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.

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.

- 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.

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.

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).

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.

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

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).

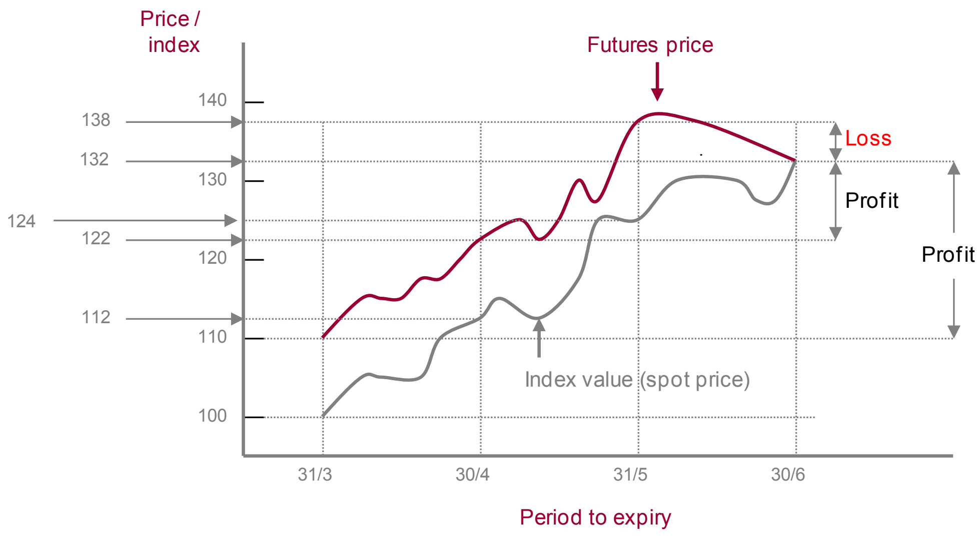

Figure 2: example of a 3-month future (index)

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.

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].

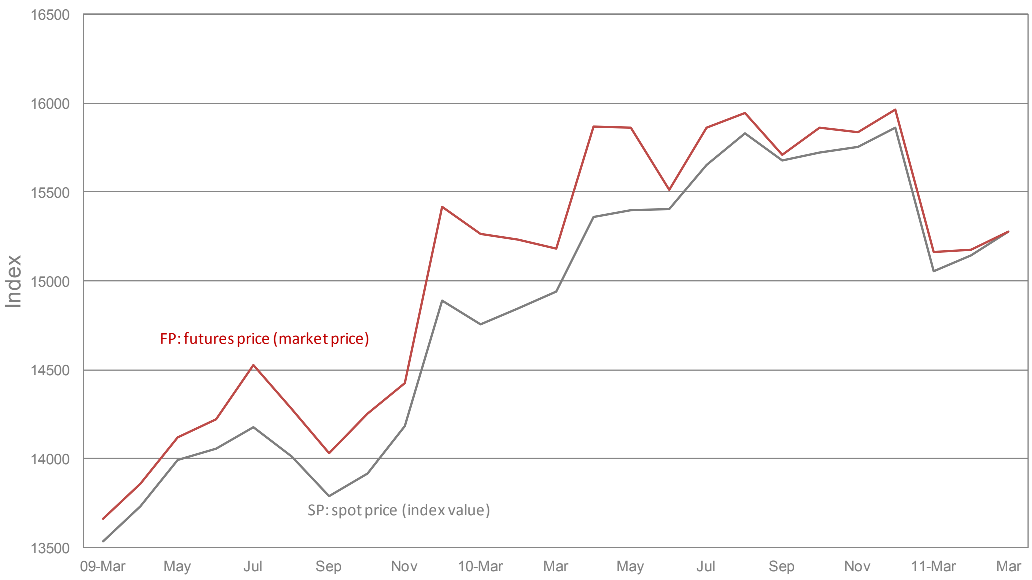

Figure 3: March 2011 all share index (ALSI) future

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).

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

3.7 Organisational structure of futures markets

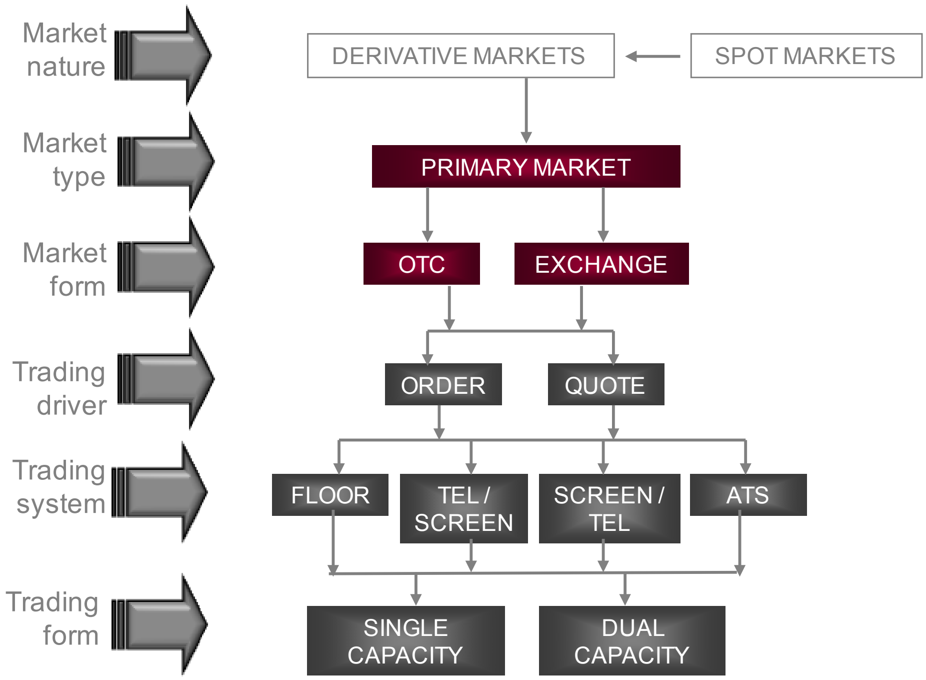

Figure 4: organisational structure of derivative financial markets

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).

- 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.

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.

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).

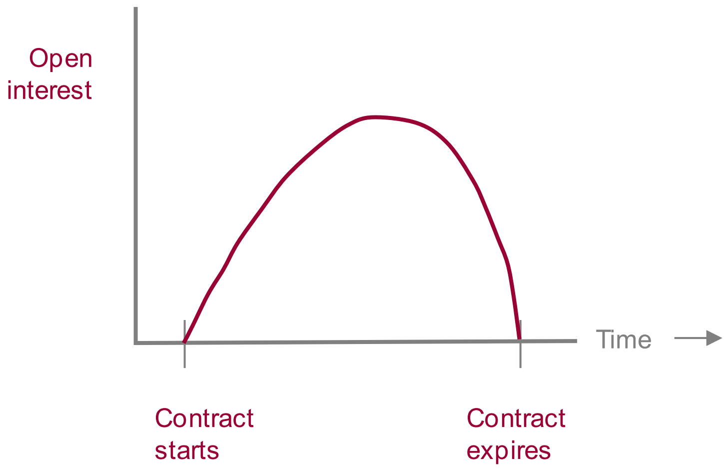

Figure 5: open interest

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.

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).

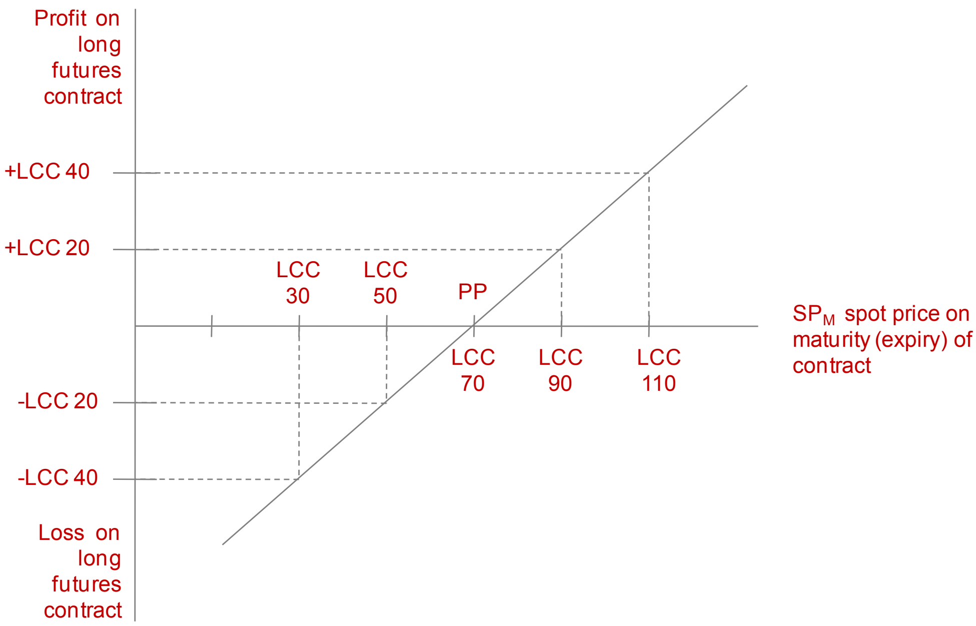

Figure 6: payoff with long futures contract (risk profile)

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).

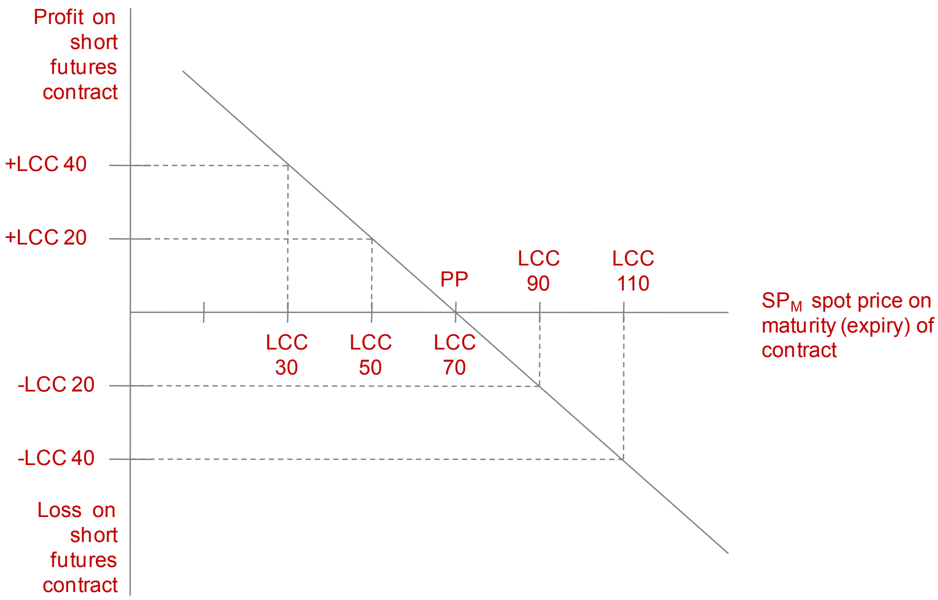

Figure 7: payoff with short futures contract (risk profile)

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 × [(rfr – I) × 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).

Thus, in the case of financial futures:

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

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

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

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

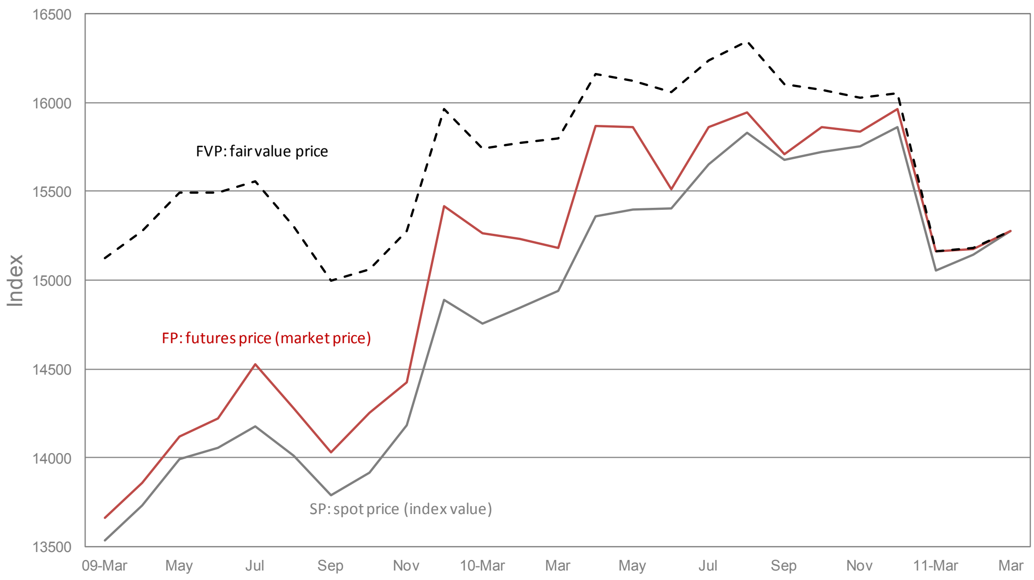

Figure 8: March 2011 all share index (ALSI) future

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.

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.

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).

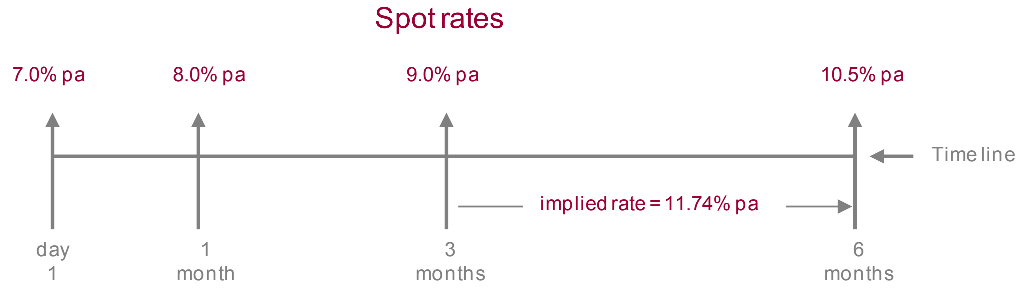

Figure 9: JIBAR spot rates and implied rate

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):

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

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)

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

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.

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]) 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.

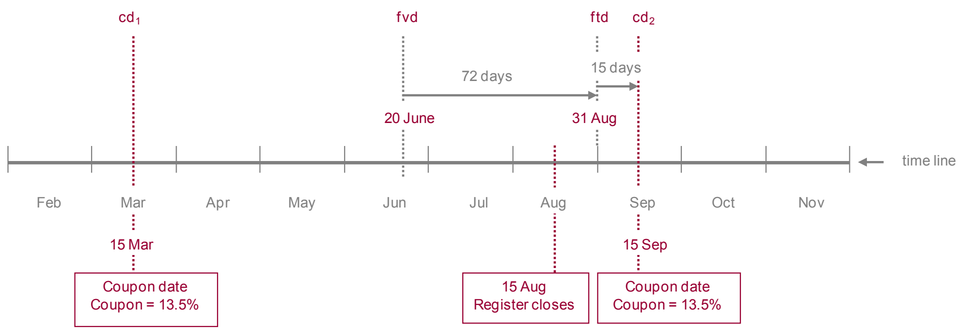

Figure 10: example of individual bond future

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.

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

FVP (per ton) = SP + CC
= SP + [SP × (rfr × t)] + (SC × dte)
= SP × [1 + (rfr × t)] + (SC × dte)
= 2732.20 × [1 + (0.075 × 174 / 365)] + (0.36 × 174)
= 2732.20 × 1.03575 + 62.64
= 2829.88 + 62.64
= LCC2 892.52

FVP (per contract) = 100 × 2892.52
= LCC289 252.00.

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:

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

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.

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 × {[1 + (ir_{vc} × t)] / [1 + (ir_{bc} × t)]}

= USD 1.5 × {[1 + (0.055 × 182 / 365)] / [1 + (0.085 × 182 / 365)]} = USD 1.5 × (1.027425 / 1.042384)
= USD 1.5 × 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.

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.

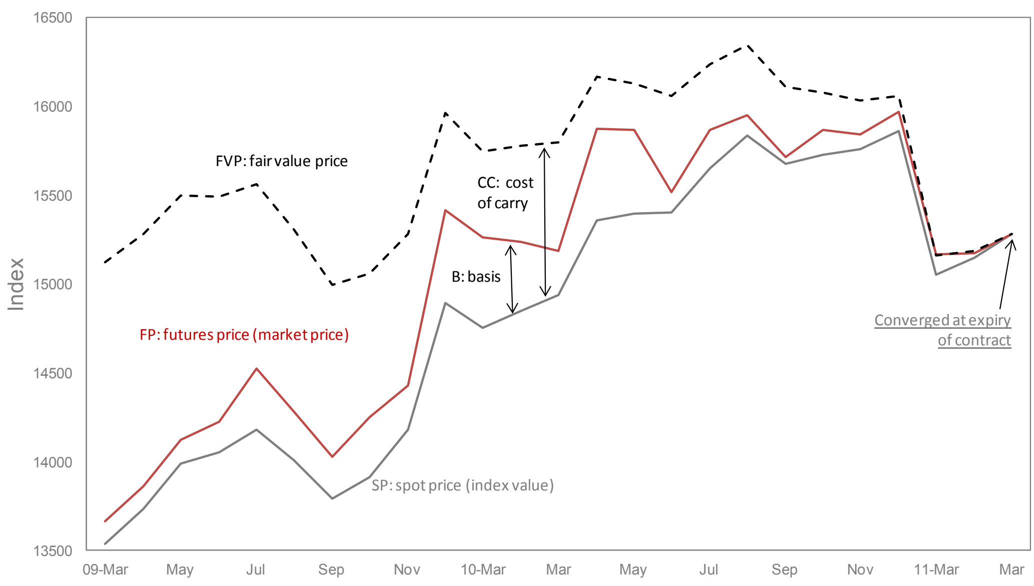

Figure 11: basis, carry cost & convergence

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

$$FVP = SP + CC,$$

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

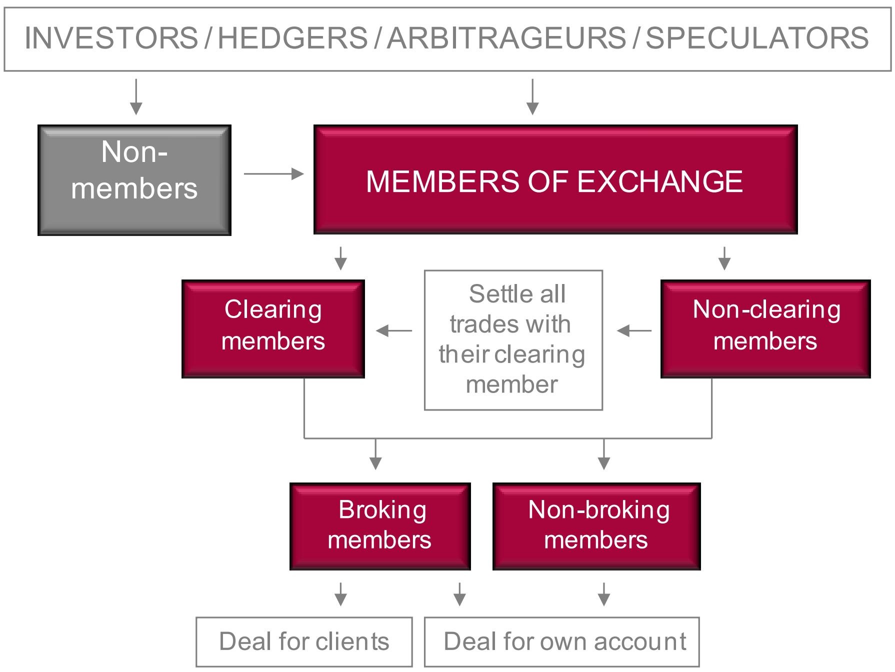

Figure 12: participants in the futures market

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.

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.

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.

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).

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]

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

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

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.

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.

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

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

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.

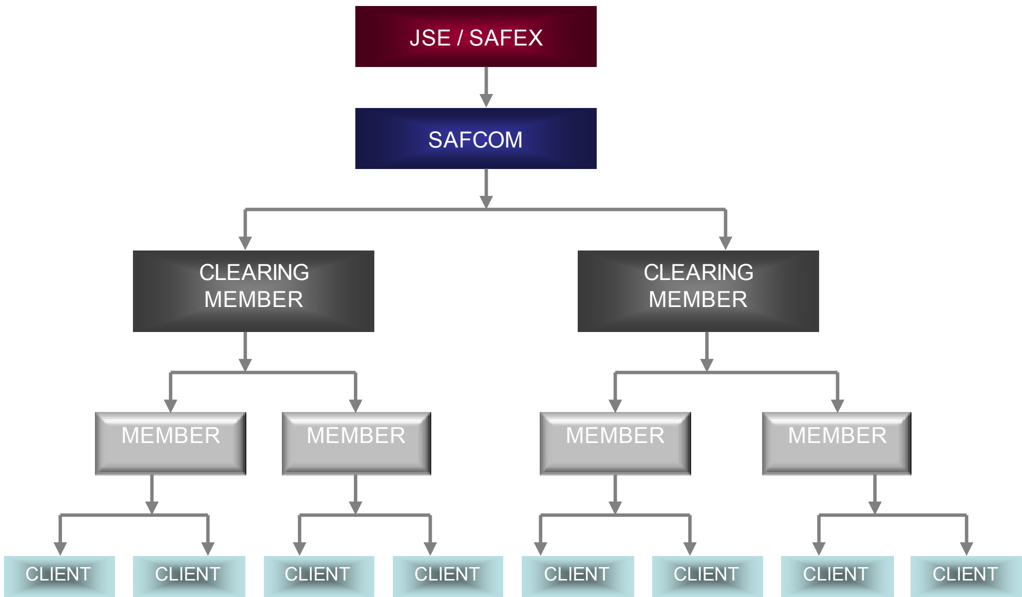

Figure 13: risk management by Safex

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.

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.

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.

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.

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.

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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