ISMA CENTRE - THE BUSINESS SCHOOL OF THE FINANCIAL MARKETS

UNIVERSITY OF READING
ENGLAND

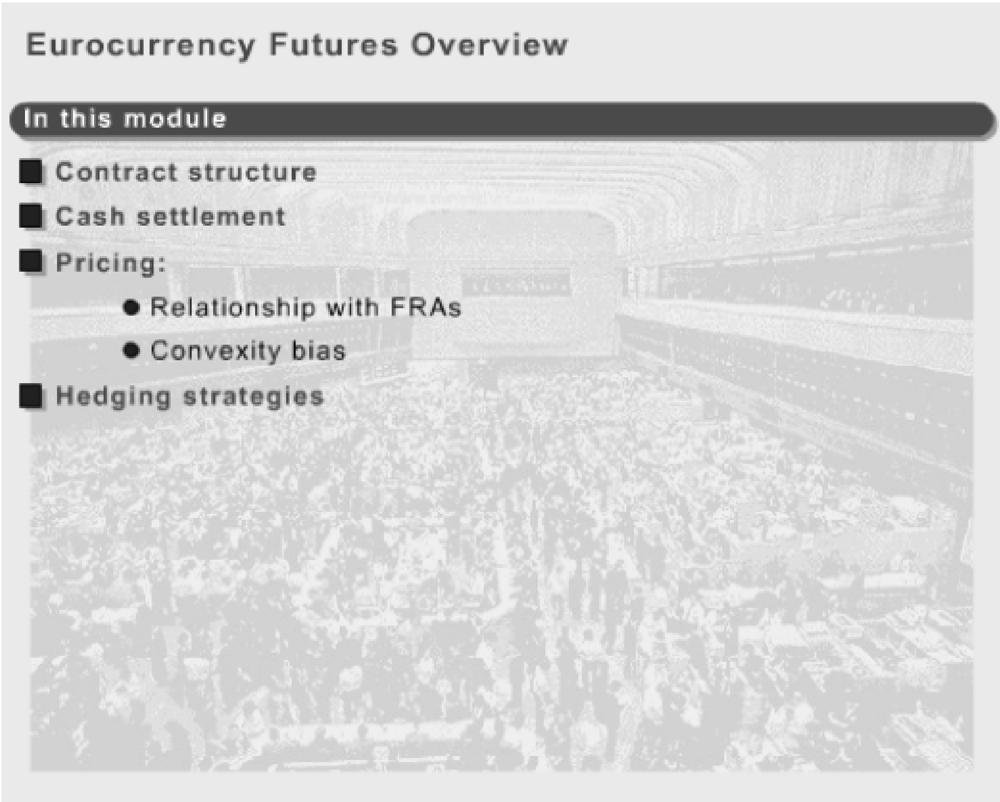
IFID Certificate Programme

Rates Trading and Hedging

Short Interest Futures

Table of contents

1. Overview



In this module we focus on the specific features and applications of the Eurocurrency futures contract. We describe how the contract is cash-settled at maturity and explain the relationship between the price of this contract and the cash LIBOR curve.

Learning Objectives

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

1. - Describe the structure and delivery settlement of the most commonly traded interest rate futures contracts

2. - Explain how the interest rate futures contract may be used to:
    - Take positions on short term rates
    - Hedge exposures to short term rates

3. - Explain the theoretical relationship between interest rate futures prices and the cash LIBOR curve

2. Definition

2.1. Example

Below is the definition of one of the most liquid interest rate futures - the three month Eurodollar futures traded in the International Monetary Market (IMM) at CME.

Contract	CME Three Month Eurodollar Interest Rate Futures
Unit of Trading	USD 1,000,000
Delivery Months	March, June, September, December
Delivery Day	Third Wednesday of Delivery Month
Last Trading Day	11:00 (London) two business days prior to Delivery Day
Quotation	100.00 minus rate of interest
Minimum Price Movement (Tick Size)	0.01% (one basis point)
Tick Value	USD 25.00
Trading Hours	07.20 - 14.00 (Chicago)

The price in this market is quoted not as an interest rate but as 100 minus the implied interest rate. This may seem a little strange, but the original intention was to make the contract behave like the 91-day Treasury bill futures, which had already been successfully introduced at CME (in bill futures the traded price is 100 less a discount rate).

The price quotation makes the Eurocurrency contract behave like a security: its price will rise when interest rates fall and vice-versa.

Unit of Trading and Tick Value

Interest rate futures contracts in other currencies differ from the Eurodollar contract mainly in terms of:

- **Unit of trading**: for example the Eurosterling contract is for GBP 500,000
- **Tick value**: The tick size is universally 0.01% but the tick value depends on the Unit of Trading

$$\textbf{Tick value} = \frac{\textbf{Tick size}}{\textbf{(100 x 4)}} \times \textbf{Contract size}$$

Example
The minimum tick size is 1 basis point, so the tick value represents approximately the interest amount gained or lost on a three month deposit as a result of a 0.01% change in the rate. For the Eurodollar contract the Tick value is:

$$\frac{0.01}{100} \times \frac{90}{360} \times 1{,}000{,}000 = \textbf{USD 25.00}$$

2.2. Delivery Settlement

In the early days this contract used to be physically settled: the longs had to place USD 1 million on a three month deposit with a bank designated by the exchange. Very soon the system was changed to **cash settlement**: at the expiry of the contract all remaining open positions are marked to market and closed at the **Exchange Delivery Settlement Price** (EDSP).

The EDSP for the Eurocurrency futures contract is based on an average of the interest rates for three month Eurodollar deposits offered to prime banking names in London between 09.30 and 11.00 on the last trading day, stated by a random sample of 16 from a list of designated banks.

Having disregarded the three highest and three lowest quotes, the EDSP is 100.00 minus the average of the remaining 10 rates.

At expiry Futures price = 100 - Three month LIBOR

Example
The table shows a trading position in the three month Eurodollar futures (ED3) which is automatically closed at the contract's last trading day. (In this example we assume that the futures broker requires initial margin of USD 6,000 per contract.)

Date	Position	Profit / (Loss)	Cashflow Out ( ) / In +	Balance on Margin A/c
Thursday, 12 March	Long 5 MAR ED3 @ 9540	0.00	Initial margin = 6,000 x 5 = **(30,000)**	30,000 CR
	Settlement: 9510	(9510 - 9540) x 25 x 5 = **(3,750)**		26,250 CR
			Variation margin **= (3,750)**	30,000 CR
Friday, 13 March	Settlement: 9550	(9550 - 9510) x 25 x 5 = **5,000**		35,000 CR
			Variation margin **= +5,000**	30,000 CR
Monday, 16 March *(last trading day)*	**EDSP = 3 Month LIBOR = 9590**	(9590 - 9550) x 25 x 5 = **5,000**		35,000 CR
			Margin back **= +35,000**	0.0 CR
Net (12 March to Expiry)		**6,250**	**6,250**	

There is no physical delivery of a USD 1 million deposit, just a cash payment whereby one party compensates another for the difference between the EDSP and the previous day's settlement price.

A Eurocurrency futures is a mutually binding contract between two parties to compensate each other in cash for movements in the three month LIBOR that will become effective at the contract's expiry.

For example, the MAR 2003 futures is a contract on a 3 month LIBOR:

- Fixed on Monday, 16 March (the last trading day)
- Effective on Wednesday, 18 March (the delivery day)
- Maturing on Thursday, 18 June

2.3. Prices

The figure below shows prices for just some of the Eurodollar contracts traded at CME. The Explanation below the table has a definition of key terms.

Three Month Eurodollar Futures

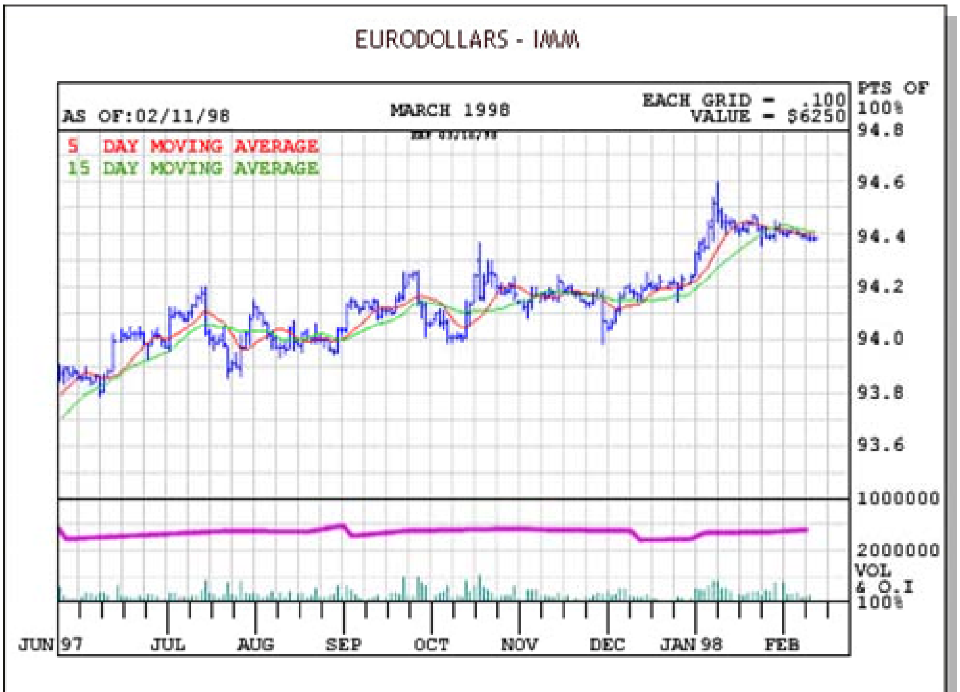
MTH/	--- SESSION ---					PT	EST	---- PRIOR	DAY ----	
	OPEN	HIGH	LOW	LAST	SETT	CHGE	VOL	SETT	VOL	INT
FEB98	94.375	94.375	94.37	94.375	94.375	UNCH	140	94.375	466	18026
MAR98	94.385	94.385	94.375	94.38	94.38	UNCH	15K	94.38	44203	474768
APR98	94.415	94.425	94.415	94.42	94.42	+1	210	94.41	1250	5550
JUN98	94.465	94.47	94.45	94.465	94.465	+1.5	40K	94.45	42260	405107
SEP98	94.405	94.49	94.46	94.48	94.48	+1.5	57K	94.465	63879	320497
DEC98	94.43	94.45	94.42	94.44	94.44	+2.5	28K	94.415	46074	275046
MAR99	94.44	94.46	94.43	94.44	94.44	+2	14K	94.42	23482	204260
JUN99	94.41	94.42	94.39	94.41	94.41	+3	10K	94.38	14815	169999
SEP99	94.37	94.38	94.35	94.37	94.37	+3	3705	94.34	9089	126243
DEC99	94.28	94.29	94.26	94.28	94.28	+3	3800	94.25	9914	130855
MAR00	94.27	94.28	94.25	94.27	94.27	+3	1440	94.24	8821	100091
JUN00	94.23	94.24	94.21	94.23	94.23	+3	1215	94.20	4677	78110
SEP00	94.19	94.20	94.18	94.20	94.20	+4	1080	94.16	3751	65783
DEC00	94.12	94.13	94.10	94.13	94.13	+5	840	94.08	3519	53536
MAR01	94.12	94.13	94.11	94.13	94.13	+5	855	94.08	4296	42059
JUN01	94.08	94.10	94.07	94.10	94.10	+6	720	94.04	3560	43545
SEP01	94.04	94.07	94.04	94.07	94.07	+6	800	94.01	3163	33541
DEC01	93.97	94.00	93.97	94.00	94.00	+6	770	93.94	2604	34217
MAR02	93.98	94.01	93.97A	94.00	94.00	+6	1120	93.94	1819	38220
JUN02	93.95	93.98	93.94A	93.97	93.97	+6	770	93.91	1923	36319
							EST.VOL		VOL	OPEN INT.
TOTAL							187590		293378	2803012

Explanation

Opening Price
The first price quoted or traded during a trading session. See also: Settlement Price

Volume
In a futures or options market, the total number of contracts traded during a session. In an OTC market, the amount traded over a given period of time. Volume figures are available from futures and options exchanges, but they are seldom reported in the OTC markets. Volume is a useful indicator of the amount of speculative interest, hence the character and stability of a market. See also **Open Interest**.

Open Interest
The number of futures or options contracts outstanding at a given time, calculated as the sum of all long or all short positions in all contracts of a given class. Open interest is a useful indicator of the amount of speculative interest, hence the character and stability of a market. See also **Volume**.
Nowadays in the Eurodollar contract there are 40 expiration months open for trading (10 years), but notice how open interest declines for the more distant contract months. Below is a price chart for the March 1998 contract.



3. Forward Rates

3.1. Definition

Forward rates are interest rates (or yields) which become effective (i.e. start accruing) at some specified future date.

Eurocurrency futures are essentially contracts on forward LIBORs. Like all derivatives, the price of a futures is derived from the price of an equivalent position in the underlying cash market – in this case the LIBOR market. The two markets – cash LIBOR and futures - are kept in line by powerful arbitrage forces.

Example - Quoting a Forward LIBOR

Date: 16 March 1998
Situation: Eurodollar cash deposit rates:
3 MTHS (92 days) 5.50 - 5.55
9 MTHS (275 days) 6.20 - 6.25

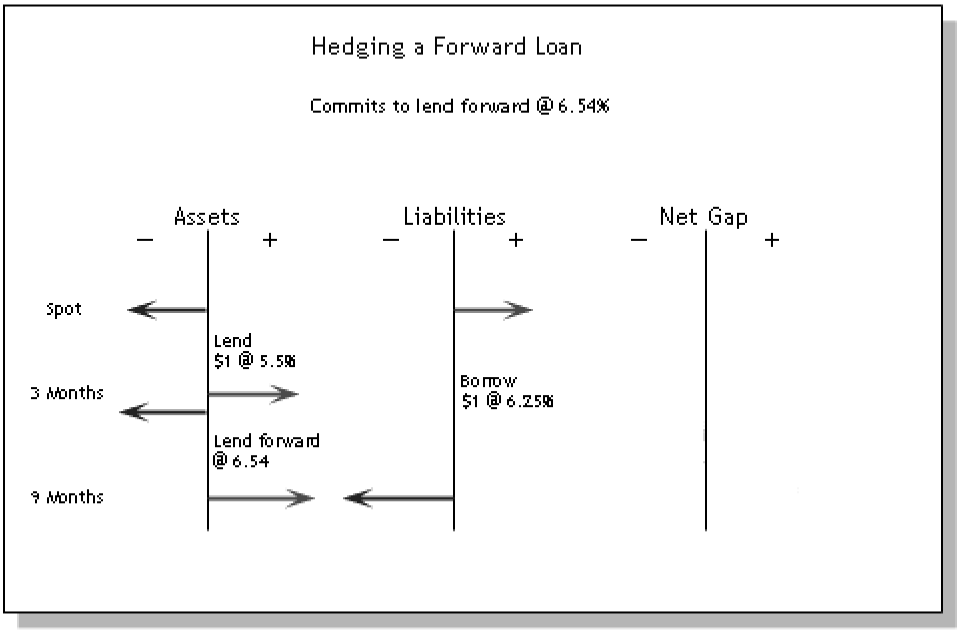
A deposit trader is asked to quote a rate for lending Eurodollars for a period of 6 months, commencing in three months' time - i.e. a 3X9 forward LIBOR.

? How should the trader quote, and at the same time cover his exposure?

Strategy:
Create a forward gap:

- Borrow funds for 9 months
- Deposit the proceeds for 3 months

The breakeven rate quoted for the 3X9 forward loan should be such that the interest earned on the 3 month deposit, plus the interest earned on the forward loan, just cover the cost of borrowing for 9 months. The dealer's position is depicted below.



3.2. General Formula

Below is the formula for calculating the breakeven forward rate (see Spot and Forward – Forward Yields for the calculation of forward yields bond market style).

Forward Interest Rates (Money Market Style)

Interest cost of funding = Interest earned on the investments

$(1 + R_{0XL} \times LD / Basis) = (1 + R_{0XS} \times SD / Basis) \times (1 + R_{SXL} \times FD / Basis)$

$$\text{Forward Rate } (R_{SXL}) = \left\{ \frac{(1 + R_{0XL} \times LD / Basis)}{(1 + R_{0XS} \times SD / Basis)} - 1 \right\} \times \frac{Basis}{FD}$$

Where:

R_{0XL} = Cash interest rate for the long date, in decimal (i.e. 5% is 0.05)
R_{0XS} = Cash interest rate for the short date, in decimal
R_{SXL} = Forward interest rate, in decimal
LD = Number of days to the long date
SD = Number of days to the short date
FD = Number of days in the forward contract period (FD LD - SD)
Basis = 360 or 365, depending on local day-count conventions.

Using the figures in our example on the previous page:

$$\text{Forward Rate} = \left\{ \frac{(1 + 0.0625 \times 275 / 360)}{(1 + 0.0550 \times 92 / 360)} - 1 \right\} \times \frac{360}{183}$$

$= 0.0654$ or **6.54%**

The 6.54% charged on the forward loan, plus the 5.50% earned on the first 3 months deposit exactly cover the cost of borrowing funds for 9 months at 6.25%.

Note:

- To calculate a forward LIBOR we take the long period LIBOR and the short period LIBID
- Therefore, to calculate the corresponding forward LIBID we would take the long period LIBID and the short period LIBOR

3.3. Exercise - Quoting a Forward LIBID

Question 1

Date: 16 March 1998
Situation: Eurodollar cash deposit rates:
3 MTHS (92 days) 5.50 - 5.55
9 MTHS (275 days) 6.20 - 6.25

Calculate the rate that a trader could quote for taking a 3X9 forward deposit (i.e. a LIBID rate).

a) Type your answer in percent to 2 decimal places in the box below.

3.4. Arbitrage Boundaries

The calculated forward rates in the examples in this section imply a bid-offer spread of 10 basis points. In practice, the difference between the price at which the futures is bid and the price at which it is offered in the market is just 1 or 2 basis points. This is because the futures is a much more liquid instrument than the underlying forward deposits.

However, the calculated forward LIBOR and LIBID define the boundaries within which the futures must trade. If the derivative was quoted outside those boundaries, then there would be an arbitrage opportunity. In our example:

- If the implied interest rate on a futures price was higher than the calculated breakeven forward LIBOR, a trader could:
    - Borrow cash from spot to the maturity of the future's notional 90 day deposit
    - Deposit the cash from spot to the effective date of the notional 90 day deposit
    - Buy the futures and lock in a profit on the rollover of the deposit

- If implied rate on a futures price was lower than the forward LIBID, the trader could:
    - Deposit cash from spot to the maturity of the future's notional 90 day deposit
    - Fund the cash from spot to the effective date of the notional 90 day deposit
    - Sell the futures and lock in a profit on the rollover of the funding position

In the next section we show how forward deposits are in fact priced off the futures contracts.

4. Applications

4.1. Example-Simple Hedge

Spot date: 16 September
Position: A Eurodollar deposit trader enters into the following transactions:

- Lent 6 month on a USD 20 million deposit
  16 September - 16 March @ 5 7/8%

- Funded for 3 months
  16 September - 16 December @ 5.1/2%

Scenario: After the trades are done there are rumours about a possible hike in interest rates, so the trader is worried about the cost of funding this position at the next rollover.

Strategy: Sell 20 DEC futures @ 9380 (implies LIBOR of 6.20%)

If rates do rise, futures prices should fall and the short futures position will return a profit, offsetting the trader's future funding costs.

- **The seller of an interest rate futures is a potential borrower of a three month fixed deposit at a rate of 100 minus the futures contract price**

- **The buyer of a futures is a potential investor in a three month fixed deposit at the same implied rate**

4.2. The Breakeven

To see how much the trader stands to lose if at the next rollover LIBOR rises, we need to calculate the **breakeven forward rate** on his current position. This is the rate (F) at which the second 3-month rollover should be fixed so that the trader does not lose money overall.

The trader carries an investment that yields a **positive net carry** of 3/8% over his current funding costs (= 5.875 - 5.50). Therefore, as a crude approximation he can afford to lose up 3/8% carrying the position during the second 3-month period.

Breakeven forward rate = Cash Price + Net carry
= 5.875 + (5.875 - 5.50)
= 6.25%

This is a crude calculation because it does not allow for the compounding of interest on the funding side. After the first 3 months interest is payable on the money borrowed and the trader will have to pay interest on interest during the second rollover, so the net carry benefit is less than it appears.

The exact breakeven rate is derived from the following relationship, which we developed in section *Forward Rates*, above:

Total return on deposit = Total cost of funding (both rollovers)

$$(1 + 0.05875 \times 181/360) = (1 + 0.055 \times 91/360) \times (1 + F \times 90/360)$$

$$F = \left[\frac{(1 + 0.05875 \times 181/360)}{(1 + 0.055 \times 91/360)} - 1 \right] \times \frac{360}{90}$$

= 0.06168 or **6.17%**

4.3. The Outcome

Date: Monday 14 December
Situation: Last trading day of the DEC futures and CME fixes the three month LIBOR at 6.50%.

DEC EDSP = 100 - 6.50 = 93.50

Analysis
The futures position was opened at 93.80 and is now closed at 93.50, down 30 ticks.

Profit on futures position = (9380 - 9350) x 25 x 20
= **USD 15,000**

On this date we assume the trader raises funds for another three months at 6.50%. Since his breakeven rate was 6.17%, the trader nets a loss of 33 basis points on the rollover.

$$\text{Net loss on cash position} = \frac{(6.50 - 6.17)}{100} \times \frac{90}{360} \times 20 \text{ million}$$

= **USD 16,500**

The hedge did not work perfectly because the futures price fell only 30 ticks, whereas the trader lost 33 on the underlying. But it worked pretty well and this should not be surprising:

Eurocurrency futures are driven by the forward LIBORs implied in the underlying cash deposit markets.

Practical Issues

Notice that in this example we have glossed over some awkward real-life complications:

- We assumed that the trader was able to raise three months cash at the same LIBOR against which the futures contract is settled, which may not be the case. Being cash-settled, the futures does not automatically cover the trader's liquidity needs - only his market risk. So the trader remains exposed to **liquidity risk**.

- We also assumed that the trader's exposure period coincided exactly with the dates of the LIBOR underlying the futures contract. More often than not the dates will not match, so the hedge may not work so precisely

5. The Futures Strip

The example below also illustrates the concept of the **futures strip**.

Example

Date: 15 April 2003
Situation: Client Inc. asks a deposit trader in London to quote an offer for a 2X8 months loan for USD 100 million. The fixing date will be 15 June and the settlement date 17 June.

Eurodollar Futures Prices
($1 million, tick size = $25.00)
JUN 93.46
SEP 93.15

? How should the trader quote and at the same time cover its exposure in the futures market?

Strategy
Sell the JUN-SEP futures strip: sell 100 JUN and 100 SEP contracts

Calculations
As a first step we establish the dates and the LIBORs implied in the futures strip:

Contract	Price	Implied LIBOR	Implied Dates
JUN	93.46	6.54	17 June - 16 September (91 days)
SEP	93.15	6.85	16 September – 16 December (91 days)

Next, we calculate the forward rate implied in this strip. Using a logic similar to the one we used to derive a zero-coupon rate from a set of forward rates (see Spot and Forwards Yields – Spot from Forward Yields), we can establish a relationship between a forward deposit rate and the rates implied in the corresponding futures strip:

Forward Rates and Futures Strips

Implied forward rate = Implied rate on futures strip

$$(1 + R_{SXL} \times FD / Basis) = (1 + R_1 \times D_1 / Basis) \times (1 + R_2 \times D_2 / Basis) \times ... \times (1 + R_n \times D_n / Basis)$$

Where:
R_{SXL} = Deposit rate for SXL months
R_i = LIBOR implied in the i^{th} futures contract
D_i = Number of days in the interest period covered by the i^{th} futures contract
FD = Number of days in the forward contract period ($FD = D_1 + D_2 + ... + D_n$)
Basis = 360 or 365, depending on local day-count conventions.

5.1. Applying the Pricing Formula

The principle behind this formula is that the total repayment amount on a loan for a term of FD days should be equivalent to the total repayment on a series of rolling shorter-dated loans. Applying this formula to our example:

$$(1 + R_{SXL} \times 182/360) = (1 + 0.0654 \times 91/360) \times (1 + 0.0685 \times 91/360)$$

$$\text{Forward rate } (R_{SXL}) = [(1 + 0.0654 \times 91/360) \times (1 + 0.0685 \times 91/360) – 1] \times 360/182$$

= 0.0675 or **6.75%**

This is the rate the deposit trader can quote on a break-even basis, if the position was hedged in the futures market.

Outcome: 15 June 2003

On this date market rates are as follows:

Futures		Eurodeposits	
JUN	9259	3 MTHS	7.35 - 7.41
SEP	9249	6 MTHS	7.47 - 7.53

? What is the trader's net profit/loss?

Analysis
The current 6 month LIBOR (7.53%) is higher than the contracted loan rate, so the trader loses money on this trade because he has to fund the client's position at more than the rate paid by the client. The loss on the loan is the present value of the difference between the rate that the client pays and the cost of funding the position.

However, this is also the last trading day on the JUN contract and its EDSP is calculated as 100 minus the 3 month LIBOR (100 - 7.41 = 92.59), so the position has made a profit. At the same time, since the dealer's funding cost has now been fixed the SEP futures is no longer needed so that position can be closed too, at a profit.

Loss on the loan $= \dfrac{(0.0675 - 0.0753) \times 100 \text{ million} \times 183/360}{(1 + 0.0675 \times 183/360)} =$ - USD 383,346

Profit on JUN futures	= (9346 - 9259) x 25 x 100	=	USD 217,500
Profit on SEP futures	= (9315 - 9249) x 25 x 100	=	USD 165,000
Net			**- USD 846**

The futures strip hedged the trader's forward deposit fairly closely, which is not surprising since prices in the two markets are closely linked. However, the relationship between the two markets is not always one-to-one, as in this example:

- Although the futures and the underlying LIBOR markets are well arbitraged, price disparities of the order of a few basis points do arise from time to time

- The dates on the futures strip may not match the forward deposit dates exactly

- Strictly speaking, hedging a USD 100 million position with a strip of 100 JUN plus 100 SEP contracts is not correct. The hedge should be **risk-weighted** using the basis point value (BPV) of the two instruments. The BPV of the Eurodollar futures is always $25 but the BPV of a $1 million forward 3-month LIBOR position is actually less than that, so slightly less than 100 contracts per delivery month are required to hedge the risk on this forward deposit.

  The construction of risk-weighted hedges using short interest futures is beyond the scope of the IFID syllabus.

- The PV of a position in a forward deposit displays convexity, just as the PV of a straight bond does (see module Interest Rate Risk - Convexity). On the other hand, short interest futures have zero convexity because their tick value is constant. This means that in practice there will be some disparity between the theoretical forward rates implied in the futures strip and the actual rates observed in the market. We shall discuss this **convexity adjustment** to forward rates further in module Interest Rate Swaps – Pricing.

6. Exercise

Question 2

Date: Monday 10 June

Situation
A corporate treasurer is informed by her sales department that her company will receive a payment of EUR 30 million for value 15 September, by way of advance on a supply order. The cash will be available for a period of six months, after which it will be required to purchase the necessary equipment.

Amid market talk of a possible cut in European interest rates, the treasurer is keen to lock into a forward deposit rate now. At this point she checks the latest futures prices.

Three Month Euribor Futures - EUR 25 per 0.01%

Month	Price	Delivery	Nr. days from today
JUN	96.35	16 June	6
SEP	96.25	15 September	97
DEC	96.10	15 December	188
MAR	95.96	15 March	279

a) Which trade would you recommend to the treasurer?

- ☐ Buy 30 SEPs
- ☐ Sell 30 SEPs
- ☐ Buy a strip of 30 SEPs and 30 DECs
- ☐ Sell 60 SEPs

b) If the futures order in a) was filled at the market prices shown, what would be the implied six month LIBOR achieved? Type in your answer in the box below, to 2 decimal places, and validate.

c) On 13 September, the last trading day of the SEP contract, EUR rates are as follows:

Cash Deposits
3 months 3 1/8 - 1/4
6 months 3 1/4 - 3/8

DEC Futures 96.59

What is the effective deposit rate achieved by the treasurer? Enter your answer to 2 decimal places.