Division of Research
Graduate School of Business Administration
The University of Michigan

JANUARY 1986

EURODOLLAR FORWARDS, SWAPS, FUTURES, AND OPTIONS

Working Paper No. 453

Gunter Dufey
University of Michigan

Ian Giddy
University of Michigan

Chapter Four

Eurodollar Forwards, Swaps, Futures, and Options

Contents

4.1 Eurodollar Interest Rate Risk Hedging Techniques

International corporations, banks and official agencies sometimes face anticipated short term future funding requirements, or anticipated temporary cash surpluses. Both expose the funds manager to the risk of interest rate changes from the present until the time when the borrowing or lending occurs. There are five ways in which such interest rate risk can be hedged.

=by mismatched maturities
=through a forward interest rate contract
=by entering into an interest rate swap
=by taking a position in interest rate futures
=by buying fixed interest options

Locking in a future interest rate through maturity mismatching is simple. Consider a corporate treasurer who anticipates in June that he will have funds on hand for some future period -- say, during July and August. He will borrow the same amount at a fixed rate now for a period ending on July 1. The borrowed funds are then placed in a fixed rate deposit maturing two months later, at the end of August. The funds that he obtains on July 1 will be used to repay the loan, while he still has money invested at a fixed rate and maturing when he needs it, at the end of August. Equally, if he instead anticipates needing money for a future period, he could borrow fixed rate money now for repayment at the end of August, and place the funds in a fixed interest deposit maturing on July 1. This will effectively lock in his future borrowing cost.

Some banks, knowing that they can do the above mismatching themselves (and more efficiently) and lock in their own future cost of funds, are willing to guarantee their borrowers a set-in-advance, future fixed borrowing rate. Depositors can similarly be offered a guaranteed rate. This is called a forward interest rate contract. Variations on it come with other names: forward forward, future rate agreement, and forward rate agreement.

While forward interest rate contracts are designed to hedge interest rate risk of relatively short maturities, for longer maturities when annual or periodic coupon payments must be made, the appropriate hedging technique is the interest rate swap. This entails an agreement to exchange fixed for floating interest payments, or to exchange floating payments linked to two different market benchmarks.

The best-developed market for hedging interest rate risk at present is the interest rate futures market. In principle,interest rate futures are similar to a forward interest rate contract, in that they are contracts for delivery of a certain fixed interest instrument, such as a bank certificate of deposit, at some future date and at a known rate. In practice they differ from forward contracts in important ways which we shall describe shortly.

Fixed interest options are like futures, in that they are exchange-traded contracts for future delivery of fixed interest instruments, but carry greater flexibility in that they provide the right, but not the obligation, to go through with the deal.

They can be particularly useful to firms that face contingent interest rate risk -- a future funding need or commitment that might, after all, not materialize if interest rates rise or fall beyond a certain level. Later we shall introduce a technique for using these options to hedge contingent Eurodollar interest rate risk.

4.2 Forward Interest Rate Contracts

A forward interest rate contract is an agreement between two parties to lock in a certain interest rate for a fixed period beginning at a fixed date in the future. In the past this technique has been used most commonly among banks in the London Eurodollar market. For some obscure reason the technique came to be known as a "forward forward."

A forward forward is a commitment on the part of one bank to deposit funds at an agreed interest rate at some date in the future in another bank, who also agrees to pay that rate. Thus the first bank commits itself not only to accepting the deposit rate, but also to accepting the credit risk of the second bank whatever the latter's condition at the future date. The second bank has locked in not only the rate but also the availability of funds.

Because a forward forward constitutes a 100 percent credit risk as well as a rate commitment, the market has not developed well and has rarely been available to nonbank borrowers wishing to lock in a cost of funds.

A major step forward was taken in the mid-1980s with the development of the Future Rate Agreement (FRA) contract, one which works through cash compensation for interest rate changes rather than through actual borrowing or lending of funds. This feature allows much -- but not all -- of the credit risk to be eliminated.

A Future Rate Agreement (FRA) is a contract between two parties to fix a future interest rate at a specified level for a specified future period. One party fixes its lending rate, while the other fixes its borrowing rate. If, at the start of the specified period, the market rate turns out to be different from the fixed-in-advance rate, the "losing" party compensates the "winning" party.

Consider a simple example. Bank Bumiputra Malaysia wants to lock in its cost of 6-month borrowing starting 9 months from now. Bumiputra telephones Standard Bank in London.

Stan: So you want to lock in the LIBOR interest rate in nine for six? Ten pounds?

Bumi: Months you mean. Millions you mean. Yes. What rate can you quote me? I see that today's sterling LIBOR is 8%.

Stan: Righto, but the yield curve is upward sloping. We can quote you 9 1/8-9 5/16. That means we'll lock in your borrowing LIBOR cost at 9 5/16, or your depositing LIBOR at 9 1/8.

Bumi: Okay, I'll take the 9 5/16 borrowing rate. But how does the deal work?

Stan: Well, we don't exactly guarantee your own borrowing cost. We simply assure you that LIBOR will be 9 5/16. If, nine months from now, LIBOR is actually above 9 5/16, we'll pay you the difference. For example, if LIBOR is 11%, we'll pay 11% minus 9 5/16%, i.e., 1 11/16%. So if you borrow at

LIBOR, your net cost will still be 9 5/16%.

Bumi: I see. What if LIBOR falls to, say, 7%?

Stan: Then you pay us 2 5/16%, semiannual. Of course if LIBOR turns out to be exactly 9 5/16% then neither of us pays the other.

How did Stan come up with his quotes of 9 1/8 - 9 5/16? A FRA is purely and simply a forward contract, and can be priced by means of the "implicit forward interest rate" calculation. This calculation is based on the assumption that any forward rate commitment can be hedged by simultaneous borrowing and lending for different maturities.

For example:

LONGER-TERM LENDING	HEDGED WITH	SHORTER-TERM BORROWING	plus	FRA

From the above, if you know the longer-term rate and the shorter-term rate, you can figure out the implicit FRA rate.

The quick-and-dirty formula is:

$$\text{FRA RATE} = \text{Implicit "forward" interest rate from yield curve} = \frac{\left(\text{longer-term rate}\right) \times \left(\text{longer maturity}\right) - \left(\text{shorter-term rate}\right) \times \left(\text{shorter maturity}\right)}{\text{maturity differential}}$$

Although a Future Rate Agreement is typically used to hedge a borrowing or lending rate, the agreement does not entail actually making or receiving a loan during the specified period.

Instead, the rate is locked in by the method of cash compensation for the gain or loss suffered by each party to the contract.

Many banks who are reluctant to make a lending commitment are nevertheless perfectly willing to make a future rate commitment because this is something they can easily hedge by mismatched borrowing and lending or in the FRA market itself.

One party (the "borrower") will receive a payment from the other if the actual interest rate rises above the fixed rate; or the other party (the "lender") will be compensated by the first party if the actual rate falls below the fixed rate. The amount of compensation will be the difference between some actual market rate (typically LIBOR) at the beginning of the specified period and the agreed-upon fixed rate. That difference is adjusted for the length of the specified period (e.g., 3 months) and multiplied by the dollar principal amount of the agreement (say $10 million).

For example, if the agreed-upon rate is 10% and three-month LIBOR turns out to be 12% at the beginning of the 90-day period, the "lender" must pay the "borrower" the 2% differential. That differential in dollar terms would be

$$(12\% - 10\%) \times \frac{90}{360} \times \$10 \text{ million}$$

except that we must also discount this amount for 3 months, at the market rate of 12% because it is paid at the beginning of the period instead of at the end, when interest is normally paid. So the calculation becomes

$$\text{Cash payment} = \left[(12\% - 10\%) \times \frac{90}{360} \times \$10 \text{ million}\right] / \left(1 + 12\% \times \frac{90}{360}\right)$$

$$= .05/1.03 \text{ (in millions of dollars)}$$

$$= \$48{,}543.60$$

Since the actual LIBOR exceeds the contractual LIBOR, this is the amount the "lender" must pay the "borrower."

More generally, the formula for the start-of-period cash compensation by "lender" to "borrower" in an FRA is, for a LIBOR-based contract,

$$\text{Cash compensation} = \left[(\text{LIBOR \%} - \underset{\text{RATE}}{\text{FIXED \%}}) \times \frac{\text{Length in days}}{360}\right.$$

$$\left. \times \text{ Principal}\right] / \left(1 + \text{LIBOR \%} \times \frac{\text{Length in days}}{360}\right)$$

As with any forward contract, where one party has to deliver something to another party at some time in the future, there is a risk of default. Clearly if the actual rate moves away from the fixed rate, the borrower will owe the lender some cash or vice-versa. The payment will not be made until the start of the contractual period, which may be many months away, even if LIBOR has already moved substantially in one party's favor.

Therefore, in a FRA, each contracting party faces a potential credit exposure. When the market rate moves, the amount of the exposure equals the market rate minus the fixed rates times the principal adjusted as shown above. The amount of potential exposure is determined quite simply by the maximum amount that the market rate could move away from the fixed rate during the remaining time of the contract.

4.3 Eurodollar Interest Rate Swaps

A Future Rate Agreement is simply a forward contract where two guys agree to exchange a fixed rate for a floating rate -- usually LIBOR -- during some future period. But a FRA locks in only one period's borrowing or lending rate. When the parties agree to exchange fixed for floating rates over a number of future successive interest contract periods (typically 3-month or 6-month periods), the contract is called an interest rate swap.1/ Interest rate swaps are used to convert variable-rate debt or assets into fixed rate, or vice-versa.

An interest rate swap is a contract between two parties where they agree to exchange interest payments of two different kinds at fixed dates in the future. In the Eurodollar market, one of these payments is usually the three- or six-month LIBOR rate. Typically, Party A will agree to pay LIBOR every six months to Party B, who in turn will agree to pay a fixed interest rate to A every six months for the duration of the contract. Thus if A had a fixed rate liability, he can now use the fixed interest receipts to service that debt and the LIBOR receipts become the new base for A's debt servicing. B might have had LIBOR-based debt in the

---

1/Another term for interest rate swaps is "coupon swaps." When boh coupons are floating it may be called a "floating-floating" swap or "basis" swap.

first place; but by paying a fixed rate to A he receives the variable rate component, LIBOR, which he passes on to his creditors each six months, thus fixing his cost of debt.

We may illustrate this technique by means of a simple example. We begin with Company A who has 5-year fixed rate debt on which it is paying 2 percent above today's 5-year Treasury bond (which it wants to convert into floating) and B who has floating rate debt on which he is paying 6-month LIBOR plus 1 percent (the cost of which it wants to fix). Thus

Before the Swap

	A	B	L + 1% Floating
Fixed T + 2%			

A's situation:

Debt:	Paying 5-year Treasury + 2%	T + 2% fixed	net cost

B's situation:

Debt:	Paying LIBOR + 1%	LIBOR + 1% floating	net cost

Now A and B meet and fall in love. They decide to exchange vows. A vows to pay LIBOR flat to B every six months. B vows to pay today's Treasury note rate, T% p.a., plus 2% p.a. to A every six months.

After the Swap

		LIBOR Floating		LIBOR + 1% Floating
	A		B	
Fixed T + 2%		Fixed T + 2%		

A's new situation:

Debt:	Paying 5-year Treasury + 2%		
Swap:	Paying LIBOR Receiving 5-year Treasury + 2%	LIBOR floating	net cost

B's new situation:

Debt:	Paying LIBOR + 1%		
Swap:	Paying 5-year Treasury + 2% Receiving LIBOR	T + 3% fixed	net cost

The union is a success! A ends up paying a floating rate whose cost will drop if interest rates fall. His net cost is the Eurodollar offer rate, a level cheaper than he might otherwise have been able to get directly. B ends up paying a fixed rate at only 3 percent per annum above the U.S. Treasury rate, cheaper than he could have obtained directly from, say, the Eurobond market. (Actually these are ridiculous numbers.)

From each according to his ability, and to each according to his need -- that's the principle of swapping. Just as currency forward contracts can convert the currency of denomination of a Eurodeposit, so interest rate swaps can convert the interest rate base of an instrument or liability.

But wait a minute, you say, what if A gets tired of this arrangement. Rates may have fallen, and A may wish to fix his cost of funds again, human nature being what it is. Happily, he does not have to break his vows but can instead phone a swaps trader who will either enter into a second, offsetting swap with A or will assume the remaining swap contract with B. In either case the swap will be "traded" at a price equal to the gain or loss on the remaining payment obligations.1/

1/For details see Ian Giddy, "Swap Valuation," January 1985. In the above example, had interest rates fallen, A would have gained and so would have to be compensated for giving up the swap. The value of the gain -- the change in the value of A's swap position -- happens to equal the change in the price of a Treasury bond that had 5 years to mature on the date of initiation of the swap.

4.4 Eurodollar Futures

Eurodollar futures, like their domestic counterparts, are contracts for delivery of a certain amount of bank deposits at some future date. The deposits to be delivered may be Eurodollar time deposits or Eurodollar CDs, depending on the particular contract, and may be settled either by cash compensation or by delivery of the CD of a major bank. The futures price agreed upon the day the contract is bought or sold determines the locked-in Eurodollar interest rate and, as with forward contracts, no money changes hands at the time the contract is entered into. In both markets, gains or losses are incurred as a result of subsequent interest rate fluctuations. The total gain or loss will equal the difference between the futures price (or forward rate) and the spot interest rate on the date of maturity of the contract, multiplied by the amount of the contract.

The difference between the forward and futures markets is that in the forward market, a profit (or loss) is realized on the maturity date, while in the futures market all profits and losses must be settled on a daily basis. This procedure, called "marking to the market," requires that funds change hands each day. The funds are added to or subtracted from a mandatory margin account that traders are required to maintain. In contrast, in the forward market no money changes hands until delivery occurs.

If (as a result of an interest rate drop) the value of a Eurodollar CD futures contract increases during the course of a day, the holder receives cash; if it falls, the holder must pay the loss. This happens every day for every change in price up to the final day of the contract. On the maturity date, the futures price must equal the cash (spot) price of the Euro CD. Hence, the payment required on the maturity date to buy the underlying CD is simply its spot price at that time.

Figure 4-1 illustrates how changes in the actual 3-month Eurodollar rate are tracked by changes in the Eurodollar futures contract yield (not perfectly, of course, because the futures yield represents the implicit forward interest rate) and how, as the contract approaches its last trading date (December 18 in this case), the futures yield must converge to the cash yield. Figure

4-2 shows the changes to the margin account -- daily gains or losses -- of someone who held a short position -- perhaps to hedge a borrowing cost -- in one Eurodollar futures contract.

Figures 4-1 and 4-2 go about here

The other chief feature of the futures market is that futures are traded through organized exchanges or clearing houses, such as the International Monetary Market (IMM) in Chicago. Trading in standardized currency contracts is conducted by open auction on the floor of the exchange. The trading matches individual buyers and sellers to set prices; however in executing each sale and purchase the clearing house of the exchange takes the opposite side of each position. The fact that losses are realized and settled every trading day limits the risk of default to the clearing house.

Eurodollar futures can be particularly useful for banks, borrowers, or investors that wish to lock in a future interest rate in the Eurodollar market. For example, a money manager who anticipates having funds to invest in the short-term fixed income markets at a known time in the future can hedge against the risk that interest rates might drop by the time of actual investing. Such an investor can hedge this risk by buying a futures contract immediately at a specified rate for delivery at a specified future time. If interest rates fall by the delivery date, the contract

Figure 4-1

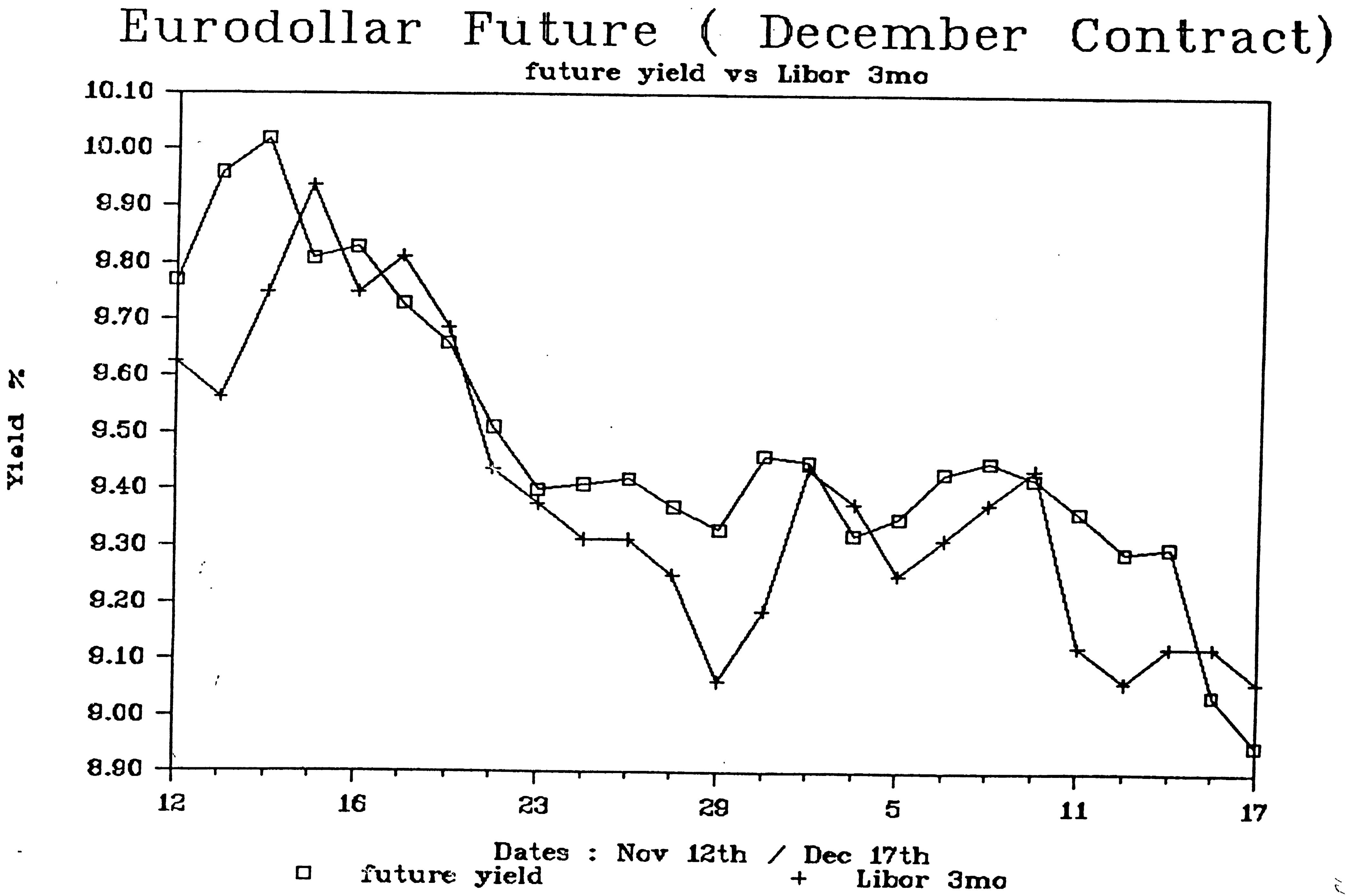
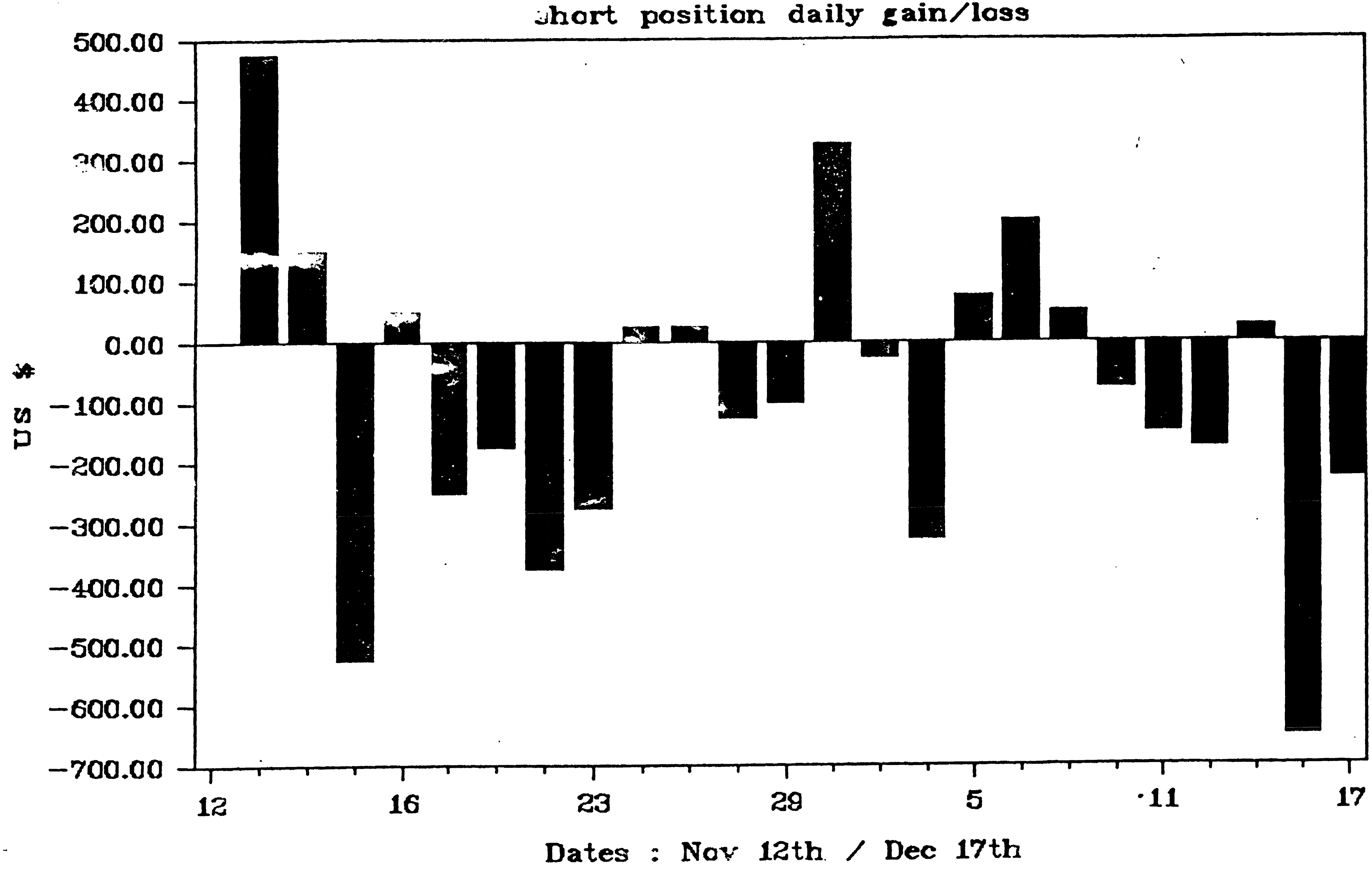

Eurodollar Future (December Contract)
future yield vs Libor 3mo
Yield %
10.10
10.00
9.90
9.80
9.70
9.60
9.50
9.40
9.30
9.20
9.10
9.00
8.90
12
16
23
29
5
11
17
Dates : Nov 12th / Dec 17th
□ future yield
+ Libor 3mo

Figure 4-2

Eurodollar Future (December Contract)



will appreciate in value. The appreciation in value on the futures contract can offset the investor's "opportunity loss" from the actual decline in interest rates. Thus for investors anticipating funds to be available for investment in the future, the appropriate futures market hedge is the purchase of a futures contract -- a "long hedge."

Borrowers in the money markets also can use interest rate futures to protect themselves against increases in interest rates by selling an interest rate contract for future delivery. If interest rates rise by the delivery date, the value of the futures contract will drop. The financial manager can buy back the contract for a lower price, thus making a gain. The gain from the futures contract can offset the increase in the cash borrowing costs. Thus for borrowers anticipating actual borrowing in the future the appropriate futures market hedge is a short hedge.

As is illustrated in Figure 4-3, the holder of a long Eurodollar futures contract gains or loses in a symmetrical fashion as the "forward" rate rises or falls, thus locking in that rate.

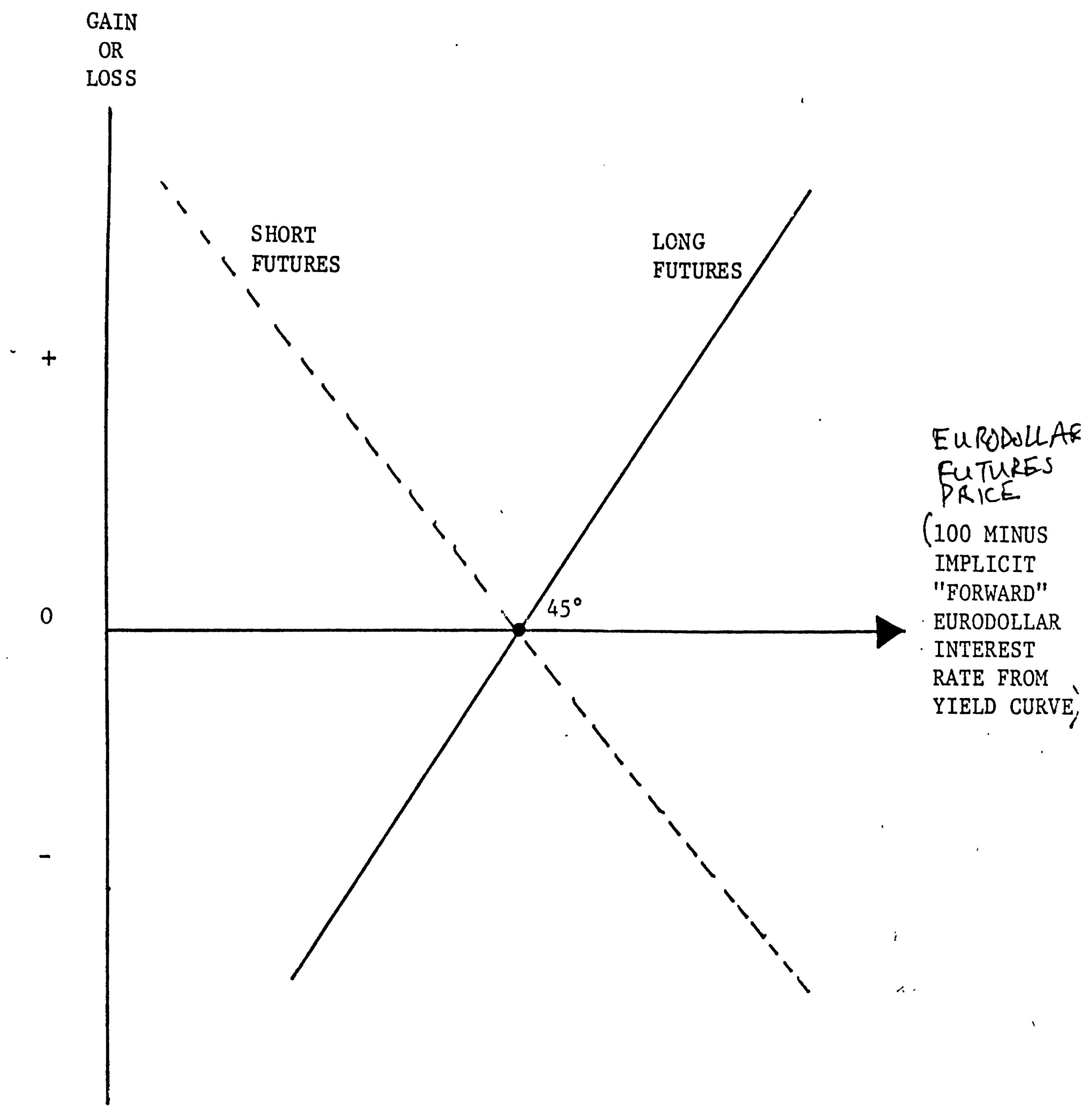
Figure 4-3 goes about here

Thus the basic techniques for hedging Eurodollar interest rate risks are as follows:

=An investor wishing to hedge against a future fall in the Eurodollar interest rate would buy Eurodollar futures contracts (a long hedge).

Figure 4-3

EURODOLLAR FUTURES "PROFIT PROFILE"



=A borrower wishing to hedge against a future rise in the Eurodollar interest rate would sell Eurodollar futures contracts (a short hedge).

Examples of each are given in the box on the opposite page. The rates used are actual ones although the names and dates have been disguised to protect the innocent. As might be expected, the hedge is not a perfect one, since the Eurodollar contract is unlikely to match precisely the characteristics of the instrument being hedged. This lack of perfect offset is known to practitioners as basis risk; students of portfolio theory would call it covariance, i.e., the degree to which the value of one position is negatively correlated with the value of the other position.

The second example in the box is a particularly interesting one, for those who have the patience to work through the numbers, because it shows how short-term futures can be used to hedge longer term instruments (in this case 3-month futures used to hedge a 6 month loan).

BOX

USING FUTURES TO HEDGE EURODOLLAR INTEREST RATE RISKS

Case 1. On Wednesday, August 3, 1984, the cash manager for CBS Corporation, Jinni Featherstone-Witty, received a telex saying that CBS would receive a dividend payment of $21 million from its Australian affiliate. The payment would be made on November 17, 1984. JFW decided that she would arrange for the funds to be deposited in a Eurodollar deposit in Singapore pending repatriation to the U.S. in mid-February 1985. In order to hedge the interest received on the three-month deposit from November 17 to February 16, she chose to buy Eurodollar futures contracts. These contracts are linked to 3-month Euro time deposits of major banks. The closest delivery date was the December contract: December 15, to be precise. She would have to buy 21 contracts of $1 million each. The sequence was as follows:

Cash Market	Futures Market
August 3, 1984	
=Do nothing 3-month Eurodollar rate: 10.50%	=Buy 21 $1m December Eurodollar Price: 88.88 Yield: 11.12%
November 17, 1984	
=Deposit $21 million in Singapore at the 3-month Eurodollar rate: 9.875%	=Sell the 21 December Eurodollar Price: 89.90 Yield: 10.10% Gain: +102 basis points, or $2550 per contract, since each basis point is worth $25. (See Fig. 4.4) Total futures gain = 102 x $25 x 21 = $53,550

Net effective interest rate received (assuming the futures gain can also be invested at 9.875%):

$$\frac{(\$21,000,000 \times .09875/4 + \$53,550 \times (1 + .09875/4)}{21,000,000} \times \frac{12}{3} \times 100 = 10.92\%$$

This illustrates the fact that JFW, by hedging in the futures market, was able to assure CBS of a return of approximately 11.12%, the December Eurodollar futures rate as of August 3. The actual rate she obtained was 10.92%. The effect of such less-than-perfect hedging is called basis risk.

Case 2. Edgar "Egg" Hatcher, chief offshore funding manager for Barclays Bank in New York, received a call from a Barclays loan officer on February 29, 1985. The loan officer had a customer who wished to borrow $13 million for 6 months starting on June 1, 1987. The customer was apparently willing to pay a premium to obtain a locked-in rate, but needed to get a quote very quickly. Could Egg Hatcher cook up something that would enable Barclays to offer such a forward interest rate contract? Looking at his Reuters screen, Egg observed the following futures rates:

3-Month Eurodollar deposit contracts

	Price	Yield	Open Interest
Mar. 85	94.84	5.16	6,263
Jun. 85	95.12	4.88	13,344
Sep. 86	94.97	5.03	8,733
Dec. 86	94.90	5.10	3,486
Mar. 87	94.72	5.28	8

Egg brooded on these facts for a while: this was not quite what he wanted. The contracts did not go far out enough, and in any case he was reluctant to deal in a contract date with only 8 contracts outstanding, such as the March 1987 contract. Also, the contracts were for 3-month, not 6 month maturities. He then hatched the following plan to hedge his borrowing cost during the 6-month period starting June 1, 1987. He would hedge the first three of those six months by selling 13 December 86 contracts now, and rolling these over (replacing them) with March 87 and finally June 87 contracts as volume built up in these. He would hedge his funding cost for the second 3-month leg, beginning on September 1, 1987, in a similar manner; by selling 13 December 86 contracts and subsequently replacing these with, in turn, March 87, June 87 and September 87 contracts. This "rollover" hedge technique, admittedly imperfect, would protect him against shifts in the overall level of interest rates.

The December 86 contract he saw, had a yield of 5.10%. He called the loan officer and (to be on the safe side) quoted him a base funding rate of 6%; the lending officer could add an appropriate spread onto the rate. The rates and actions that followed were these:

Cash Market	Futures Market
February 29, 1985	
3-Month Eurodollar rate: 5.375%	Dec. 86 contract price: 94.90, Yield, 5.10%
=Commit "forward" funding rate of 6%	=Sell 26 (2 x 13) Dec. 86 contracts

April 5, 1985

3-Month Eurodollar rate: 6.7%	Dec. 86 contract price: 94.00, Yield: 6.00% =Buy back 26 Dec. 86 contracts Mar. 87 contract price: 94.30 Yield: 5.70% =Sell 26 Mar. 87 contracts Gain: 90 basis points x $25 x 26 = $58,500

September 1, 1985

3-Month Eurodollar rate: 8.125%	Mar. 87 contract price: 92.15, Yield: 7.85% Jun. 87 contract price: 92.30, Yield: 7.70% Sep. 87 contract price: 92.45, Yield: 7.55% =Buy back 26 Mar. 87 contracts =Sell 13 Jun. 87 contracts =Sell 13 Sep. 87 contracts Gain: 215 basis points x $25 x 26 = $139,750

(At this point the hedge is fully in place and nothing need be done until the date of the loan.

June 1, 1987

3-Month Eurodollar rate: 7.375%	Jun. 87 contract price: 93.05, Yield 6.95%
=Issue 3-month $13 million Eurodollar deposit	=Buy back 13 June 87 contracts
Interest Cost: $13 million x .07375/4 = $239,687.50	Loss: 75 basis points x $25 x 13 = $24,375

August 1, 1987

3-Month Eurodollar rate: 7.75%	Sep. 87 contract price: 92.50, Yield: 7.50%
=Issue 3-Month Eurodollar deposit	=Buy back 13 Sep. 87 contracts
Interest Cost: $13 million x .0775/4 = $251,875	Loss: 5 basis points x $25 x 13 = $1,625

Total Interest Cost: $491,562.50

Total Futures Gains/Losses: $172,250

Net effective interest rate paid (ignoring interest on futures gains/losses):

$$\frac{\$491{,}562.50 - \$172{,}250}{\$13{,}000{,}000} \times 12 \times 100 = 4.9125\%$$

Thus Egg Hatcher was able, in mid-1987, to fund the 6-month loan at an effective cost very close to the 5.10% futures rate prevailing back in February 1985 when he had promised a fixed forward rate to the customer. This illustrates the fact that futures contracts used in succession can be used to hedge interest rates for longer-term securities and beyond the date of the most distant contract currently available. While the technique hedges against a parallel shift in the yield curve, it leaves the hedger vulnerable to a change in the slope of the curve.

End of box

It also demonstrates that near-term futures (such as the December 1986 contract) can be used to hedge more distant interest rate risk (June 1987 in the example), as long as the hedge is rolled over -- that is, successive short-term hedges can substitute for (nonexistent) distant futures contracts. Again, the hedge will not be perfect: you face a risk whenever the slope of the yield curve changes. However the roll over hedge technique does protect against a movement in the level of interest rates.

In summary, the two techniques noted above are:

=To hedge a longer-term instrument than the instrument of the futures contract, take out multiple interest rate contracts, for the successive periods within the longer-term instrument's time span.

[For example, to fix your cost of Euromarket funding for the 9 months period starting in December, sell a December, a March, and a June contract.]

=To hedge a more distant period than is available in the futures market, hedge with the most distant futures contract currently available, and replace this with the contract closest to the desired period when that becomes available.

[For example, to fix the return on a Eurodeposit two years hence, buy the 18-month away contract, hold it for six months, and then sell it and buy the newly-opened 18-month away contract.]

It is not unusual for these two situations to be combined. For example, a bank might wish to lock in the cost of three-year money funds, funded in the 91-day Eurodollar CD market. This involves a longer maturity than the 3-month Eurodollar contract and extends beyond the horizon of the most distant currently available contract. We would then have to hedge out as far as possible (say 1 1/2 years) with a set of contracts of different delivery dates, and hedge the remaining periods with successive "rollovers" of distant futures contracts as they become available. At each point you would hold a number of futures contracts equal to the amount in millions times the number of interest-contract periods being hedged. Thus, to hedge a $1 million, 3 year, variable-rate loan, starting on January 1, 1985, you would:

On January 1, 1986: Borrow funds in the cash Eurodollar market for the first leg (say, for a period ending Dec. 15, 1986).

Sell 1 Mar. 87 contract (to hedge 3/87-6/87)
Sell 1 Jun. 87 contract (to hedge 6/87-9/87)
Sell 1 Jun. 87 contract (to hedge 9/87-12/87)
Sell 1 Jun. 87 contract (to hedge 12/87-3/88)
Sell 1 Jun. 87 contract (to hedge 3/88-6/88)
Sell 1 Jun. 87 contract (to hedge 6/88-9/88)
Sell 1 Jun. 87 contract (to hedge 9/88-12/88)

(in fact you would sell a total of 8 contracts corresponding to the 8 interest-contract periods to be hedged, including 6 Jun. 87 contracts because no more distant ones are yet available.)

On March 15, 1986:	Buy 5 Jun. 87 contracts Sell 5 Sep. 87 contracts
On June 15, 1986:	Buy 4 Sep. 87 contracts Sell 4 Dec. 87 contracts
On September 15, 1986:	Buy 3 Dec. 87 contracts Sell 3 Mar. 88 contracts
On December 15, 1986:	Buy 2 Mar. 88 contracts Sell 2 Jun. 88 contracts (Also: Buy 1 Dec. 86 contract Issue 3-month Euro CD, repay debt)
On March 15, 1987:	Buy 1 Jun. 88 contract Sell 1 Sep. 88 contract (Also: Buy 1 Mar. 87 contract Issue 3-month Euro CD, repay previous one)

And so on. At this point you have a full array of short futures contracts corresponding to the borrowing periods remaining, and all future 3-month borrowing periods are hedged.

4.5 How to Read the Newspaper Again

Eurodollar futures on the IMM are contracts for delivery of a $1 million time deposit in one of several major banks in London at some specified future date. The Eurodollar futures price is actually an index that is calculated as 100 minus the yield (in annual percentage terms). The yield for Eurodollar time deposits is calculated as an add-on yield (i.e., as a percentage of the initial value -- $1 million -- rather than as a percentage of the maturity value of the instrument. The latter is a discount yield, and is used for T bill yield calculations.) Typical quotations are presented as follows in Figure 4-4. Comparing the "price settle" and "yield settle" columns, one can see that the add-on yield is simply 100 minus the settlement price, the closing price at the end of the trading day.

Figure 4-4 goes about here

4.6 The Hedge Ratio Approach

The discussion and examples so far show that Eurodollar futures contracts can be used to hedge the interest rate risk inherent in a floating-rate Eurodollar instrument, such as an adjustable-rate loan, a floating-rate certificate of deposit (FRCD), or a floating-rate note (FRN). Nevertheless, it was evident that one can seldom find a set of Eurodollar futures whose maturity dates and underlying instruments precisely match those of the interest rate setting periods of the Euroinstrument. Some risk remains because of "basis risk" -- the futures contracts may change in the right direction, but by an amount greater than or less than the rise or fall of interest rates paid or received on the variable-rate instrument.

Figure 4-4

EURODOLLAR FUTURES

FUTURES PRICES
Wednesday, June 5, 1985

The face value of the contract is $1 million. That means that each basis point (.01%) change in the 3-month contract price is worth $25
[$1,000,000 x .0001 x 1/4]

The Eurodollar futures yield is an "add-on" yield, not a discount rate, and as in the Eurodollar market is calculated on a 360-day basis.

Contracts traded at the International Monetary Market in Chicago. [Eurodollar futures are also traded in London on the LIFFE.]

Settlement price, normally the last trade, used for marking-to-market, i.e., daily adjustment of margin accounts. Calculated as (100-yield).

Change from previous day's settlement price.

Day's lowest and highest prices

Yield that you would lock in if you bought a futures contract at the settlement price.

Price of the day's first trade

Expiration months of actively traded contracts. On the actual expiration date, the third Wednesday of the expiration month, the futures yield converges to the cash market yield, i.e., to LIBOR.

Number of contracts open as of previous trading day, i.e., Tuesday in this case. [Each unit represents a long and a short contract.]

EURODOLLAR (IMM)—$1 million; pts of 100%

	Open	High	Low	Settle	Chg	Yield Settle	Yield Chg	Open Interest
June	92.50	92.59	92.46	92.55	+ .17	7.45	– .17	30,686
Sept	92.13	92.26	92.10	92,23	+ .30	7.77	– .30	61,743
Dec	91.69	91.82	91.65	91.78	+ .31	8.22	– .31	19,433
Mr86	91.30	91.42	91.26	91.39	+ .32	8.61	– .32	6,634
June	90.96	91.07	90.91	91.06	+ .32	8.94	– .32	3,740
Sept	90.70	90.78	90.66	90.78	+ .31	9.22	– .31	2,669
Dec	90.40	90.53	90.40	90.52	+ .32	9.48	– .32	2,142
Mr87	90.14	90.27	90.14	90.26	+ .32	9.74	– .32	1,365

Est vol 50,603; vol Tues 34,172; open int 128,412, –1,500.

Number of contracts traded. [Each unit represents a buyer and a seller.]

Total open interest as of previous trading day, i.e. sum of right-hand column.

The hedge ratio approach faces this issue head on: it says that one should explicitly take into account the correlation between changes in the instrument hedged and changes in the value of particular futures contracts. Another term for this is the price sensitivity of the futures with respect to the instrument being hedged. If you know this relationship, you determine the ratio of futures contracts that best hedges one unit of the underlying instrument. For example, if you want to hedge a Eurodollar CD whose value, you have found, goes down 2 percent for each 1 percent rise in short-term interest rates, and the near-term Eurodollar futures contract's value falls only 1/4 percent for a 1 percent rise in the Eurodollar rate, then you would sell eight Eurodollar futures contracts to hedge a $1 million CD.

A key element in this approach is a measure of how much futures prices and cash prices will change for a given change in interest rates. A versatile measure is the duration of the instrument. Calculated from the weighted present value of future cash flows the duration of an instrument tells you how much, in percentage terms, a bond or futures contract will fall in value for a 1% rise in interest rates. The accompanying box provides a brief review of the concept.

Since this method is designed to hedge against changes in the value of a security, it is of particular interest to portfolio managers who wish to avoid any loss that might result from interest-rate fluctuations on bonds that they hold and anticipate selling, or on bonds that they anticipate buying.

2/For information on hedge ratio or price sensitivity approaches, see Robert Kolb, Interest Rate Futures, Richmond, Va: Robert F. Dame, 1982, Ch. 5, or Robert Kolb and R. Chiang, "Improving Hedging Performance Using Interest Rate Futures," Financial Management, Vol. 10, No. 4 (1981), pp. 72-79.

BOX

Duration

The duration of a bond is a measure of its interest rate sensitivity. A bond with a duration of 2 will suffer a fall in value of (approximately) 2% if interest rate bond yields rise by one percentage point. As a rule, bonds with longer maturity are more vulnerable to interest rate changes; however, duration measures this vulnerability more precisely because it takes into account the size and timing of coupon payments.

Duration can also be calculated for a portfolio of fixed income securities, simply by figuring the weighted average of the durations of each security. One can also measure the duration -- change in value for a given interest rate change -- of interest-rate contracts, such as Eurodollar futures, Future Rate Agreements and interest rate swaps.

Measurement: Duration is measured as a weighted-average term to maturity in which the weights are the present value of cash flows from the bond.

$$\text{Duration} = \frac{\sum_{t=1}^{n} \frac{\text{Cash Flow} \times t}{(1 + r)}}{\sum_{t=1}^{n} \frac{\text{Cash Flow}}{(1 + r)}} \times 1$$

where c = interest and/or principal payment in period t

t = number of periods to the interest and/or principal payment

n = number of periods to final maturity

r = yield to maturity

m = number of interest payments per year.

Use: To control interest-rate risk, because the price sensitivity of a bond to changes in interest rates is related to its duration:

$$\begin{array}{c}\text{Percentage}\\ \text{change in}\\ \text{bond's price}\end{array} = \begin{array}{c}\text{Change in}\\ \text{market yield}\\ \text{(in percentage points)}\end{array} \times \frac{\text{Duration}}{1 + \frac{\text{market yield}}{m}}$$

where m = number of coupon interest payments per year.

This measure is sometimes called the adjusted duration.

In financial institutions, a strategy of setting the average duration of assets equal to the average duration of liabilities will immunize a portfolio from the effects of a change in interest rates.

Limitations: The Macaulay measure of duration, shown above, assumes a flat yield curve and parallel shifts in the curve. Also, a bond's duration changes slightly as the market yield changes. For most situations, however, these effects are small relative to the usefulness of the concept.

End of box

4.7 A Eurodollar Futures Plus Two Forward Exchange Contracts Equals a Eurosterling Futures

Back to futures. German marks, Swiss francs, Polish zlotys, and even pounds sterling have feelings too, so why all this talk about Eurodollar interest rate futures and swaps? The answer, of course, is that everything we've said about dollar contracts applies to those worthy fellows too. Except that futures and swap markets in the other currencies are typically less developed if they exist at all.

So now we're going to show you how to create a fake Eurosterling -- or Eurocurrency -- interest rate futures contract. The trick is to use the interest rate parity relationship to combine a Eurodollar futures with one long and one short sterling currency futures or forward contract. Let's look at it intuitively. The Eurosterling interest rate (on, say, a 3-month deposit in Zurich) equals the Eurodollar interest rate plus the sterling-dollar interest rate differential. This holds true from here to eternity. Also, foreign exchange dealers' arbitrage ensures that the Euromarket dollar-sterling interest rate differential equals the forward exchange premium or discount ("forward premium" for short). We assume this too will hold true from now until Kingdom Come. Knowing this we can create

a simulated Eurosterling interest rate futures contract	(i.e. lock in a future sterling Eurodeposit rate)

by

locking in the future Eurodollar interest rate	(by means of a Eurodollar futures contract)
and	
locking in the forward premium	(by means of simultaneous forward purchase and forward sale of sterling at different dates)

For example, assume a Eurobanker wants to guarantee to a customer the price of a 3-month Eurosterling loan to be provided in mid-March and repaid in mid-June. He will

(1) sell a March Eurodollar futures contract (to lock in the cost of borrowing Eurodollars);

(2) buy sterling forward for delivery in mid-March (to lock in the cost of exchanging the borrowed dollars into sterling);

(3) sell sterling forward for delivery in mid-June (to lock in the cost of exchanging the sterling back into dollars to repay the dollar debt).

We have illustrated the technique using foreign exchange forward contracts to hedge the interest differential. Currency futures contracts might just as well have been used, although major banks and corporations would normally find forwards more convenient. In addition, a Eurodollar interest rate swap may be used instead of a Eurodollar futures contract to hedge the dollar interest rate, thus converting a Eurodollar interest rate swap into, say, a EuroFrench franc interest rate swap. This technique would not, however, normally be used for short-term interest rate hedging of the kind illustrated in the example.

All in all, the cross-currency interest rate hedging technique is a versatile device that can be employed in a number of ways. Rather than count them, let's see some examples.

=A U.S. bank has easy access to dollar funds but wants to commit itself to lending at a fixed-in-advance rate in a foreign currency. As described in the example above, the bank would short a Eurodollar interest rate futures, at the same time buying the foreign currency forward at the earlier date and selling it forward at the later date.

=A Japanese multinational firm wishes to lock in the future cost of borrowing Euroyen. Again, the technique is to lock in the dollar rate and simultaneously lock in the interest differential by means of a "forward swap." The firm would sell a Eurodollar futures contract for delivery near to the starting date of the loan, buy yen forward (or futures) with dollars for the same delivery date, and sell yen forward or futures for delivery on a date close to the loan repayment date.

=The same Japanese corporation wants to hedge on anticipated borrowing cost, but this time it will borrow in a third currency -- say, Australian dollars. It will borrow Australian dollars in March for repayment in June. Easy enough: to lock in the Australian dollar cost of future borrowing analogously to the previous example, we would advise it to sell a March Eurodollar futures contract, buy Australian dollars forward (with U.S. dollars) for March delivery and sell Australian dollars into U.S. dollars for forward delivery in June. In general, no matter where the borrower is located, he can lock in the cost of borrowing his own or any foreign currency using Eurodollar futures as long as there exists a forward exchange market that will allow him to lock in the future interest rate differential between dollars and that currency.

=A German pension fund manager finds a newly-issued Eurodollar bond priced to yield a rather attractive return but wishes to hedge its value in German marks six months. Also, he does not have the funds now to buy it -- he will do so in a month's time. Can he lock in the rate of return? Certainly; nothing fancy about it. We don't have to worry about coupons since Eurobond interest is paid annually. All we need is two sets of hedges: one to lock in the price at which the bond will be bought; and another set to lock in the price at which the bond will be sold. Hedging the dollar price of a bond for some future date entails using the hedge ratio approach described earlier. Given the hedging futures contract -- Eurobond futures if available, otherwise Eurodollar futures --and the price sensitivity of this contract with respect to the bond being hedged, we can (imperfectly) lock in the buying price (by buying Eurodollar futures) and the selling price (by selling futures) in dollars. Call these PB and PS respectively. To lock in the German mark buying price, we buy \$PB German marks forward for delivery in one month (the buying date), and sell \$PS for German marks for delivery in seven months (the selling date). This locks in the total market cost and revenue, i.e., the return in German marks.

=As a final example, put yourself in the place of a British foreign exchange dealer who believes that the interest rate differential between Germany and Switzerland is abnormally wide. You think that it will narrow within the next three months. Since the interest differential in the Eurocurrency market equals the forward premium between the two currencies, you can bet on a change in the interest differential by taking a position in a forward swap. If the EuroGerman mark rate falls relative to the Eurodollar rate, the forward premium will narrow; thus the DM/SF cross rate (the value of the mark in terms of Swiss francs) for near delivery will rise relative to the cross rate for more distance delivery. To position yourself to gain from this, buy francs with marks for (say) three month delivery, and sell francs for marks for six month delivery. If the interest gap falls within the next three months, the position will have produced a profit. But don't believe us -- try it out for yourself with an example.

This last application is a good place to end this section because it illustrates the fundamental feature of cross-interest rate hedging: that the forward swap -- one long and another short forward exchange contracts -- is purely a device to take a position on an interest rate differential. When it's coupled with a position on a dollar interest rate, as a Eurodollar futures contract provides, then it produces a position on another interest rate. The latter can be used to speculate on a change in the foreign interest rate, or, when done together with an existing, opposite position, to hedge against such a change.

4.8 The Cross-Currency Interest Rate Swap

We have pointed out that long-term interest rate swaps are, in effect, forward contracts and are thus substitutes for futures contracts. Whatever can be done with futures can also be done in principle with swaps, and vice versa. The cross currency interest rate swap is a technique that does for the medium- and longer-term financial market what the cross-currency interest rate futures hedge achieves in the short-term market. A cross-currency interest rate swap is a technique that takes floating rate debt servicing in one currency (coupon and principal repayments) and hedges the cost in terms of another currency. It is thus a combination of an interest rate hedge and a currency hedge. The cross-currency interest rate swap is used for a corporate or other borrower that wishes to:

(1) change a floating interest rate debt (or investment) denominated in one currency into a fixed interest rate debt (or investment) denominated in another currency, or

(2) change a fixed interest rate debt (or investment) denominated in one currency into a floating interest rate debt (or investment) denominated in another currency.

In other words,

Floating-rate instrument denominated in currency X	plus	Cross-currency interest rate swap	=	Fixed-interest instrument denominated in currency Y

We have now seen three kinds of swaps: currency swaps, interest rate swaps and cross-currency interest rate swaps. Just as the forward and futures markets create hedges across currencies and maturities in the international money market, so currency swaps and rate swaps link the international capital markets. The roles of the three kinds of swaps are shown schematically in Figure 4-5.

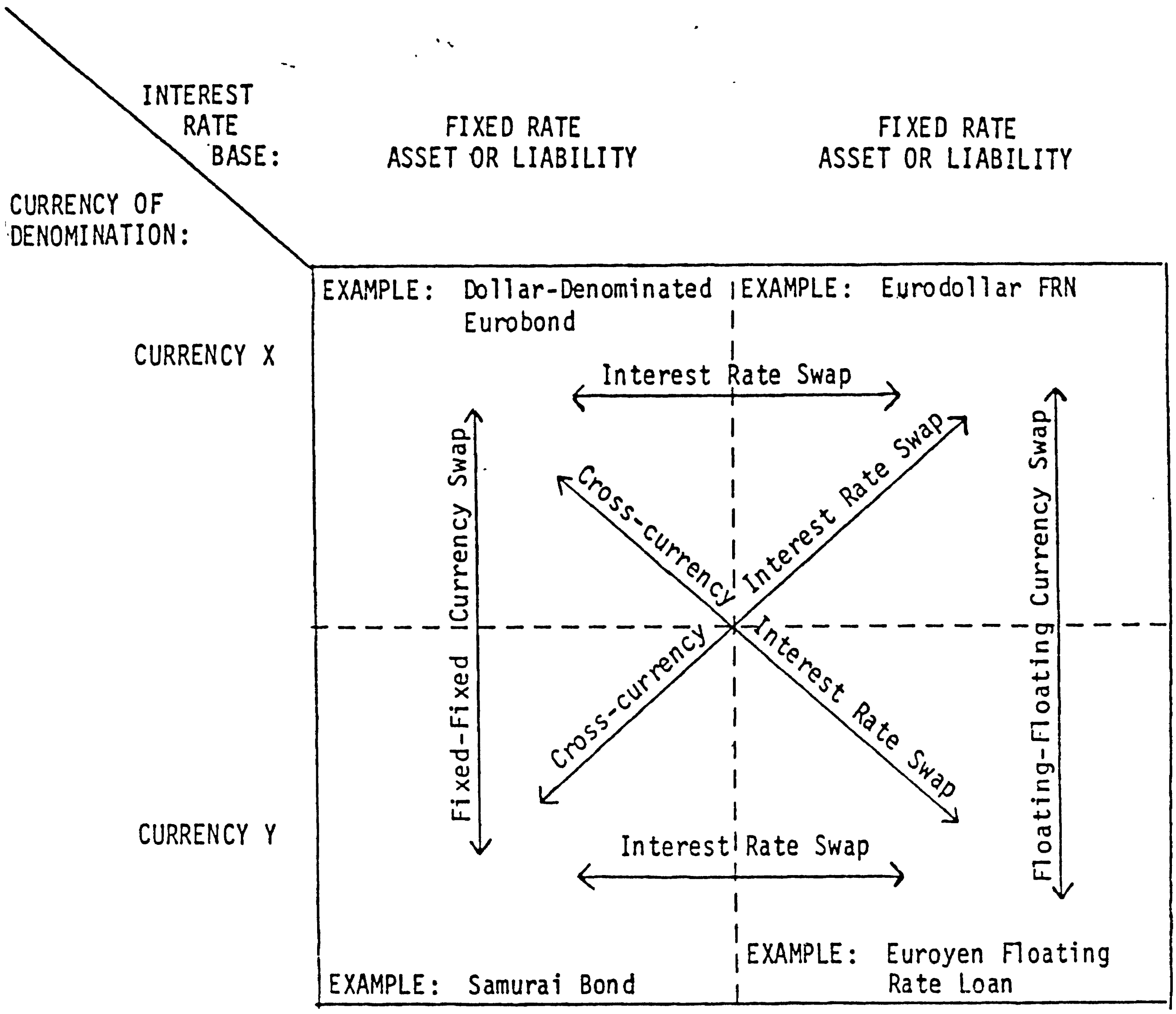
Figure 4-5 goes about here

4.9 Eurodollar Options

Futures, forwards and swaps are all contracts in which two parties oblige themselves to exchange something in the future. They are thus useful to hedge or convert known currency or interest rate exposures. An option, in contrast, gives one party the right but not the obligation to buy or sell an asset under specified conditions while the counterparty assumes an obligation to sell or buy that asset if that option is exercised.

Figure 4.5

HOW SWAPS LINK THE INTERNATIONAL CAPITAL MARKETS



Since 1982 options on various fixed-income instruments, such as Treasury bills and bonds, have been traded on the organized exchanges. The contracts take two forms: (a) options on so-called physicals, i.e., actual securities, and (b) options on futures.

Eurodollar options have been traded since 1985. The first Eurodollar options were options on Eurodollar futures, thus requiring delivery of the underlying futures contract. Now options on Eurodollar cash time deposits themselves are also traded. Let us see how these work and how they are related to Eurodollar futures.

As with all options, there are two kinds of Eurodollar options: puts and calls. A call option gives the holder (or "buyer" since he must pay for his rights) the right to purchase a Eurodollar time deposit on a certain date, one bearing a certain interest rate, say 12 percent. If, at expiration, the market interest rate turns out to be higher than the rate specified in the option contract, say 13 percent, it will make sense for the option holder to let the option expire. But if the market rate is 9 percent, below the contractual rate, the holder of the Eurodollar call option will exercise his right to receive an instrument at the higher rate.

A put option is, conversely, the right to sell a Eurodollar time deposit at a contractual rate to the writer (or seller) of the option.

The buyer of any option will, of course, have to pay cash up front for the rights he receives. This up-front option price is called the premium. The greater the likelihood of the option being exercised profitably, the higher is the premium.

Eurodollar options are useful for anyone who requires a gain if interest rates go one way, but wants protection against loss if rates go the other way. The most the holder of an option can lose is the premium he paid for it. Naturally, the option writer faces the mirror image of the holder's picture: if you sell (or "write") an option (call or put), the most you can get is the premium if the option dies for lack of exercise. The writer of a call option can face a substantial loss if the option is exercised, i.e., he is forced to deliver a Eurodollar deposit at an above-market interest rate (below-market price). If he wrote a put option and the put is exercised, then he is obliged to buy the Eurodollar at a below-market interest rate (above market price).

Unlike futures, forwards and swap-type hedges, therefore, Eurodollar options represent an "asymmetrical" risk profile. This lopsidedness works to the advantage of the holder and the disadvantage of the writer -- but that, after all, is what the holder is paying for. When two parties enter into a symmetrical contract, like a forward, both can gain or lose equally and neither party feels obliged to charge the other for the privilege. Forwards, futures and swaps are mutual obligations; options are one-sided. As may be seen in Figure 4-6, the holder of a call has a downside risk limited to the premium paid up front; beyond that he gains one-for-one with the price of the underlying security.

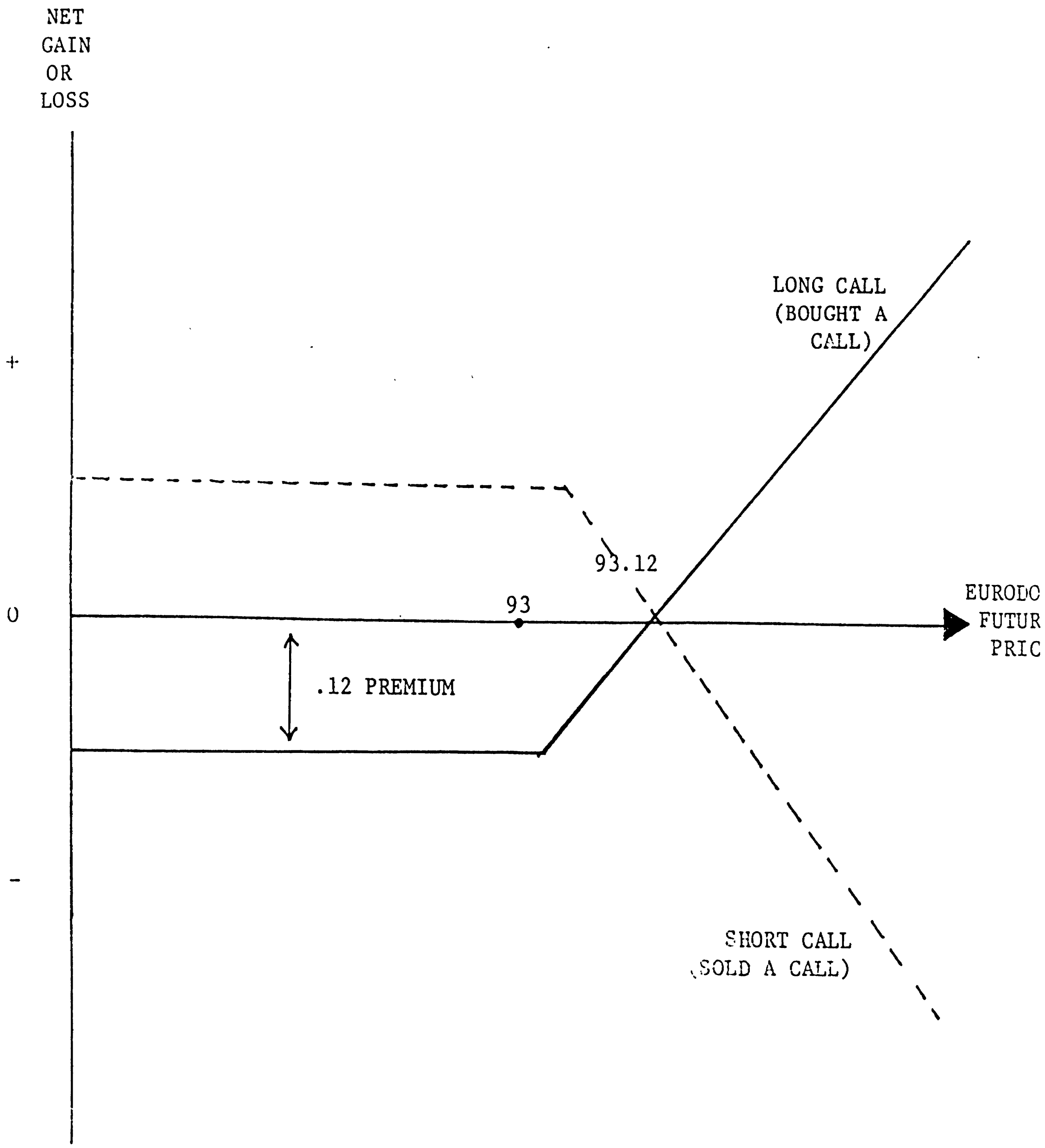
Figure 4-6 goes about here

From the asymmetrical risk profile of options it follows that they are ideally suited to offsetting Eurodollar interest rate risks that are themselves asymmetrical. The risk of a forward rate agreement is symmetrical: hence matching it with a Eurodollar option will not be a perfect hedge -- doing so would leave you with an open, or speculative, position. For symmetrical risks, Eurodollar futures, FRAs and interest rate swaps are suitable hedges. Eurodollar options are suitable hedges only for institutions whose interest rate risk is already lopsided, or for those who choose to speculate on the direction and volatility of rates. The following are examples of possible uses of Eurodollar options. We leave it to the reader to decide which are speculative and which are the hedges.

> Hedging Floating Rate Securities - Investors in floating rate securities are exposed to falling rates. If rates decline, the coupon on the floater will reset at a lower level. Call options on Eurodollars can be purchased to effect a floor rate. The strike price of the option will determine the effective minimum coupon. If rates decline below the strike price, profits from the call option position will compensate the investor for the lower coupon on the floater. These options are particularly suitable in situations where the resets on the floater are based on the three-month LIBOR rate. Call options also offer the investor the flexibility to alter the degree of desired protection.
>
> Bank and Thrift Liability Management - A bank or thrift institution whose outlook is for short-term interest rates to rise, can hedge the issuance of certificates of deposit with put options on Eurodollars. A put option purchase will allow

Figure 4-6

EURODOLLAR OPTIONS "PROFIT PROFILE"



the bank to realize a lower cost of funds in the event of a rate decline but protect the bank if rates rise. Alternatively, if futures had been used as a hedge vehicle, the bank or thrift would have "locked in" the funding cost.

Hedging "Cap-Rate" Loans - A lender incorporating a "rate cap," as is typical in adjustable rate mortgages, has interest rate risk if rates should rise about the cap-rate. To protect against this exposure, the lender could purchase puts on the Eurodollar futures contract at a strike price which closely matches the cap-rate. If rates rise above the cap, the profit from the put position will compensate the lender and offset the interest rate on the loan which is capped at below market rates.

Hedging Contract Bids. A contractor making a bid to provide goods or services that will have to be financed at an uncertain cost if the bid is won may want to have the assurance but not the obligation of a known borrowing cost. The contractor buys a Eurodollar put option and incorporates the option cost into his bid. If the bid is accepted, his option will give him a gain if rates rise, offsetting his higher cost. If the bid is not accepted, he can let the option expire or sell it, perhaps even at a profit.

Hedging debt that has a minimum rate - Issuers of floating rate notes linked to LIBOR frequently guarantee that the rate will never fall below some "floor" rate, such as 5 1/4%. If LIBOR does drop below 5 1/4%, these borrowers, who are often banks, will find themselves paying an above-market rate. Buying Eurodollar call options can protect them against such a risk.

How do these Eurodollar options work in practice? As mentioned, there are two kinds of exchange traded options -- options on futures and options on cash -- whose distinguishing characteristics we will outline below. However, all exchange-traded options have the following features in common. As with Eurodollar futures, they are standardized contracts with a face value of $1 million and four expiration dates: March, June, September and December (the same as for the Eurodollar futures). both the strike price and the price of the underlying security are quoted as an index, defined as 100 minus the Eurodollar interest rate. For example, if the Eurodollar cash (or futures) yield is 11.75 percent, the index is 88.25. A call option gains value, and a put loses value, as this index rises (i.e., as the Eurodollar rate falls). Conversely, if the index falls (when rates rise), a Eurodollar call option loses value while a put gains.

In neither Eurodollar contract is a genuine Eurodollar time deposit actually delivered. Both involve a form of "cash settlement," where the option seller has to pay the holder an amount equal to the option's "intrinsic value" -- the difference between the strike price and the price of the "deliverable security" (actually the index mentioned above), which in turn is linked to LIBOR. Actual delivery of a Eurodollar would be difficult because time deposits are nonnegotiable and because of uncertainties about which bank's liability would be delivered -- a problem that has plagued the domestic CD futures market.

In all exchange-traded options contracts the margin requirements differ from futures contracts in that the option buyer is never required to deposit money in a margin account, because he has no obligation to perform after paying the premium. Since the seller must perform if the option is exercised, he is required to deposit margin when a position is opened. As in the futures market, the margin account will be marked-to-market daily to reflect changes in the options value.

In both Eurodollar options markets the price or premium is quoted in percent; for example an option price of 1.50 means 1.50

percent of $1,000,000, i.e., $3,750. Each basis point, or .01 percent, is .001 x $1,000,000 for 3 months or $25. Thus, if you bought a call option priced at 1.50 and the reference index rose by .20 percent (because the Eurodollar rate fell by .20 percent), then you would have gained 20 x $25 or $500. The minimum price move is .01, or $25.

Finally, in neither kind of option is there any limit on how much the price can move during any given trading day.

4.10 Options on Cash versus Options on Eurodollar Futures

The two kinds of Eurodollar options -- options on the instrument itself, and options on Eurodollar futures contracts -- serve essentially the same purpose, which is to give a one-way hedge against movements of LIBOR. Both contracts are linked to LIBOR, because the cash option and the futures contract are both settled by cash compensation linked to LIBOR at the maturity date. On that maturity date, when the futures contract has zero days to run, the Eurodollar futures yield has converged to LIBOR. The Eurodollar futures option expires on the last trading day of the underlying futures contract, so the futures option converges to the cash price too.

In other markets, the choice between a cash option and a futures option rests on convenience of delivery: individual Treasury bonds, for example, may be costly and time-consuming to deliver. The design of both Eurodollar options contracts effectively circumvents such problems. Another aspect is the ease with which the option can be hedged and arbitraged with the underlying security -- and here the option on futures may have an advantage, for the Eurodollar futures is an active and liquid instrument. Since both the Eurodollar options and futures are traded on the same floor and processed through the same clearing system, exercise of the option can be easily accomplished by book entry. Exercise of a Eurodollar futures option contract results in a long futures position for a call buyer or a put writer and a short futures position for a put buyer or a call writer. This may be an inconvenience in those rare instances of early exercise, for the options trader may prefer cash settlement to ending up with a futures position.

Perhaps a more important feature of the Philadelphia option on Eurodollars is that it is a so-called European option, meaning that the option can only be exercised on the expiration date. For the vast majority of hedging purposes this provides as much protection as the American option privilege of early exercise that characterizes the options on Eurodollar futures (and most other traded options). European options allow users to sell options with confidence that they will not be involuntarily liquidated prior to expiration. This feature facilitates certain trading strategies, such as spreads and straddles and arbitrage between options and forwards or futures by assuring the trader that the position will not be broken prematurely.

A final point: since American options offer an additional right -- the privilege of exercise on any date up to the expiration date -- it gives the buyer greater flexibility and the writer greater risk. American options will therefore tend to be priced slightly higher than European options.

These considerations aside, for most banks and corporate hedgers the most important consideration is the liquidity of the market. On that score, time will be the referee.

4.11 How to Read the Newspaper Once Again

Figure 4-7 displays the newspaper quotations of Eurodollar options prices in Chicago, where the contract is for options on futures. From these quotations you may see which options are actively traded and perhaps find one that meets your needs. Say, for example, you expect to invest $5 million in September and are prepared to pay to be sure of getting at least 78 percent on your money. This implies that you want to buy a Eurodollar deposit at a reference price (100 - yield) of 93. What you want, in other words, is 5 September Eurodollar call options with a strike price of 93. According to the quotations, this would cost you .12, or $300.

Figure 4-7 goes about here

Remember that Eurodollar futures are quoted such that the value of each "basis point" (.01) in the contract is worth $25. This represents the value of a .01 percent change in the rate on a three-month one million dollar deposit. By convention, option