6 Derivative instruments

6.1 Learning objectives

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

- Describe broadly the money market derivative instrument markets.
- Broadly describe each of the money market derivative instruments.

6.2 Introduction

Earlier we defined the money market as encompassing:

- 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 non-marketable debt (NMD) securities and marketable debt (MD) securities].
- The cb2b IBM and the b2bc IBM where monetary policy is played out and interest rates have their genesis (i.e. where repo is implemented).
- The b2b IBM where the repo rate has its secondary impact, i.e. on the interbank rate.
- The money market derivative markets (= an addendum).

We are concerned with the latter in this text. Before we get to the instruments, a few words on derivative instruments in general are required.

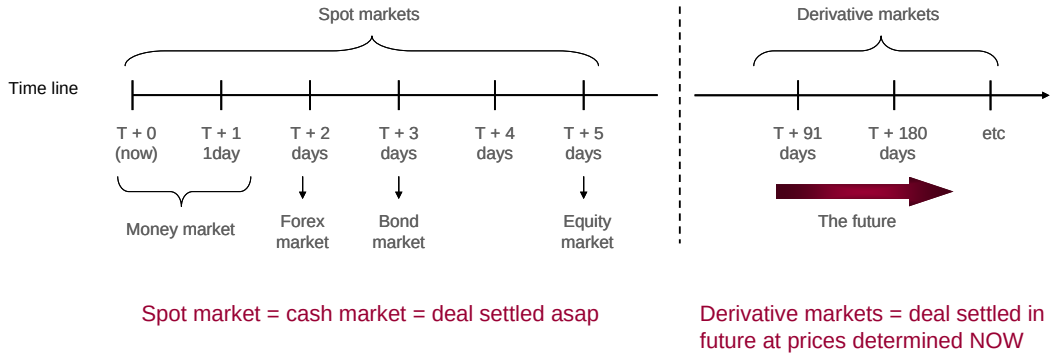

Figure 1: financial markets: spot & derivatives

In the spot (also called cash) markets transactions (deals) are settled as soon as is practically possible. In most countries spot market deals are settled as indicated in Figure 1. In the derivative markets deals are done now (on T+0) but they are settled on dates other that spot settlement dates – usually many weeks or months (or even years) into the future. For example if one sells a future the deal is struck now at a price determined now for settlement in 90 days' time. In the case of an option the deal is done now but settlement *may* take place between now and 120 days into the future, depending on the strike price which is stipulated now.

There are many types of derivatives; they are categorised in Figure 2. These instruments are found in all the instruments / prices / rates in all the markets: money market, bond market, equity market, foreign exchange market and commodities markets.

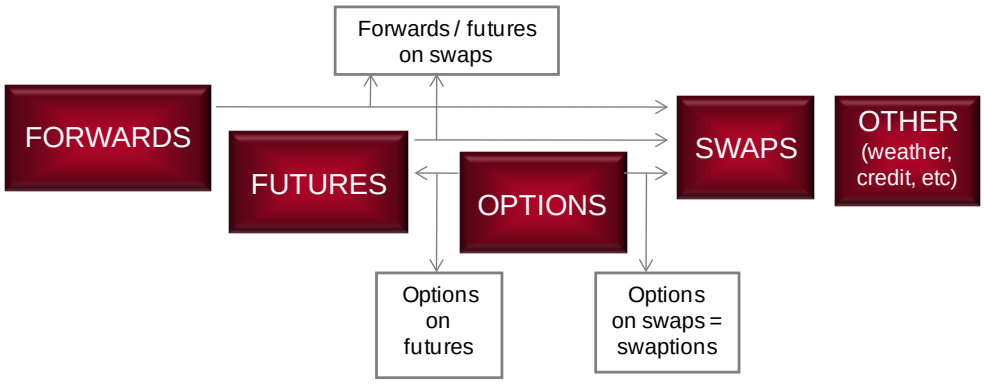

Figure 2: derivative instruments / markets

Derivatives instruments are called *derivatives* because they are "derived" from the spot-settled instruments of the various markets, i.e. they cannot exist without these *underlying* instruments or indices based on them. The values of the derivatives change as their underlying instruments change in value.

The money market derivative instruments that adorn the landscape of many money markets around the world are:

- Forwards:
  - forward interest rate contracts
  - repurchase agreements
  - forward rate agreements.
- Money market interest rate future.
- Interest rate swaps.
- Options:
  - interest rate caps and floors
  - money market options.
- Derivatives on derivatives.

It is to be noted that this text serves as a mere introduction to the money market derivatives.

6.3 Forwards

6.3.1 Forward interest rate contracts

A forward interest rate contract (FIRC) is the sale / purchase of a debt instrument on a pre-specified future date at a pre-specified rate of interest. An example is probably the best way to describe this derivative. A FIRC deal usually contains details as follows (see also Figure 3):

- 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.

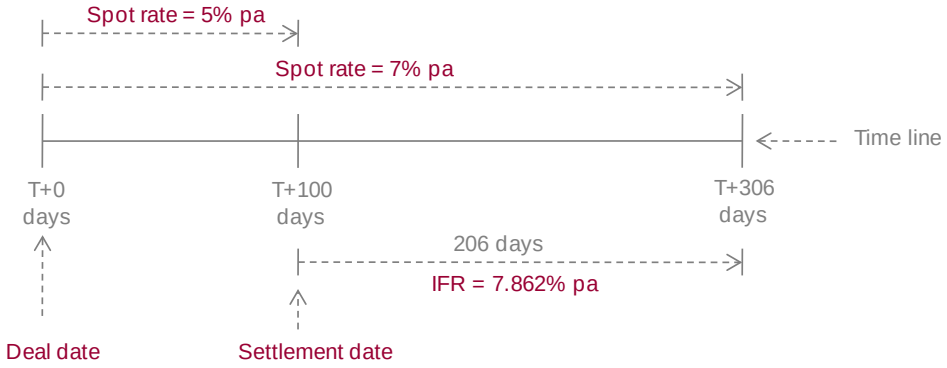

Figure 3: example of forward interest rate contract

An insurance company requires a LCC 100 million (plus) 206-day 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 – T+0)

It approaches a dealing bank and asks for a forward rate on LCC 100 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 these existing rates. This involves the calculation of the rate *implied* in the existing spot rates, i.e. the *implied forward rate* (IFR):

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

where

ir_L = spot interest rate for the longer period (306 days) = 7% pa
ir_S = spot interest rate for shorter period (100 days) = 5% pa
t_L = longer period, expressed in days / 365 = 306 / 365
t_S = shorter period, expressed in days / 365 = 100 / 365.

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

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 206-day NCDs to the insurer at 7.862% pa after 100 days.

The financial logic is as follows[50]: the dealing bank could buy a 306-day NCD from another bank at 7% pa 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 LCC 100 million 306-day NCDs at the spot rate of 7.0% pa. The interest amount = 7.0 / 100 × LCC 100 000 000 × 306 / 365 = LCC 5 868 493.15.
2. The maturity value (MV) of the investment = cash outlay + interest for the period = LCC 100 000 000 + LCC 5 868 493.15 = LCC 105 868 493.15.
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 LCC 100 million NCDs at market value (LCC 100 million) for a period of 100 days at the market rate of interest for money for 100 days (5% pa).
4. After 100 days, the bank pays the "carrier" of the NCDs interest for 100 days at 5.0% pa on LCC 100 million = LCC 100 000 000 × 5.0 / 100 × 100 / 365 = LCC 1 369 863.01.
5. The bank now sells the NCDs to the insurer at the IFR of 7.862% pa. The calculation is: MV / [1 + (IFR / 100 x days remaining to maturity / 365)] = LCC 105 868 493.15 / [1 + (7.862 / 100 × 206 / 365)] = LCC 101 370 498.00.
6. The insurer earns MV – cash outlay for the NCDs = LCC 105 868 493.15 – LCC 101 370 498.00 = LCC 4 497 995.10 for the period.
7. Converting this to a pa interest rate: [(interest amount to be earned / cash outlay) × (365 / period in days)] = [(LCC 4 497 995.10 / LCC 101 370 498.00) × (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 module.

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 (exchange-driven) and the risk lies between the two parties. It is for this reason that the FIRC market is the *domain of the large players*, and these are the large banks, and the institutions[51].

6.3.2 Repurchase agreements[52]

A repurchase agreement (repo) is a contractual transaction in terms of which an existing security is sold at the market value (or higher) of the security at an agreed rate of interest, coupled with an agreement to repurchase the same security on a specified, or unspecified, date in the future. The parts of this definition require further elaboration.

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. Underlying all repos is the ISDA[53] Master Repurchase Agreement, i.e. an internationally recognised repo contract.

An example will be useful (see Figure 4):

A small bank has in portfolio a 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 for 70 days. 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 applicable rate is the price of money for 70 days (the risk-free rate plus a premium reflecting the quality of the maker of the repo and the NCD).

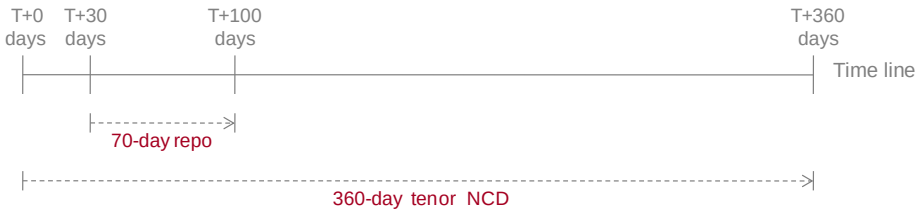

Figure 4: example of 70-day repo in NCDs

There are two main types of repos: the *open repo* and the *fixed term repo*. 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 / benchmark of which is agreed in advance.

Fixed term repos are agreements where the rate and the term are agreed at the outset of the agreement. The terms of repos usually range from a day to a few months. The repo markets in most countries far outweigh the spot money markets.

Repos are dealt on a yield basis, i.e. the interest is calculated on an add-on basis (single payment at end of period). The termination value (TV), which is the future value (FV) of the transaction, is calculated as follows:

$$TV\ (FV) = MV \times [1 + (ir \times t)]$$

where

MV = market value (= PV) of the underlying securities
ir = agreed interest rate pa expressed as a unit of 1
t = term of the agreement in days / 365

If in the above example the bank sold LCC 105 million (= maturity value) NCDs for LCC 100 million (= MV = PV) for 70 days at the 70-day repo rate of 8.55% pa, the TV is:

$$\begin{aligned} TV\ (FV) &= MV \times [1 + (ir \times t)] \\ &= LCC\ 100\ 000\ 000 \times [1 + (0.0855 \times 70 / 365)] \\ &= LCC\ 100\ 000\ 000 \times (1.0163972603) \\ &= LCC\ 101\ 639\ 726.03 \end{aligned}$$

The bank receives LCC 100 000 000 at the start date of the repo and pays the buyer of the repo LCC 101 639 726.03 after 70 days. Clearly the interest amount is LCC 1 639 726.03 [LCC 100 000 000 × (0.0855 × 70 / 365)].

6.3.3 Forward rate agreements

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 some time 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.

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 is depicted in Figure 5.

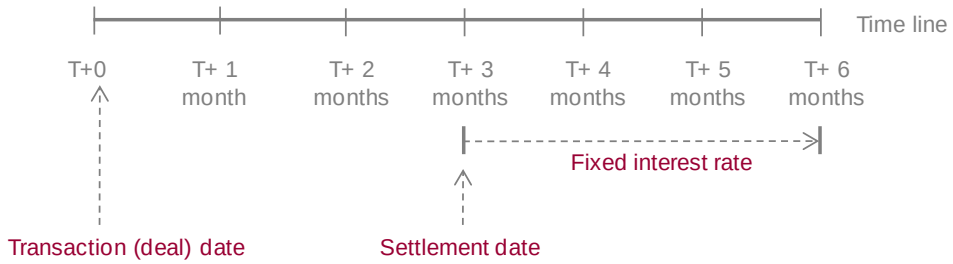

Figure 5: 3 x 6 FRA

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 repo rate and that the interest rates on commercial paper (CP – his borrowing habitat) will rise sharply. He needs to borrow LCC 20 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[54].

TABLE 1: FICTIONAL FRA QUOTES

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

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 LCC 20 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 LCC 20 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 IBAR[55] rate, which is a yield rate.

On settlement date, i.e. 4 June, the 3-month IBAR rate is 10.50% pa. On this day the 3-month (91-day) CP rate is also 10.50% pa (which it should be because the IBAR rate is representative of the 3-month rate). The company borrows the LCC 20 million required at 10.50% through the issue of CP 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 IBAR = 10.50% pa) and the agreed FRA rate (i.e. 10.10% pa) times the notional amount. This is calculated as follows:

SA = NA x ird x t

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 = LCC 20 000 000 × 0.004 × (91 / 365)
= LCC 19 945.21.

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:

$$df = 1 / [1 + (rr \times t)]$$

where

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

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

Therefore (PVSA = present value of settlement amount):

$$PVSA = SA \times df$$
$$= LCC\ 19\ 945.21 \times 0.97449$$
$$= LCC\ 19\ 436.41$$

This transaction is illustrated in Figure 6. It will be evident that the exchange of interest on LCC 20 million does not take place; the dealing bank only settles the difference.

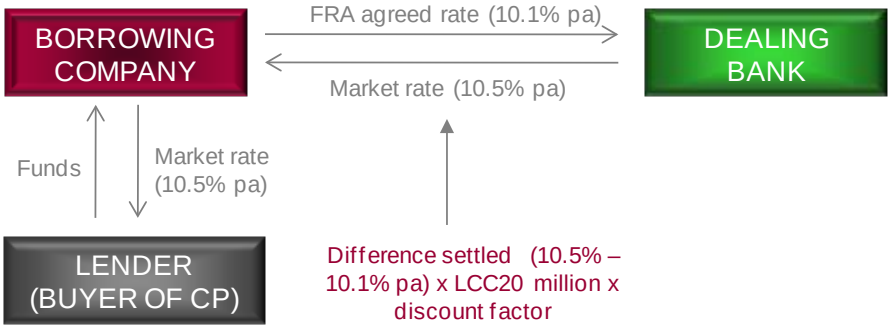

Figure 6: example of FRA: bank settles difference

6.4 Money market interest rate future

A future (correct terminology: futures contract) is an obligation to "buy" or "sell" a standard quantity and quality of an asset [which can be a notional asset (a share index), a financial asset (a specific share) or a commodity (maize)] on a specified date in the future, at a price determined at the time of making / transacting in the contract.

All futures markets are exchange-driven, and the exchange guarantees the futures contracts in the form of interposing itself between the buyers and the sellers in all transactions (see Figure 7).

Figure 7: participants in futures deal

An example of a money market interest rate future is the fictitious *3-month IBAR interest rate future* listed on the exchange of Local Country. The features of this future are shown in Table 2. [The theoretical price or fair value price (FVP) is determined from the calculated *forward-forward rate* (which is also called the *implied forward rate*)].

TABLE 2: SPECIFICATIONS OF THE 3-MONTH IBAR FUTURE	
UNDERLYING INSTRUMENT (CONTRACT BASE)	The 3-month Interbank Agreed Rate (IBAR)
CONTRACT SIZE (NOTIONAL)	LCC 100 000 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	LCC 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 IBAR on expiry
INITIAL MARGIN	LCC 100 per contract
Source: example adapted from the South African 3-month JIBAR interest rate contract listed on the JSE.	

Money market futures are used to hedge money market positions / investments and to speculate on future interest rate movements.

6.5 Interest rate swaps

An interest rate swap (IRS) is a transaction (agreement) that involves the swapping (exchanging) of interest rate obligations by two parties. In an interest rate swap one party has a fixed rate obligation and the other a floating rate obligation, and there are two different kinds of debt instruments involved. No principal amount is exchanged. Only the interest rate obligation is exchanged, and these are based on a notional amount. The circumstances that give rise to interest rate swaps usually involve interest rate risk or a comparative rate advantage. The following swaps may be identified:

- IRS that transforms a liability.
- IRS that transforms an asset.
- Comparative rate advantage IRS.

An example of an IRS used to transform a liability is presented in Figure 8. In this example Company A has borrowed LCC 100 million through the issuing of 91-day CP (which is re-priced every 91 days at the then prevailing rate), while Company B has borrowed LCC 100 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 (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.

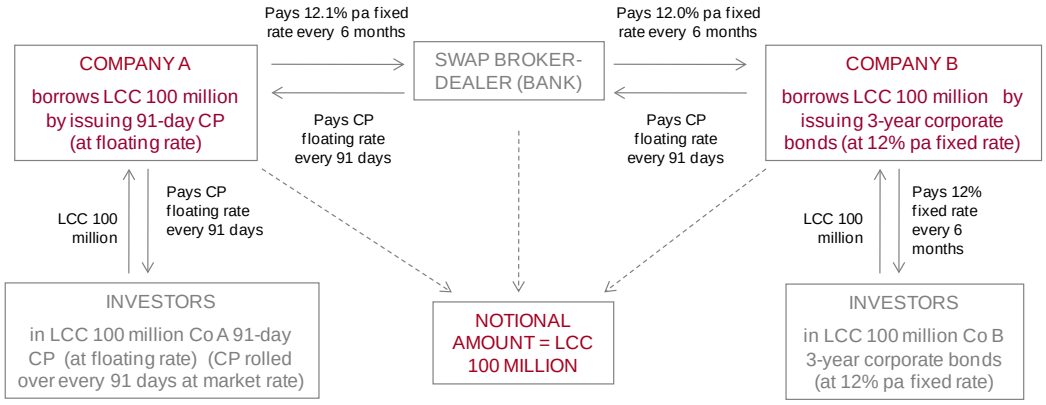

Figure 8: interest rate swap: transforming a liability

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 CP rate every 91-days
- the notional amount of the swap is LCC 100 million.

Company B

- Company B and the bank enter into an interest rate swap agreement
- Company B agrees to pay the bank the CP 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 LCC 100 million.

The deals are agreed. Company A's obligation to pay the 91-day CP rate to the holders (which may be different in each rollover period) is matched by the bank's payment of the 91-day CP rate to it. It is then left 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 CP 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 (LCC 100 000 per annum excluding compounding and PV calculations).

6.6 Options

6.6.1 Interest rate caps and floors

An interest rate cap (or protected interest rate agreement) is an agreement between a party (usually a bank) and a corporate borrower with a *floating rate debt obligation* to *cap* the borrowing rate. The bank undertakes to *cap* the floating interest rate at a particular level over an agreed period in exchange for a premium (price). In terms of the agreement the bank *undertakes to pay any interest amount in excess of the agreed interest*. An example will elucidate:

Index (reference)	= 91-day BA rate
Term:	= 1 January 2001 to 31 December 2002
Cap level (strike)	= 12% pa
Amount (notional)	= LCC 100 million
Premium:	= LCC 1 million (1% of amount).

This agreement would typically be done by a borrower who has invested in a project that is expected to be profitable at a cost of borrowing not exceeding 13% pa (i.e. the cap level of 12% pa plus the premium which equates to a rate of 1% pa). Thus, the highest interest rate that would be paid by the borrower is 13% pa, but the borrower benefits should the BA rate remain below 12% pa.

The converse of the cap is the interest rate floor, which determines a minimum rate level, and a combination of the purchase of a cap and the sale of a floor is termed a *collar*.

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.

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 benchmark rate such as the fictitious IBAR mentioned earlier). 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 to the seller.

It is perhaps best to elucidate a cap with the assistance of an example (see Figure 9): *borrowing company buys a T3-month – T6-month cap:*

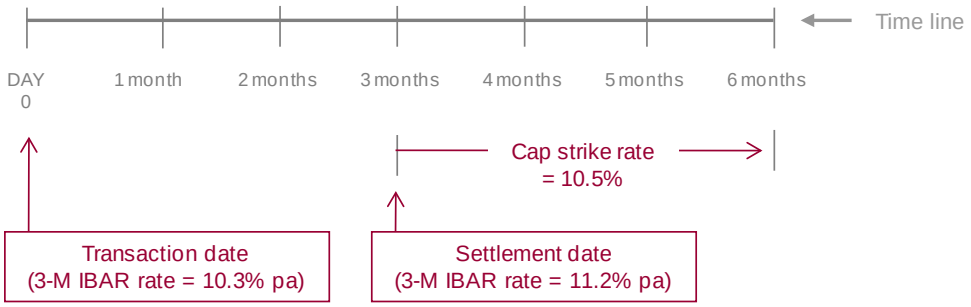

Figure 9: example of T3-month –T6-month cap

A company needs to borrow LCC 20 million in 3 months' time for a period of 3 months, and is concerned that rates are about to rise sharply. The present 3-month market rate (IBAR 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% pa, i.e. the 3-month IBAR 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.

If the IBAR rate (= market rate on CP, the borrower's borrowing habitat) in 3-months' time (i.e. settlement date), is 9.3%, the company will allow the cap to lapse and instead will borrow in the market at this rate by selling (issuing) CP. The total cost to the company will be the 9.3% interest plus the premium paid for the cap:

Cost to company = (C × ir × t) + P

where

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

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 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 IBAR 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.

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:

Cost to company = (C × ir × t) – (SA – P)
= (LCC 20 000 000 × 0.112 × 91 / 365) – (LCC 9 901.11)
= LCC 558 465.75 – LCC 9 901.11
= LCC 548 564.64

Total interest rate paid = (LCC 548 564.64 / LCC 20 000 000) × (365 / 91)
= 0.0274282 × 4.010989
= 0.110001
= 11.00% pa.

6.6.2 Money market options

An option is defined as a contract that imparts to the holder (buyer) the right, without the obligation, to buy from (in the case of a call option) or to sell to (in the case of a put option) the writer of the option, an asset / security on which the contract is written, on or before a specified date in the future.

The money market options market has three sub-markets:

- Options on specific securities.
- Options on the interest rate future.
- Swaptions.

Options on specific securities, as the name suggests, are options to buy (call options) or sell (put options), for example, the 91-day treasury bill. In most countries the options market (on money market assets) is limited. This market is generally an OTC market.

6.7 Derivatives on derivatives

There are a number of derivatives on other derivative instruments in many of the money markets of the world. Examples are:

- Forwards on swaps.
- Options on interest rate futures.
- Swaptions (options on swaps).

6.8 Summary

There are five main derivative categories: forwards, futures, swaps, options, and "other" (weather derivatives, credit derivations etc). Money market derivatives are found in the first four categories.

Essentially, derivatives are obligations or options to buy or sell real / notional securities / commodities on dates in the future other than spot settlement dates.

The money market derivatives are:

- Forwards:
  - forward interest rate contracts
  - repurchase agreements
  - forward rate agreements.
- Money market interest rate future.
- Interest rate swaps.
- Options:
  - interest rate caps and floors
  - money market options.
- Derivatives on derivatives (forwards on swaps, options on interest rate futures and swaptions).

6.9 Bibliography

Faure, AP, 2007. **The derivative markets**. Cape Town: Quoin Institute (Pty) Limited.