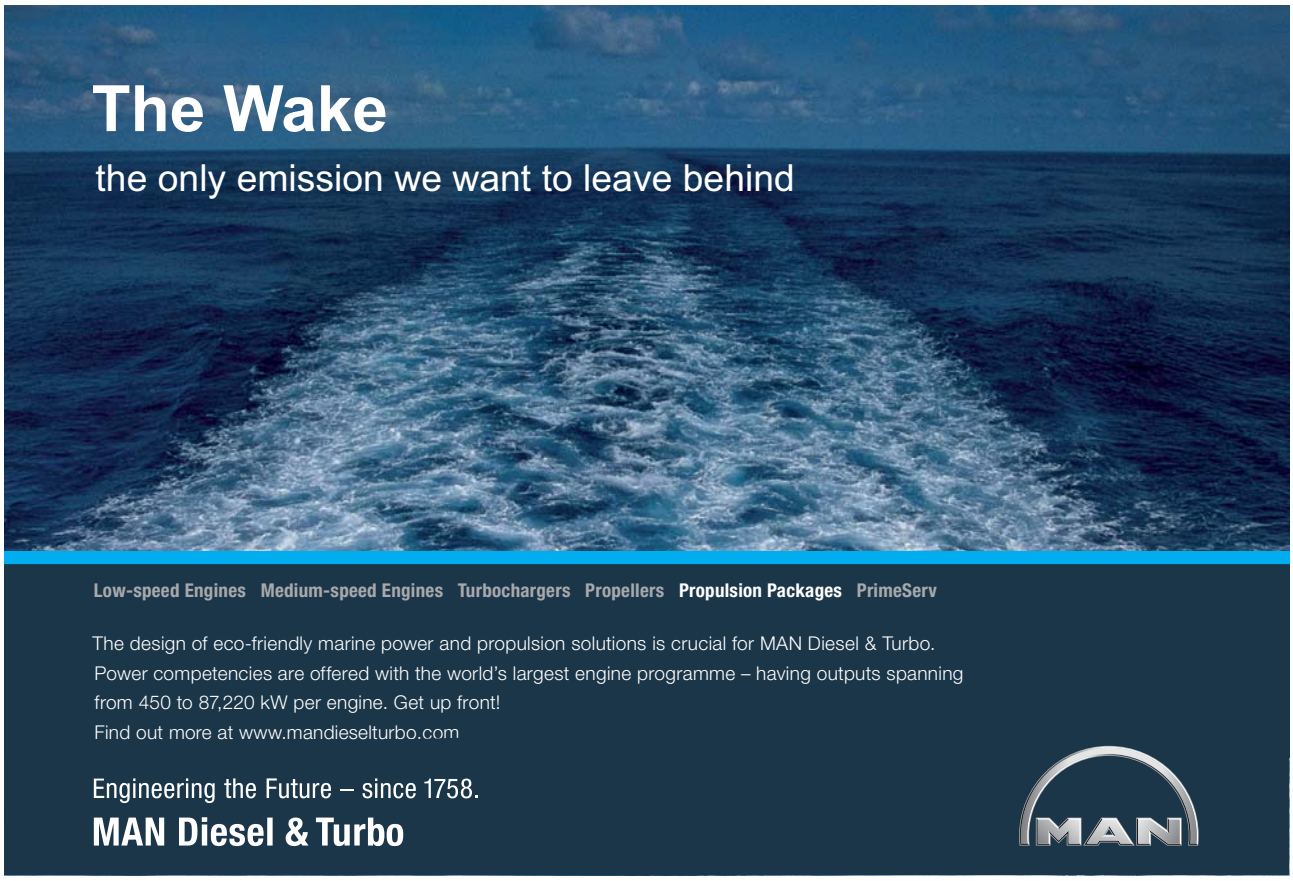
An example is required: LCC157[29] bond future:

Bond	= LCC157
Maturity date	= 15 September 2015
Coupon (c)	=13.5% pa
Coupon payment dates (cd_1 & cd_2)	=15 March and 15 September
Yield to maturity (ytm)	= 8.2%
Carry cost (rfr)	= 7.5% pa
Purchase (valuation) date of future (fvd)	= 20 June
Termination date of future (ftd)	= 31 August[30]
Books (register) closes	= one month before coupon dates[31].

As noted, the FVP of a bond future is made up of three parts:

FVP = A + B – C (i.e. bond spot price + carry cost (excl income) – income [32])



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where

A = dirty (all-in) price of underlying bond at market (current) rate on bond futures valuation date (fvd) [33]
= 105.71077 (note: this price is assumed so that it does not date)

B = A × {(rfr / 100) × [(ftd – fvd) / 365]}
= 105.71077 × [0.075 × (72 / 365)]
= 105.71077 × (0.075 × 0.19726)
= 105.71077 × 0.014795
= 1.56394

C = (c / 2) × (1 + {(rfr / 100) × [(ftd – cd_2) / 365)]})
[if the futures termination date crosses a books-closed date and its associated coupon date (i.e. is not ex-interest)]

or

= (c / 2) / (1 + {(rfr / 100) × [(cd_2 – ftd) / 365)])
[if the futures termination date crosses a books closed date but not the associated coupon date (i.e. is in ex-interest period, which is the case here)]
= (13.5 / 2) / (1 + {0.075 × [(cd_2 – ftd) / 365]})
= 6.75 / {1 + [0.075 × (15 / 365)]}
= 6.75 / [1 + (0.075 × 0.04110)]
= 6.75 / 1.00308
= 6.72927.

Thus:

FVP = A + B – C
= 105.71077 + 1.56394 – 6.72927
= 100.5454.

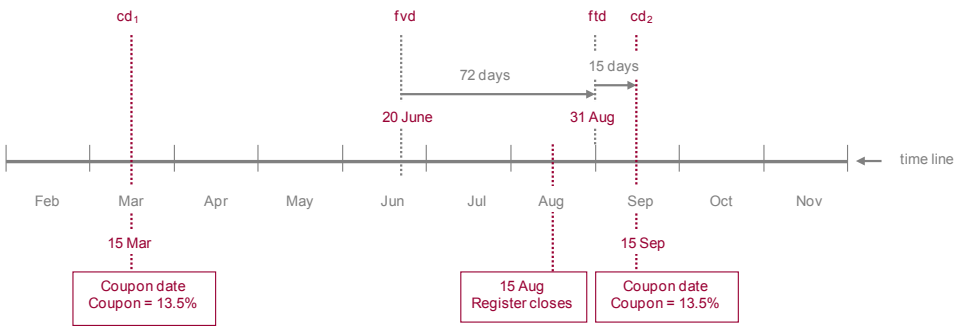

Figure 10: example of individual bond future

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3.14.4 Equity / share index futures

We covered the case of equity / share index futures in our first example where the simple interest *net carry cost* calculation was introduced:

$$\begin{aligned} FVP &= SP + CC \\ &= SP + \{SP \times [(rfr - I) \times t]\} \\ &= SP \times \{1 + [(rfr - I) \times t]\}. \end{aligned}$$

Here we provide another example (ALSI future):

SP (spot price, i.e. index value)	= 10765
rfr	= 11.5% pa
I (dividend yield, assumed)	= 3.5% pa
t (number of days to expiry of contract / 365)	245 / 365

$$\begin{aligned} FVP &= SP + CC) \\ &= SP + \{SP \times [(rfr - I) \times t]\} \\ &= SP \times \{1 + [(rfr - I) \times t]\} \\ &= 10765 \times \{1 + [(0.115 - 0.035) \times (245 / 365)]\} \\ &= 10765 \times (1 + (0.08 \times 0.6712329)) \\ &= 10765 \times 1.05369863 \\ &= 11343. \end{aligned}$$

3.14.5 Individual equity / share futures

Individual equity / share futures are also called *single stock futures* (in short SSFs). Calculation of the FVP of SSFs is the same as above – i.e. as for equity / share index futures, except that the dividend yield will be easier to predict.

It is appropriate to mention a futures product which is closely allied with SSFs: the *dividend future* (DIVF). They are used to hedge against the dividend risk that accompanies a position in a SSF. As we have seen, dividend expectations (I) are part of the FVP calculation; therefore there is a need for such contracts.

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3.14.6 Commodity futures

With commodities, where insurance and storage is payable (such as maize), and the amount is not proportional to the spot price, it is simply added to the FVP. An example follows [we assume there are only storage costs (SC); note: there is no income (I)]:

Contract	= WMAZ (white maize)
Contract size	= 100 metric tons
Number of contracts	= 1
Date of valuation	= 31 March
Expiry of contract	= 21 September
Days to expiry (dte)	= 174 days (31 March to 21 September)
t = dte / 365	= 174 / 365
rfr	= 7.5% pa
SP	= LCC2 732.20 (per metric ton)
Storage costs (SC)	= 36 cents per ton per day

$$
\begin{aligned}
\text{FVP (per ton)} &= \text{SP} + \text{CC} \\
&= \text{SP} + [\text{SP} \times (\text{rfr} \times \text{t})] + (\text{SC} \times \text{dte}) \\
&= \text{SP} \times [1 + (\text{rfr} \times \text{t})] + (\text{SC} \times \text{dte}) \\
&= 2732.20 \times [1 + (0.075 \times 174 / 365)] + (0.36 \times 174) \\
&= 2732.20 \times 1.03575 + 62.64 \\
&= 2829.88 + 62.64 \\
&= \text{LCC2 } 892.52
\end{aligned}
$$

$$
\begin{aligned}
\text{FVP (per contract)} &= 100 \times 2892.52 \\
&= \text{LCC289 } 252.00.
\end{aligned}
$$

3.14.7 Currency futures

Currency futures are similar to foreign exchange forward contracts, and the *covered interest parity formula* (a variation of the CCM) is therefore applicable:

$$\text{FVP} = \text{SR} \times \{[1 + (\text{ir}_{vc} \times \text{t})] / [1 + (\text{ir}_{bc} \times \text{t})]\}$$

where:

SR = spot rate
ir_{vc} = interest rate of variable currency for period to expiry
ir_{bc} = interest rate for base currency for period to expiry
t = number of days to expiry of contract / 365.

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An example is called for [base currency (i.e. the 1 unit currency) = GBP; variable currency = USD]:

$SR = GBP / USD\ 1.5$
$ir_{vc} = 5.5\%$
$ir_{bc} = 8.5\%\ pa$
$t = 182 / 365$

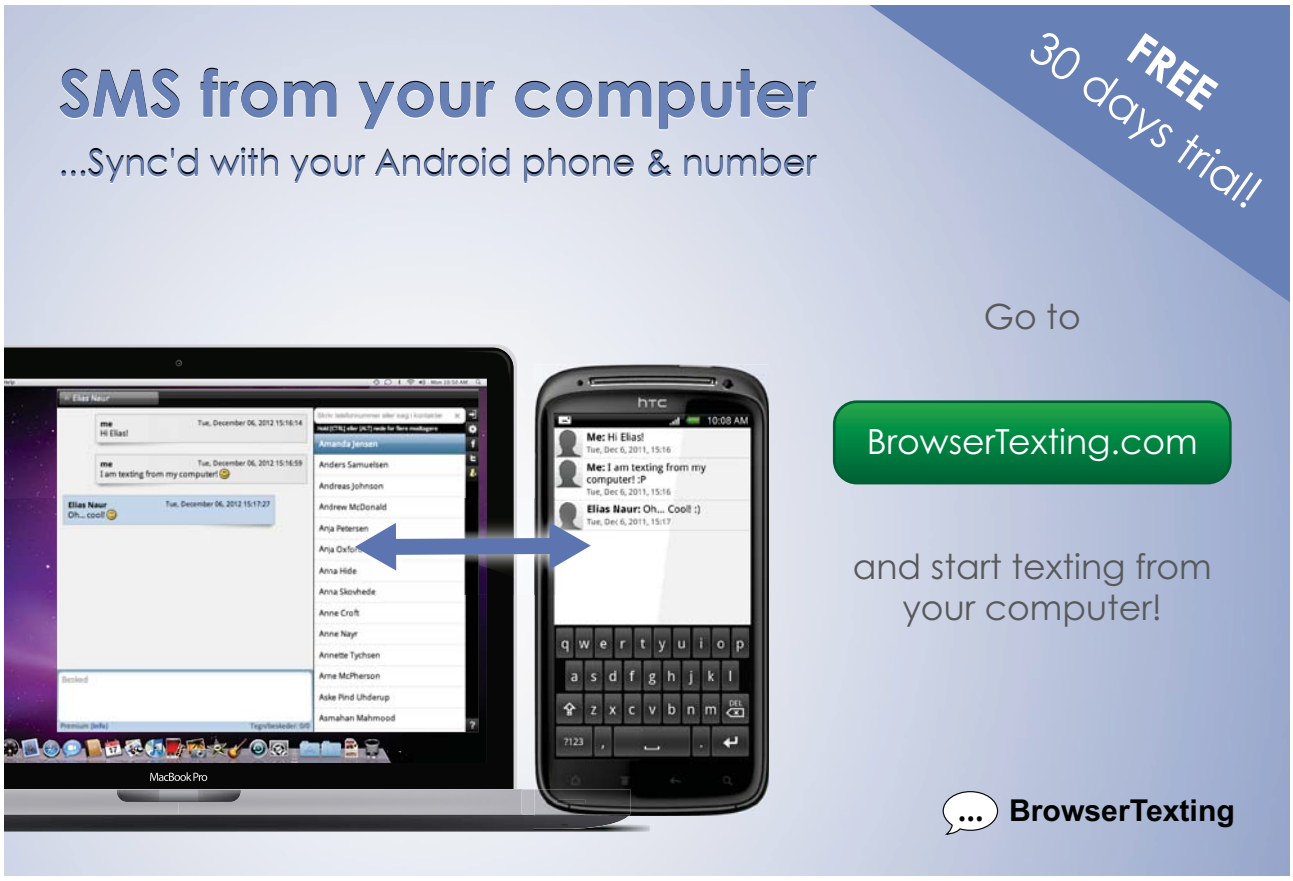
$$FVP = SR \times \{[1 + (ir_{vc} \times t)] / [1 + (ir_{bc} \times t)]\}$$

$$= USD\ 1.5 \times \{[1 + (0.055 \times 182 / 365)] / [1 + (0.085 \times 182 / 365)]\} = USD\ 1.5 \times (1.027425 / 1.042384)$$
$$= USD\ 1.5 \times 0.985649$$
$$= USD\ 1.47847.$$

It will be evident here that the formula is similar to the CCM, with the difference being that there are two rates of interest taken into account: the foreign rate and the local rate.

3.14.8 Futures on other derivatives

As in the case of forwards (forwards on swaps) there are futures on other derivatives, for example futures on FRAs and futures on swaps.



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3.14.9 Other futures

Another future listed on the JSE deserves mention: the *variance future* (VARF). Variance is a statistical measure of volatility (= risk). The generally accepted measure of risk in the Finance discipline is the standard deviation of an asset's return (= the extent of deviation from the mean return). Standard deviation is closely related to variance; it is the square root of variance.

The variances and standard deviations of returns on assets (like shares) change considerably from period to period. It is also a major input in the pricing of options. There is a need by some investors to hedge against this risk, and certain speculators seek exposure to this risk. These two parties make the trading of this instrument a possibility.

In short, a variance future is a futures contract on realised annualised variance of returns on assets / indices. This instrument is regarded by some as a new asset class.

3.15 Basis

Participants in the futures market frequently use the terminology "basis" (B), "cost of carry" (CC) and "convergence". As regards the latter: as time in the life of a futures contract goes by, the futures price (FP) and the fair value price of the future (FVP) converge on the spot price (SP), and they are equal on the expiry date of the future, as indicated in Figure 11.

Figure 11: basis, carry cost & convergence

It will be evident from the discussion above on the CCM, which gave us

$$FVP = SP + CC,$$

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that cost of carry (CC) is the difference between the fair value price (FVP) and the spot price (SP) of the underlying asset as follows:

$$CC = FVP - SP.$$

Basis (B), on the other hand, is the difference between the SP and the FP of the underlying asset:

$$B = SP - FP.$$

The above concepts are illustrated as in Figure 11. It will be apparent that the FVP is higher than the SP when the CC is positive (i.e. when rfr > I on the underlying asset). However, when I > rfr, i.e. CC is negative, FVP < SP. When CC is negative, B is positive.

What is the significance of basis? It is that the basis is a known number when a hedge is undertaken (buy the underlying and sell the future or sell the underlying and buy the future). If the basis changes during the life of the hedge (which is likely), risk (called basis risk) emerges, and the hedge will not be a perfect one, i.e. if the basis strengthens or weakens, the outcome of the hedge will be different from that hoped for or expected.

3.16 Participants in the futures market

3.16.1 Introduction

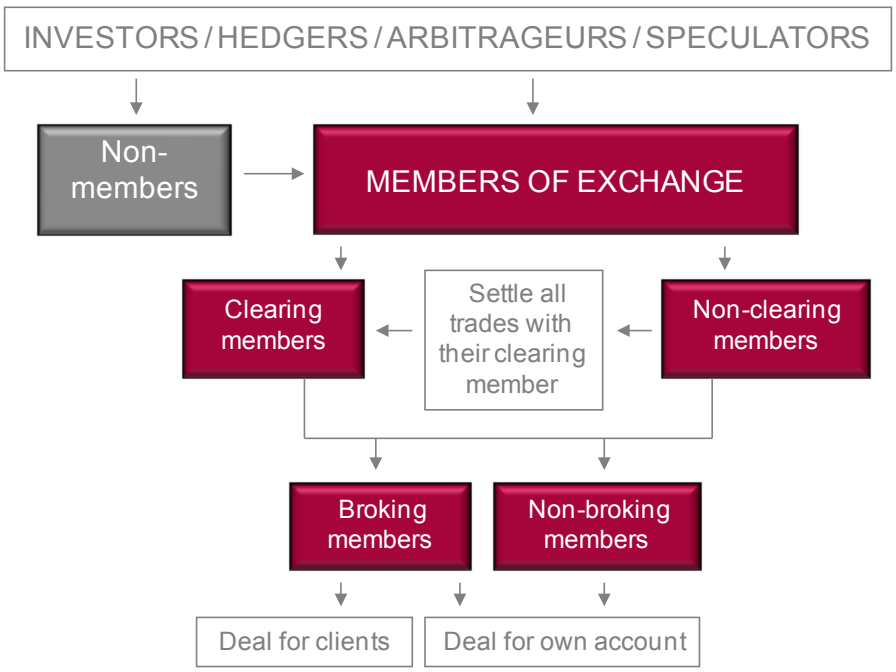

Figure 12: participants in the futures market

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The participants in the futures market can be categorised in a number of ways. One can, for example, categorise participants according to membership of the exchange (all futures markets are formalised):

- Futures exchange members:
  - clearing members (clear for self, own clients and all other members)
  - non-clearing members (all other members)
  - broking members (deal for own account and/or for clients)
  - non-broking members (deal for own account).
- Non-members (the clients of members):
  - foreign sector
  - household sector (individuals)
  - corporate sector
  - financial intermediaries (banks, insurers, retirement funds, CISs, etc.).

However, the most logical categorisation is according to functionality as follows:

- Investors.
- Arbitrageurs.
- Hedgers.
- Speculators.

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These participants are found in both the categories non-members and members of the exchange, meaning that some members themselves are engaged in investing, arbitrage, hedging and speculation. All the participants in the futures market may be depicted as in Figure 12. We examine each of these categories briefly.

3.16.2 Investors

Investors in the futures market are those that view the futures market as an *alternative to the cash market* (i.e. the underlying market). For example, an investor may wish to earn the All Share Index (ALSI) and, instead of buying the shares in the proportions that make up the index, can achieve this by buying the appropriate number of ALSI futures contracts. She may do this for the sake of convenience, to avoid transactions costs (depending on the fair value price) or she may view the underlying market as lacking in liquidity.

An investor may also use long-term instruments and *short* futures contracts to invest short-term, or use short-term financial instruments and *long* futures contracts to invest long term.[34] These positions are alternatives to straightforward investing for the desired investment horizon (see Table 5).

Investment term desired	Cash market alternative	Use of futures market alternative	What is known?	Comparison
3 months (March to June)	Buy 3-month treasury bill (in March; maturity June)	• Buy government bond with 10-year maturity • Sell (go short of) a 10-year government bond futures contract with June maturity	• Buy rate • Sell rate locked in	Compare computed rate with 3-month treasury bill rate
10 years (it is now March)	Buy 10-year government bond (in March)	• Buy (go long of) a 10-year government bond futures contract with June maturity • Invest funds in 3-month treasury bill (March–June)	• Buy rate locked in • 3-month rate locked in	

Table 5: Use of futures to manage investment horizon

3.16.3 Arbitrageurs

Arbitrageurs endeavour to profit from price differentials (mispricing) that may exist in different markets on similar securities. For example, if the industrial index (let us assume it is called INDI) futures price is trading far in excess of its fair value price, the arbitrageur may sell the INDI future and buy the individual equities that make up the INDI.

Arbitrageurs play a significant role in the futures market by ensuring that futures prices do not stray too far from fair value prices and by adding to the liquidity of the market.

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3.16.4 Hedgers

Hedgers are those participants that have exposures in cash markets and wish to reduce risk by taking the opposite positions in the futures markets. Most investors, such as retirement funds, life offices and banks hedge their portfolios from time to time in the financial futures market. The equivalents in the commodity futures markets are the producers (e.g. farmers) and consumers (e.g. millers of flour) of commodities.

The opposite parties to hedgers are usually the speculators that willingly take on risk in order to profit from their views in respect of the future movement of prices / rates. Thus, *hedgers transfer risk to speculators and speculators willingly seek risk positions (accept the risk being shed)*.

3.16.5 Speculators

Speculators are those participants that endeavour to gain from price movements in the futures market. Given the small outlay (i.e. the margin) in comparison with cash markets (where the full price is paid), speculators are attracted to futures markets because they are able to "gear up".

For example, if a speculator has LCC1 million with which to speculate, she is able to buy shares to the value of LCC1 million in the cash market. In the futures market she is able to get exposure (and risk) to the extent of the amount on hand times the reciprocal of the margin requirement. Thus, if the margin requirement is 8% of the value of the future/s, she is able to go long of futures by 12.5 (1 / 0.08) times LCC1 million.[35]

Speculators and hedgers play a significant role in the futures market in terms of enhancing the liquidity of this market. It should be apparent that hedgers endeavour to eliminate or reduce risk faced from holding inventories of financial instruments or commodities, while speculators assume the risk. Thus, *speculators willingly take on the risks transferred to them by hedgers.*

3.16.6 Closing remarks

It will be evident that there is no clear-cut distinction between membership of the exchange, the ultimate lenders and borrowers, the financial intermediaries, and functionality. For example, an arbitrageur may be a member of the exchange. Similarly, a speculator may be a member of the exchange, and he may be a broking or a non-broking member. Broking members can generally be divided into 3 categories, i.e. those dealing for own account (i.e. arbitrageurs and/or speculators) (in which case they may be non-broking members), pure brokers and those dealing for own account and for clients. Note that it is one of the significant rules of the exchange that if a broking member takes the opposite position of a client, she is obliged to inform the client as such.

Because of the significant role played by hedgers in the futures market, the function of hedging is covered further in some detail in the following section.

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3.17 Hedging with futures

3.17.1 Introduction

Hedging may be defined as the transferring of risk from the hedger, who has a portfolio or who is awaiting a certain sum of cash, to some other party in the market, usually another hedger or speculator. The hedger *is concerned with price movements* that may influence her existing portfolio, or a planned or anticipated portfolio.

The opportunities for hedging are many, and many a book has been written on hedging strategies. As this is an introductory text, this section deals with hedging basics and jargon and provides a few hedging examples.

3.17.2 Hedging basics and jargon

The jargon for hedging operations is interesting. For example, the investment community uses the terms ***micro hedging*** and ***macro hedging***[36]. *Micro hedging* is where each item in a balance sheet (liabilities and/or assets) is valued separately and an autonomous hedge set up for each item. *Macro hedging* is where the aggregate asset and/or liability portfolios are considered, and the overall risk is hedged in one operation. Examples are interest rate gap management (a banking problem) and changing asset allocation (an institutional problem).

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A hedger may have a certain ***hedging horizon***, i.e. a certain date on which the hedge will end (for example, a maize farmer who wishes to hedge from the planting stage to the harvest stage), or have no horizon at all (for example, a maize dealer who holds a permanent portfolio of maize and supplies feedlots and millers as they demand the product).

A hedge may be a ***long hedge*** or a ***short hedge***, and they may be ***anticipatory hedges*** or ***cash hedges***. A hedge may also be a ***direct hedge*** or a ***cross hedge***. For example, a manufacturer of bread requires wheat on a regular basis. If the manufacturer requires additional wheat in two months' time and is concerned that the price will rise over this period, it is able to put in place a ***long anticipatory hedge*** by buying an appropriate number of wheat contracts now that mature in two months' time (if it is happy with the two-month futures price). This action fixes the delivery price in two months' time.

A ***short hedge*** is where the hedger sells a futures contract. For example, a gold producer is concerned that the gold price will fall sharply over the next three months when it will have 5 000 ounces to market, which will adversely affect profitability. Assuming that the producer is pleased with the three-month delivery futures price, it will sell an appropriate number of gold contracts (assuming no physical delivery) and thereby fix its price of delivery. If the spot price in three months time is lower than the futures price it will sell the 5 000 ounces at the spot price; but it will profit on the futures contracts to the extent of the difference between the spot price and the futures price. Thus, the producer's delivery price will be the futures price.

Generally, it is difficult to exactly match the cash market position with the futures hedge position undertaken, in terms of:

- Time horizon.
- Amount of the asset / commodity.
- Characteristics of the goods (e.g. maize or wheat grade).

In these cases the hedger will attempt to match as closely as possible the characteristics of the cash market asset with the futures position; the hedge will be a ***cross hedge***.

Hedgers wish to establish a ***hedge ratio (HR)***. This ratio establishes the number of futures contracts to buy / sell for a given position in the cash market. The hedge ratio is given by:

HR = – (futures position / cash market position).

The hedger will undertake HR units of the futures to establish the futures market hedge. For example, if HR = -1, the hedger will have a matched long cash position and a short futures position.

A few examples of hedging follow.[37]

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3.17.3 Hedging using the 3-month JIBAR future

As we used the example of the JSE's 3-month JIBAR future above, we use it here in a hedging example. We assume that it is 23 June 2010 and the 3-month JIBAR future expires on 22 September 2010 (91 days later). We further assume that Company A has a loan of ZAR1 million at an interest rate of 3-month JIBAR + 2% (on 23 June JIBAR = 11%, i.e. the borrowing rate is 11% + 2% = 13%), and it is repriced on the JIBAR future expiry dates (which are the third Wednesday of March, June, September and December).

Thus the borrowing rate now (23 June 2010) for 3 months is 13%, and is due to change again on 22 September (obviously, it is unknown today). The company is concerned that the 3-month JIBAR rate on 22 September will be higher and the company will therefore pay a higher rate for the 3-month period following 22 September.

The company hedges itself by *selling* ten 3-month JIBAR futures contracts (contract size = ZAR100 000; 10 × ZAR100 000 = ZAR1 million exposure). The rate / price of the future is now 11.3% (when the 3-month JIBAR rate = 11.0%).During the course of the next three months the rate / price of the contract will move up or down in minimum amounts of 0.001 ("minimum price movement" – see the contract specifications in Table 6), also called "minimum tick size". You will recall that the basis point (0.01% pa) value = ZAR2.50 per contract [remember the principle: ZAR100 000 × (0.01 / 100 × (91.25 / 365)].

If the company is correct in its view (increasing rates) and the future closes out at 12.3% pa on 22 September (when the 3-month JIBAR rate = 12% pa), the company makes a profit of ZAR2 500 (100 basis points × 10 contracts × ZAR2.50) on the futures contract. This amount is offset against the new rate it will be paying on its borrowing for the next three months, i.e. 14% (12% + 2%). It will be evident that the "extra" the company will be paying (14% – 13%) in the next 3-month period is ZAR2 493.15 [(1.0 / 100) × (91 / 365) × ZAR1 000 000]. The two amounts are similar.

Date / rate	Cash market position	Problem	Solution
• 23 June • 3-month JIBAR rate = 11.% pa	• Borrowing of ZAR1 000 000 • Rate = JIBAR + 200bp • Repricing every 91days	• Borrowing rate = 11% + 2% = 13% • Concerned that rates will rise and borrowing rate will increase on next repricing date of 22 September	• Sell ten ZAR100 000 3-month JIBAR futures (maturity 22 September) • Rate / price = 11.3%
• 22 September • 3-month JIBAR rate = 12% pa	• Roll over borrowing at new rate = 12% + 2%	• **No problem**	• Future closes out at 12.3% • Profit = 100 × 10 × ZAR2.50 = ZAR2 500 • Company pays ZAR2 493.15 extra • Result: borrowing rate of close to 13% locked in
Tick size = 0.001 (in price) = ZAR2.50			

Table 6: Hedging with interest rate future

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It will also be apparent that a speculator, who does not have a cash market "position", and who undertook the above futures position, would have benefited to the extent of ZAR2 500. Had rates declined by 100 basis points over the period, she would have lost this amount, i.e. the correct futures position would have been a long (buy) contract in the case of falling rates.

3.17.4 Hedging with share index futures

Date / price	Cash market position	Problem	Solution
• 28 June • ALSI = 28000 • 19 September ALSI future price = 28100	• Share portfolio of LCC280 000 well spread over share market (representative of share market)	• Concerned that share prices will fall over next few months and that portfolio will be worth less	• Sell September ALSI future at current price of 28100 (maturity 19 September) • Contract size = 10 × index value = 10 × 28100 = exposure of LCC281 000
• 19 September • ALSI = 27000	• Share portfolio value declines by 3.6% (1 – 27000 / 28000 × 1) to) LCC269 920	• **No problem**	• Future closes out at 27000 • Profit = LCC281 000 – LCC270 000 = LCC11 000 • LCC11 000 profit added to new portfolio value of LCC269 920 = LCC280 920 = similar to original value

Table 7: Hedging with share index future

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An individual has a portfolio valued at LCC280 000 that is well spread over the share market (meaning he will earn the change in the ALSI value more or less). The All Share Index (ALSI) currently (28 June) is 28000, and the September all share index future (September ALSI, due 19 September) is trading at 28100. The individual is concerned that share prices "across the board" are about to fall sharply, and that the value of his portfolio will fall commensurately.

The individual decides to sell the September ALSI future. The contract size is 10 times index value, i.e. LCC281 000 (10 × 28100). He sells the ALSI future, and it closes out at 27000 on 19 September. The profit made is LCC11 000 (LCC281 000 – LCC270 000).

He compares this with the loss in the *market value* of the portfolio of LCC10 080 (280 000 – 269 920 (= a decline of 3.6% = the decline in the value of the ALSI from 28000 to 27000). This loss is more than compensated for by the profit on the futures position of LCC11 000.

3.17.5 Hedging with currency futures

A Local Country exporter is convinced that the USD proceeds (assume USD 100 000) from a export order will be worth less when it is received in three months time, as a result of the dollar depreciating (the LCC appreciating). The exporter *sells* a USD/LCC futures contract (contract size USD 100 000) at USD / LCC 10.2 which happens to be the same as the spot rate[38]. It has three months to expiry. The value of the contract now in LCC terms is LCC1 020 000.

At the end of the three month period, i.e. when the contract expires, the USD/LCC exchange rate is USD / LCC 9.55. The contract (which is settled in cash) value on expiry is LCC955 000. The exporter makes a profit of LCC65 000 (LCC1 020 000 – LCC955 000) on the futures contract.

The export proceeds of USD 100 000 are received, which is converted at the new rand/dollar spot rate of USD / LCC 9.55, i.e. a rand value of LCC955 000. On this leg the exporter "loses" LCC65 000 (meaning earns this amount less). Through hedging (*short anticipatory hedge*) the exporter "locked in" a certain outcome. Of course she gave up a potential gain (if the USD / LCC exchange rate depreciated to say USD / LCC 11.0) in exchange for a certain outcome. This is the price of hedging.

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Date / price	Cash market position	Problem	Solution
• Now • Spot rate = USD / LCC 10.2 • Futures price = USD / LCC 10.2	• Exporter expecting USD 100 000 in 3 months time	• Concerned that USD will depreciate (LCC appreciate)	• Sell rand/dollar 3-month future at USD / LCC 10.2 • Contract size = USD 100 000 • Contract value = LCC1 020 000 (USD 100 000 × 10.2)
• Three months later • Spot rate = USD / LCC 9.55	• Sell proceeds of USD 100 000 at spot rate = LCC955 000 • Exporter earned LCC65 000 less	• **No problem**	• Future closes out at USD / LCC 9.55 • Contract value = LCC955 000 (USD 100 000 × 9.55) • Profit = LCC1 020 000 – LCC955 000 = LCC65 000 • Profit = loss on cash market position

Table 8: Hedging with currency future

3.18 Basis trading

We saw earlier that basis (B) is the difference between the SP and the FP of the underlying asset:

B = SP – FP (note that B is often also calculated as B = FP – SP).

Basis trading in the futures market is a trading tactic consisting usually of the purchase of a security and the sale of a futures contract with the same underlying security. The motivation is that the speculator / arbitrageur is of the opinion that the two securities are mispriced with respect to each other, and that the mispricing will correct itself at some stage in the near future, or that a profit will occur upon expiry of the contract.

The best example of a successful basis-trade is where the spot purchase price of a share (SP) plus the cost of carry (CC) (remember, SP + CC = FVP) is less than the futures price (FP) (i.e. the basis number is larger than the CC). The (almost) risk-free profit will be evident in this case: the speculator / arbitrageur will (1) buy the share (at the SP), have it carried in the market at the CC until expiry (remember, SP + CC = FVP), (2) sell the corresponding futures contract. In effect, the overvalued security (the future) is sold and the correctly priced security is purchased. This trade is also called cash-and-carry trade.

3.19 Spread trading

A *spread* is the difference between the prices of two similar or related securities (here regarded as futures contracts), and a *spread trade* has two legs, usually executed simultaneously as a unit (to avoid execution aka leg risk): the purchase of one security and sale of a similar or related security. The result is a spread (a value), and the motivation is an expected change (narrowing or widening) in the spread over time.

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It will be evident that the speculator / arbitrageur hopes to profit not from the changes in the prices of the legs directly, but from the narrowing or widening of the spread. Also clear is that the volatility in the spread will be lower than that of the legs, thus lowering risk, but also lowering the potential profit. This is reflected lower margin requirements.

There are two categories of spreads: *intra-market spreads* and *inter-market spreads*. The former is where a spread trade is undertaken in the same market but in *different maturities* of contracts, for example: the sale of a June contract on Share A, and the purchase of a December contract on Share A. An intra-market spread is also referred to as a *calendar spread*. In the commodity futures market, intra-market spreads are referred to as *intra-commodity spreads.* An example of the latter follows (one contract = 100 tons) in Table 9.

	Price per ton		
	Opened position	Position after 1 month	Change
September white maize (**buy** one contract)	LCC 2700	LCC 2900	+LCC 200
December white maize (**sell** one contract)	(LCC 2500)	(LCC 2600)	(+ LCC 100)
Spread	LCC 200	LCC 300	+LCC 100

Table 9: Example of spread trade

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The prices of both futures increased, but the nearby contract by more than the distant one. The spread started off at LCC 200 and increased to LCC 300: by LCC 100. The speculator / arbitrageur makes a profit of LCC 100 × 100 tons = LCC 10 000.

The example above is an example of *selling the spread*: sale of distant contract and purchase of nearby contract. *Buying the spread* is the opposite: sale of nearby contract and purchase of distant contract.

An *inter-market spread* is where a trade is undertaken in different but related assets, for example the sale of a June soybean contract and the purchase of a June wheat contract. Another example is the purchase of a September GBP deposit future and the sale of a September Eurodollar deposit future. In the case of commodities, inter-market spreads are also referred to as *inter-commodity spreads*. Intra- and inter-commodity spreads are sometimes called *commodity product spreads*.

3.20 Futures market contracts

Table 10 presents a selection of futures contracts, and their specifications[39] listed on the South African exchange (the JSE). The specifications of the individual share futures contracts are shown in Table 11. There are close to 200 individual equity / share futures contracts (also called single-stock futures) listed on the JSE.

FUTURES CONTRACT	FTSE/JSE TOP 40 INDEX FUTURE	FTSE/JSE GOLD MINING INDEX FUTURE	FTSE/JSE SA LISTED PROPERTY INDEX	BOND FUTURES
CODE	ALSI	GLDX	SAPI	VARIOUS
UNDERLYING INSTRUMENT	FTSE/JSE Top 40 Index	FTSE/JSE Gold Mining Index Future	FTSE/JSE SA Listed Property Index	Various listed bonds – e.g. R201, R203
CONTRACT SIZE	R10 × Index Level	R10 × Index Level	R10 × Index Level	R100 000 nominal
EXPIRY DATES & TIMES	15h40 on 3rd Thursday of Mar, Jun, Sep & Dec. (or previous business day if a public holiday)	13h40 on 3rd Thursday of Mar, Jun, Sep & Dec. (or previous business day if a public holiday)	13h40 on 3rd Thursday of Mar, Jun, Sep & Dec. (or previous business day if a public holiday)	12h00 on the first business Thursday of February, may, August & November
QUOTATIONS	Index Level (no decimal points)	Index Level (no decimal points)	Index Level to Two Decimal points	Ytm (generally nacs) for settlement on the delivery date
MINIMUM PRICE MOVEMENT	One Index Point (R10)	One Index Point (R10)	0.01	1/10th point
SETTLEMENT METHOD	Cash Settled	Cash Settled	Cash Settled	Delivery of the physical bond

Table 10: Selection of JSE contracts and specifications

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FUTURES CODE	Various
UNDERLYING INSTRUMENT	The various listed companies
CONTRACT SIZE	100 × the share price (e.g. share price 85.25, future price R8,525.00) 110 × the share price for NEDQ
EXPIRY DATES & TIMES	If the contract is a constituent of any of the traded indices, 15h40 on the 3rd Thursday of Mar, Jun, Sep & Dec. (Or the previous business day if a public holiday) If the contract is not a constituent of any of the traded indices, 17h00 on the 3rd Thursday of Mar, Jun, Sep & Dec. (Or the previous business day if a public holiday)
QUOTATIONS	Price per underlying share to two decimals
MINIMUM PRICE MOVEMENT	R 1 (R 0.01 in the share price)
EXPIRY VALUATION METHOD	If the contract forms a constituent of any of the traded indices then, arithmetic average of 100 iterations taken every 60 seconds between 14h01 and 15h40 will be used. If the contract does not form a constituent of any of the traded indices then, the official closing price determined by the JSE Securities Exchange will be used
SETTLEMENT METHOD	Physically settled in terms of Rule 8.4.7.

Table 11: Individual share futures contracts listed on the JSE

3.21 Risk management by a futures exchange

An exchange (in this case the South African JSE) states boldly that its risk management philosophy "…is very simple – 'You stand good for your client.' What this means is that each member will carry its client's losses if the client defaults just as each clearing member will carry its member's (for whom it clears) losses if the member defaults. This pyramid structure forms the basis of the… Risk Management Structure." The structure is depicted as in Figure 13.

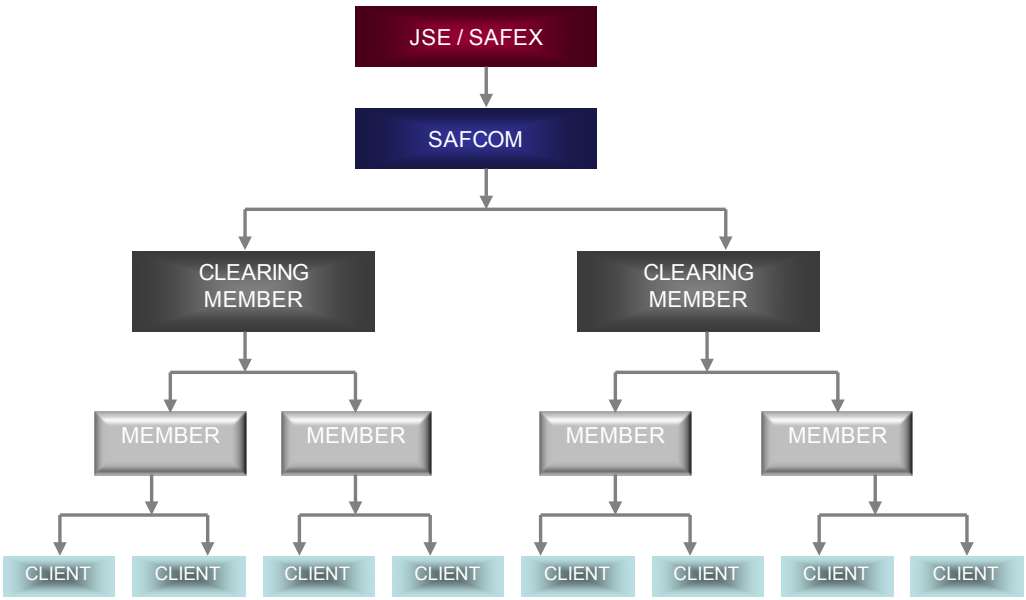

Figure 13: risk management by Safex

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The responsibility of appropriate risk management is placed on the shoulders of the clearing members who, in turn, pass this accountability onto the members for whom they clear, i.e. the non-clearing members. They, in turn, risk manage in terms of the rules of the exchange which stipulates the "levying" of a margin deposit.

As noted, the exchange requires a margin deposit to be paid by all participants when they take on a position in futures. This margin is registered in the name of the client or member, and it is equivalent to between 2% and 8% of the value of the contract. This is a reflection of the parameters of the risk that is associated with trading in the futures market in one day. As noted earlier, the initial margin is reassessed each day by the exchange and brings into play the variation margin.

Ultimately, the risk that the exchange bears is the risk that one of the clearing members defaults, whether the result of a non-clearing member causing it to default or as a result of its own activities. However, this is remote, as the clearing members are all major banks.

3.22 Economic significance of futures markets[40]

3.22.1 Introduction

There is not much debate amongst scholars of futures markets regarding the economic functions of these markets, although the functions are described in different ways. The economic functions are as follows:

- Price discovery.
- Market liquidity.
- Market efficiency.
- Resource allocation.
- Capital formation.
- Output.
- Public welfare.
- Competition.
- New product development.

Although these functions are described separately below, they should not be seen in isolation but as interdependent.

3.22.2 Price discovery

Futures markets have developed from the desire of participants in the financial and commodities markets to hedge against the risk of adverse price changes in these markets in the future. Thus, there was a need for an instrument to allow participants to hedge against unexpected cash market prices in the future.

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As noted earlier, the theoretical futures price (fair value price) is made up of the cash market price plus the net carry cost. It is also known that futures prices do not always equate to the theoretical price. Futures prices can be substantially above the theoretical price (i.e. at a premium), at a discount to the theoretical price and even at a discount to the cash market price. Clearly then, futures prices are not only influenced by the cash market price plus net carry costs, but are also heavily influenced by *expectations of price changes in the underlying market*.

Thus, the futures price is the outcome of the cash market price, the net carry cost and the perceptions of the many participants in the futures market regarding the course of the cash market price in the future (i.e. the futures price reflects all available information and the participants' interpretation of this information). It can thus be said that the futures market, at any point in time, *"discovers" the cash market price in the future*.

The question that arises now is to what extent the futures price can be regarded as rational and correct. This question is more pertinent the further away the expiry date of the futures contract. As shown, the futures price converges with the cash market price and becomes zero at expiry date. Thus, the closer to expiry, the more rational and correct the futures price is in terms of "discovering" the cash market price on expiry.

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Controversy in the above regard abounds. The debate revolves mainly around:

- The determinants of price variability
- The causality of price movements between the futures market and the cash market
- The general economic consequences of price volatility.

Some scholars of the futures market believe that *price volatility is an inherent characteristic of the futures market and attracts speculators to the market*. These speculators enhance liquidity, which is necessary for the efficient functioning of the market; they thus contribute to rational and correct pricing. Critics, however, believe that *price volatility results from speculative activity and obstructs the process of price discovery*.

As regards the causality of price movements, certain commentators believe that because futures prices are based on perceptions of price changes in the cash market in the future, the *causality is from the cash market to the futures market*. Critics, however, contend that futures market activities result in the causality being reversed, i.e. *prices in the futures market dictate price movements in the cash market*.

Concerning the *economic consequences of price volatility*, some critics state that volatile futures prices are transmitted to the underlying markets and cause distortions in the spot prices of these commodities. This could have consequences for production.

However, as we saw above, there are commodity markets where the spot price is derived from the near futures price. Thus it can be said that the futures market is essential for price discovery in the spot market.

3.22.3 Market liquidity

It is generally accepted that "liquidity" refers to the ease of entry and exit from a market. Futures markets are generally very liquid for two main reasons:

- They are "derived" from underlying markets which are generally liquid
- Futures contracts are standardised and restricted in terms of expiry dates (i.e. there are not many contracts; thus activity is not dispersed amongst many contracts).

It will be understood that if participants in the cash market expect adverse and/or volatile price changes in this market, they may withhold from investing until the risk exposure is reduced to acceptable levels. Futures contracts provide the means of reducing exposure, thus allowing the participant to enter the cash market now. The existence of the futures market also encourages speculators and arbitrageurs to enter the cash market. In general, the existence of an active futures market enhances liquidity in the cash market.

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3.22.4 Market efficiency

Market efficiency has to do with *prices fully reflecting all available information*. This is the case if all information is available to all participants at no cost, if there are no transaction costs and all participants are in agreement with regard to the implications for price formation of current and future information.

Closely related to market efficiency is market liquidity. A market cannot be efficient if there is limited competition (market participation). Wide market participation (i.e. intense competition) ensures that all available information is reflected in the price. If prices reflect true economic values and the information pertaining to them, capital in the market would be allocated correctly.

It will be evident that if a futures market is efficient, then it contributes to the efficient functioning of the related markets (the closest relative is, of course, the underlying market). For example, an *efficient futures market reduces the cost of hedging and promotes the use of the underlying markets*. This has *benefits* down the line such as increased production and demand, increased inventory holdings, the encouragement of specialisation (and resultant economies of scale), etc.

3.22.5 Allocation of resources

Closely related to market liquidity and efficiency is the allocation of resources (in fact, these should not be separated). Certain students of the economics of futures markets (particularly commodity futures markets) have indicated that the presence of a futures market for specific exhaustible resources increases the allocative efficiency of that market. The argument is that when futures trading exists the market is broad and contains more information. Prices are likely to be more efficient and resources are allocated more efficiently.

3.22.6 Capital formation

The effect of futures markets on capital formation is a contentious issue. The critics maintain that the existence of futures markets redirects risk capital away from the underlying markets, thus impeding capital formation. On the other hand, proponents agree that, by enabling producers to hedge, futures markets enhance capital formation – through putting producers in a better situation in terms of planning future production.

3.22.7 Output

Demand and supply fluctuations in an underlying market result in risk for producers. Uncertainty with regard to future prices and demand could result in lower output (and capital formation). The existence of an efficient futures market creates the opportunity for producers to relate output to demand (by utilising appropriate hedging techniques). The futures market thus reduces and distributes the risk associated with production and prices in the future – in this way contributing to increased output.

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3.22.8 Competition

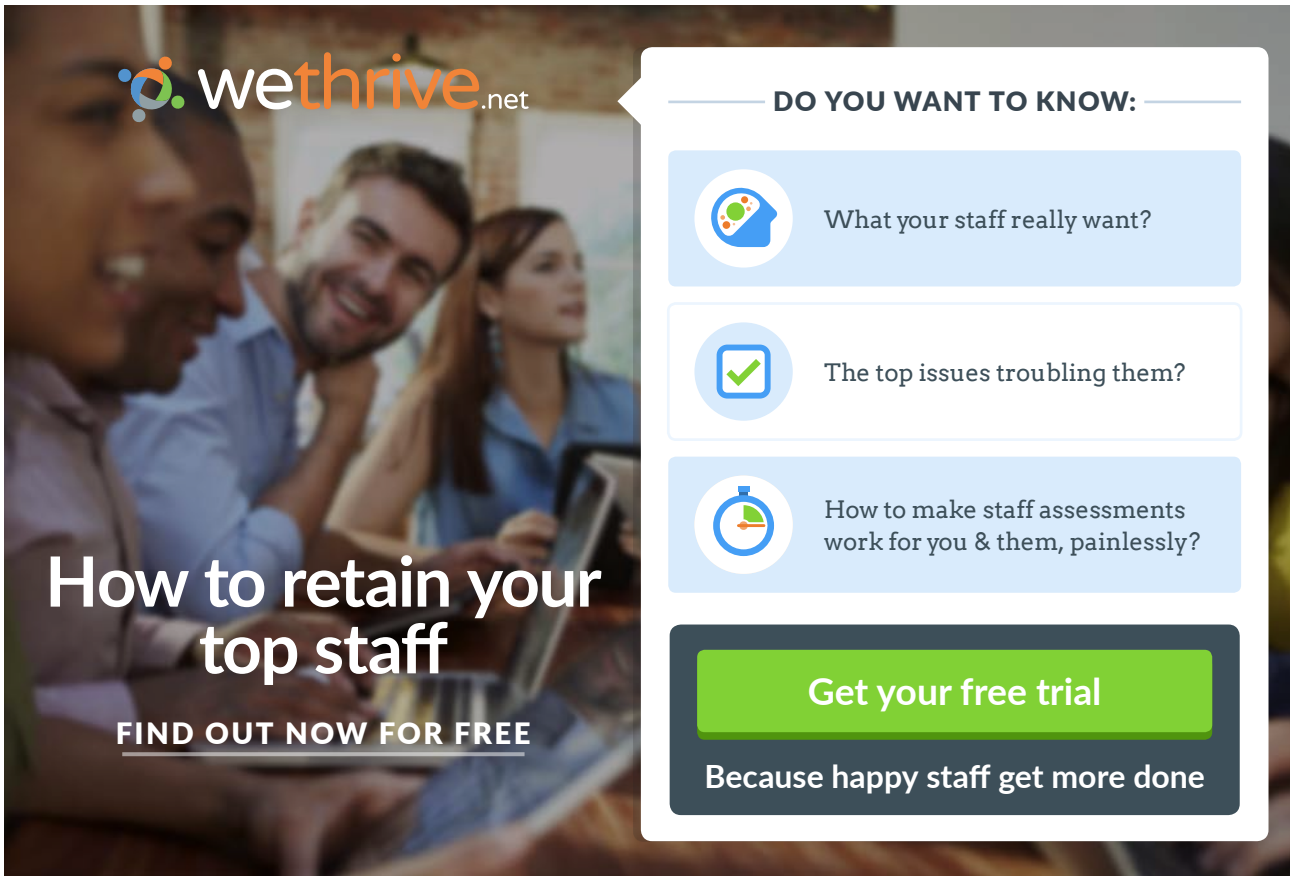
Certain commentators suggest that futures markets contribute to greater and more effective competition in the underlying markets and thus to prices which are lower than they otherwise would be. This favourable characteristic is believed to be transmitted to other related markets.

3.22.9 New product development

It is also maintained that the development of new products and services have been encouraged by the introduction of futures markets. Firms are more likely to create new products if they are able to reduce the risks and transaction costs involved (through hedging).

3.22.10 Public welfare

It is contended that the existence of efficient futures markets, through the effects on the underlying markets in terms of price discovery, resource allocation, liquidity, competition, new product development and on the output of firms, contributes to general public welfare.



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3.23 Summary

Futures are contracts between two parties via a futures exchange (which accepts the double counterparty risk, and risk manages cautiously, inter alia by a margining system) to buy or sell an asset at an agreed price on a specified date in the future other than the spot settlement date of the underlying instrument. Settlement may be with the asset or in cash. The price of the futures contract is the spot rate / price of the underlying instrument plus the carry cost (the rate of interest less any income) for the relevant period.

The participants in the market are the broker-dealers, investors (that at times use futures as substitutes for the underlying), hedgers, arbitrageurs and speculators. Futures turnover in many futures markets is vast, flowing over into the underlying markets, both of which bring about efficient price discovery. The futures market has many economic benefits including the raising of economic welfare.

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4 Derivative markets: swaps

4.1 Learning outcomes

After studying this text the learner should / should be able to:

1. Define a swap.
2. Describe the different types of swaps.
3. Elucidate the motivations underlying interest rate swaps.
4. Illustrate how swaps are utilised in risk management.
5. Appreciate the variations on the main themes of swaps.

4.2 Introduction

Figure 1 presents the derivatives and their relationship with the spot markets.

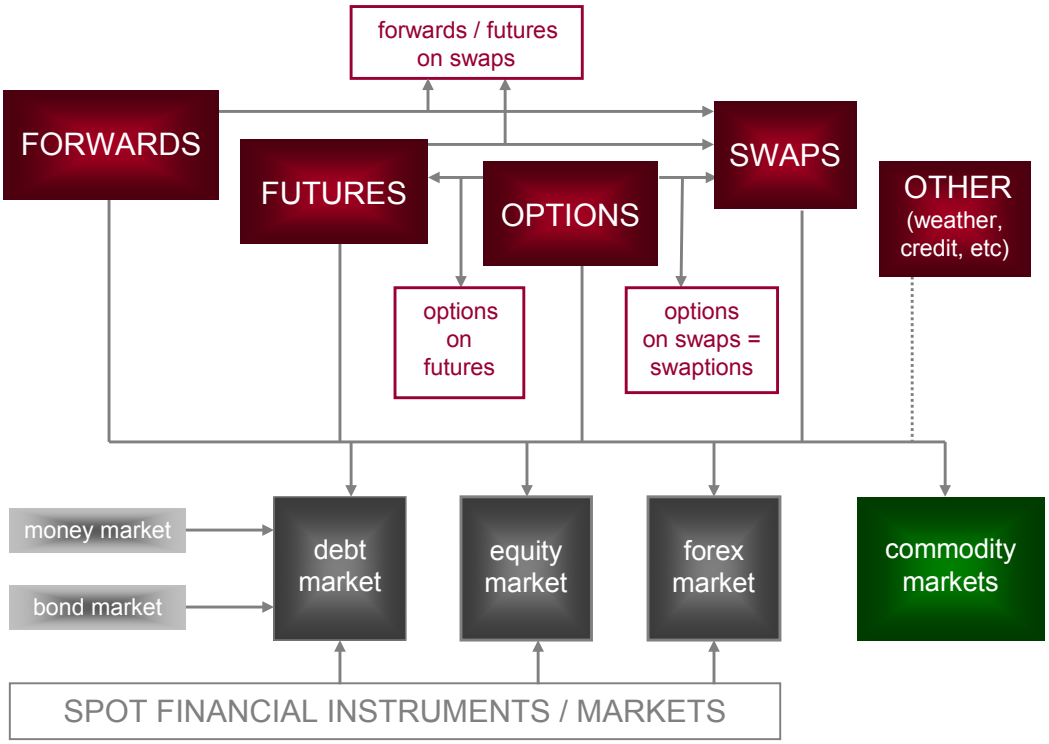

Figure 1: derivatives and relationship with spot markets

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Swaps emerged internationally in the early eighties, and the market has grown significantly. An attempt was made in the early eighties in some smaller to kick-start the interest rate swap market, but few money market benchmarks were available at that stage to underpin this new market. It was only in the middle nineties that the swap market emerged in some of these smaller countries, and this was made possible by the creation and development of acceptable benchmark money market rates. The latter are critical for the development of the derivative markets.

We cover swaps before options because of the existence of *options on swaps*. This illustration shows that we find swaps in all the spot financial markets.

A swap may be defined as an agreement between counterparties (usually two but there can be more parties involved in some swaps) to *exchange specific periodic cash flows in the future based on specified prices / interest rates*. The cash flow calculations are made with reference to an agreed notional amount (i.e. an amount that is not exchanged). Swaps allow financial market participants to better manage risk in their relevant preferred habitat markets.

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Swaps are a significant part of the financial markets and, as noted, are found in all the markets. The *interest rate swap* has a leg in the money market and a leg in the bond market. *Equity / share swaps* have a leg in the share market and the other in the bond market (and sometimes the money market). *Currency swaps* (not to be confused with foreign exchange swaps) have two legs in the foreign exchange market, but in different geographic markets. *Commodity swaps* involve the exchange of a fixed price on a commodity for the spot price (usually an average), and sometimes the transaction does not include the same commodity. The swap market may be depicted as in Figure 2.

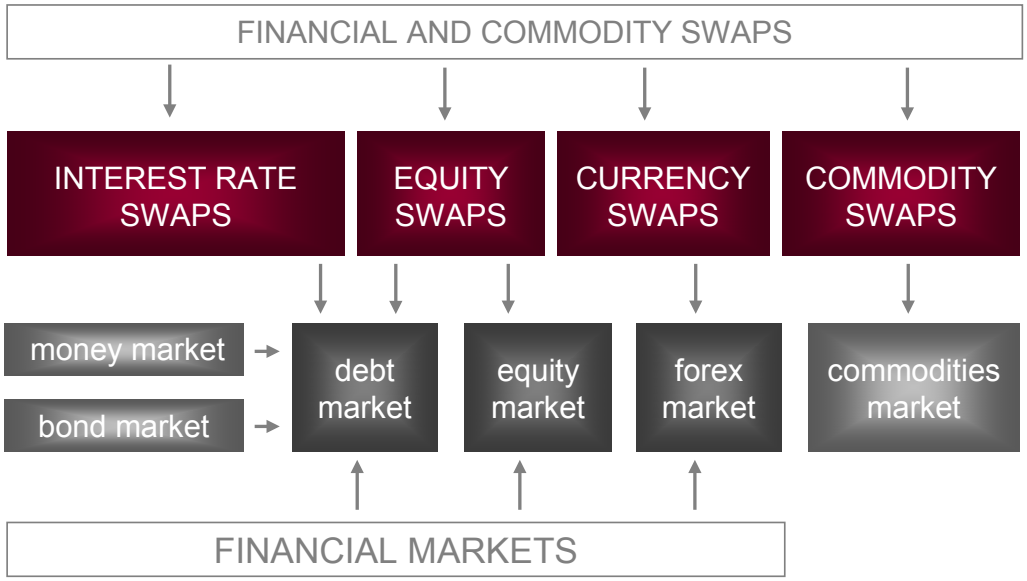

Figure 2: swaps

To this list may be added the *credit risk swap*, but as the compensation for the "protection buyer" is contingent upon a "credit event", it is more akin to an insurance policy, and will be discussed in the "other derivatives" section.

The various swaps undertaken in the five markets are covered briefly below. Interest rate swaps dominate and are given pole position, and we conclude with brief sections on the listed swaps in South Africa and the organisation of the swap market. The following are the headings:

- Interest rate swaps.
- Currency swaps.
- Equity / share swaps.
- Commodity swaps.
- Listed swaps.
- Organisation of the swap market.

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4.3 Interest rate swaps

4.3.1 Introduction

An interest rate swap entails the swapping of differing interest obligations between two parties via a facilitator, usually a bank that focuses on this market (and makes a market in this market). It is an agreement between two parties to exchange a series of *fixed rate cash flows* for a series of *floating rate cash flows* in the *same currency*. These interest amounts are calculated with reference to a mutually agreed *notional amount*. The notional amount is not exchanged between the parties.

The party that agrees to make *fixed interest rate* payments is called the *buyer* and the party that undertakes to make *floating rate payments* is called the *seller*. These swaps are also called *coupon swaps*. When two floating rates are exchanged they are called *basis swaps*. In fact, there are a variety of interest rate swaps, and these are mentioned at the close of this section. The following sections are covered here:

- Motivation for interest rate swaps.
- Coupon swap: transforming a liability.
- Coupon swap: transforming an asset.
- Coupon swap: comparative advantage.
- Organisation of the swap market.
- Variations on the theme.

4.3.2 Motivation for interest rate swaps

The circumstances that give rise to interest rate swaps (IRSs) usually involve interest rate risk or comparative advantage. The following main IRSs may be identified:

- Transforming a liability.
- Transforming an asset.
- Comparative advantage.

4.3.3 Coupon swap: transforming a liability

An example of an IRS that transforms a liability is shown in Figure 3.

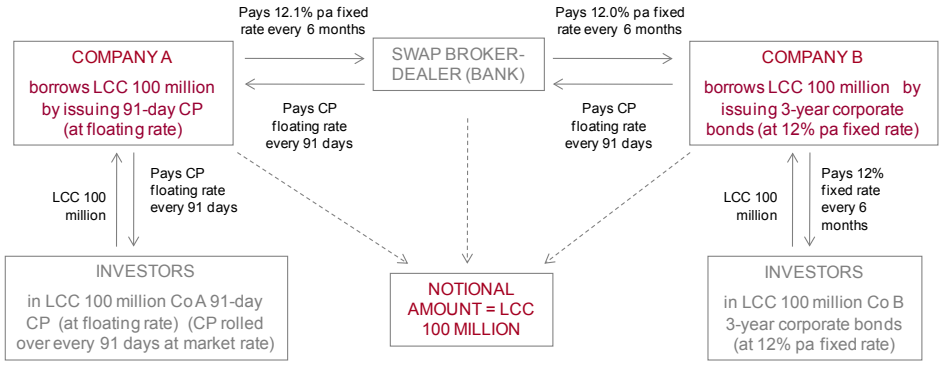

Figure 3: interest rate swap: transforming a liability

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In this example Company A has borrowed LCC100 million through the issuing of 91-day commercial paper (which is re-priced every 91 days at the then prevailing rate), while Company B has borrowed LCC100 million by the issuing of corporate bonds at a fixed rate of 12% pa for a 3-year period. These borrowing habitats could reflect the following:

- Company A believes interest rates are going to move down or sideways. It therefore does not want to "lock in" a rate for a long period, and wants to take advantage of rates declining if this does come about.
- Company B is of the view that rates are about to rise and wishes to lock in a rate now for the next three years.

Time passes and the two parties change their views. A sharp banker spots the changed views of the two companies and puts the following deals to them:

Company A

- Company A and the bank enter into an interest rate swap agreement.
- Company A agrees to pay to the bank a fixed rate of 12.1% for the next three years, interest payable six-monthly.
- The bank agrees to pay Company A the floating commercial paper rate every 91-days.
- The notional amount of the swap is LCC100 million.

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Company B

- Company B and the bank enter into an interest rate swap agreement.
- Company B agrees to pay to the bank the commercial paper floating rate every 91 days.
- The bank agrees to pay to Company B paying a fixed rate of 12.0%, interest payable six-monthly.
- The notional amount of the swap is LCC100 million.

Because of their changed views, the deals are accepted by both companies. Company A's obligation to pay the 91-day commercial paper rate to the holders (which may be different in each rollover period) is matched by the bank's payment of the 91-day commercial paper rate to it. It is then left only with the obligation to pay the fixed rate of 12.1% pa to the bank.

Conversely, Company B's obligation to pay the fixed 12% pa to the investors in its paper is matched by the bank's obligation to pay the fixed 12% pa rate to it. Company B is thus left with the obligation to pay the 91-day commercial paper rate to the bank.

The interest obligations of the bank match, with the exception that the bank earns 0.1% on the fixed interest leg of the transaction (LCC100 000 per annum excluding compounding and present value calculations).

The mathematics of this deal is straightforward, and simply amounts to interest payments (i.e. cash flows) over the three-year period. The cash flows are shown in Table 1.

	Company A pays	Company B pays	Floating rate (% pa) assumed
Year 1			
Day 0	-	-	-
Day 91 (91 days)		2 966 849.32	11.9
Day 182 (91 days)	6 050 000	2 991 780.82	12.0
Day 273 (91 days)		3 066 575.34	12.3
Day 365 (92 days)	6 050 000	3 166 301.37	12.7
Year 2			
Day 91 (91 days)		3 241 095.89	13.0
Day 182 (91 days)	6 050 000	3 365 753.43	13.5
Day 273 (91 days)		3 490 410.96	14.0
Day 365 (92 days)	6 050 000	3 427 945.21	13.6
Year 3			
Day 91 (91 days)		3 340 821.92	13.4
Day 182 (91 days)	6 050 000	3 116 438.36	12.5
Day 273 (91 days)		2 991 780.82	12.0
Day 365 (92 days)	6 050 000	2 867 123.29	11.5
Total	36 300 000	38 032 876.73	

Table 1: Fixed for floating interest rate swap (fixed rate = 12% pa) (LCC)

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Company A's floating rate obligation is cancelled out by the matching payments from the bank, and Company B's fixed rate obligation is cancelled out by the payments from the bank. Company A thus over the period of 3 years paid out a total of LCC36.3 million in interest, compared with Company B's LCC38 032 876.73. Thus, Company A's amended interest rate view was correct, and it saved LCC1.7 million. Company B's treasurer should have stuck to his original view.

Counterparty risk

It is rare that counterparties in swap deals are able to find one another and do a deal to their mutual satisfaction. If they do, the *deal rests on the integrity of the two parties*, i.e. they are each exposed to counterparty risk. More generally, it is bankers that seek out these transactions.

The banks then interpose themselves between the clients (principals), and undertake to receive and pay the relevant interest amounts. Clearly, it is only the large banks that are able to do these deals, because the counterparty of each principal is the intermediary bank (sometimes called the *swap agent*).

Fixed rates and floating rates

The above was an example of a plain vanilla swap. The floating rate used was the 91-day commercial paper rate. Most swaps in reality involve other well-known benchmark rates, such as the LIBOR in the UK, the Fedfunds rate in the US, the ROD or JIBAR rates in South Africa, and so on. The fixed leg is not benchmarked because it is an agreed number.

4.3.4 Coupon swap: transforming an asset

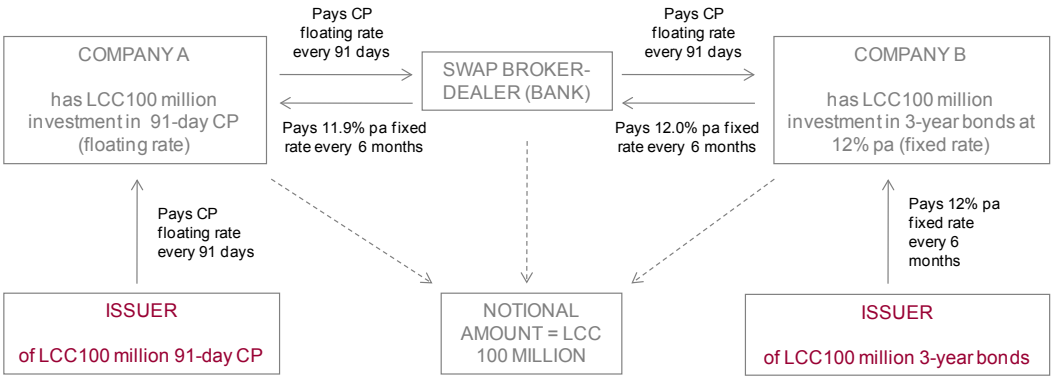

Figure 4: interest rate swap: transforming an asset

In the example presented in Figure 4, Company A transforms its investment in 91-day commercial paper, which is repriced every 91-days, into an 11.9% fixed rate investment. Company B does the reverse. In this example the motivation for the deal was a change in interest rate views. It will be noted that there is a mismatch in the timing of the interest payments. This does not have to be the case.

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4.3.5 Coupon swap: comparative advantage[41]

Rating	Company	3-year fixed rate (bond market)	Floating rate (money market)
AAA BBB	Company A Company B	11.0% 12.0%	6-month JIBAR[42] + 0.0% 6-month JIBAR + 0.5%
Difference (B – A)		+1.0%	+ 0.5%

Table 2: Example of comparative advantage IRS[42]

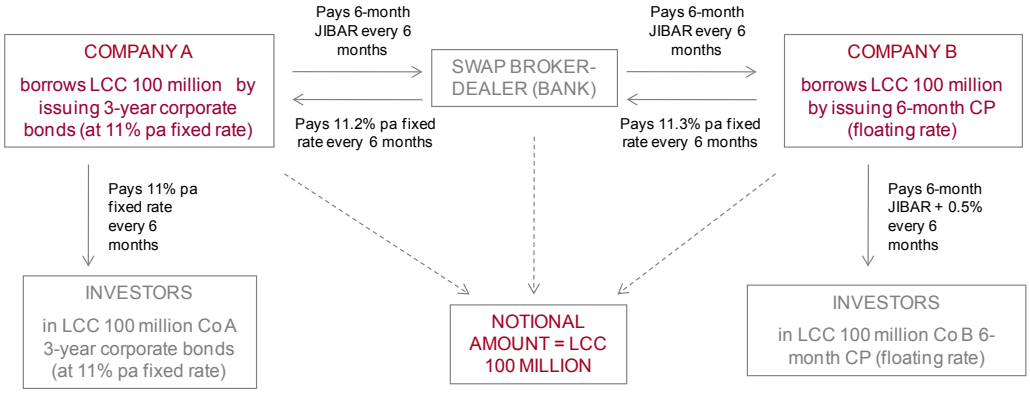

Figure 5: interest rate swap: comparative advantage

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The comparative advantage motivation for a swap deal rests on the existence of a differential in borrowing rates in different markets. An example is presented in Table 2.

Company A has an *absolute advantage* in both markets (as a result of the credit rating difference), i.e. borrows at a lower rate in both markets. However, it will be evident that while Company B pays a higher rate than Company A in both markets, it is "penalised" to a lesser extent in the money market than in the bond market (which could be because of the lower probability of default in the short-term). On the other hand, Company A pays less in the bond market than in the money market when compared with Company B.

Thus, Company A has a *comparative advantage* in the bond market, while Company B has a *comparative advantage* in the money market.

Important assumptions have to be made in this example:

- Company A wants to borrow floating.
- Company B wants to borrow fixed.

An astute banker sees the opportunity and proposes the following deal:

- Company A borrows in the market where it has a comparative advantage in relation to Company B (bond market).
- Company B borrows in the market where it has a comparative advantage in relation to Company A (money market).

The deal is accepted and the IRS then takes place as illustrated in Figure 5.

The details of the transaction supplied in Table 3 should be apparent.

Co	Wanted to borrow	Borrows (paying to investors)	Receives	Paying to bank	Actually paying
A	floating @ 6-m JIBAR	fixed @ 11%	11.2% fixed	6-m JIBAR	6-m JIBAR – 0.2%
B	fixed @ 12%	floating @ 6-m JIBAR + 0.5%	JIBAR	11.3% fixed	11.3% + 0.5%
Bank			0.1% (net)		

Table 3: Example of comparative advantage irs: interest payments

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Company A borrows out of its preferred habitat (floating rate), but the swap synthesises the preferred habitat, and the company benefits by 0.2%. Company B wants to borrow fixed, but borrows floating every 6 months for 3 years at 6-month JIBAR + 0.5%. It receives 6-month JIBAR, and therefore makes a loss on this leg of 0.5%. It however pays 11.3% fixed to the bank, making its total cost 11.8%, which is 0.2% lower than the fixed rate it would have paid in the bond market for its 3-year paper. The banker pockets 0.1% pa on LCC100 million for 3 years (LCC100 000 per year).

4.3.6 Variations on the theme

There are many variations on the main IRS theme. A few examples are:

- *Basis swap:* A swap where two floating rates are swapped.
- *Amortising swap:* A swap with a notional value that reduces over the life of the swap in a predetermined way.
- *Accreting swap* (also called *step-up swap):* A swap in terms of which the notional amount increases in a predetermined manner during the term of the swap.
- *Roller-coaster swap:* A swap in terms of which the notional amount increases and decreases during the term of the swap.
- *Deferred swap* (also called *forward start swap*): A swap where the counterparties do not start exchanging interest payments until a future date.
- *Extendable swap*: A swap where one party has the option to extend the life of the swap beyond the term of the swap, according to predetermined conditions.
- *Puttable swap*: A swap where one party has the option to terminate the swap prior to maturity date, according to predetermined conditions.
- *Constant maturity swap*: A swap where a floating rate (for example LIBOR) is exchanged for a specific rate (for example the 10-year rate on government bonds).
- *Index amortizing rate swap* (also called *indexed principal swap*): A swap where the notional amount reduces in a way that is dependent on the level of interest rates.
- *Timing-mismatched swap*: A swap with a timing mismatch.

4.4 Currency swaps

4.4.1 Definition

A currency swap in its simplest form involves the exchange of principal and interest payments in one currency for principal and interest payments in another currency. The amounts involved are usually of equal magnitude and they are exchanged with interest at the beginning and the end of the life of the swap. The following currency swaps are covered here:

- Simple currency swap.
- Comparative advantage currency swap.
- Variations on the theme.

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4.4.2 Simple currency swap

Our first example of a swap is a simple one (see Figure 7; assumption: starting exchange rate = GBP / USD 1.5).

The UK financial intermediary company has all its assets in UK pounds, but has GBP 100 million of its liabilities in USD (2-year 10% pa fixed bond issue in USD = USD 150 million). In a similar fashion, a US financial intermediary has all its assets in USD but has USD 150 million of GBP liabilities (2-year 10% pa fixed GBP-denominated bond = GBP 100 million). Interest on both bonds is payable annually.

After a year the UK intermediary becomes concerned that the GBP will *depreciate* in relation to the USD and it will have to service the debt (interest and principal) with more pounds in the future. At the same time the US intermediary becomes concerned that the USD is about to *depreciate* in relation to the GBP, and that it will have to service its UK pound debt (interest and principal) with depreciated dollars.

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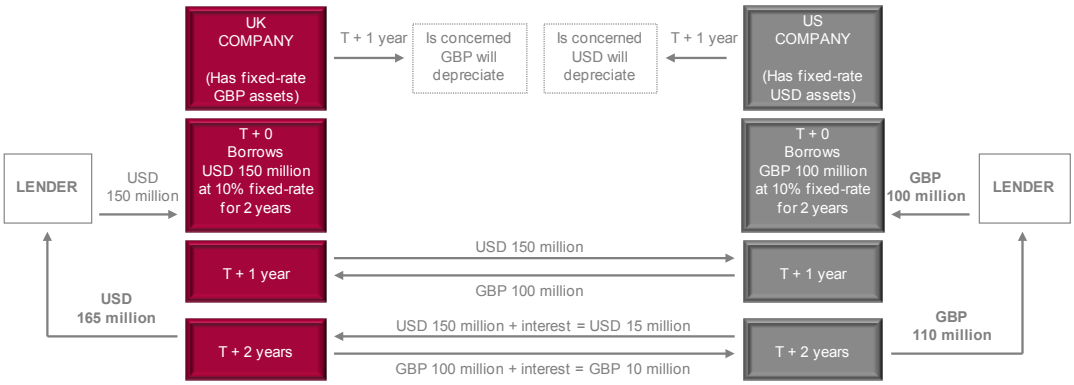

Figure 7: example of currency swap

There is always a smart banker that will spot this "opposing currency risk condition". He proposes the deal as illustrated in Figure 7, and takes a "small" turn in one of the legs (which we ignore here for the sake of simplicity).

The swap is done for principal and interest and the relevant amounts change hands at T+1year. At T+2 (expiry of the swap and the bonds) the amounts plus interest are exchanged again in order for the debtors to repay the creditors the principal plus interest amounts.

If at T+2 the exchange rate is GBP / USD 1.4, i.e. the GBP has depreciated (less USD per GBP or more GBP per dollar: 1 / 1.4 = 0.71429 GBP per USD, compared with 1 / 1.5 = 0.66667 GBP per USD), the UK company is better off than it would have been in the absence of the swap, with the position of the US company being the converse. In the absence of the swap the UK company would have had to buy USD 165 million for GBP 117.86 million (1 / 1.4 × USD 150 million),compared with GBP 110 million it paid. The US company would have been better of had the swap not been undertaken: it would have bought GBP 110 for USD 154 million (1.4 × GBP 110 million), compared with USD 165 million it paid.

The above is an example where the currency swap transmutes liabilities from one currency to another, with the purpose of managing currency risk. Another example is where a comparative advantage exists. This follows.

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4.4.3 Comparative advantage currency swap[43]

The second example is more realistic and is illustrated in Figure 8.

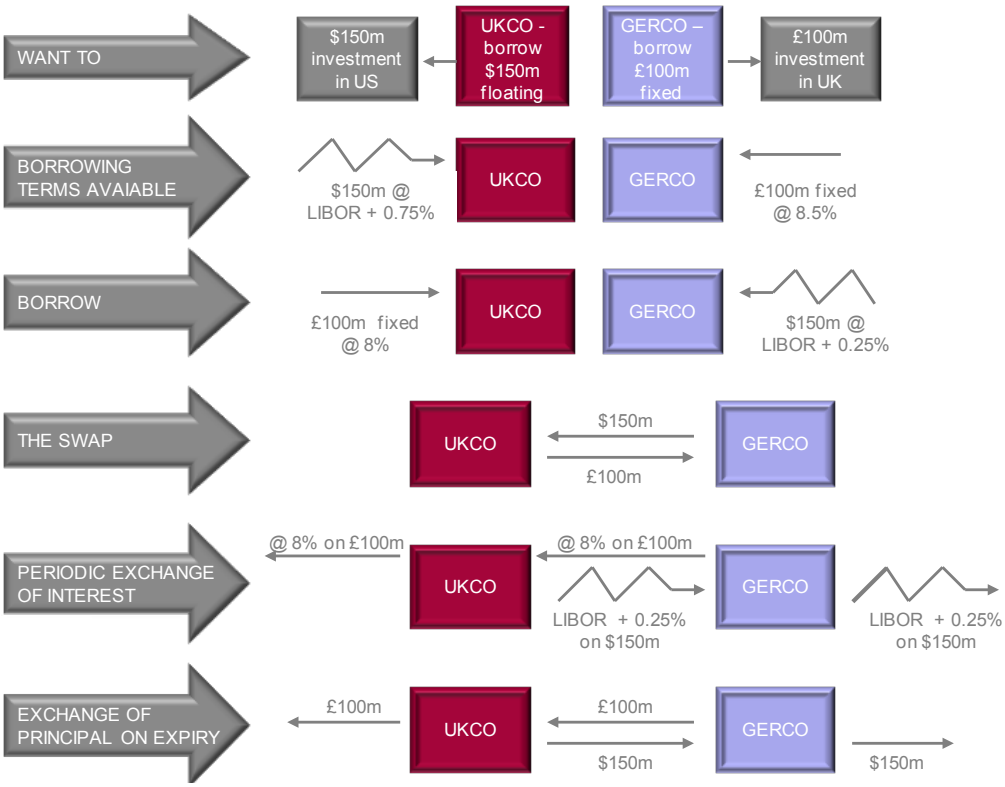

Figure 8: example of currency swap

Wants / needs:

A UK company (UKCO) wants to borrow USD 150 million at a floating rate for 10 years in order to make an investment in the US. A German company wants to raise GBP 100 million for 10 years at a fixed rate for investment in the UK. The exchange rate is GBP / USD 1.5.

The following terms are available to them:

- UKCO: USD 150 million at LIBOR + 0.75%
- GERCO: GBP 100 million at 8.5% fixed.

Prelude to swap:

Their banker (they happen to have the same bank as their advisor) advises them that they should not borrow on these terms, but rather as follows which they are able to:

- UKCO: borrow GBP 100 million at a fixed rate of 8% for 10 years
- GERCO: borrow USD 150 million at LIBOR + 0.25%

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and that they simultaneously undertake to swap the principal and the obligations (interest is payable every six months). It is evident that if they exchange debt obligations, their *wants will be satisfied* and they will be *borrowing at a lower rate*.

A summary of the borrowing terms is given in Table 4.

Co	USD rate	GBP rate	Wants to borrow in:	Actually borrows in:
UKCO	LIBOR + 0.75	Fixed rate 8% pa	USD	GBP
GERCO	LIBOR + 0.25	Fixed rate 8.5% pa	GBP	USD

Table 4: Example of comparative advantage currency swap: interest payments

Each party has an advantage in a market compared with the other party: UKCO in the GBP market and GERCO in the USD market.

Borrowing and the swap:

UKCO and GERCO see the advantages, accept the terms, borrow as advised, and the swap takes place. Each is able to make their desired investment as follows:

- UKCO: investment of USD 150 million
- GERCO: investment of GBP 100 million.

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The periodic exchange of interest:

The following cash flows take place over the period of 10 years (interest is payable every six months):

- UKCO:
  - Pay: 8% fixed rate on GBP 100m (to holders of securities)
  - Receive: 8% fixed rate on GBP 100m (from GERCO)
  - Pay: LIBOR + 0.25% on USD 150m (to GERCO)
- GERCO
  - Pay: LIBOR + 0.25% on USD 150m (to holders of securities)
  - Receive: LIBOR + 0.25% on USD 150m (from UKCO)
  - Pay: 8% fixed rate on GBP 100m (to UKCO).

Exchange of principal on expiry of contract:

At expiry of the swap the principal amounts are exchanged as follows:

- UKCO: USD 150 million to GERCO
- GERCO: GBP 100 million to UKCO.

They are able to repay the holders of the securities they issued.

Net result:

The net result of the swap is that UKCO *gets to borrow in its preferred habitat*: USD 150 million at LIBOR, but it *borrows at a cheaper rate* (i.e. LIBOR + 0.25% as opposed to LIBOR + 0.75%). Similarly, GERCO *borrows where it wanted* to (GBP 100 million in the UK at a fixed rate), but also at a *cheaper rate* (8.0% fixed as opposed to 8.5% fixed).

It is to be noted that the interposition of the bank was left out in the numbers. It will be evident that the savings by each party allow for the banker to take a "healthy" turn. The banker was excluded because of the extra arrows that would have rendered the illustrations untidy.

4.4.4 Variations on the theme

There are variations on the main theme of currency swaps, but not as many as in the case of interest rate swaps. One of them is the *cross currency swap* (also called currency coupon swap). It involves the exchange of a floating rate in one currency for a fixed rate in another currency. This is essentially a hybrid of the currency swap and the plain vanilla interest rate swap.

Another is the *differential swap* (also termed the *diff swap*), which involves the exchange of a floating rate in the domestic currency for a floating rate in a foreign currency. Both payments are referenced against a domestic notional amount.

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4.5 Equity / share swaps

4.5.1 Introduction

An equity / share swap is a *fixed-for-equity swap*. It is similar to the conventional interest rate swap in terms of a term to maturity, notional principal amount, specified payment intervals and dates, fixed rate and floating rate. The difference lies therein that the *floating rate is linked to the return on a specified share index* (usually total return, i.e. capital appreciation and dividend). The following are the sections covered here:

- Example of equity / share swap
- Variations on the theme.

4.5.2 Example of equity / share swap

These swaps are a relatively new invention (first emerged in 1989), and are used for temporary desired changes to the income of a portfolio without having to sell the relevant instrument/s. For example (see Figure 9), a portfolio manager may believe that equities are to yield inferior returns for, say, two years, and that over this period bonds should perform well. An equity / share swap is an ideal instrument for this purpose, i.e. the share return is swapped for a fixed rate of return for two years.

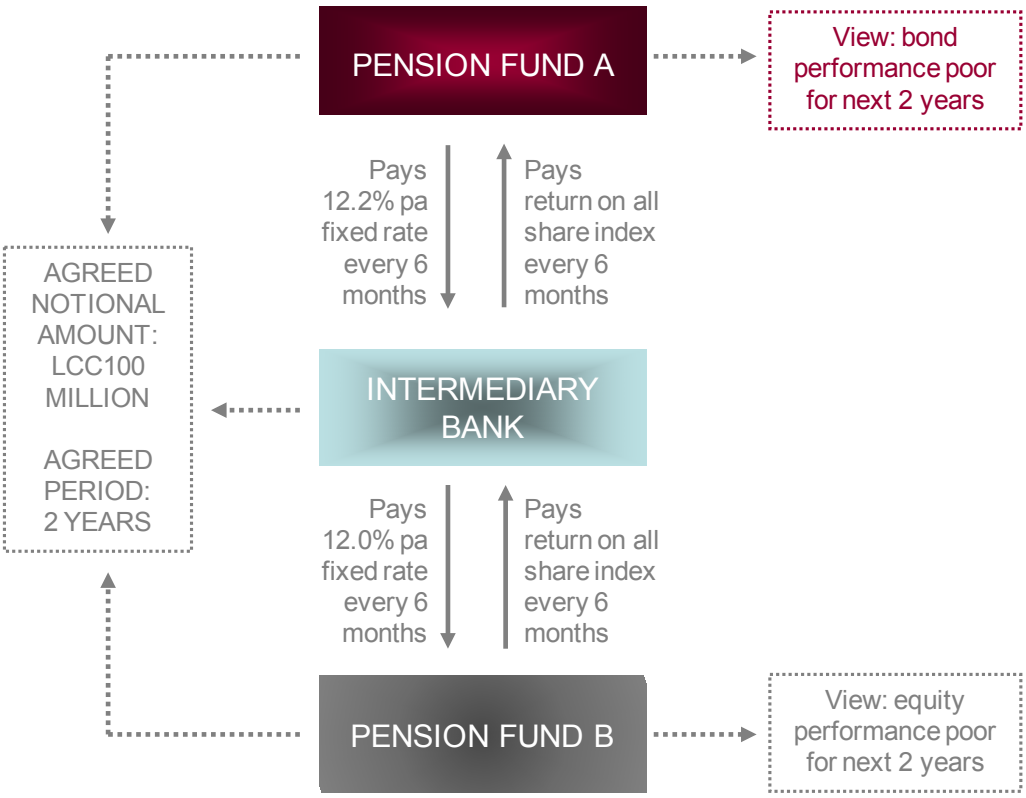

Figure 9: example of an equityswap

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It will have been noted that the intermediary bank (who arranged the deal) profits by 0.2% pa on the fixed leg (LCC200 000 pa for 2 years). The two principals (pension funds) are not aware of this because they deal with the bank.

4.5.3 Variations on the theme

There are some variations to this plain vanilla equity / share swap:

- *Floating-for-equity equity swap*: An equity swap with one leg benchmarked against a floating rate of interest and the other leg benchmarked against an equity index.
- *Asset allocation equity swap*: An equity swap where the equity leg is benchmarked against the greater of two equity indices.
- *Quantro equity swap*: An equity swap with two equity legs, the return on one equity index is swapped for the return on another equity index.
- *Blended-index equity swap*: An equity swap where the floating leg is an average (weighted or otherwise) of two or more equity indices.
- *Rainbow-blended-index equity swap*: Same as the previous, but the indices are different foreign indices.

4.6 Commodity swaps

Commodity swaps are where parties *exchange fixed for floating* ***prices*** *on a stipulated quantity of a commodity* (for example a 20 000 ounces of platinum). An example: a South African producer of platinum wishes to fix a price on part of its production (20 000 ounces), because it is of the opinion that the price of platinum is about to fall (wants to *receive fixed*, i.e. a fixed price, and *pay floating*, i.e. the spot rate).

On the other hand, a manufacturer of jewellery in Italy believes that the price of platinum is about to rise sharply (wants to *pay fixed*, i.e. fixed price, and *receive floating*, i.e. spot price).

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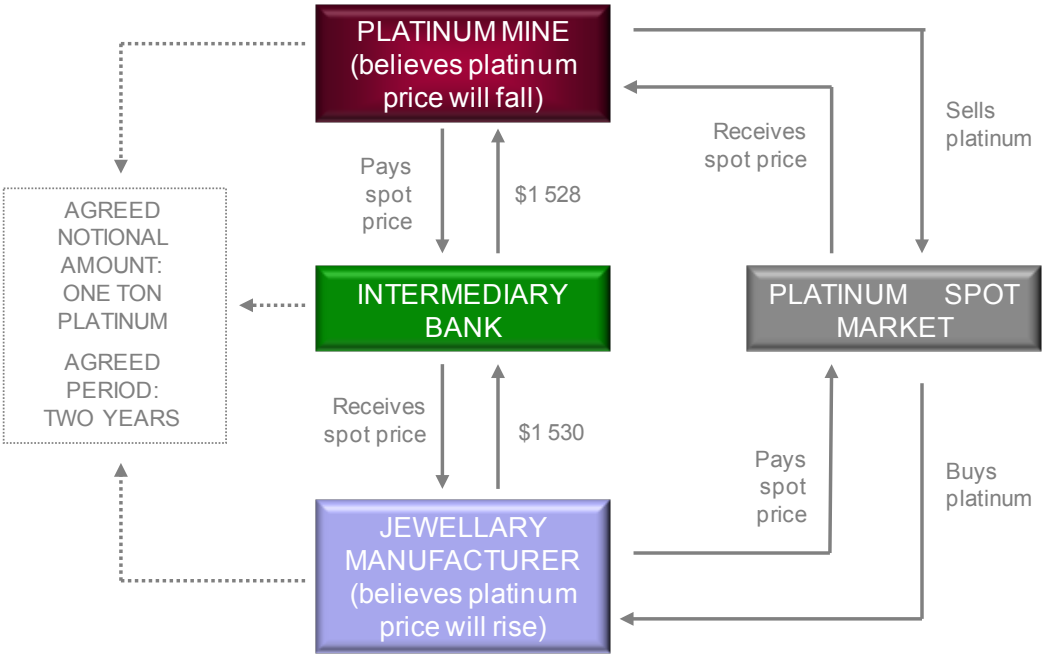
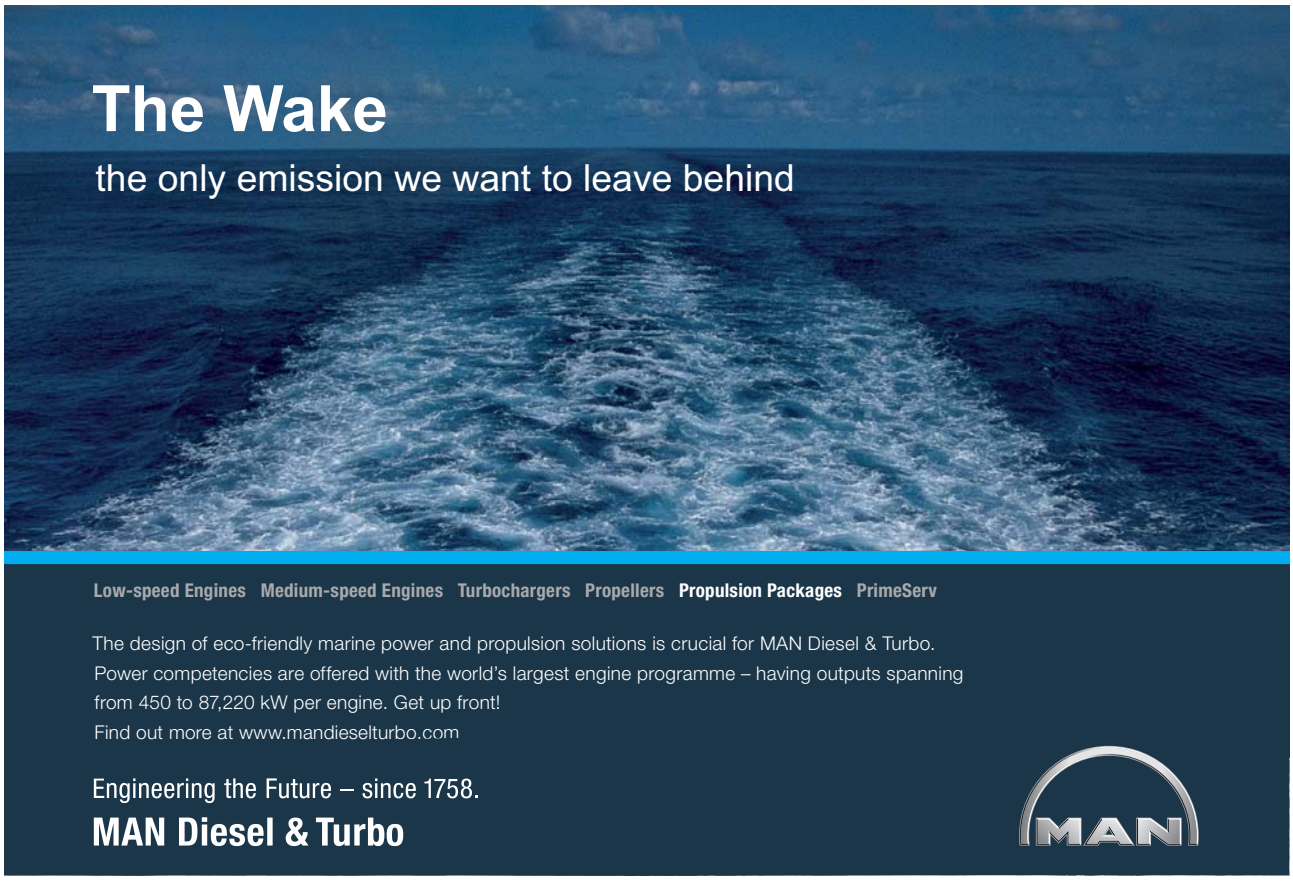


Figure 10: example of a commodity swap



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An on-the-ball intermediary bank spots this difference of opinion and puts together the following deal (spot price at inception of the deal is USD 1 529 per ounce):

- The bank offers the mine a fixed price of USD 1 528 per ounce for the next 2 years, payable monthly, in exchange for monthly payments of the average spot rate for the preceding month.
- The bank offers the jewellery manufacturer monthly payments of the average spot rate for the preceding month, in exchange for a fixed price of USD 1 530 per ounce for the next 2 years, payable monthly.

Both parties cannot believe their good fortune and accept the deal. The banker is also pleased. It will be apparent that if the platinum price falls, the mine will be extremely pleased, because it receives the ever-declining price on the spot market and pays this to the intermediary bank. In exchange the miner receives the fixed price of USD 1 528 per ounce.

The jewellery manufacturer, on the other hand, will be smarting because it is paying floating in the spot market and receiving this same amount, while paying a fixed price that is increasingly higher than the spot price. The opposite case will be obvious. This swap deal is depicted in Figure 10.

4.7 Listed swaps

Generally speaking the swap market is an OTC market "made" by the banks (see next section). However, in certain markets listed swaps are listed on financial exchanges. In some countries the following listed swaps are found:

- Plain vanilla swaps.
- Coupon swaps.
- On-demand swaps.
- Bond look-alike swaps.
- Overnight swaps.

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4.8 Organisational structure of swap market

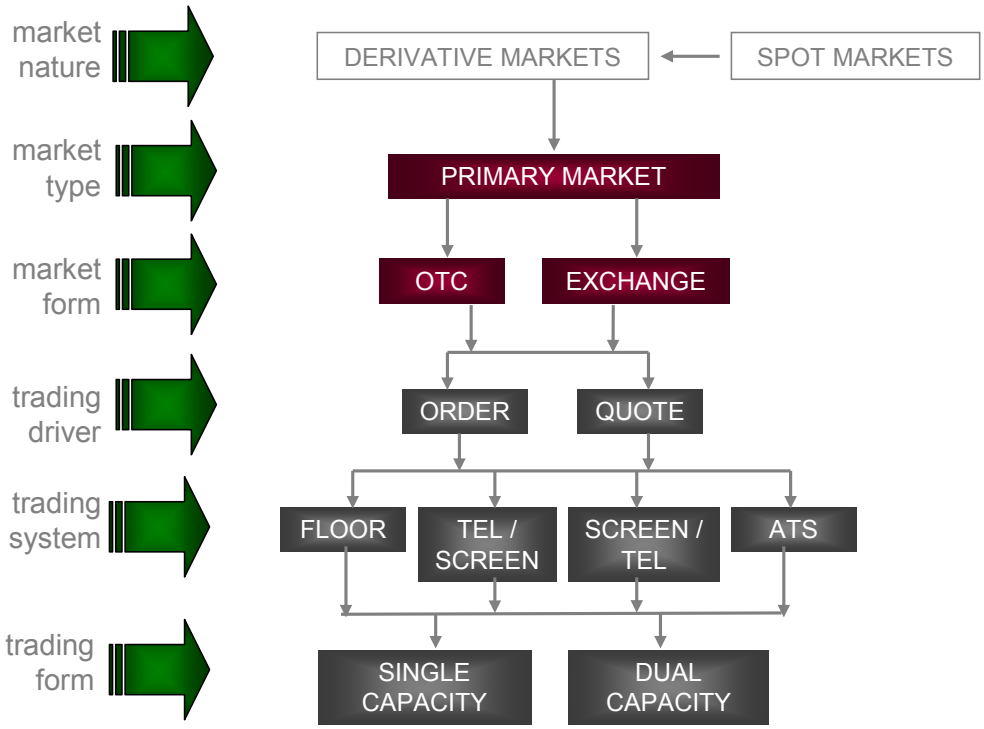

Figure 11: organisation of derivative financial markets

As noted, the swap market is largely an OTC market and it is dominated by the banks. As such, it is largely a primary market. As in the case of OTC forwards, the OTC swaps are difficult to sell and "getting out" of them amounts to finding an equal and opposite OTC deal (which is not always easy to find).

This also applies to the listed swap market, but there is a major difference: the contracts are standardised, and exchange-traded, and trading "out" of them is easier. Another advantage is that the exchange guarantees the swap deals.

In the OTC swap market the trading driver is "quote" (mainly done by the banks) whereas in the exchange-driven market participants place orders with their broker-dealers. The trading system in the OTC market is screen / telephone, i.e. firm prices are quoted on screen and confirmed on the telephone. In the exchange-driven markets it is a combination of ATS and screen-telephone.

4.9 Summary

Swaps are obligations to swap cash flows ion future dates. They are used to transform liability and asset portfolios and to take advantages of pricing / credit anomalies in markets. The market is usually OTC but some swap products are traded on exchanges.

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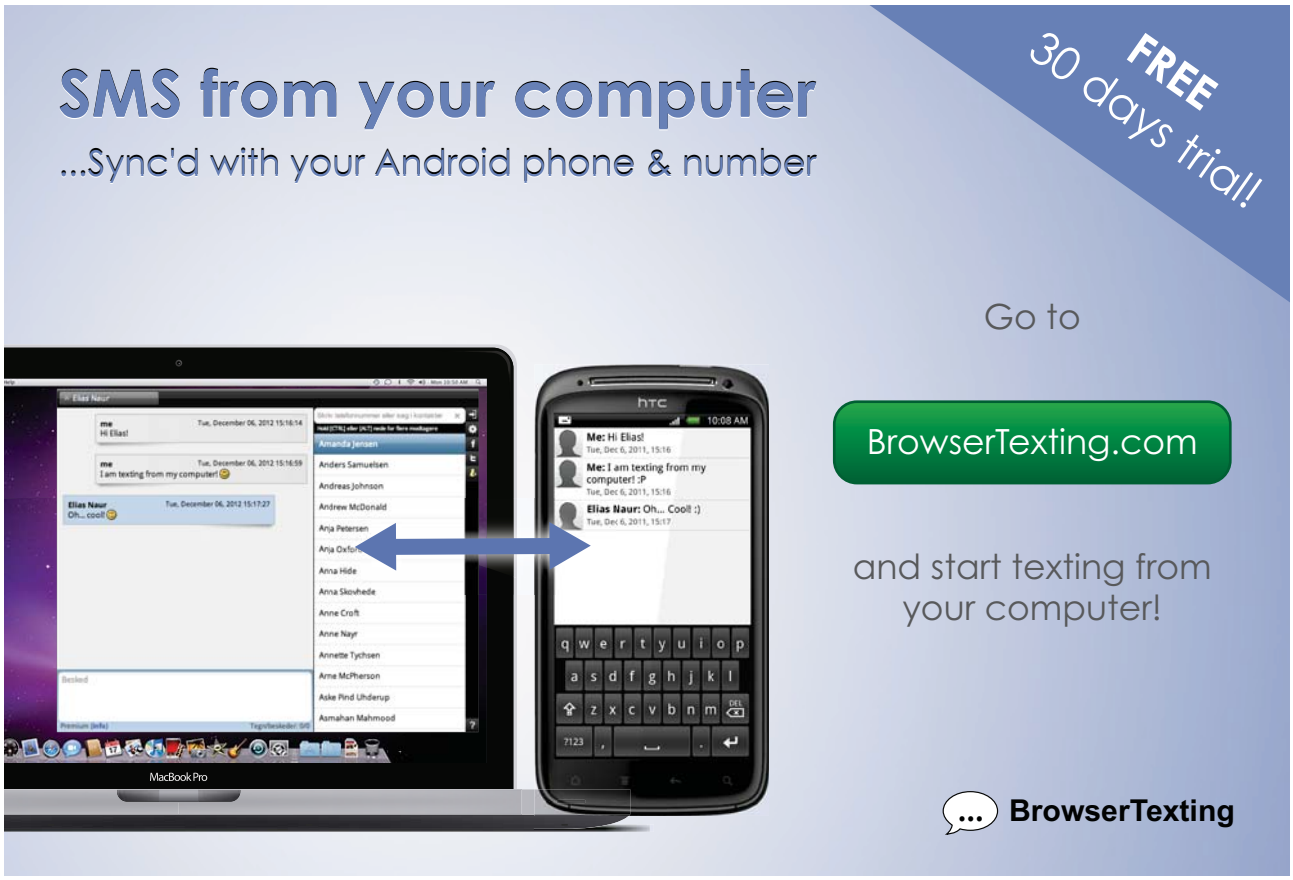

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5 Derivative markets: options

5.1 Learning outcomes

After studying this text the learner should / should be able to:

1. Define an option.
2. Elucidate the characteristics of an option.
3. Describe the different types of, and concepts relating to options.
4. Explain the payoff profiles of the various option types.
5. Comprehend intrinsic value and time value.
6. Elucidate the motivation for undertaking (buying or writing) option contracts.
7. Comprehend option strategies.
8. Understand delta hedging.

5.2 Introduction

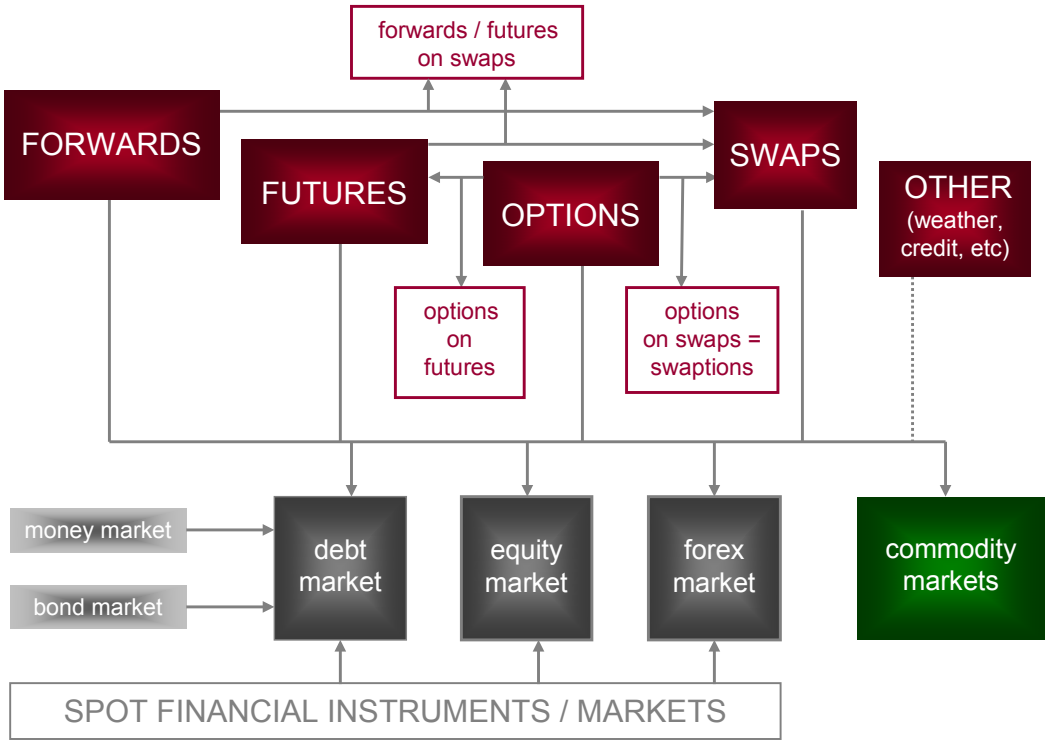

Figure 1: derivatives and relationship with spot markets

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A depiction of the derivatives markets and their relationship to the spot markets is shown in Figure 1. The figure shows that there exist *options on specific instruments* (called "physicals") in the various financial markets and the commodities market, and *options on other derivatives*, i.e. futures, and swaps (with the exception of the category "other"). However, Figure 1 cannot demonstrate the detail of the options markets; this is portrayed in Figure 2.

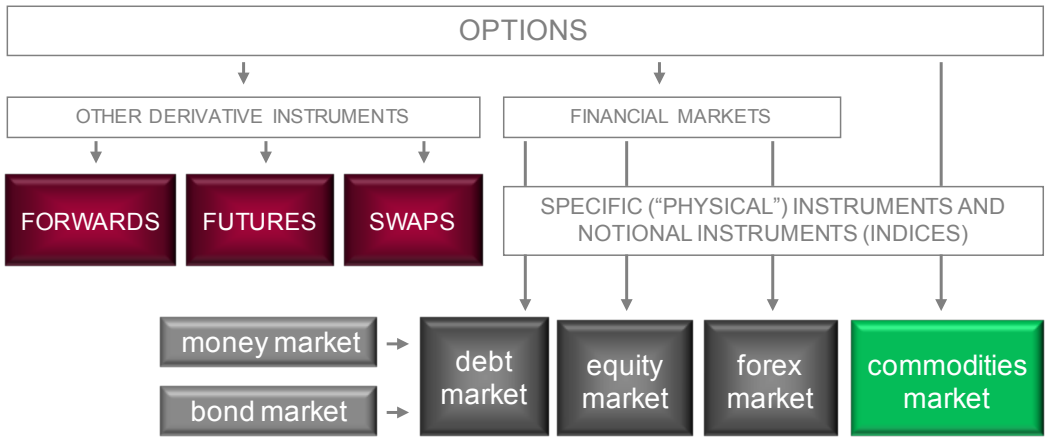

Figure 2: options

Figure 2 shows that there exist options on the derivatives futures and swaps (called swaptions), and that there are options on specific instruments and indices in the various financial markets and the commodity markets. These are covered in the following sections:

- The basics of options.
- Intrinsic value and time value.
- Option valuation and pricing.
- Organisation of options markets.
- Options on derivatives: futures.
- Options on derivatives: swaps.
- Options on debt market instruments.
- Options on equity / share market instruments.
- Options on foreign exchange.
- Options on commodities.
- Option strategies.
- Exotic options.

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5.3 The basics of options

5.3.1 Definitions

An option bestows upon the holder the right, but not the obligation, to buy or sell the asset underlying the option at a predetermined price during or at the end of a specified period. Holders exercise their options only if it is rewarding to do so, and their potential profit is not finite, while their potential loss is limited to the premium paid for the option.

There are *two parties* to each option: the writer and the owner or holder. The writer grants the rights that the option bestows on the owner.

There are three *brands* of options, i.e. American, European and Bermudan:

- An American option bestows the right upon the holder to exercise the option at any time before and on the expiry date of the option.
- A European option gives the holder to exercise the option only on the expiry date of the option.
- A Bermudan option is an option where early exercise is restricted to certain dates during the life of the option. It derives its name from the fact that its exercise characteristics are somewhere between those of the American (exercisable at any time during the life of the option) and the European (exercisable only at the expiration of the option) style of options.

The majority of options traded locally and internationally are American options. It is to be noted that the three option brands do not refer to a geographic location. American and Bermudan options exist in Europe and European and Bermudan options can be found in America.

Options are classified as *call* options and *put* options:

- The *call* option bestows upon the purchaser the right to *buy* (think "call for…") the underlying asset at the pre-specified price or rate from the writer of the option.
- The *put* option gives the holder the option to *sell* the underlying asset at the pre-specified price or rate to the writer (think "put the writer with…").

The buyer pays the writer of the option an amount of money called the *premium*. It is called this because an option is much like an insurance policy.

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Thus, there are *two sides* to every option contract (in the primary market):

- The buyer who has taken a *long position*, i.e. he has *bought* the option and has the benefits of the option (the "option" to do something). The buyer pays the premium for the option to the seller.
- The seller who has taken a *short position*, i.e. he has *sold* the option and received the premium (the seller has "no options" but is contracted to do something if the buyer decides to exercise the option). The *seller* of an option is the *writer* of the option.

The terms *long position* and *short position* applies to both puts and calls, i.e. one can have a *long put* and a *long call* (see below). It will be apparent that the writer's "position" is the reverse of that of the buyer of the option. If the writer does not have an offsetting position in the underlying market, he is said to be *naked* or *uncovered*. If the writer does then he is *covered*.

Options are said to be *in-the-money* (ITM), *at-the-money* (ATM) and *out-the-money* (OTM) (obviously from the point of view of the holder) as follows (in the case of *call* options):

- ITM: Price of underlying asset > strike price
- ATM: Price of underlying asset = strike price
- OTM: Price of underlying asset < strike price.

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Another few parts of the definition require further illumination:

- underlying asset
- exercising
- exercise price
- expiration
- lapse.

Options are written on "something". This "something" is anything, i.e. options can be written on anything. As each house buyer and seller knows, the most common option is an option to buy a house. The seller of the house gives (writes) the option to the potential buyer of the house to buy the house at a *specified price* (exercise or strike price) during a specified period.

The house option is usually written free of charge (i.e. no *premium* is payable), and has a fixed term of a day or two or three. The holder of the option can *exercise* the option at any time between the time of the writing of the option and the *expiration* of the option at the *strike* (or *exercise) price* (i.e. specified price). The option *lapses* if the holder decides to not *exercise* his rights under the option. If the buyer exercises the option, the seller is *obliged* to do the deal, i.e. deliver the *underlying asset* (the house).

As seen earlier, the *underlying assets* in the options markets of the world are *other derivatives* (futures and swaps), and *specific instruments* ("physicals") and *notional instruments* (indices) of the various markets.

5.3.2 Payoff profiles

5.3.2.1 Introduction

There are 8 possibilities in terms of profit and/or losses when the price of the underlying asset changes (simple assumption: strike price = price of underlying). They are as shown in Table 1.

These payoff/loss profiles may be depicted as follows, but first we provide the assumptions:

Underlying commodity	= platinum
Contract	= 100 ounces
Strike price	= see diagrams below
Premium (option price)	= USD 10 per ounce (i.e. total of USD 1 000)
Option type	= European.

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Position	Change in price of underlying asset	Profit or loss
Call option – buy *(long call)*	Fall	Loss: premium only
	Rise	Profit: unlimited
Call option – sell (write) *(short call)*	Fall	Gain: premium only
	Rise	Loss: unlimited
Put option – buy *(long put)*	Fall	Profit: unlimited
	Rise	Loss: premium only
Put option – sell (write) *(short put)*	Fall	Loss: unlimited*
	Rise	Gain: premium only
Note: these profiles only apply if strike price = price of underlying on deal day. * = unlimited up to the point where the underlying has no value.		

Table 1: Payoff profiles of writer and buyer

5.3.2.2 Call option: buy (long call) at expiry

The long call option is depicted in Figure 3[44]. If the price of platinum remains at USD 450 (per ounce[45]) or falls below USD 450 for the term of the option contract, the buyer will not exercise the option, because it is not profitable to do so. The option will lapse, and the buyer loses the premium amount USD 10 per ounce, i.e. USD 1 000 (USD 10 × 100). He cannot lose more than this amount.

If the price moves upwards to say USD 455 at the end of the life of the option, the holder will exercise the option because he will recover part of the premium paid, i.e. USD 500 (USD 5 × 100). The total loss of the holder of the option will be half the premium, i.e. USD 500.

It should be clear that the exercising of the option means that the writer delivers 100 ounces of platinum to the buyer for which the buyer pays USD 450 × 100 = USD 45 000. The total cost to the buyer / holder of the option now is USD 46 000 (USD 45 000 plus the USD 1 000 premium). The buyer / holder of the platinum now sells the platinum in the spot market at the spot market price of USD 455 and receives USD 45 500 (USD 455 × 100). The total loss is USD 500 (USD 46 000 – USD 45 500). If the holder does not exercise the option the loss is USD 1 000 (the premium).

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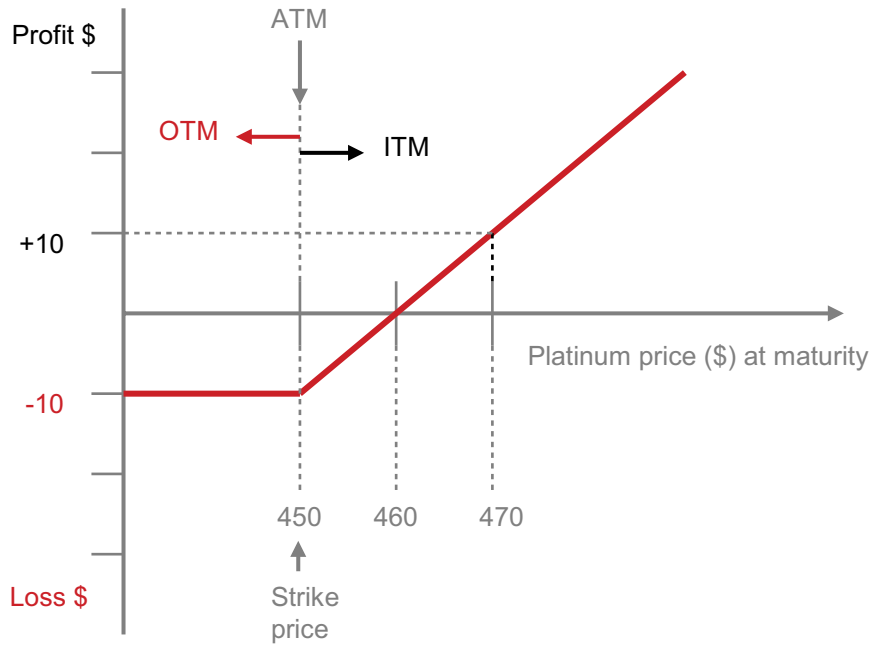

Figure 3: long call option

There are two other "options" for the buyer / holder in this regard:

- The holder could sell the option contract in the secondary market that exists for this paper. The value of the contract will be close to the market price of the underlying asset (pricing is discussed in some detail below).
- If the market is cash settled and the holder exercises, the writer pays the relevant amount to the holder (i.e. USD 500), and the writer's profit is USD 500.

If the spot platinum price moves to USD 460 (i.e. the strike price plus the premium) at the end of the life of the option, it also pays the holder to exercise the option because he will recover the premium paid. The option holder pays the writer USD 450 × 100 = USD 45 000, and sells the 100 ounces at the spot price of USD 460, i.e. for USD 460 × 100 = USD 46 000. The difference is USD 1 000 (USD 46 000 – USD 45 000), which is equal to the premium paid.

At any price above USD 460, there are 3 possibilities (that apply every day until expiry):

- Exercise the option.
- Sell the option.
- Keep the option (to expiry and exercise on expiry).

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It will be apparent that the *profit potential of the holder is unlimited*. If say the platinum price moves to USD 600 and the holder exercises, the profit is:

Amount paid	= 100 × USD 450	= USD 45 000
Premium paid	= 100 × USD 10	= USD 1 000
Total cost		= USD 46 000
Amount sold for	= 100 × USD 600	= USD 60 000
Profit	= USD 60 000 – USD 46 000	= USD 14 000.

5.3.2.3 Call option: sell (write) (short call) at expiry

The short call option payoff profile is depicted in Figure 4. The payoff profile of the seller/writer of the call option is the reverse of that of the buyer. The maximum the seller can earn is USD 1 000, and the loss potential is unlimited. Thus, if the price at expiry is USD 450 or lower, he makes a profit of USD 1 000. At USD 460, the writer makes nothing, and at any price above USD 460, the writer makes a loss.

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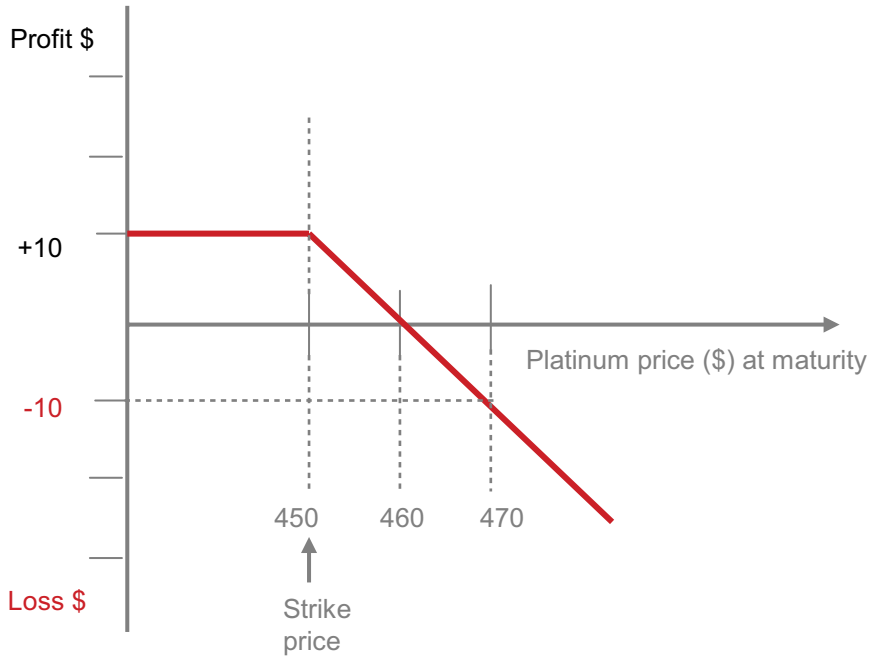

Figure 4: short call option

Some of the jargon referred to earlier is pertinent here. An *uncovered* or *naked short call* is where the writer does not have a position in the underlying instrument, i.e. is not holding the underlying instrument in portfolio (in this case 100 ounces of platinum). Where the writer does have a matching position in the underlying asset, he is *covered*, i.e. has a *covered short call*.

5.3.2.4 Put option: buy (long put) at expiry

The long put option payoff profile is depicted in Figure 5.

A put option is where the buyer has the right to "put" (sell to) the writer the underlying asset at a pre-specified price. In this example, the strike price is USD 470, and the buyer pays a premium of USD 1 000 (remember, USD 10 per ounce).

This is the mirror image of buying a call, i.e. the buyer is hoping for a fall in the price to make a profit. At a spot price of USD 470 or higher the buyer will allow the put option to lapse. At USD 460, the buyer breaks even and he will exercise the option before or at expiry in order to break even. At any price lower than USD 460 the buyer will make a profit.

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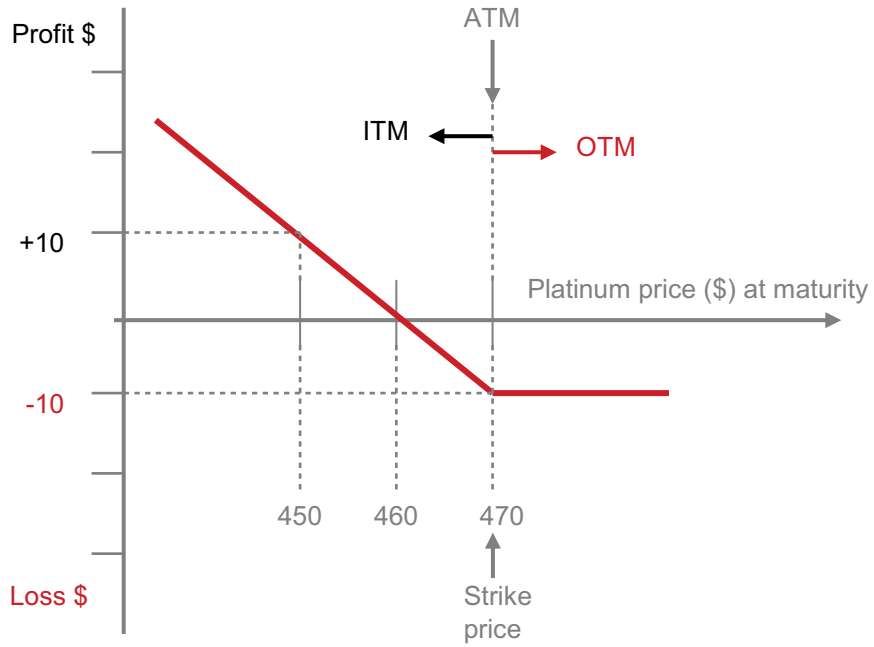

Figure 5: long put option

5.3.2.5 Put option: sell (write) (short put) at expiry

The short put option payoff profile is depicted in Figure 6.

At a spot platinum price of USD 470 or higher, the writer of a put option with a strike price of USD 470 will make a profit of USD 1 000 (i.e. the premium). At say USD 465 the profit will be halved because the buyer will exercise at expiry date). At any platinum price lower than USD 460, the writer's potential loss is unlimited (up to point where platinum price = 0).

5.4 Intrinsic value and time value

5.4.1 Introduction

The *price or premium* (P) of an option has two parts, i.e.:

- Intrinsic value (IV).
- Time value (TV).

Therefore:

$$P = IV + TV.$$

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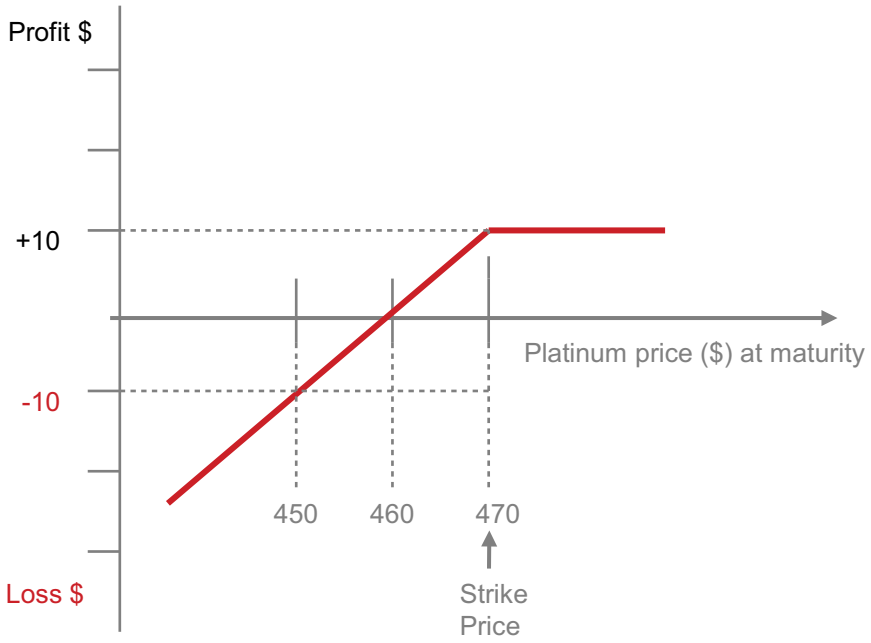

Figure 6: short put option

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4.2 Intrinsic value

The difference between the *spot price of the underlying asset* (SP) and the *exercise price of the option* (EP) is termed the *intrinsic value* (IV) of the option.

As seen, there are 3 categories in this regard:

- In-the-money (ITM) options (have an intrinsic value)
- At-the-money (ATM) options (have no intrinsic value)
- Out-the-money (OTM) options (have no intrinsic value).

ITM options are:

- Call options where: SP > EP
- Put options where: SP < EP.

Clearly, the following options have no intrinsic value (OTM):

- Call options where: SP < EP
- Put options where: SP > EP
- Call options where: SP = EP
- Put options where: SP = EP.

Thus:

IV = SP – EP (call options); positive when SP > EP
IV = EP – SP (put options); positive when EP > SP.

A summary is provided in Table 2.

ITM / ATM / OTM	Call options		Put options	
ITM	SP > EP	IV > 0	SP < EP	IV > 0
ATM	SP = EP	IV = 0	SP = EP	IV = 0
OTM	SP < EP	IV = 0	SP > EP	IV = 0

Table 2: Payoff profiles: ITM, ATM and OTM options

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5.4.3 Time value

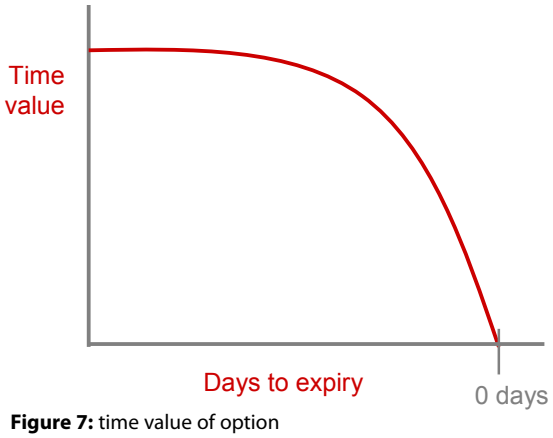

Figure 7: time value of option

The *time value* (TV) of an option is the difference between the *premium* (P) of an option and its *intrinsic value* (IV):

P = IV + TV
TV = P – IV.

An example is required:

Option		= call option
Underlying asset		= ABC share
Underlying asset spot market price (SP)		= LCC 70
Option exercise price (EP)		= LCC 60
Intrinsic value (IV)	= SP – EP = IV	= LCC 70 – LCC 60 = LCC 10
Premium (P)		= LCC 12
Time value (TV)	= P – IV = TV	= LCC 12 – LCC 10 = LCC 2.

The option has *time value* of LCC 2, and this indicates that there is a *probability that the intrinsic value could increase between the time of the purchase and the expiration date*. If the option is exercised now (i.e. at LCC 60), the intrinsic value is gained, *but time value is forgone*. It will be apparent that as an option moves towards the expiration date, time value diminishes, and that at expiration time value is zero. This is portrayed in Figure 7.

5.5 Option valuation/pricing

5.5.1 Introduction

There are two main option pricing / valuation models that are used by market participants:

- Black-Scholes model.
- Binomial model.

Below we also mention the other pricing models and define the so-called "Greeks".

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5.5.2 Black-Scholes model

5.5.2.1 Introduction

The Black-Scholes model was first published in 1973 and essentially holds that the fair option price (or premium) is a function of the probability distribution of the underlying asset price at expiry. It has as its main constituents the following (see the valuation formula below)[46]:

- Spot (current) price of underlying asset (assume share) (SP).
- Exercise (strike) price (EP).
- Time to expiration.
- Risk free rate (i.e. treasury bill rate).
- Dividends expected on the underlying asset during the life of the option.
- Volatility of the underlying asset (share) price.

Each of these elements is covered briefly below.

5.5.2.2 Spot (current) price of underlying asset and exercise price

If a call option is exercised the *profit* is:

SP – EP (obviously if SP < EP, there is no profit).

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Call options are therefore more valuable as the SP of the underlying asset *increases* (EP a given) and less valuable the higher EP is (SP a given). The opposite applies in the case of put options. The profit on a put option if exercised is:

EP – SP (obviously if EP < SP there is no profit).

Put options are therefore more valuable as the SP of the underlying asset *decreases* (EP a given) and less valuable the lower EP is (SP a given).

5.5.2.3 Time to expiration

The longer the time to expiration the more valuable both call and put options are. The holder of a short-term option has certain *exercise opportunities*. The holder of a similar long-term option also has these opportunities and more. Therefore the long option must be at least equal in value to a short-term option with similar characteristics. As noted above, the longer the time to expiration the higher the probability that the price of the underlying assets will increase/decrease.

5.5.2.4 Risk free rate

The risk free rate (rfr) is the rate on government securities. The effect of the rfr on option prices is not as clear-cut as one would expect. As the economy expands, rates tend to increase, but so does the expected rate of share price increases, because dividends increase. It is also known that the present value of future cash flows also decreases as rates increase.

These two effects tend to reduce the prices of put options, i.e. the value of put options decreases as the rfr increases. However, it has been shown that the value of call options increase as the rfr increases, as the former effect tends to dominate the latter effect.

5.5.2.5 Dividends

Dividends have the effect of reducing the share price on the ex-dividend date. This is positive for puts and negative for calls. The size of the expected dividend is important, and the value of call options is therefore negatively related to the size of the expected dividend. The opposite applies to put options.

5.5.2.6 Volatility

Of these factors, the only one that is *not observable* is *volatility*, i.e. the extent of variance in the underlying asset price. This is estimated (calculated) from data in the immediate past.

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It will be clear that as volatility increases, so does the chance that the share will do well or badly. The investor in a share will not be affected because these two outcomes offset one another over time. However, in the case of an *option holder* the situation is different:

- The call option holder benefits as prices increase and has limited downsize risk if prices fall.
- The put option holder benefits as prices decrease and has limited downsize risk if prices rise.

Thus, both puts and calls increase in value as volatility increases.

5.5.2.7 The model

The Black-Scholes valuation model is as follows (European call option):

$$P_c = N(d_1)S_0 - E(e^{-rt})N(d_2)$$

where

P_c = price of European call option
S_0 = price of the underlying asset currently
E = exercise price of the option
e = base of the natural logarithm, or the exponential function
r = risk-free rate per annum with maturity at expiration date
N(d) = value of the cumulative normal distribution evaluated at d_1 and d_2
t = time to expiry in years (short-term = fraction of a year)
d_1 = $[\ln(S_0/E) + (r + \sigma^2/2)t] / \sigma\sqrt{t}$
d_2 = $d_1 - \sigma\sqrt{t}$
ln = natural logarithm (Naperian constant = 2.718)
σ^2 = variance (of price of underlying asset on annual basis)
σ = standard deviation (of price of underlying asset on annual basis).

In the case of a European put option, the price formula changes to:

$$P_p = -E(e^{-rt})N(-d_2) - N(-d_1)S_0.$$

The one parameter of the model that cannot be directly observed is the *price volatility* of the underlying asset (standard deviation). It is a measure of the uncertainty in respect of returns on the asset. According to research, typically, volatility tends to be in the range of 20–40% pa. This can be estimated from the history of the assets. An alternative approach is *implied volatility*, which is the volatility implied by the option price observed in the market.[47]

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Implied volatilities are used to gauge the opinion of market participants about the volatility of a particular underlying asset. Implied volatilities are derived from actively traded options and are used to make comparisons of option prices.

The Black-Scholes option pricing model is not the Midas formula, because it rests on a number of simplifying assumptions such as the underlying asset pays no interest or dividends during its life, the risk-free rate is fixed for the life of the option, the financial markets are efficient and transactions costs are zero, etc. However, it is very useful in the case of certain options (see section on binomial model after the following section). Next we present an example.

5.5.3 Example of black-scholes option pricing

The underlying asset is a non-dividend-paying share of company XYZ the current share price of which is LCC 100. The option is a European call, its exercise price is LCC 100 and it has a year to expiry. The risk-free rate is 6.0% pa, historical volatility is 30% and the standard deviation of the share's returns is 0.1 per year. Thus:

S_0 = LCC 100
E = LCC 100
r = 0.06
t = 1

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$\sigma^2 = 0.01$

$\sigma = 0.1$

$$
\begin{aligned}
d_1 &= [\ln(S_0/E) + (r + \sigma^2/2)t] / \sigma\sqrt{t} \\
&= [\ln(100/100) + (0.06 + 0.005)1] / 0.1\sqrt{1} \\
&= 0.065 / 0.1 \\
&= 0.65.
\end{aligned}
$$

From the cumulative normal distribution table[48] one can establish the value of $N(d_1)$:

$$N(d_1) = N(0.65) = 0.7422.$$

Similarly we find the value of $N(d_2)$:

$$
\begin{aligned}
d_2 &= d_1 - \sigma\sqrt{t} \\
&= 0.65 - 0.1 \\
&= 0.55 \\
N(d_2) &= (0.55) = 0.7088 \text{ (from table).}
\end{aligned}
$$

We are now able to complete the model:

$$
\begin{aligned}
P_c &= N(d_1)S_0 - E(e^{-rt})N(d_2) \\
&= (0.7422 \times \text{LCC } 100) - (\text{LCC } 100 \times 2.718^{-0.06\times1} \times 0.7088) \\
&= \text{LCC } 74.22 - (\text{LCC } 100 \times 0.94177 \times 0.7088) \\
&= \text{LCC } 74.22 - \text{LCC } 66.75 \\
&= \text{LCC } 7.47.
\end{aligned}
$$

5.5.4 Binomial model

The Black-Scholes model is regarded as a good valuation model for certain options, particularly for European options on commodities. However, it is regarded as less accurate for dividend paying options and particularly so if the option is of the American variety. Also, it tends to undervalue deep-in-the-money options. Another problem is the assumption of log normality of future asset prices.

Where the Black-Scholes is regarded as weak, the binomial model is used. This model involves the construction of a *binomial tree*, i.e. a diagram representing different possible paths that may be followed by the underlying asset over the life of the option.

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5.5.5 Other models

In addition to these two valuation models, there are:

- Monte Carlo simulation.
- Finite difference methods (implicit finite difference method and explicit finite difference method).

5.5.6 The Greeks

In the derivative markets reference is often made to the Greek letters, known as the "Greeks". The "Greeks" measure different dimensions of risk in option positions as follows:[49]

Delta

The *delta* is the rate of change of the option price with respect to the price of the underlying asset.

Theta

The *theta* of a portfolio of derivatives is the rate of change of the portfolio value with respect to the passage of time (*ceteris paribus* – when all else remains the same). It is often referred to as the *time decay* of the portfolio.

Gamma

The *gamma* of a portfolio of derivatives on an underlying asset is the rate of change of the portfolio's *delta* with respect to the price of the underlying asset.

Vega

The *vega* of a portfolio of derivatives is the rate of change of the value of the portfolio with respect to the volatility of the underlying asset.

Rho

The *rho* of a portfolio of derivatives is the rate of change of the portfolio value with respect to the interest rate.

5.6 Organisational structure of option markets

One way of depicting the organisational structure of option markets is as in Figure 8.

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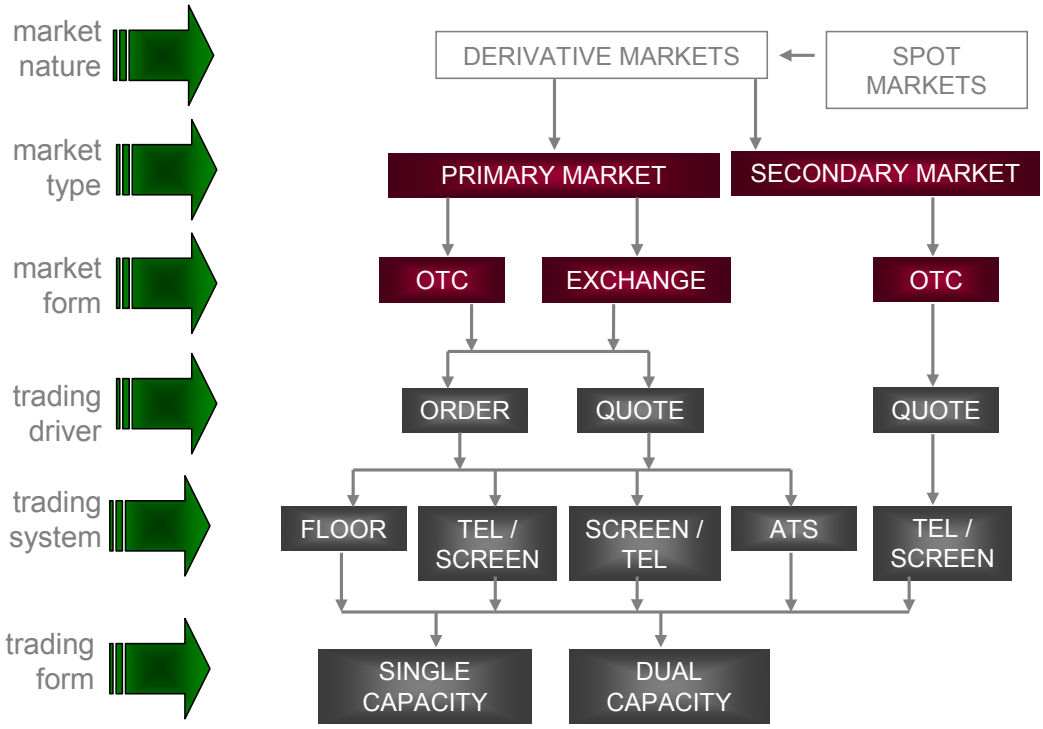

Figure 8: organisation of options markets

The *market form* of options is a mixture of *formal* in the shape of an exchange where options are listed, and *OTC*. There are many futures / options exchanges in the world, or futures / options divisions of exchanges. There are also substantial OTC markets.

As to whether option markets are *primary markets* and/or *secondary markets*, the answer depends on whether they are OTC or exchange-traded. In the case of the OTC markets, there are primary markets in which options are issued and secondary markets in which existing options can be sold and bought. In the case of exchange-traded options the primary and secondary markets are "merged". They are issued by the exchange (primary market) and can be "sold" ("closed out") in the sense of dealing in the opposite direction. For example, if a client has bought a call option, she can close out the position by selling the same call option. However, the holder/ buyer of an option has other alternatives: exercise the option (if it is an American option and has value), or letting it expire worthless on expiration date.

The main advantage of exchange-traded options is that they are guaranteed by the exchange, they are standardised and they are (usually) liquid markets. The main advantage of the OTC market is that the options are customised. The differences between these two markets are as shown in Table 3.

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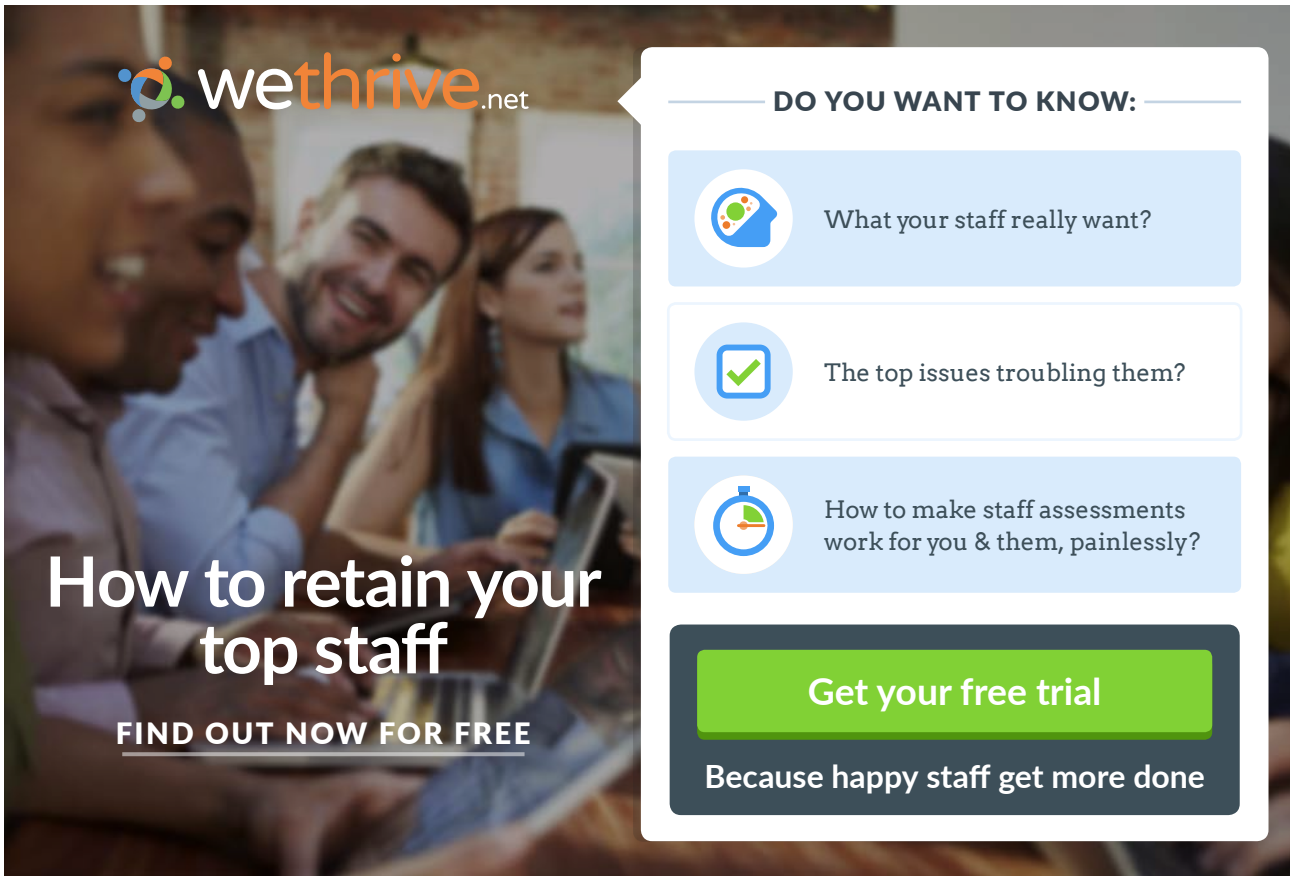
	OTC	Exchange-traded
Regulation	None	Yes
Contracts	Usually not standardised (standardised in certain respects)	Standardised
Margin	Sometimes	Yes
Delivery dates	Customised (large range)	Standardised (limited range)
Delivery of underlying instrument	Almost always	Few settled by delivery
Instruments	Virtually all	Virtually all
Secondary market tradability	Limited	Liquid secondary markets
Participants	Large players only	Large and small players
Risk	Deal between counterparties – each faces risk	Contracts guaranteed by exchange
Market	Screen or telephone or both	Open outcry on exchange floor, or telephone or ATS

Table 3: Comparison of otc and formalised options markets



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The *trading-driver* process of *listed* options is the same as in the case of listed futures. The client telephones the broker and places an *order* to sell or buy a particular number of call or put options. She will of course also state the expiration date/s and strike price/s. The order placed is either a *market order* or a *limit order*. The former is an instruction to deal at the best available price, while the latter is an order to transact at a specific price.

In most listed options markets this information will be inputted into the *ATS system* and left there until a match is found (which in most markets is usually a few seconds or minutes because these markets are so liquid). In the case of an open outcry system of trading (as in certain overseas markets), the order is communicated to the trader in the pit. Traders form groups reflecting the various delivery dates. The order is "cried out" and another trader "cries out" if she has an opposite matching order. The trade is done with a floor broker, a market maker or a professional trader.

In OTC markets the *method of trading* is screen / telephone or just telephone, and the *trading driver is quote*. Certain broker-dealers quote option buying and selling prices (premiums). Settlement takes place on T+1 or T+2.

It will be apparent that not just anyone is able to trade in the OTC market, and this is because each party is directly exposed to the other party in terms of risks such as settlement risk, risk of tainted scrip, default risk, etc. One needs credentials and a track record to deal in the OTC options markets.

5.7 Options on derivatives: futures

5.7.1 Introduction

The options market overview illustration is reproduced here for the sake of orientation (see Figure 9).

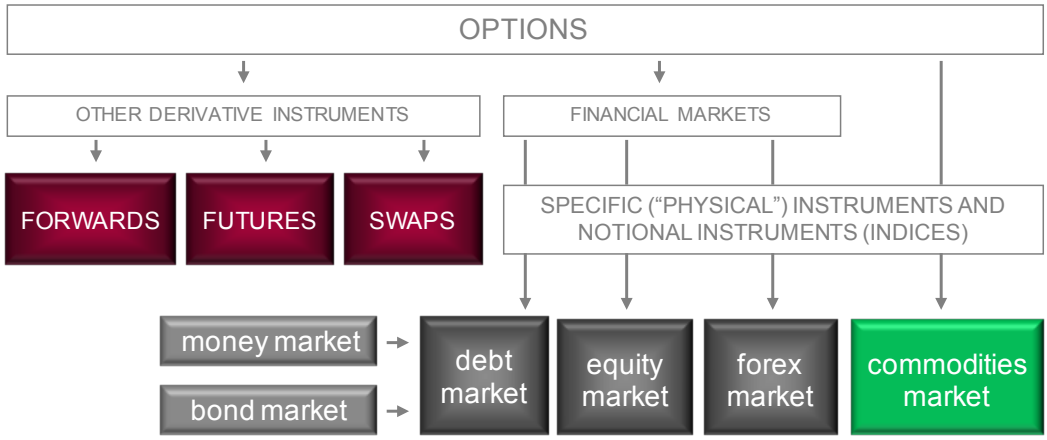

Figure 9: options

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As noted, all futures markets are formalised markets. Options are available on virtually all futures, and most of these options are exchange-traded. The word "most" is used here because in some markets *OTC options on futures* also exist.

With options on futures (also called "futures options") the *underlying instrument is a futures contract* (not the underlying instrument of the future). The relevant price is therefore the price of the futures contract (and not the price of the underlying instrument or index). The futures contract usually matures a short while after the expiration of the futures option. When the holder of a call futures option *exercises* the option, the *writer is obligated to deliver* to the holder of the option:

- A long position in the underlying futures contract.
- Plus an amount that is equal to the difference between the last MTM[50] futures price and the exercise price (futures price – exercise price).

Conversely, when the holder of a put on a future *exercises* the option, the *writer is obligated to deliver* to the holder of the put:

- A short position in the underlying futures contract.
- Plus an amount that is equal to the difference between the exercise price and the last MTM futures price (exercise price – futures price).

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In practice, however, most options on futures are settled in cash.

It will be recalled that the futures market may be categorised (with examples included) as shown in Table 4.

FINANCIAL			COMMODITIES	
Interest rate	Equity / share	Foreign currencies	Agricultural	Metals and energy
Physical Treasury bonds Treasury notes Treasury bills Federal funds Canadian govt bond Eurodollar Euromark Euroyen Eurobond **Index (notional)** Short sterling bond index Long sterling bond index Municipal bond index	**Physical** Various specific shares **Index (notional)** DJ Industrial S&P 500 NASDAQ 100 CAC-40 DAX-30 FTSE 100 Toronto 35 Nikkei 225 NYSE	**Physical** Japanese yen DM British pound Swiss franc French franc Australian dollar Brazilian real Mexican peso Sterling/mark cross rate **Index (notional)** US dollar index	**Grains and oilseeds** Wheat Soybeans Corn (maize) **Livestock and meat** Cattle – live Hogs – lean Pork bellies **Food and fibre** Cocoa Coffee Sugar Cotton Orange juice	**Physical -Metals** Gold Platinum Silver Copper Aluminium Palladium **Physical -Energy** Crude oil – light sweet Natural gas Brent crude Propane **Index (notional)** CRB index
Physical = the actual instrument, currency, commodity. Index = indices of exchanges, etc. CRB index = Commodity Research Bureau.				

Table 4: Examples of futures contracts

As noted, options are available on virtually all futures. In the US the most active options on futures contracts are the options on treasury bond futures and treasury note futures, options on the Eurodollar futures, and options on the futures contracts on corn, soybeans, and crude oil.

It may be useful to provide an example of an option on futures deal:

5.7.2 Example

An investor requiring a general equity / share exposure to the extent of LCC 1 million decides to acquire this exposure through the purchase of call options on the All Share Index (ALSI) future. If the index is currently recorded at 5 000, she would require 20 call option contracts (20 × LCC 10 × 5000 = R1 000 000) (remember that one ALSI futures contract is equal to LCC 10 times the index value).

Because the investor is buying the *right* to purchase the future and has *no obligation* in this regard, she pays a premium to the writer. In this example we make the assumption that the premium is LCC 1 500 per contract (LCC 30 000 for 20 contracts). The investor is thus paying LCC 30 000 for the right to purchase 20 ALSI futures contracts at an exercise or strike price of 5000 on or before the expiry date of the options contract.

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It will be evident that the premium per contract of LCC 1 500 translates into 150 points in the all share index (LCC 1 500 / LCC 10 per point). Thus, the investor's *breakeven price* is 5150 (5000 + 150). This can be depicted as the plum-coloured line in the payoff diagram shown in Figure 10.

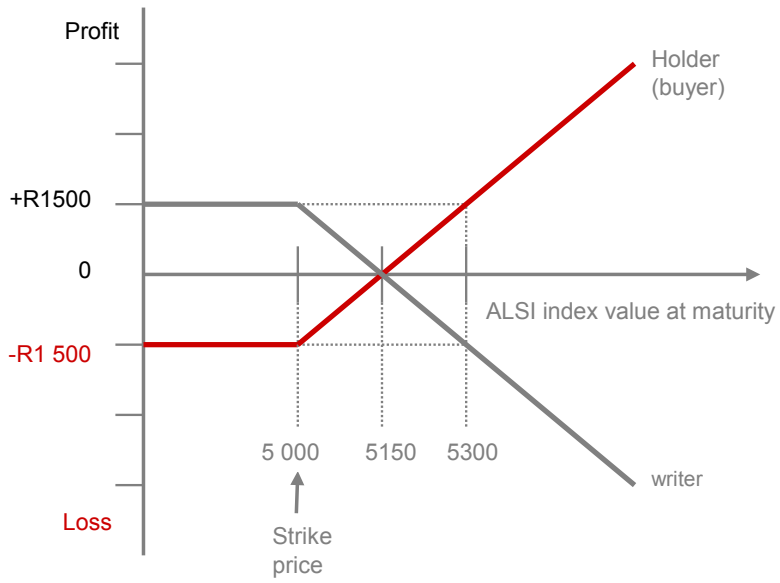

Figure 10: payoff profile of writer and holder of call option

Assuming that the buyer (investor) holds the contracts to expiry:

- If the price closes at or below 5000 she will not exercise. She incurs a loss equal to the premium paid, i.e. LCC 1 500 per contract.
- If the price closes between 5000 and 5150 she will exercise the options and recover a portion of the premium.
- If the market closes at a price above 5150 she will exercise and make a profit. For example, if the price at expiry is 5400, her profit is LCC 2 500 per contract [i.e. LCC 10 × (5400 – 5150)].

The risk profile of the writer is exactly the reverse of that of the holder. As can be seen in Figure 10:

- The writer makes a profit of LCC 1 500 (the premium) per contract if the price closes at or below 5000.
- The writer makes a profit of less than LCC 1 500 per contract if the price closes at between 5000 and 5150. This is because the holder will exercise between these two prices in order to recover a portion of her premium.
- The writer makes a loss if the price rises above 5150. For example, if the price closes at 5600, the writer will make a loss of LCC 4 500 [LCC 10 × (5600 – 5150)] per contract.

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It will be apparent that the investor gained her LCC 1 million exposure with a monetary outlay of LCC 30 000. Thus, she is able to invest the balance of LCC 970 000 in the money market and receive the current interest rate. The money market rate (rfr) is thus an important input in the pricing of options (as seen above).

Figure 11: payoff profile of writer and holder of call option

The buyer of a put option has a risk profile which is the converse of that represented by a call option (see Figure 11). For example, an investor wanting to hedge his LCC 1 million equity / share exposure (i.e. anticipating that share prices will fall) would buy 20 put option contracts on the ALSI future (assuming the strike price to be 5000). She is thus hedged to the extent of LCC 10 × 20 × 5000 = LCC 1 000 000. She thus has the right, but not the obligation, to sell to the writer (seller) 20 ALSI futures contracts on or before the expiry date of the options contracts. Assuming that the premium paid is LCC 1 500 per contract, her risk profile is as depicted in Figure 11.

As far as the holder is concerned:

- If the price closes at 5000 or higher, she will not exercise and the loss is limited to LCC 1 500 per contract.
- If the price closes at between 5000 and 4850, she will exercise and recover a portion of the premium.
- If the price falls below 4850 she makes a profit equal to LCC 10 per point per contract.

Conversely, the writer of the put options will profit to the extent of LCC 1 500 per contract if the price at close is 5000 or better, profit less than LCC 1 500 at a price between 4850 and 5000 and incur a loss at a price below 4850 to the extent of LCC 10 per point per contract.

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Options on futures are also subject to margin requirements. These are the same as for the underlying futures.

5.7.3 Option specifications

As will be understood, options contracts take on many of the features of the underlying instruments, i.e. the futures contracts. The below-mentioned option specifications should therefore be read together with the futures contract specifications (see Table 6[51]).

The two basic uses of options on futures are to protect a future investment's return from falling interest rates / rising prices (call option), and to protect against rising interest rates / falling prices (put options).

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Expiry	The same time and date as the underlying futures contract
Style	American
Types	Both a call and a put at each strike (exercise)
Strike price units	Strike prices are specified in the units of quotation of the underlying futures contract
Strike price intervals	Strike prices are at fixed intervals.
Live strikes	Three strike prices are "live", i.e. are accommodated on the screens. The corresponding options are "at", "in" and "out" of the money, and are referred to as "strike 1", "strike 2" and "strike 3" on the screens. A separate screen gives the value of the strike price associated with each of the three.
Strike shifts	The live strikes are shifted, and new strikes introduced (if necessary) whenever the underlying financial instrument's price: • Moves beyond either of the away-from-the-money strikes or • Is consistently closer to an away-from-the-money strike than to the at-the-money strike for one trading day. Shifts are not normally more frequent than daily, and are made overnight. All shifts are made at the exchange's discretion.
Free-format screens	Quotations for options whose strike prices are not live are entered onto one or more free-format screens
Contract size	Each option is on *one* contract of its underlying financial instrument
Standard lot size	(Number of options that quotations are good for). The same as the underlying financial instrument's standard lot size.
Quotations	Quotations are in whole rands per option
Settlement of premiums	Through the mark to market process over the life of the option
Mark-to-market	Daily according to the option's mark to market price (i.e. the same as for futures)
Determination of mark to market prices	• Quoted doubles are used where available • Implied volatilities are calculated from available prices to value options (on the same underlying financial instrument) lacking quotes • Exchange has the discretion to override the former and to specify volatilities overriding the latter
Exercise	May be exercised at any time until expiry. A client's option is exercised through his member directly with the exchange
Settlement on exercise	Into the underlying financial instrument
Assignment	Options exercised will be randomly assigned to short positions in the same option. Assigned holders (or their members), and their clearing members, will be notified immediately. Assignment will be in standard lot sizes as far as possible.
Automatic exercise	All in-the-money options will be automatically exercised (into the underlying financial instrument) on expiry. This happens before the close out by the exchange of positions in futures contracts.
Margins	Option positions are subject to the same initial margin requirements as their underlying financial instruments. However, the potential profit/loss profile of options is recognised. Margins are also affected by volatility margin requirements.
Source: Safex / JSE.	

Table 6: Option specifications

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5.8 Options on derivatives: swaps

Figure 12 is presented here for the sake of orientation. We discussed *swaps* in some detail in a previous section. An option on this derivative is the *option on the swap*, called the *swaption*.

We saw earlier that there are four types of swaps that relate to the financial markets and the commodity market (see Figure 13). We also saw that there exists a *forward swap* (or deferred swap) (it is mentioned here again because it is touched upon below).

Options are not found on all these swaps, but only on the *interest rate swap*, i.e. a *swaption* is a *combination of an interest rate swap and an option*. As elucidated above, in interest rate swaps, fixed-rate obligations (cash flows) are swapped for floating rate obligations. In swaptions, the underlying instrument is the *fixed-rate* obligation. Thus, a *call swaption imparts the right to the holder to receive the fixed rate in exchange for the floating rate, while in put swaptions the holder has the right to pay fixed and receive floating*.

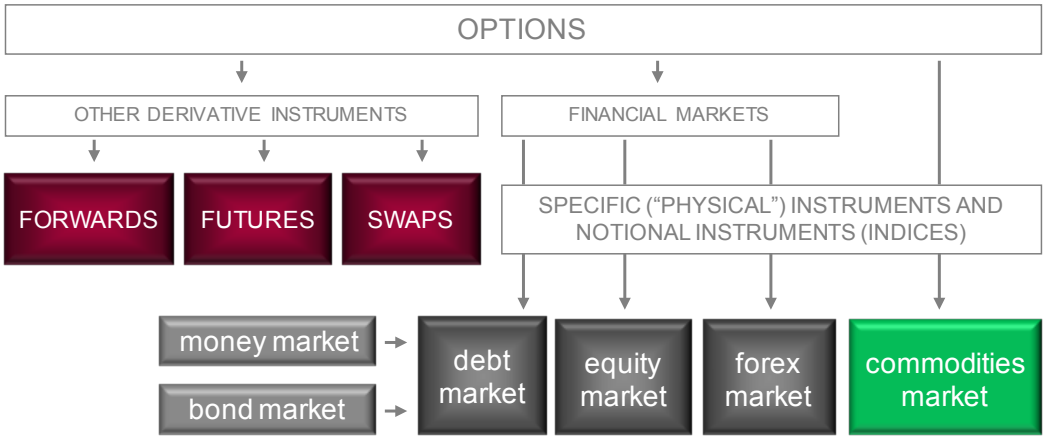

Figure 12: options

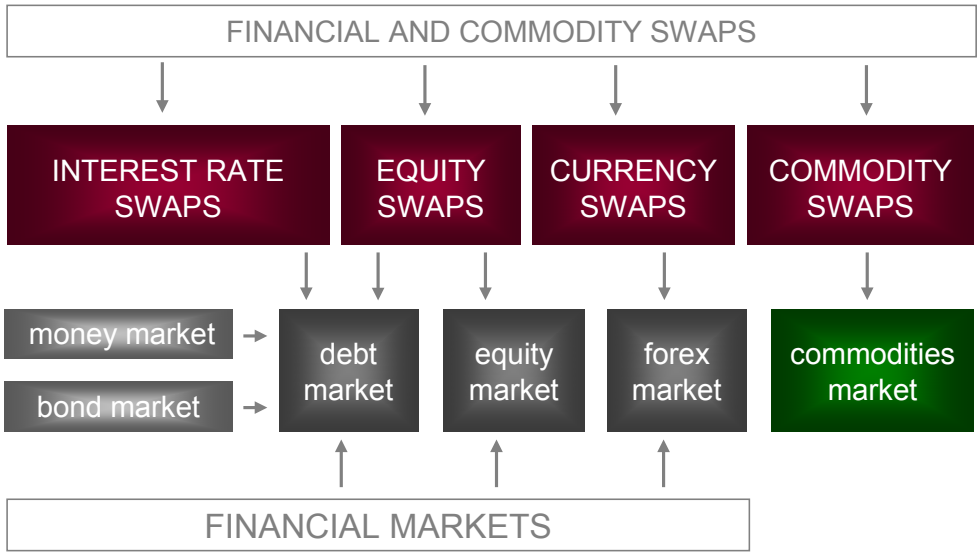

Figure 13: swaps

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An example may be useful.[52] A company knows that in six months' time it is to enter into a five-year floating rate loan (i.e. borrowing) agreement at 3-month JIBAR, and wants to swap the floating rate payments into fixed rate payments, i.e. to convert the loan into a fixed rate loan (because the company believes that rates are about to rise).

For a premium, the company can buy a (put) swaption from a broker-dealer in this type of paper. The swaption gives the company the right to receive the 3-month JIBAR rate on a notional amount that is equal to its loan, and to pay a fixed rate of interest every three months at 14% pa (assumed) for the next five years, starting in six months' time. The "options" the company has are clear:

- If in six months time the fixed rate on a normal 5-year swap is lower than 14%, the company will allow the swaption to lapse (remember the company wants to pay fixed).
- The company will then undertake a normal interest rate swap at the lower fixed rate (the floating rate will probably still be 3-month JIBAR).
- If the fixed rate on normal swaps is higher than 14%, the holder will exercise the swap and take up the swap.

The company is guaranteed that the fixed rate it will pay on the future will not exceed an agreed fixed rate. Thus the company has protection against rates moving up, while retaining the option to benefit from lower rates in the future.

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The swaption is an *alternative* to the *forward swap*. The latter obliges the holder to enter into a swap after a stipulated period, but the holder pays no premium for it. In the case of the swaption, the holder is not obligated and can allow the swaption to lapse, i.e. it allows the holder to benefit from favourable interest rate movements.[53]

5.9 Options on debt market instruments

5.9.1 Introduction

The options market illustration presented here again is designed to orientate the reader in terms of the place of the market being discussed (see Figure 14).

The term "debt market instruments" in respect of options encompasses money and bond market *specific instruments* ("physicals") (or rather some of them) and *notional instruments* (indices) (or some of them). They may be classified as follows:

- Money market options:
  - Options on specific money market instruments.
  - Interest rate caps and floors.
- Bond market options:
  - Options on specific bonds.
  - Options on bond indices.
  - Bond warrants (retail options).
  - Bond warrants (call options).
  - Callable and puttable bonds (bonds with embedded options).
  - Convertible bonds.

Money market options are comprised of options on specific money market instruments (and this includes ordinary deposits) and caps and floors (these are *option-like* instruments). As seen in the list, there are a number of bond option varieties. The first three mentioned above are full-blooded bond options, while the latter three may be termed *option-like securities* in the bond market. We discuss all these a little later. Options on *bond futures* are obviously not discussed in this section (they were discussed under "options on derivatives").

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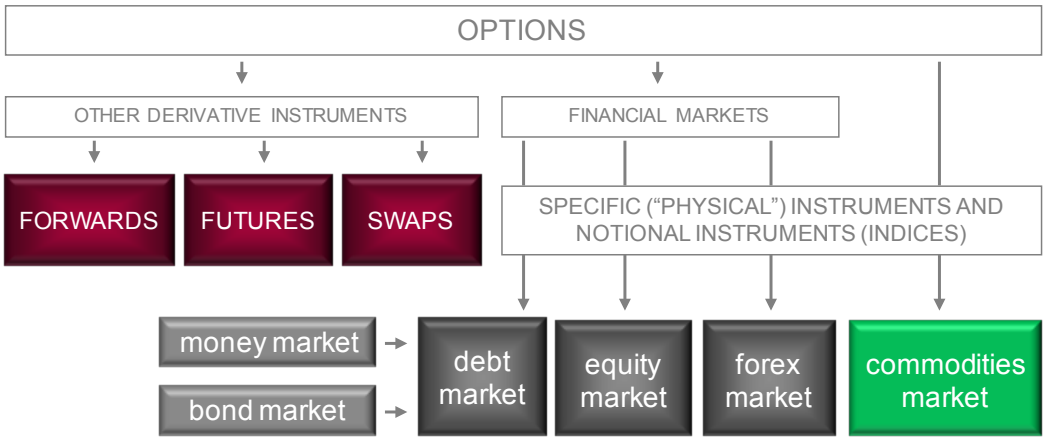

Figure 14: options

5.9.2 Options on specific money market instruments

Money market options are options that are written on specific money market instruments, such as commercial paper, NCDs, deposits, etc. Not many countries have specific asset money market options, because of the existence of the active markets in other money market derivatives (swaps, swaptions, repos, caps and floors, FRAs, and interest rate futures).

Some countries, however, have options on *notional* money market instruments. A UK example is presented in Table 8.[54]

Let us focus in on the June call option at a strike (exercise) price of 9350, and a premium of 0.09. What do these numbers mean? The holder of the option has the right to make a deposit of GBP 500 000 on the expiry date in June (the date is specified) at an interest rate of 6.5% (100 – 93.50) for 3 months. Each tick movement on the contract, which is equivalent to one basis point, is worth the value of the contract (GBP 500 000) multiplied by 1 basis point (0.01% or 0.0001) and a quarter of a year (0.25), i.e.:

$$\text{GBP } 500\,000 \times 0.0001 \times 0.25 = \text{GBP } 12.50.$$

Strike price	Calls			Puts		
	Dec	Mar	Jun	Dec	Mar	Jun
9350	0.11	0.08	**0.09**	0.06	0.33	0.66
9375	0.01	0.02	0.04	0.21	0.52	0.86
9400	0.00	0.01	0.02	0.45	0.76	1.09

Table 8: Example of option on money market instrument

The cost of the call option (i.e. the premium) is therefore 9 × GBP 12.50 = GBP 112.50.

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If by the expiry date the contract strike price rises to 9450 (interest rates have fallen to 5.5%) the holder is entitled to a gain of 100 basis points, and the profit is 100 × GBP 12.50 = GBP 1 250.00 less the premium of GBP 112.50 = GBP 1 137.50.

On the other hand, if interest rates have risen (to 7% pa) so that the contract is trading at 9300, the contract will not be exercised and the holder will forego the premium of GBP 112.50.

5.9.3 Caps and floors

5.9.3.1 Description

Caps and *floors* (a combination of which is termed a *collar*) are akin to options. In fact they are so similar to options that they could be termed *cap options* and *floor options*. Because of their option-like attributes, they are placed in this section on options.

A *cap* purchased makes it possible for a company with a *borrowing requirement* to hedge itself against *rising interest rates*. The cap contract establishes a ceiling, but the company *retains the right to benefit from falling interest rates*. On the other hand, a *floor* contract allows a company with an *investment requirement* (surplus funds) to shield itself against *declining interest rates* by determining a specified floor upfront, while it *retains the right to profit from rising interest rates*.

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On the *exercise date* of the cap or floor contract, the specified *strike rate* is evaluated against the *standard reference rate* (i.e. usually the equivalent-term JIBAR rate). The interest differential is then applied to the *notional principal amount* that is specified in the contract, and the *difference is paid* by the seller/writer to the buyer/holder. The buyer of a floor or cap pays a *premium* for the contract, as in the case of an option or insurance policy.

5.9.3.2 Caps

It is perhaps best to elucidate a cap with the assistance of an example: *borrowing company buys a T3-month – T6-month cap* (see Figure 15).

A company needs to borrow LCC 20 million in 3 months' time for a period of 3 months, and is *concerned that interest rates are about to rise sharply*. The present 3-month market rate (JIBAR[55] rate = market rate) is 10.3% pa. The company is quoted a T3-month – T6-month (T3m-T6m) cap by the dealing bank at 10.5%, i.e. the 3-month JIBAR borrowing rate for the company is fixed 3-months ahead. The company accepts the quote and pays the premium of LCC 25 000 to the dealing bank. The number of days of the period for which the rate is fixed is 91.

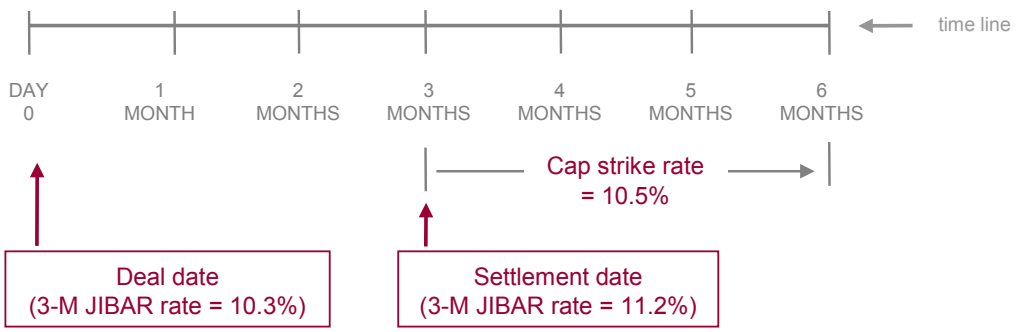

Figure 15: example of T3-month – T6-month cap

If the JIBAR rate (= market rate on commercial paper, the borrower's borrowing habitat) in 3-months' time (i.e. settlement date), is 9.3%, the company will allow the cap to lapse (i.e. will *not exercise the cap*) and instead will borrow in the market at this rate by issuing 91-day commercial paper. The total cost to the company will be the 9.3% interest *plus the premium paid* for the cap:

$$\text{Cost to company} = (C \times ir \times t) + P$$

where

C	= consideration (amount borrowed)
ir	= interest rate (expressed as a unit of 1)
t	= term, expressed as number of days / 365
P	= premium

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Cost to company = (C × ir × t) + P
= LCC 20 000 000 × 0.093 × 91 / 365) + LCC 25 000
= LCC 463 726.03 + LCC 25 000
= LCC 488 726.03.

It will be apparent that the interest rate actually paid by the company (ignoring the fact that the premium is paid upfront) is:

Total interest rate paid = LCC 488 726.03 / LCC 20 000 000 × 365 / 91
= 0.0244363 × 4.010989
= 0.09801
= 9.80% pa.

If the JIBAR rate on the settlement date is say 11.2% pa, settlement will take place with the dealing bank according to the following formula:

SA = NA × [(rr – csr) × t]

where

SA = settlement amount
NA = notional amount
rr = reference rate
csr = cap strike rate
t = term, expressed as number of days / 365

SA = LCC 20 000 000 × [(0.112 – 0.105) × 91 / 365]
= LCC 20 000 000 × (0.007 × 91 / 365)
= LCC 34 904.11.

The financial benefit to the company is equal to the settlement amount minus the premium:

Financial benefit = SA – P
= LCC 34 904.11 – LCC 25 000
= LCC 9 901.11.

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The company thus borrows at the market rate of 11.2%, but this rate is reduced by the amount paid by the bank to the company less the premium paid to the bank:

$$\begin{aligned}\text{Cost to company} &= (C \times ir \times t) - (SA - P)\\ &= (\text{LCC } 20\,000\,000 \times 0.112 \times 91 / 365) - (\text{LCC } 9\,901.11)\\ &= \text{LCC } 558\,465.75 - \text{LCC } 9\,901.11\\ &= \text{LCC } 548\,564.64\end{aligned}$$

$$\begin{aligned}\text{Total interest rate paid} &= (\text{LCC } 548\,564.64 / \text{LCC } 20\,000\,000) \times (365 / 91)\\ &= 0.0274282 \times 4.010989\\ &= 0.110001\\ &= 11.00\% \text{ pa.}\end{aligned}$$

This of course ignores the fact that the premium is paid upfront.

9.3.3 Floors

It is useful to elucidate floors with the use of a specific example: *investing company buys a T3-month – T6-month floor* (see Figure 16).

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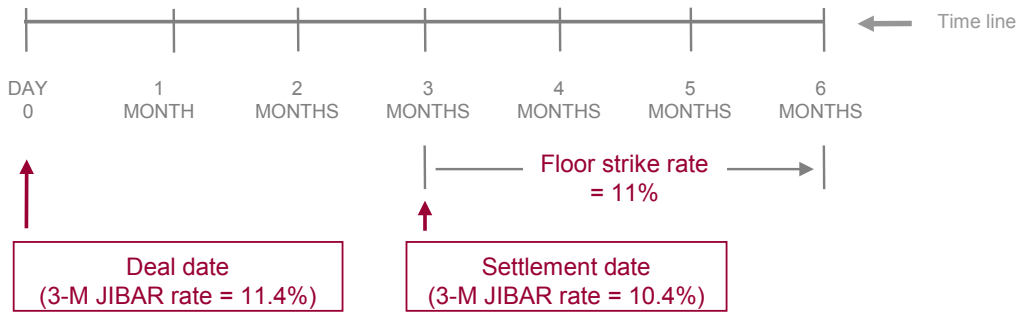

Figure 16: example of T3-month – T6-month floor

An investor expects to receive LCC 20 million in 3 months' time, and these funds will be free for 3 months before it is required for a project. The investor *expects rates to fall* and would like to lock in a 3-month rate now for the 3-month period (assume 91 days) in three months' time. He approaches a dealing bank and receives a quote for a T3m–T6m floor at 11.0% on a day when the 3-month market (JIBAR) rate is 11.4%. He verifies this rate with other dealing banks, and decides to deal. The premium payable is LCC 19 000.

Three months later (on the settlement date) the JIBAR 3-month rate is 10.4% pa. The investor was correct in his view and the bank not, and the bank coughs up the following (fsr = floor strike rate):

$$
\begin{aligned}
SA &= NA \times [(fsr - rr) \times t] \\
&= LCC\ 20\ 000\ 000 \times [(0.11 - 0.104) \times 91 / 365] \\
&= LCC\ 20\ 000\ 000 \times (0.006 \times 91 / 365) \\
&= LCC\ 20\ 000\ 000 \times 0.00149589 \\
&= LCC\ 29\ 917.81.
\end{aligned}
$$

The financial benefit to the company is:

$$
\begin{aligned}
&\text{Financial benefit} \\
&\quad = SA - P \\
&\quad = LCC\ 29\ 917.81 - LCC\ 19\ 000 \\
&\quad = LCC\ 10\ 917.81.
\end{aligned}
$$

The company thus *invests* at the 3-month *cash (spot) market rate* of 10.4% pa on the settlement date, and its earnings are boosted by the settlement amount less the premium paid to the bank:

$$
\begin{aligned}
&\text{Earning on investment} \\
&\quad = (C \times ir \times t) + (SA - P) \\
&\quad = [LCC\ 20\ 000\ 000 \times (0.104 \times 91 / 365)] + LCC\ 10\ 917.81 \\
&\quad = (LCC\ 20\ 000\ 000 \times 0.025929) = LCC\ 10\ 917.81 \\
&\quad = LCC\ 518\ 575.34 + LCC\ 10\ 917.81 \\
&\quad = LCC\ 529\ 493.15.
\end{aligned}
$$

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Thus, the *actual rate* (ignoring the fact that the premium is paid upfront) earned by the company is:

Total interest rate earned

= (LCC 529 493.15 / LCC 20 000 000) × (365 / 91)

= 0.0264747 × 4.010989

= 0.1061897

= 10.62% pa.

It will be evident that if the spot market rate is say 11.5%, the treasurer of the investing company *will let the floor contract lapse* (i.e. *not exercise*). He will invest at 11.5% for the 3-month period, but this return is eroded by the premium paid for the floor. The following are the relevant numbers:

Earnings on investment

= (C × ir × t) – P

= (LCC 20 000 000 × 0.115 × 91 / 365) – LCC 19 000

= LCC 573 424.66 – LCC 19 000

= LCC 554 424.66.

It will be apparent that the interest rate actually earned by the company (ignoring the fact that the premium is paid upfront) is:

Total interest rate earned

= (LCC 554 424.66 / LCC 20 000 000) × (365 / 91)

= 0.0277212 × 4.010989

= 0.1118943

= 11.12% pa.

Thus, the investor would have been *worse off* if he had exercised the floor.

5.9.4 Options on specific bonds

An option on a specific bond, also called a bond option, may be defined as *an option to buy (call) or sell (put) a specific bond on or before an expiry date at a pre-specified price or rate.* "Price or rate" is mentioned because some markets deal on price and some on rate. Bond option markets are OTC or exchange-driven markets.

In the OTC options markets, the contracts are generally standardised (in most respects). Options are written on the most marketable short- and long-term bonds, which are the high-capitalisation bonds.

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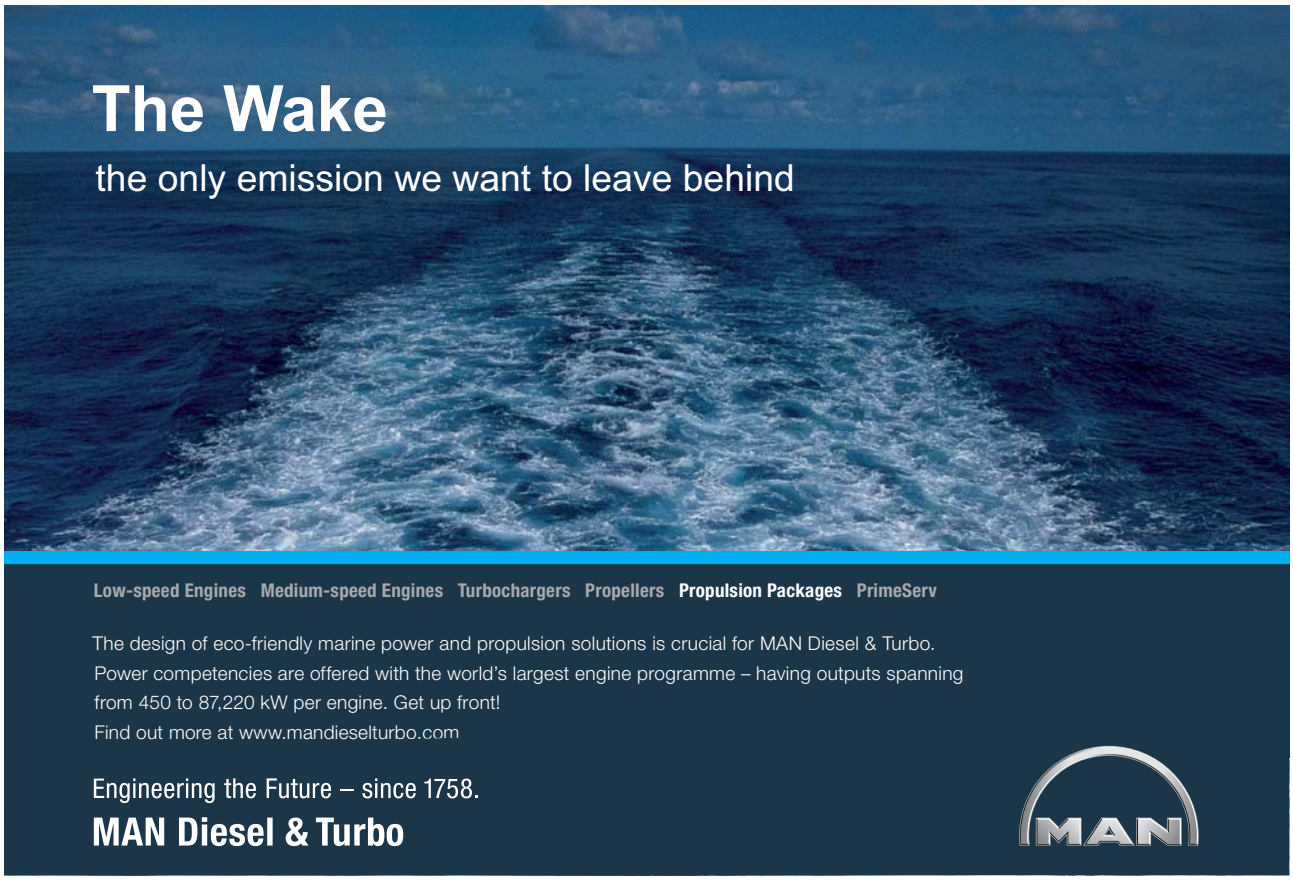
The OTC bond options written and traded are of the standardised and American variety. European options are also written from time to time, and there are also non-standardised options. The latter, which include "overnighters" (i.e. contracts written to expire the following day) are usually written to suit particular hedging strategies. They differ from the standardised contracts in terms of expiration date and strike rate level.

The main characteristics of standardised bond options are shown in Table 9.

Size of contract	LCC 1 million (nominal value), but the standard trading amount is LCC 10 million or multiples of this amount
Underlying instruments	Various government and public enterprise bonds
Market price/rate	Yield to maturity
Strike rate intervals	0.25%, for example 8.00%, 8.25%, 8.50%, 8.75%
Expiry dates	12 noon on the first Thursday of February, May, August and November
Commission	As there are no fixed commission rates, the commission is included in the premium paid by the purchaser
Form of settlement	Cheque for the premium negotiated on the day of settlement

Table 9: Characteristics of standardised bond options

Listed bond options are options on specific bonds that are listed on an exchange. Many exchanges have such options.



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5.9.5 Options on bond indices

A bond index option may be defined as an option to buy (call) or sell (put) a specific bond index on or before an expiry date at a pre-specified price (not rate; rate applies to options on specific bonds). Local Country, for example, has the following bond indices[56]:

- *All Bond Index* (ALBI), consisting of the most liquid sovereign (i.e. central government) and non-sovereign (e.g. local government, public utilities and corporate) bonds.
- *Government Bond Index* (GOVI), containing those government bonds of the ALBI in which the primary dealers make a market, i.e. the most liquid bonds.
- *Other Bond Index* (OTHI), being the non-govenment bonds in the ALBI basket.

The indices enable investors to measure the performance of bonds of various terms. Bond options are written on these three indices.

5.9.6 Bond warrants (call options)

There are two types of bond warrants:

- Bond warrants (retail options).
- Bond warrants (call options).

The term "bond warrant" internationally generally refers to *call* options on specific bonds but with a difference: when a bond warrant (call option) is exercised, this leads to the issuer issuing *new bonds*. In the case of the ordinary bond options, the issuer is not involved – the writer of a call that is exercised sells existing bonds to the holder of the option.

The term to expiry of bond warrants (call options), unlike normal options, is long, sometimes running for many tears. The underlying bond also has a long term to maturity, usually 10 years or longer.

5.9.7 Bond warrants (retail options)

In some countries, however, the term "bond warrant" refers to ordinary options on specific bonds, but they are *retail options*, i.e. the denominations are small. Calls and puts are written and traded and a call does *not lead to the issue of new bonds*.

The issuer of bond warrants is an entity, usually a bank, which is not associated with the issuer of the underlying bond (which in the main is government bonds). The issuer of the warrant is the writer, and the holder therefore has the right to exercise it against the issuer. As such the warrant holder assumes counterparty risk, i.e. the credit risk associated with the issuer.

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Bond warrants enable investors / speculators to profit from expected movements in interest rates on specific bonds. Call warrants are bought in order to profit from an expected increase in the bond price (decrease in ytm), and bond put warrants are bought to profit from an expected decrease in the bond price (increase in the ytm).

There are two types of bond warrants: American or European. They are usually listed on the exchange and are traded and settled with members of the exchange (therefore settlement is guaranteed by the exchange). The issuers of warrants make a market in them by quoting bid and offer prices simultaneously at all times. The buyer pays the premium quoted by the market-maker. Bond warrants are cash settled.

The advantages of warrants and the risks associated with warrants are covered under equity warrants below, as this is the largest warrants market in most countries.

5.9.8 Callable and puttable bonds (bonds with embedded options)

Bonds with embedded options are bonds that are issued with *provisions* that allow the *issuer to repurchase* (callable bond) the bond, or the *holder to sell back to the issuer* (puttable bond) the bond at a pre-specified price/rate at certain dates in the future.

The *callable bond* means that the buyer of the bond has sold to the issuer a call option to repurchase the bond. The strike price/rate (also called the *call price*) is the pre-determined price/rate that the issuer is obliged to pay to the bondholder.

It is usual that callable bonds are not callable for some years after issue. For example, a 15-year bond may not be callable for 10 years, and a price is set for each year after 10 years. A portion of the bond or the full amount may be callable. The fact that the buyer has "sold" to the issuer a call option means that these bonds are issued at a lower price (higher rate) than equivalent term and rated "ordinary" bonds.

Puttable bonds, i.e. bonds with embedded put options, are also issued in some markets. As noted, such bonds have provisions that allow the holder to sell the bond back to the issuer at pre-specified prices/rates on pre-determined dates. This means that the holder of the bond has bought a put option from the issuer. These bonds are issued and trade at lower yields (higher price) than equivalent term and rated bonds without such options attached.

5.9.9 Convertible bonds

Convertible bonds are bonds that are *convertible into shares* (ordinary or preference) at the *option of the holder* on pre-specified terms (e.g. number of shares per nominal value).

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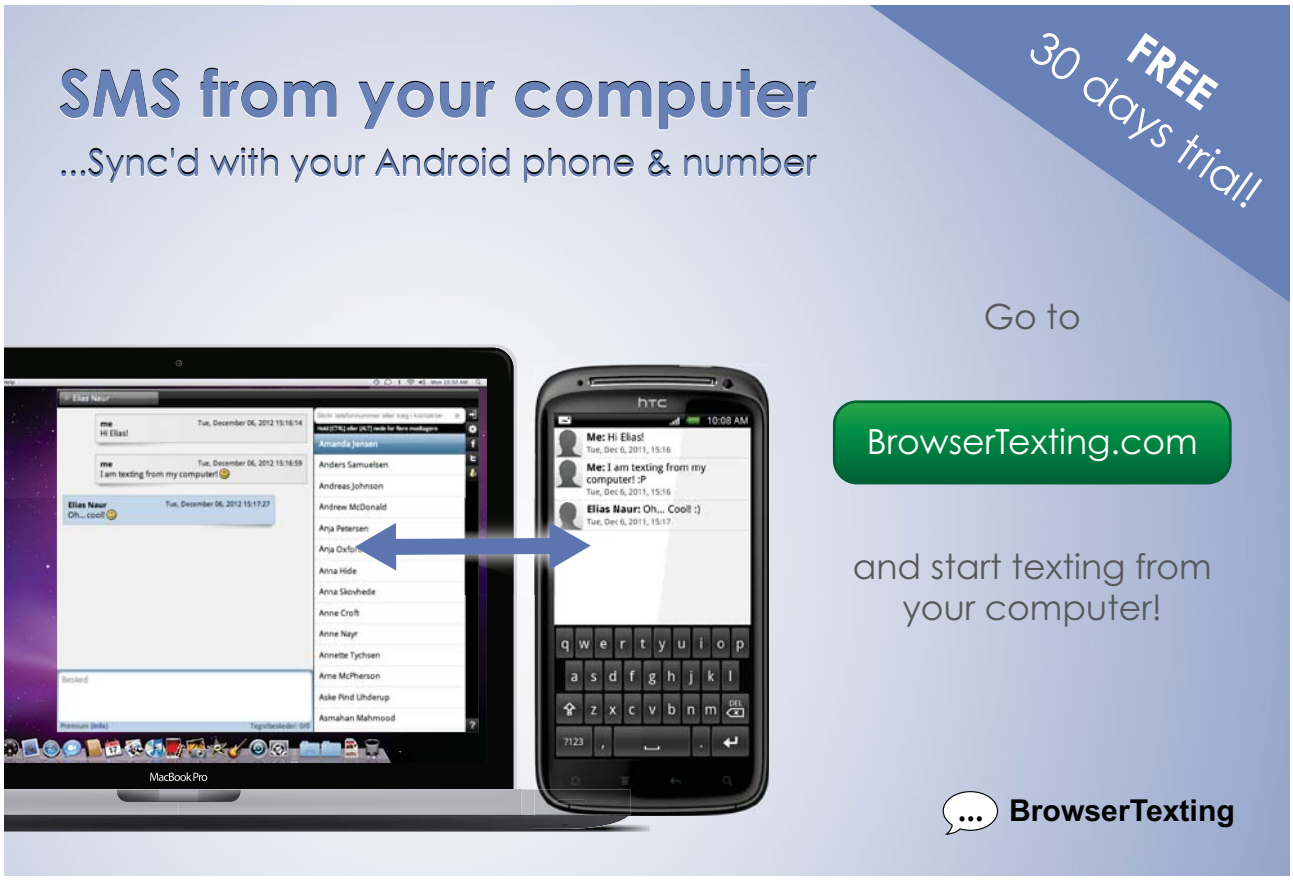
5.10 Options on equity / share market instruments

5.10.1 Introduction

We repeat our illustration on options introduced earlier for the sake of orientation (see Figure 17).

Options on equities may be divided into the following categories:

- Options on specific equities.
- Options on equity / share indices.
- Equity / share warrants (call options).
- Equity / share warrants (retail options).
- Redeemable preference shares.



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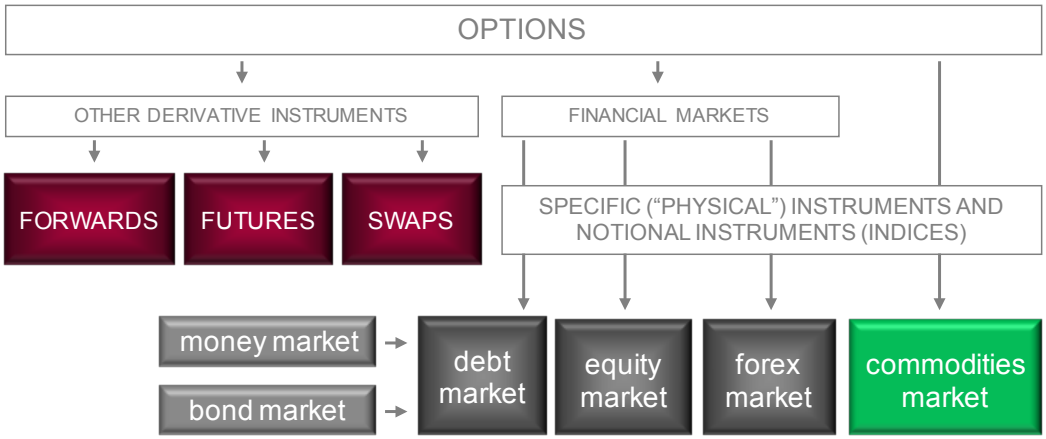

Figure 17: options

Examples of the options in the first two categories are shown in Table 11 for the US market. The many different exchanges involved in these markets will be noted. It is obvious that these markets are exchange-traded, but it should be pointed out that there is also an OTC market in shares and these and other indices.

Type	Exchange	Share / index
Options on shares (stocks in US)	CBOE AM PB PC NY	Many specific shares (stocks) Many specific shares (stocks) Many specific shares (stocks) Many specific shares (stocks) Many specific shares (stocks)
Options on share (stock in US) indices	CBOE CBOE CBOE AM PB PB PB	Dow Jones Industrial Average NASDAQ 100 S&P 100 index Major market index Gold Oil service index Utility index
CBE = Chicago Board of Trade. CME = Chicago Mercantile Exchange. LIFFE = London International Financial Futures Exchange. CBOE = Chicago Board of Option Exchange. AM = American Exchange. PB = Philadelphia Exchange. PC = Pacific Stock Exchange. NY = New York Stock Exchange.		

Table 11: Examples of US market options on equities

5.10.2 Options on specific equities

There are many exchanges in the US and the UK (and other markets including the JSE) that list and trade options on specific equities. Such options are usually written on the shares that have a large market capitalisation, and are well traded (i.e. liquid). An example is required (see Table 12).[57]

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Strike price	Calls			Puts		
	Dec	Mar	Jun	Dec	Mar	Jun
360	27.0	33.0	38.5	0.5	7.5	12.5
390	6.5	14.5	**22.0**	10.0	22.0	27.0

Table 12: Lloyds TSB equity / share options (quoted on liffe) (current price 384 pence)

In this example there are two strike prices, i.e. 360 pence and 390 pence at a time when the share in trading at 384 pence. The limited number of strike rates and contract maturity dates ensure that there is liquidity in the option contracts.

There are two sets of prices quoted, i.e. one for call options and one for put options. For example, the June call price at a strike price of 390 is 22.0 pence. This means that a buyer of this call option will pay 22 pence per share. The minimum contract size is 100 shares; thus the option contract will cost the buyer GBP 220 (i.e. the premium). The buyer of the call has the right but not the obligation to buy 100 Lloyds shares at a price of 390 pence and the cost of the option is GBP 220. Alternatively, a June put option at a strike price of 390 will cost GBP 270, and this will bestow upon the buyer the right to sell 100 Lloyds shares at a price of 390 pence at any stage up to the expiry date of the option in June.

The markets in options on individual shares are large, and they are usually exchange-traded. There are also OTC markets in options on individual shares.

There is also an option that is a hybrid of an exchange listed option and an OTC option in that it is listed but has the flexibility of an OTC option: the so-called *Can-Do Option*. It is designed to provide fund managers with a means to tailor derivatives to their particular exposures.

The following features distinguish it from other options on equities:

- Minimum contract size = large (usually the local equivalent of USD 1 million indicating that it is aimed at the professional investor).
- Contract size = any amount over local equivalent of USD 1 million.
- Underlying instruments = basket of shares can be specified by the investor.
- Expiry date = specified by the investor.
- Settlement = cash or physical at the option of the investor.

5.10.3 Options on equity / share indices

The options on indices markets of the world are also large and active. Examples of indices are the FTSE 100 in the UK, the DJIA and the S&P 500 in the US, the ALSI and the INDI in South Africa. They are mostly exchange-traded, but an OTC market also exists.

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An option on a share index allows the holder to take a position in the index (short or long) for the price of the premium quoted. This means that to buyer of a share index is buying the right to "invest" in a diversified portfolio (of the shares that make up the index) at a pre-specified price.

The size of index options is established by a multiplier applied to an index, i.e. the size of a share index option is equal to the index value (specifically the strike index value / price – SIV) times the multiplier. For example, the size of an option on the S&P 500 is = SIV × USD 500. In the case of the DJIAA it is SIV × USD 100. If for example the SIV on the S&P 500 = 1635, the size / exposure of the option = 1635 × USD 500 = USD 817 500. These options are *settled in cash*, obviously because the index cannot be delivered.

An example may be constructive here:[58] An investor has a portfolio that he set up to replicate the S&P 500 share index. He is concerned that monetary policy is about to be tightened and that share prices are about to fall sharply, but he does not want to sell because it is expensive to sell and to reconstruct this portfolio again after the fall (because of brokerage, taxes, etc). The value of his portfolio is USD 2.8 million and the S&P 500 SIV of a 3-month put option = 1400. The size of each option is thus 1400 × USD 500 = USD 700 000. The investor will buy four 3-month put options on the S&P index. Thus the investor is hedging his USD 2.8 million portfolio with four put options = USD 2 800 000 (4 × USD 500 × 1400).

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We assume that the investor is right in his view and the index over three months falls to 1120 (i.e. by 280 points or 20%). The value of the investor's portfolio will be USD 2.24 million (remember he replicated the S&P 500 index with "physical" shares), i.e. he incurs a loss of USD 560 000[59]. However, the investor exercises the four put options on expiry date, and makes a profit of:

(1400 – 1120) × USD 500 × 4 = USD 560 000,

which = the loss on his portfolio.

5.10.4 Equity / share warrants (call options)

As in the case of bond warrants, internationally equity / share warrants bestow the right (option) on the holder of the warrant to take up *new shares* of the relevant company. These call options are usually long term in duration.

5.10.5 Equity / share warrants (retail options)[60]

In some countries a version of equity / share warrants (as in the case of bond warrants) exist: they are ordinary options (call and put options), but are small in size, i.e. retail. Exercising of a warrant does not lead to the issue of new shares of the relevant company. Warrants are also written on equity / share indices.

The retail warrants market has grown rapidly in recent years. Warrants comprise call and put options on specific shares and on certain indices. They are of the American and European varieties and are usually listed on the exchange. As such they are traded and settled via a stockbroking broker-dealer firm. The issuers make a market in their equity warrants, i.e. quote bid (holder sells to the issuer) and offer (holder buys from the issuer) prices simultaneously, for example, bid: 12 cents / offer: 13 cents (these prices are called premiums).

The advantages of warrants are many. One of the issuers and market-makers lists eight as follows[61]:

1. Warrants enable investors to trade on the exchange with the same ease as trading ordinary shares.
2. Warrants offer a low cost entry into blue chip shares.
3. There is potential to leverage or gear up your investment.
4. Your risk is limited to the initial premium (price of the warrant) paid.
5. Warrants have the transparency of a listed instrument.
6. Small investors can short the market or hedge their portfolios through the use of put warrants and so profit from falls in the market.
7. The warrants market is extremely liquid, as the issuer is required to provide both bids and offers.
8. Warrants are an extremely cheap instrument to trade.

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The risks associated with warrants are price risk and credit risk. However, as shown above, price risk is limited to the premium which is a fraction of the value of the relevant share; i.e. there is limited downside risk and marked upside profit opportunity. While settlement is guaranteed by the exchange, the holder takes on credit risk because the counterparty to the deal is the issuer. As seen, these are the larger banks; as such credit risk is deemed to be small.

As noted, warrants are written on specific shares, usually the high market capitalisation shares, and on certain indices. In addition to the "ordinary" equity warrants, there are a number of variations on the theme, such as reset warrants and knockout warrants.

5.10.6 Redeemable preference shares

Preference shares (also called "preferred stock") in many countries are like perpetual bonds in that they never mature: perpetual preference shares. In other countries they are required to be redeemable or redeemable at the *option* of the issuer.

5.11 Options on foreign exchange

5.11.1 Introduction

We repeat our illustration on options introduced earlier for the sake of orientation (see Figure 18).

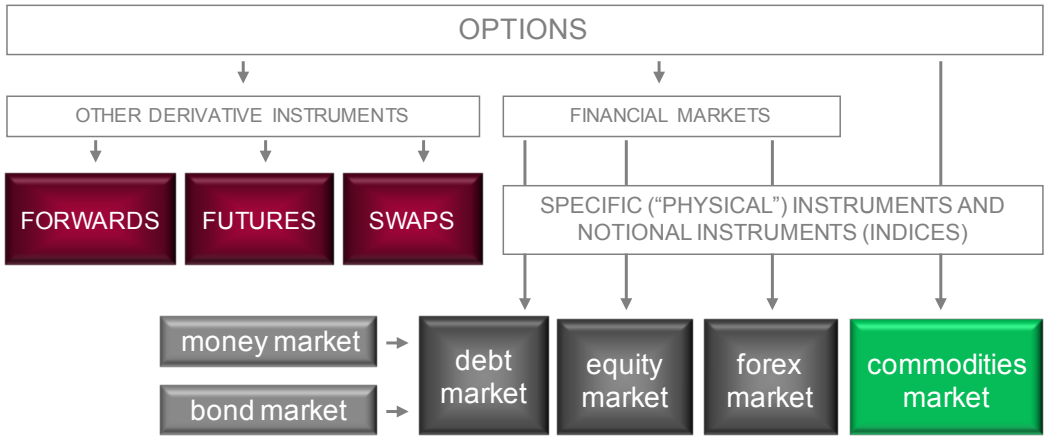

Figure 18: options

As in the case of bonds and shares, the options market in foreign currency can be divided into the wholesale and retail markets as follows:

- Options on foreign exchange (wholesale).
- Options on foreign exchange (retail: warrants).

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5.11.2 Options on foreign exchange (wholesale)

Options on foreign exchange (also called *currency options*) are traded the world over, and the most tradable contracts are those written on USD / EUR (example: EUR 62 500 on the PHLX), USD / JPY (example: JPY 12 500 000 on the PHLX), USD / GBP (example GBP 31 250 on the PHLX), USD / CAD (example: CAD 50 000 on the PHLX), USD / AUD (example: AUD 50 000 on the PHLX). In the US, the Philadelphia Options Exchange (PHLX) is particularly active in currency options.

The underlying asset in a currency option is an exchange rate. A call option on the GBP for example will give the buyer the right to buy GBP for a given price in dollars (i.e. the strike price).

Strike price	Calls			Puts		
	June	July	August	June	July	August
1.63	**1.5**	2.4	2.9	1.1	1.55	2.23
1.64	1.3	1.84	2.35	1.5	2.01	2.62
1.65	0.94	1.43	1.89	1.05	2.55	3.21

Table 13: Philadelphia options exchange GBP / USD options GBP 31 250 (cents per GBP)
(spot price: GBP / USD 1.6383)

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An example is always useful (see Table 13). The GBP / USD spot price is GBP / USD 1.6383. The face value of currency option contracts is fixed at an amount of currency; in this example it is GBP 31 250). A US investor purchases a June GBP *call* option at an exercise / strike price of 1.63 (this of course means GBP / USD 1.63). The face value of the contract is GBP 31 250.

At the end of the life of the option the GBP increases in value relative to the USD. We assume GBP / USD 1.76. The investor exercises the option and receives GBP 31 250 for which he pays USD 50 937.50 (1.63 × GBP 31 250). The investor sells the GBP in the spot forex market at the spot exchange rate of GBP / USD 1.76, and receives USD 55 000 (1.76 × GBP 31 250). The profit made is USD 4 062.50 (USD 55 000 – USD 50 937.50) less the premium paid for the option.

The *premium* is quoted in US cents per GBP. In the above example the premium is 1.5 US cents per GBP, i.e. the premium amount is 31 250 × 1.5 / 100 = USD 468.75. Total net profit is USD 3 593.75 (USD 4 062.50 – USD 468.75).

5.11.3 Options on foreign exchange (retail: warrants)

In addition to the wholesale market, there exists a market in retail options on foreign currencies. In some copuntries these are called *currency reference warrants* (CRWs).[62] CRWs are of the European variety, are available as call and put warrants, are usually listed on the exchange, and are cash settled.

CRWs enable investors to hedge themselves against unexpected movements in the LCC. Call warrants enable investors to buy a foreign currency (i.e. to sell the LCC) when they believe the LCC will weaken (read: pay more LCC for one unit of the foreign currency). On the other hand, put warrants enable investors to sell a foreign currency (i.e. to buy the LCC) when they believe the LCC will strengthen (read: less LCC for one unit of the foreign currency)

5.12 Options on commodities

The commodities options markets are also large markets internationally, but they fade into the background when compared with the options on financial instruments markets. Options are written on all the larger commodities, such as gold, oil, wheat, maize, soybean, and certain commodity indices such as the AMEX oil index. The commodity options markets are both formalised and OTC.

In addition to the wholesale options on commodities market, there exists a retail market: warrants on commodities.[63] These are called *commodity reference warrant* (CoRWs) in some countries. The underlying assets of CoRWs are commodities such as gold, platinum, and oil, expressed in LCC. They are available in puts and calls.

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5.13 Option strategies

5.13.1 Introduction

There are no fundamental dissimilarities between operations in the futures and options markets, i.e. dealings in the options market can be divided into the four types:

- Speculative.
- Hedging.
- Arbitrage.
- Investment.

However, we know that a hedger, speculator or investor has the choice between futures and options, and the essential difference between them is that in the case of the options the buyer has limited downside risk. We also know that there are a number of payoff situations for buyers are sellers of options. In addition, a virtually unlimited variety of payoff patterns may be attained by the *combination* of calls and puts with various exercise prices. Here we consider only two of the combinations of options, the straddle and the strangle.[64]

5.13.2 Straddle

Underlying price of share at expiry	Profit / loss on call option	Profit / loss on put option	Net profit / loss on straddle
440	-10	+31	+21
445	-10	+26	+16
450	-10	+21	+11
455	-10	+16	+6
460	-10	+11	+1
465	-10	+6	-4
470	-10	+1	-9
475	-10	-4	-14
480	**-10**	**-9**	**-19**
485	-5	-9	-14
490	0	-9	-9
495	+5	-9	-4
500	+10	-9	+1
505	+15	-9	+6
510	+20	-9	+11
515	+25	-9	+16
520	+30	-9	+21

Table 14: Profit / loss profile of a long straddle

	$SP_t < X$	$SP_t \geq X$
Payoff of call	0	$SP_t - X$
+ Payoff of put	$X - SP_t$	0
= Total	$X - SP_t$	$SP_t - X$

Table 15: Value of straddle at expiry

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The straddle is generally put into place when an investor *believes that the price of the underlying is about to "run" but she is uncertain of the direction*. The straddle involves the purchasing of *a call and a put at the same strike price and expiration date*.

The share price of Company ABC is trading at 480 pence currently. The price of a call at a strike of 480 pence is 10 pence and the price of a put at the same strike is 9 pence. The position is held to maturity (six months from purchase). Table 14 and Figure 19 set out the profit and loss profile.

The solid line in the lowest part of the chart shows the payoff condition of the straddle. At X = SP_t the payoff is equal to zero. It is only at this point that the payoff is zero; at all other points the straddle has a positive payoff. One may then ask why these combinations are not more popular. The answer is that if prices are not volatile the holder may lose heavily because she is paying a *much higher premium* than is usually the case.

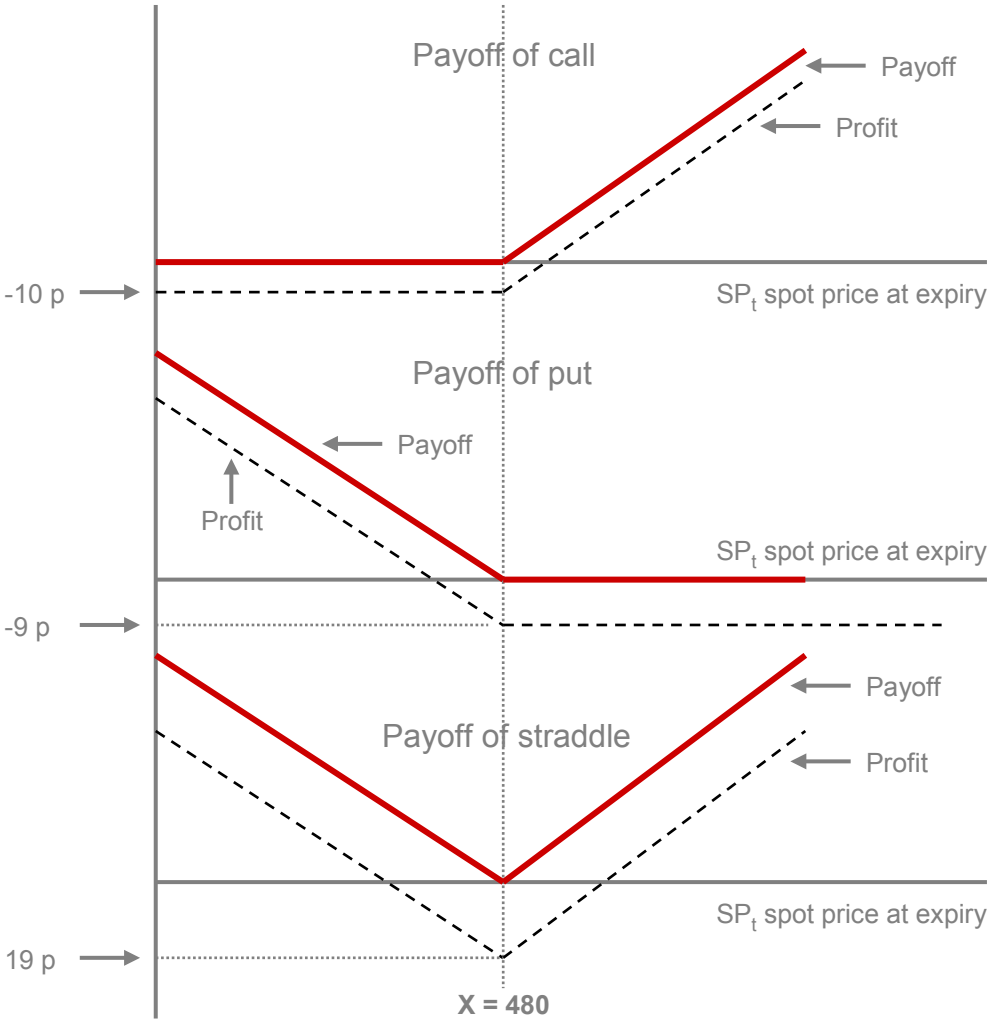

Figure 19: profit / loss profile of a long straddle

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The dotted line in the chart represents the profit of the straddle. It is below the solid line by the cost of the straddle, i.e. the premium, in this case 19 pence. This is the maximum that can be lost.

5.13.3 Strangle

A strangle is the *same as the straddle except that the exercise prices differ*. An example is shown in Table 16.[65]

The share price of Company ABC is trading at 480 pence. The price of a call option at strike 460 is 25 pence, and the price of the put at strike 480 is 9 pence. The table shows the payoff profile. It will be clear that there is a range where maximum losses are made and this is between the two strike prices. The loss is capped at 14 pence. Beyond this range the losses are reduced or profits rise and they do so in a symmetrical fashion.

Underlying price of share at expiry	Profit / loss on call option	Profit / loss on put option	Net profit / loss on straddle
440	-25	+31	+6
445	-25	+26	+1
450	-25	+21	-4
455	-25	+16	-9
460 (call strike)	**-25 (call premium)**	+11	**-14**
465	-20	+6	**-14**
470	-15	+1	**-14**
475	-10	-4	**-14**
480 (put strike)	-5	**-9 (put premium)**	**-14**
485	0	-9	-9
490	+5	-9	-4
495	+10	-9	+1
500	+15	-9	+6
505	+20	-9	+11
510	+25	-9	+16
515	+30	-9	+21
520	+35	-9	+26

Table 16: Profit / loss profile of a long strangle

5.13.4 Delta hedging

In normal hedging strategies (for example, holding of an asset and buying a put with the asset as the underlying when it is expected that its price will decline), some hidden risks lurk, requiring an appreciation of the "Greeks": delta, theta, gamma, vega and rho. We covered them briefly earlier. Here we discuss the most prominent one, delta, and specifically delta hedging, in a little more detail.

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It will be recalled that *delta* is the rate of change of the option price with respect to the price of the underlying asset. If a call option has a delta of +1 it means that when the value of the underlying increases, the value of the option changes by the same amount. If the delta of a call option is +0.5, it means that when the price of the underlying increases by a number, the price of the option changes by 50% of that number. (It will be clear that the delta of a put option is negative.) When the delta of an option is removed from +1 or -1 (i.e. closer to 0), it constitutes risk in a hedge. The delta can also change over time due to changes in the underlying price, volatility or a shortening of the time to expiration (referred to as *delta-variable*).

A *delta-neutral* position is obtained when an options / underlying instrument position is constructed so that it is insensitive to price movements in the underlying instrument. Thus, if an investor has a long position in shares, she is able to hedge the position against losses by buying puts (long put position) or selling calls (short call position) to the extent of the *inverse of the delta*. If the delta of a put option is 0.75, the *hedge ratio* is 1 / 0.75 = 1.33. This means that 1.33 put options are required to offset one unit of the long position in shares. With this in place the investor has a *delta-neutral hedge.*

An example: if an investors holds 30 000 ABC shares, she will need to buy put options (with a delta of 0.75) to the extent of 30 000 / 0.75 = 40 000 (assuming a put option on 1 share could be bought). If the put option contract size is 1 000 shares, then 40 contracts are required [30 000 / (0.75 × 1 000)] to achieve a *delta-neutral hedge.*

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As noted above, the delta values of options contracts do change over time; therefore the position needs to be rebalanced every so often to maintain a hedge ratio of h = -1. This is called *dynamic hedging*.

5.14 Exotic options[66]

Securities broker-dealers and investment banks have over the years developed many so-called exotic options. Many of them cross the various markets. The following may be mentioned as examples:

As you like it options (AYLIO)

The AYLIO is an option that allows the holder to convert from one type of option to another at a certain pre-specified point prior to expiration. This is usually from a call to a put or vice versa. This option type is also called "call or put option" or "chooser option".

Average rate options (ARO)

The ARO is an option on which settlement is based on the difference between strike price and the average of the share or index on certain given dates. The "average" attribute of the ARO renders this option less volatile and thus cheaper than a conventional "spot price option". The ARO is also called an "Asian Option".

Barrier options (BAO)

There are many types of barrier options. Their payoff is dependent on the price of the underlying asset and on whether the asset reaches a pre-determined barrier at any time in the life of the option. There are, for example, knock-in options and knock-out options. The former is activated when the price of the underlying asset reaches a pre-determined level. The latter option is "killed" if the price of the underlying reaches a pre-determined level.

Compound options (CO)

A CO is an option on an option. The buyer has the right to buy a specific option at a preset date at a preset price.

Lookback options (LO)

A LO is an option where the payout is determined by using the highest intrinsic value of the underlying security or index over its life. For a lookback call the highest price is used, whereas the lowest price is used in a lookback put.

Quantro options (QO)

A QO is a currency option in terms of which the foreign exchange risks in an underlying security have been eliminated.

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Package options (PO)

A PO is a portfolio consisting of standard European calls, standard European puts, forward contracts, cash and the underlying asset itself. An example is a range forward contract.

Forward start options (FSO)

FSOs are options that start their life at some stage in the future. They are used in employee incentive schemes.

Binary options (BIO)

BIOs are options with discontinuous payoffs. An example is a cash-or-nothing call. This pays off nothing if the share price ends up below the strike price at some time in the future and pays a fixed amount if it ends up above the strike price.

Shout options (SO)

SOs are European options where the holder can "shout" to the writer at one time during its life. At the end of the life of the option the holder receives either the usual payoff from a European option or the intrinsic value at the time of the shout whichever is greater.

Other options

There are also other options such as options to exchange one asset for another (*exchange options*), options involving several assets (*rainbow options*), basket options, etc.

5.15 Summary

An option is the right to buy or sell an asset on or during the period up to the option expiry date which is in the future (in exchange for a premium). The writer has an obligation to receive or deliver the asset on or before expiry date. Options are written on most financial market instruments and many commodities. Seen simply an option is worth the intrinsic value and the time value of the option. The most used pricing formula includes a number of variables.

- Spot (current) price of underlying asset (assume share) (SP).
- Exercise (strike) price (EP).
- Time to expiration.
- Risk free rate (i.e. treasury bill rate).
- Dividends expected on the underlying asset during the life of the option.
- Volatility of the underlying asset (share) price.

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6 Other derivatives

6.1 Learning outcomes

After studying this text the learner should / should be able to:

1. Comprehend the existence of derivatives that are not classified under the traditional derivatives (forwards, futures, swaps and options)
2. Describe the derivative product: products of securitisation
3. Elucidate the derivative product: credit derivatives
4. Explain the derivative product: weather derivatives.

6.2 Introduction

The mainstream derivatives were discussed above. As stated before, derivatives are instruments that cannot exist without their underlying instruments and their value depends on the value of these underling instruments; and the traditional underling instruments are share prices, share indices, interest rates, commodity prices, exchange rates, etc.

Over the past decades, and in some cases over the past few years, other derivatives have been developed that are based on the prices of other underlying variables. For example, the following derivatives are available in international markets):

- Securitisation.
- Credit derivatives.
- Weather derivatives.
- Insurance derivatives.
- Electricity derivatives.

Insurance derivatives have payoffs that are dependent of the amount of insurance claims of a specified type made during the period of the contract. *Electricity derivatives* have payoffs that are dependent on the spot price of electricity. Here we briefly discuss the other three mentioned.

6.3 Securitisation

The products of securitisation *may also be seen as "derivatives"* because they and their prices are derived from debt or other securities that are placed in a legal vehicle such as a company or a trust. Some analysts will insist that these products are *not derivatives*. However, the jury is still out in this respect.

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Securitisation amounts to the pooling of certain non-marketable assets that have a regular cash flow in a legal vehicle created for this purpose (called a special purpose vehicle or SPV) and the issuing by the SPV of marketable securities to finance the pool of assets. The regular cash flow generated by the assets in the SPV is used to service the interest payable on the securities issued by the SPV.

There are many assets (representing debt) that may be securitised, and the list includes the following:

- Residential mortgages.
- Commercial mortgages.
- Debtors books.
- Credit card receivables.
- Motor vehicle leases.
- Certain securities with a high yield.
- Equipment leases.
- Department store card debit balances (examples: Edgars card and Stuttafords card).

For the banks, securitisation amounts to the taking of assets off balance sheet and freeing up capital[67]. For companies, securitisation presents an alternative to the traditional forms of finance. An example of the latter is the securitisation of company's debtors' book.

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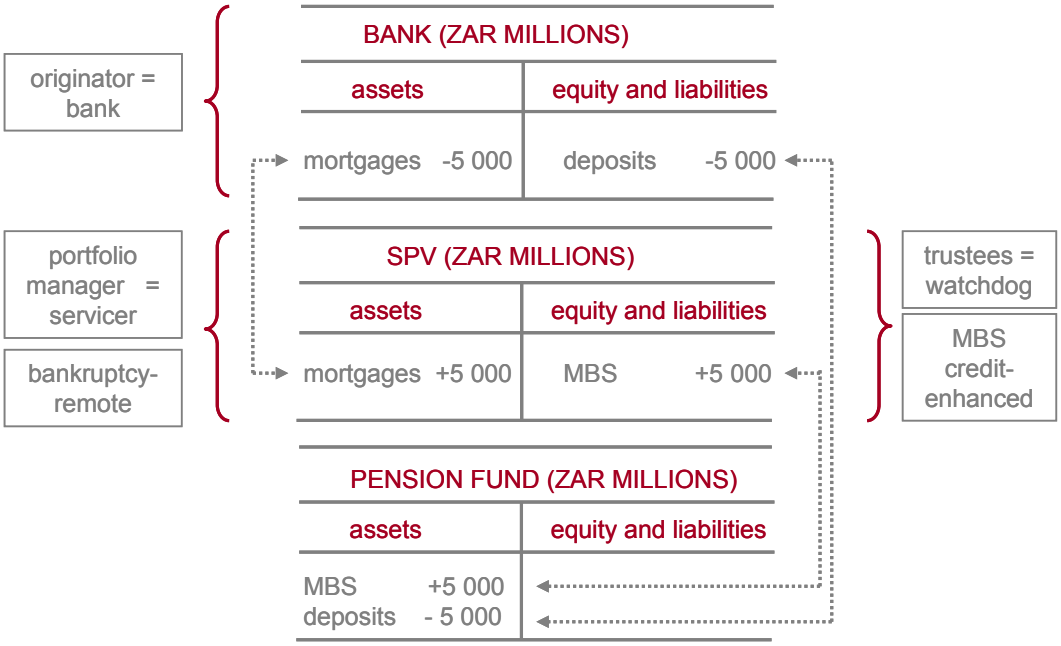

Figure 1: example of bank securitisation of mortgages

A typical securitisation (of mortgages) may be illustrated as in Figure 1. In this example, the bank decides to securitise part of its mortgage book, in order to free up the capital allocated to this asset. It places R5 billion of mortgages into a SPV, and the SPV issues R5 billion of mortgage-backed securities (MBS) at a floating rate benchmarked to the 3-month JIBAR to finance these assets. A portfolio manager manages the SPV, and trustees appointed in terms of the scheme monitor the process on behalf of the investors (in this case assumed to be pension funds) in the MBS.

It should be noted that the details of the above securitisation have been ignored, in the interests of understanding the basic principles of the transaction. In real life, the scheme is extremely lawyer-friendly, and the MBS issued are rated AAA by the rating agency/agencies in order to attract investors. This is achieved by the credit-enhancement process, by which is meant that the SPV is properly "capitalised". The latter in turn is achieved by the SPV issuing 3 streams of MBS in the following manner (this is an example)[68]:

- AAA rated MBS: 90% of the total (i.e. R4 500 billion).
- BBB rated MBS (called mezzanine debt): 7% of the total (i.e. R350 million).
- Unrated MBS (called subordinated debt): 3% of the total (i.e. R150 million).

The AAA rated paper, as noted, is sold to the market, while the BBB paper is usually purchased by one of the sponsors at an excellent rate of interest.[69] The management company usually holds the unrated paper in portfolio, and a mixture of equity / shares and debt finances this company.

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The variable rate of interest paid on the underlying assets (and the cost of the credit enhancement) determines the rate payable on the three streams of paper created by the SPV.

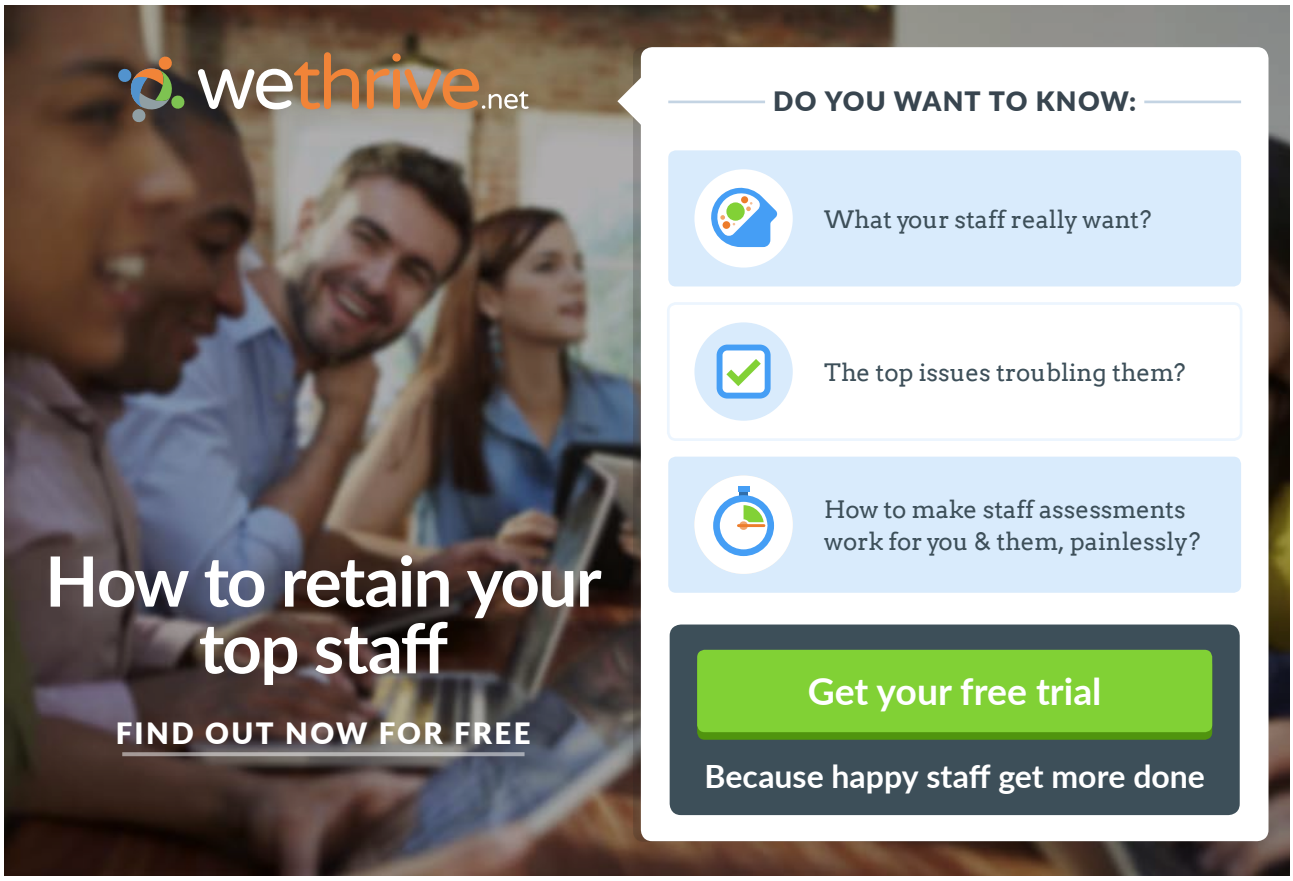
6.4 Credit derivatives

6.4.1 Introduction

Credit derivatives emerged in the 1990s, and the market and the range of products have grown significantly since then. A credit derivative may be defined as "…a contract where the payoffs depend partly upon the creditworthiness of one or more commercial or sovereign entities."[70] There are a number of credit derivative contracts, such as *total return swaps* (e.g. where the return from one asset is swapped for the return on another asset), *credit spread options* (e.g. an option on the spread between the yields on two assets; the payoff depends on a change in the spread) and *credit default swaps*. The latter is the most utilised credit derivative[71], and we focus on this one below.

6.4.2 Example of credit default swap

A credit default swap is a bilateral contract between a *protection purchaser* and a *protection seller* that compensates the *purchaser* upon the occurrence of a *credit event* during the life of the contract. For this protection the protection purchaser makes periodic payments to the protection seller. The *credit event* is objective and observable, and examples are: default, bankruptcy, ratings downgrade, and fall in market price.



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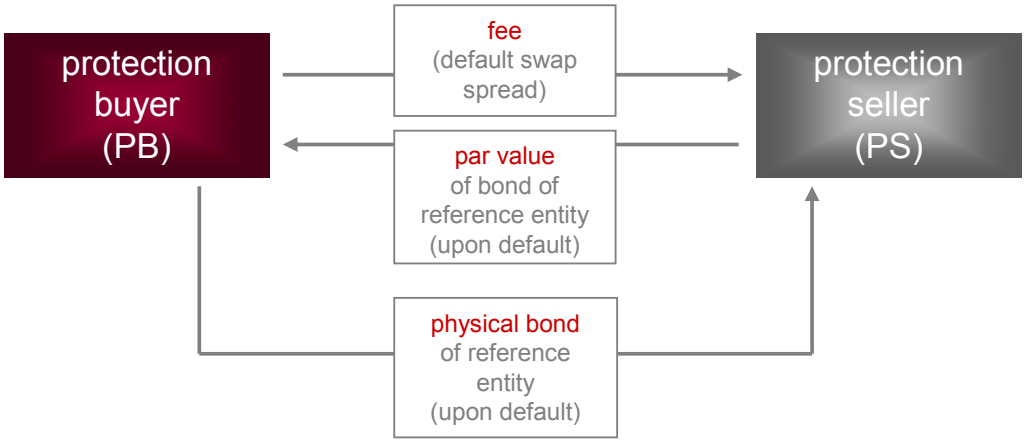

Figure 2: example of a credit default swap

An example is required (default by an issuer of a bond): a credit default swap contract in terms of which INVESTCO Limited (an investor; called the *protection buyer*) has the right to sell a bond[72] issued by DEFCO Limited (a bond issuer; called the *reference entity*) to INSURECO Limited (an insurer; called the *protection seller*) in the event of DEFCO defaulting on its bond issue (the specified *credit event*). In this event the bond is sold at face value (100%).

In exchange for the protection, the protection buyer undertakes to settle an amount of money (or fee) in the form of *regular payments* to the protection seller until the maturity date of the contract or until default. The fee is called the *default swap spread*. This contract may be illustrated as in Figure 2.[73]

As noted, the fee is payable until maturity of the bond or until default. If default takes place, the protection buyer has the right to sell the bond to the protection seller at par value. It is then up to the protection seller to attempt to recover any funds from the defaulting bond issuer. The following are the details of the contract:[74]

Protection buyer	= INVESTCO Limited
Protection seller	= INSURECO Limited
Reference entity (issuer)	= DEFCO Limited
Currency of bond	= ZAR
Maturity of bond	= 3 years
Face value	= ZAR 30 million
Default swap spread	= 35 basis points pa
Frequency	= Six monthly
Payoff upon default	= Physical delivery of bond for par value
Credit event	= Default by DEFCO Limited on bond.

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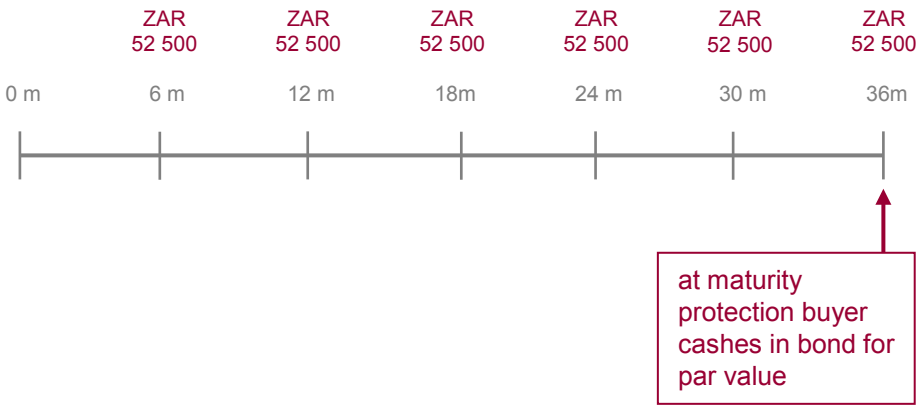

Figure 3: cash flows with no default (to protection seller)

The cash flows in the event of no default and default are as shown in Figure 3 and Figure 4.

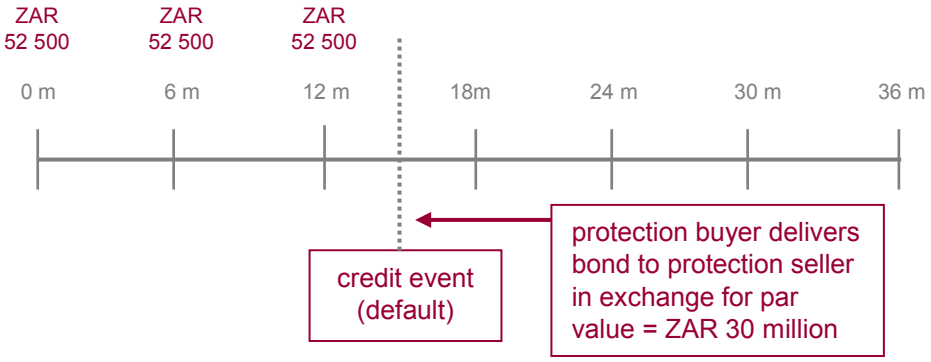

Figure 4: cash flows in event of default

6.4.3 Pricing

The pricing of credit derivatives is straightforward. The fee payable on the swap, i.e. the default swap spread (DSP), should be equal to the risk premium (RP) that exists *over* the risk-free rate (rfr = rate on equivalent term government bonds). In other words, the DSP should be equal to the RP which is equal to the yield to maturity (ytm) on the DEFCO bond less the rfr:

$$DSP = RP = ytm - rfr.$$

This is so if the credit default swap is priced correctly. If this is not the case, arbitrage opportunities arise. For example, if rfr = 10.0% pa and RP = 5.0% pa then ytm = 15.0% pa. If the market rate (ytm) of the reference bond is 17.0% pa, and DSP = 5.0% pa, it will pay an investor (protection buyer) to buy the bond at 17.0% pa and do the credit swap (cost = 5% pa) because he is getting a 200bp better return than the rfr (10% pa) on a synthetic risk-free security.

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Conversely, if the ytm of the reference bond is 13.0% pa, and DSP = 5.0% pa, it pays the protection seller to short the reference bond and enter into the swap. This means that the protection seller is borrowing money at 13% pa (the ytm at which the reference bond is sold), and investing at the rfr (10.0% pa) and earning the DSP of 5.0% pa, i.e. a profit of 200 bp.

Clearly these examples point to the fact that arbitrage will ensure that in an approximate sense DSP = RP.

The main participants in the credit derivatives market are the banks (63% of protection buyers and 47% of protection sellers), securities firms (18% of protection buyers and 16% of protection sellers) and insurers (7% of protection buyers and 23% of protection sellers).[75] The other participants are the hedge funds, mutual funds, pension funds, companies, government, and export credit agencies.

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6.5 Weather derivatives

The weather derivative is a relatively new instrument, but it is growing in popularity because many businesses depend on or are affected by the weather. Examples are:

- Retailers in London (example: loss of sales in bad weather).
- Agricultural concerns (example: loss of crops).
- Insurers of agricultural concerns (example: claims for hail damage).
- Construction enterprises (example: loss of time spent on a contract as a result of inclement weather).
- Football stadiums (example: lower turnstile takings as a result of bad weather).
- Large landlords (example: additional heating costs in cold periods).

According to Applied Derivatives Trading Magazine[76], 75% of the profits of enterprises rise and fall as a result of changes in the weather. The magazine also reported that in the first 18 months since weather derivatives were introduced some 1 000 contracts were signed.

Weather derivative contracts are usually structured as futures, options (caps, floors, collars) and swaps, and are settled in the same way as these. The contracts have a number of parameters as follows[77]:

- Contract type (cap, floor, swap).
- Contract duration.
- Official weather station (often weather service data stations located at major airports).
- Definition of underlying weather index (temperature, rainfall, snow, frost).
- Strike for options or index for swap.
- Tick for linear payout or fixed payment for binary payment scheme.

As seen, weather hedges can be based on temperature, rainfall, etc. The most common is contracts based on temperature. The underlying "instrument" or "value" in the case of temperature-related weather derivatives is Celsius-scale temperature as measured by "degree days" (DD). A DD is the absolute value of the difference between the average daily temperature and 18°C. The winter measure of average daily temperature below 18°C is called heating degree days (HDDs), and the summer measure of average daily temperature above 18°C is termed cooling degree days (CDDs). If for example the mean temperature of a day in December were 3°C, the HDD would be 15. The number for the month is the total of the daily HDDs (negatives are ignored).

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Examples of temperature contracts:

- Caps (also known as call options) establish a DD ceiling. The holder is compensated for every DD above the ceiling up to a maximum amount.
- Floors (also known as put options) establish a DD minimum. The holder is compensated for every DD below the floor up to a maximum amount.
- Collars or swaps establish a DD ceiling and a DD floor. The holder is compensated for every DD above the ceiling or below the floor.

An example is required[78]. A London retailer reviews historical weather and revenue data to uncover the correlation between temperature and sales. They find that 225 HDDs in December is the point below which *winter apparel sales* start to fall. Each DD below 225 corresponds to a potential GBP 10 000 in lost sales. The retailer decides to buy a weather floor for December of 225 HDDs, with a payout of GBP 10 000 per DD and a maximum of GBP 1 million. The weather index used is the weather station at London Weather Centre. The premium is GBP 85 000.

December passes and the data is available on 3 January. The December cumulative number of HDDs is 200 (i.e. 25 below the floor of 225), i.e. it was warmer and winter apparel sales were indeed down. The seller of the hedge pays out:

GBP 10 000 × 25 = GBP 250 000,

and the total income of the retailer is:

GBP 250 000 – GBP 85 000 (the premium paid) = GBP 165 000.

6.6 Carbon credit derivatives

In order to comprehend carbon credits, some background information is required. In 1979 an international climate conference took place. This led to the formation in 1992 (at the Rio Earth Summit) of the *United Nations Framework Convention on Climate Change* (UNFCCC), which became operational in 1994. The countries which ratified the UNFCCC (now close to 200) are called *Parties to the Convention* and their frequent meetings are called *Convention of the Parties* (COP). Each meeting is given a COP-number and a name, for example, the *Kyoto Protocol* (COP3), and the 2011 *Durban Platform for Enhanced Action* (COP17).

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The ultimate objective on the UNFCCC is to stabilise greenhouse gas concentrations "at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system." It further states that "such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner."[79]

According to the UNFCCC, by 1995 "countries realized that emission reductions provisions in the Convention were inadequate. They launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol. The Kyoto Protocol legally binds developed countries to emission reduction targets. The Protocol's first commitment period started in 2008 and ends in 2012."[80] In essence, the Kyoto Protocol sets binding emission reduction targets for 37 industrialised countries and the European Community. On average the target is an emissions-reduction of 5% compared to 1990 levels over the period 2008–2012.[81]

At the latest Convention, COP17 in 2011, the parties agreed on a pathway to a legally binding instrument that will compel all countries to take action to slow the pace of global warming. It is to be agreed by 2015 and implemented by 2020). The parties also agreed to a second commitment period of the Kyoto Protocol starting in 2013.

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What is a carbon credit? Unfortunately, the answer is not a short one. In terms of the the Kyoto Protocol[82] the *developed* countries are assigned *quotas* (aka *caps*) for greenhouse gas (GHG) emissions, termed *assigned amounts*. The initial assigned amounts are made up of units termed *assigned amount units* (AAUs). Each AAU is an *allowance* to emit one metric ton of CO_2 (or CO_2 equivalent GHGs), and each developed country has a National Registry of its AAUs. The AAUs are known as carbon credits (and they can also be created – see below).

The developed countries, in turn, set quotas for the GHG emissions of local private and public enterprises (called operators), managed through their National Registries (and required to be validated and monitored for compliance by the UNFCCC). Thus, each operator has an *allowance* of carbon credit units, and each carbon credit unit represents the right to emit one ton of CO_2 (or other equivalent GHGs).[83]

In addition to the AAUs, another tradable carbon credit exists (created under the *Clean Development Mechanism* (CDM) of the Kyoto Protocol): an *offset of emissions*, termed *certified emission reductions* (CERs), when approved by the UNFCCC. A developed country can fund a GHG reduction project in a developing country (which has ratified the Kyoto Protocol), and the developed country would be allocated credits for meeting its emission reduction targets.

Operators that are about to exceed their quotas can buy carbon credits (AAUs and / or CERs) from operators that have not used up their quotas. This can be done on the open market or privately. Each transfer is reported to and authorised by the UNFCCC.

In addition to the UN-regulated market a voluntary market exists, elucidated by Nadaa Taiyab as follows: "Parallel with the CDM market, there has emerged a voluntary market for carbon offsets. The voluntary market consists of companies, governments, organisations, organisers of international events, and individuals, taking responsibility for their carbon emissions by voluntarily purchasing carbon offsets. These voluntary offsets are often bought from retailers or organisations that invest in a portfolio of offset projects and sell slices of the resulting emissions reductions to customers in relatively small quantities. As retailers generally sell to the voluntary market, the projects in which they invest do not necessarily have to follow the CDM process. Free of the stringent guidelines, lengthy paper work, and high transaction costs, project developers have more freedom to invest in small-scale community based projects. The co-benefits of these projects, in terms of, for example, local economic development or biodiversity, are often a key selling point."

There are a number of exchanges that trade in carbon credits: Chicago Climate Exchange, European Climate Exchange, NASDAQ OMX Commodities Europe, PowerNext, Commodity Exchange Bratislava and the European Energy Exchange.[84] There are spot markets and futures and options markets. The trading unit is one allowance / carbon credit.

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6.7 Freight (or shipping) derivatives

At times the volatility of rates in the freight markets is high, i.e. a high level of risk exists for commodity producers and traders, ship owners, ship operators and other participants in freight. This led to the creation of *forward freight agreements* (FFAs) in the early nineties.[85] A FFA is a contract between two parties, which stipulates an agreed future freight rate for carrying commodities (wet and dry) at sea. The contract does not involve any actual freight or any actual ships. It is a financial agreement which is cash settled.

The underlying asset is a freight rate (the contract rate) for a specified route (the contract route) over a specified period (the contract period). The rates on the routes are "assessed"[86] daily and published by the Baltic Exchange (there are also other smaller publishers of rates, such as Platt's). The rates are published as indices [e.g. the Baltic Exchange Panamax Index (BPI)] or rates. Thus, FFAs have four main terms:

- The agreed route.
- The settlement/expiry date.
- The contract size.
- The contract rate at which differences will be settled.

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FFAs are OTC products made on a principal-to-principal basis, As such they are flexible and are not traded on an exchange. Brokers are involved in deals but:

- Settlement is between the principals (in cash usually within a few days after the settlement date).
- Commissions are agreed between the principal and the broker.
- The broker acts as an intermediary only, and is therefore not responsible for the performance of the contract.[87]

There are two types of FFAs: OTC swaps and OTC "futures". The latter are actually forwards, but are called "futures" by market participants, because they enjoy clearing facilities [by the London Clearing House (LCH), the Norwegian Futures and Options Clearinghouse (NOS), the Singapore Exchange (SGX) and the Chicago Mercantile Exchange (CME)].

In essence FFAs are cash-settled, privately negotiated (via non-principal brokers) bespoke financial contracts between two parties in terms of which one party agrees to pay the other party an amount equal to the difference between the contract price of the underlying index / rate of a specified route and the settlement price of the index / rate of the route.

The participants in the freight derivatives market are the abovementioned commodity producers and traders, ship owners, ship operators, etc (i.e. those that wish to shed risk / hedge), as well as the speculators in the freight market (those that take on risk), including investment banks and hedge funds.

Variations of FFAs have emerged, including container-freight derivatives[88], options and spread dealing.[89]

6.8 Energy derivatives

Energy derivatives is the term for forwards, futures, swaps and options on energy products, that is, the underlying assets of these derivatives are energy products, including oil, natural gas and electricity. The derivatives trade either on exchanges or OTC. We touched on the derivatives on commodities in the body of this text and present this section merely for the sake of completeness.

6.9 Summary

The mainstream derivative instruments are forwards, futures, options and swaps with which financial and commodity risk can be hedged. In addition to these there is a demand for hedging other risks such as weather risk, energy price risk and credit risk; the hence the development of weather, energy, credit, etc derivatives. Securitisations are not hedging products but the marketable liabilities of SPVs are derived from other non-marketable assets.

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In conclusion, we present a summary of the derivatives covered in this course (excluding the exotic options) in Table 1.

	SPOT MARKETS			
Derivatives	Debt market	Equity market	Forex market	Commodity markets
Forwards				
Forward interest rate contracts	Yes			
Repurchase agreements	Yes			
Forward rate agreements	Yes			
Outright forwards	Yes	Yes	Yes	Yes
Foreign exchange swaps			Yes	
Forward forwards			Yes	
Time options (obliged to exercise)			Yes	
Forwards on commodities				Yes
Forwards on swaps[1]	Yes			
Futures				
On specific instruments ("physicals")	Yes	Yes	Yes	Yes
On notional instruments (indices)	Yes	Yes	Yes	Yes
Swaps	Yes[2]	Yes[3]	Yes[4]	Yes[5]
Options				
Options on futures	Yes	Yes	Yes	Yes
Options on swaps	Yes			
Options on specific instruments	Yes	Yes	Yes	Yes
Options on notional instruments	Yes	Yes	Yes	Yes
Interest rate caps and floors	Yes			
Warrants (retail options)	Yes	Yes	Yes	Yes
Warrants (call options)	Yes	Yes		
Callable and puttable bonds	Yes			
Convertible bonds	Yes			
Other				
Products of securitisation	Yes			
Credit derivatives	Yes			
Weather derivatives				
Carbon credit derivatives				
Freight derivatives				
Energy derivatives				
1. On interest rate swaps. 2 = Interest rate swaps. 3 = Equity swaps. 4 = Currency swaps. 5 = Commodity swaps.				

Table 1: Spot markets and derivative instruments

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7 Endnotes

1. Local Country is the name of a fictitious country. The code for its currency is LCC (Local Country Currency).
2. The KIR is called by many names around the world: discount rate, repo rate, bank rate, base rate, etc. We refer to it as KIR.
3. Ignoring notes and coins.
4. Imagine Mr Spender utilising a credit card (CC) facility at the local supermarket. When the latter deposits the CC receipt it receives a deposit and Mr Spender has accessed a loan. The latter is a bank asset and the former a bank deposit (= money). The bank earns the difference between the lending rate and the deposit rate.
5. This is a little simplified, but the gist is sound.
6. Because lending and borrowing domestically do not take place in this market.
7. *Dematerialisation* means that scrip (physical certificates) no longer exist, while *immobilisation* means that scrip exists but is placed in a scrip depository which holds them on behalf of the investors (usually this means one certificate).
8. The interest rate represents the cost to the farmer of holding a stock of maize, referred to as the "cost of carry". As we will show later, the rate used in calculations of the fair value price (FVP) of forwards / futures is the risk-free rate (rfr).
9. Based on the" arbitrage principle", i.e. if this were not the rate, arbitrage could take place.
10. The term "institutions" is used loosely in the financial markets to apply to the large investors, i.e. the retirement funds, insurers and securities unit trusts.
11. Certificates are only applicable in markets where dematerialisation or immobilisation has not been implemented.
12. In terms of credit risk management practices, companies have limits on their exposure to individual banks (and other institutions).
13. Certain banks act as market makers in FRAs.
14. "Joint Interbank Agreed Rate". In Local Country the banks some years ago agreed to create a series of reference rates which represent the market. They supply 1-day, 1-month, 2 month, 3-month, etc rates (at which they are prepared to take deposits from one another) to the local stock exchange (because it is a neutral party) which averages them and makes the averages available to the market.
15. It depicts a normally shaped yield curve.
16. Many authors prefer to write this example as: LCC 7.5125 / USD 1.0 or simply as R/$ 7.5125, meaning rand per dollar. Note that with this format the "/" in USD / LCC is not a mathematical sign.
17. Note that these forwards are merely touched upon here because the detail is covered in a separate book.
18. "Market making banks" refers to the fact that the foreign exchange market is "made" by the banks; they quote bid and offer exchange rates simultaneously at all times in response to the approaches of clients (importers, exporters, etc.).
19. Note here that we increase the number of decimals (from the market norm) for purposes of demonstrating the principle.
20. Note that this transaction increases bank liquidity (if it is the only transaction that day).

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21. This transaction decreases bank liquidity
22. Example adapted from Steiner, R (1998: 7–8)
23. See Steiner (1998: 177).
24. "Short" sale means the sale of an instrument that the seller does not own. The seller borrows the instrument from an investor / lender for a fee and delivers it back to the lender when the short sale is unwound by the purchase of the instrument. A short sale is undertaken to profit opportunistically from an expected decline in price.
25. In most derivative formulae the risk free rate (rfr) is used, and this is so because it is a well known and easily accessible rate. There is no standard definition for the rfr but most analysts / academics apply this term to the 91-day treasury bill rate.
26. Prices are of course available minute to minute and the mark-to-market price is set once a day.
27. JIBAR denotes "Johannesburg Interbank Agreed Rate". The JSE gathers in a series of JIBAR rates from the banks. They are averages of the main banks' rates for the relevant terms.
28. The author acknowledges the assistance of Alan Joffe and Colin Wakefield in respect of this section.
29. This is a code for a specific bond in Local Country denominated in the local currency.
30. Assumed for purposes of the example; futures generally terminate in the middle of relevant months.
31. We assume this for purposes of the example (spacing in the illustration); in practice the books close 10 days before the coupon dates.
32. "Income" is too simple a description; it should be described as "accumulated value of income received during the life of the futures contract" (suggested by Colin Wakefield).

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33. Another assumption made is that bond transactions are settled on deal date (so that the example is rendered uncomplicated). In practice bond deals are settled on T+3. Thus, in the example, the fvd and the ftd should be regarded as settlement dates.
34. In this regard see McInish (2000: 334).
35. It is this property of the futures market, and the significant losses made by some irresponsible traders, that gives the futures market a bad name.
36. In this regard see Falkena (1989: 39–59).
37. With some assistance from Pilbeam, 1998.
38. Because USD and ZAR interest rates are the same (assumed).
39. Almost verbatim from www.jse.co.za. All the futures and their specifications can be found on this website.
40. This section summarises the work of Collings, 1993.
41. It is to be noted that the comparative advantage swap is almost extinct in the more sophisticated financial markets; this is because the differentials that exists will be arbitraged out or not exist in the first place because, clearly, incorrect credit risk pricing has occurred.
42. The *Joint Interbank Agreed Rate* of the major banks in Local Country. The major banks agreed to create a series of rates to be used as benchmark rates. The various rates (overnight, 1 month. 2 months, 3 months, and so on) are supplied to an independent party (the exchange), averaged by them and made public.
43. Example from Pilbeam,1998.
44. Note that in the figures the platinum price is per ounce and therefore profits / losses are per ounce.
45. All prices quoted hereafter are "per ounce".
46. This section relies heavily on Hull (2000: 250).
47. See Hull (2000: 255).
48. Not supplied here.
49. This section draws heavily from Hull (2000).
50. Last mark to market price. In this regard see Hull (2000:285).
51. This is a South African example.
52. With assistance from Hull (2000:.543).
53. The swaption-swap differences are similar to the differences between an option on forex and a forex forward. See Hull (2000: 543).
54. Example (slightly) adapted from Pilbeam, 1998.
55. A reminder: Joint Interbank Agreed Rate of Local Country, a benchmark rate (the average of the market participants' rates).
56. These are South African bond indices.
57. Example from Pilbeam, 1998.
58. With some assistance from Saunders and Cornett, 2001. They also assisted with the currency option example.
59. This is approximate because the market index could have differed from the SIV.
60. See www.jse.co.za
61. https://securities.standardbank.co.za/ost/nsp/BrochureWarepublic/Ost/products/warrants.html
62. See https://www.warrants.standardbank.co.za/proxy/warrants/docs/ProductBrochures/CRW%20Brochure-Final.pdf
63. See: https://securities.standardbank.co.za/ost/nsp/BrochureWarepublic/Ost/products/warrants.html (Accessed 12 01 2012).

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64. Example from Pilbeam, 1998.
65. Example from Pilbeam, 1998.
66. See Pilbeam, 1998 and Hull, 2000.
67. Not always though; it depends on credit enhancement facilties.
68. There are other requirements as well, such as a liquidity requirement.
69. As high as 400 basis points above the AAA-rated paper (i.e. + 4%).
70. Definition from Hull (2000: 644)
71. Estimated by the British Bankers' Association at close to 40% of the market (in 1999).
72. Some contracts are also settled in cash.
73. Example much adapted from Lehman Brothers International (Europe), 2001.
74. Ibid.
75. Estimates by the British Bankers' Association in 1999.
76. See Applied Derivatives Trading Magazine (November 1998).
77. See: http://www.financialmarketsjournal.co.za/1stedition/printedarticles/printweatherderivatives.htm
78. Clemmons, L and Mooney, N (1999)
79. See: http://unfccc.int/essential_background/convention/items/6036.php
80. See: http://unfccc.int/essential_background/items/6031.php
81. See: http://unfccc.int/essential_background/kyoto_protocol/items/6034.php
82. See: http://unfccc.int/resource/docs/publications/08_unfccc_kp_ref_manual.pdf
83. See http://en.wikipedia.org/wiki/Carbon_credit
84. See: http://en.wikipedia.org/wiki/Carbon_credit
85. See: http://www.olympicvessels.com/derivatives.php
86. An estimated mid-price of the bids and offers of brokers at 17.30.
    See: http://www.balticexchange.com/default.asp?action=article&ID=5133 (Accessed 19 01 2012).
87. See: http://www.balticexchange.com/default.asp?action=article&ID=35 (Accessed 15 01 2012).
88. See: http://www.economist.com/node/16846627 (Accessed 12 01 2012).
89. See: http://www.clarksonsecurities.com/ (Accessed 12 01 2012).

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