

Pricing of Futures and Options Contracts

LEARNING OBJECTIVES

After reading this chapter, you will understand

- the theory of pricing a futures contract
- how arbitrage between the futures market and the cash or spot market links the prices of those markets
- the meaning of the terms cost of carry and net financing cost
- the convergence of the futures and cash prices for a particular asset at the settlement date of the futures contract
- why the actual futures price may differ from the theoretical futures price
- how the market price of an option can be broken down into an intrinsic value and a time premium
- why arbitrage ensures that the prices of calls and puts on the same underlying asset with the same exercise price and expiration date have a certain relationship to each other
- the factors that affect the price of an option: the underlying asset's current price and expected price volatility, the contract's expiration date and exercise price, the short-term rate of interest, and any cash flows from the underlying asset
- the principles of the binomial option pricing model and how the model is derived

In this chapter, we explain how to determine the theoretical price of these contracts using arbitrage arguments. A close examination of the underlying assumptions necessary to derive the theoretical price indicates how it must be modified to price the specific contracts.

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PRICING OF FUTURES CONTRACTS

To understand what determines the futures price, consider the futures contract where the underlying instrument is Asset XYZ. We make several assumptions:

1. Asset XYZ is selling for $100 in the cash market.
2. Asset XYZ pays the holder (with certainty) $12 per year in four quarterly payments of $3, and the next quarterly payment is exactly three months from now.
3. The futures contract requires delivery three months from now.
4. The current three-month interest rate at which funds can be lent or borrowed is 8% per year.

What should the price of this futures contract be? That is, what should the futures price be? Suppose the price of the futures contract is $107. Consider this strategy:

Sell the futures contract at $107.
Purchase Asset XYZ in the cash market for $100.
Borrow $100 for three months at 8% per year.

The borrowed funds are used to purchase Asset XYZ, resulting in no initial cash outlay for this strategy. At the end of three months, $3 will be received from holding Asset XYZ. Three months from now, Asset XYZ must be delivered to settle the futures contract, and the loan must be repaid. This strategy produces an outcome as follows:

1. From settlement of the futures contract:

Proceeds from sale of Asset XYZ to settle the futures contract	= $107
Payment received from investing in Asset XYZ for three months	= 3
Total proceeds	= $110

2. From the loan:

Repayment of principal of loan	= $100
Interest on loan (2% for three months)	= 2
Total outlay	= $102

3. Profit: $ 8

Notice that this strategy guarantees a profit of $8. Moreover, this profit is generated with no investment outlay; the funds needed to buy Asset XYZ were borrowed. The profit is realized regardless of what the futures price at the settlement date is. In financial terms, the profit arises from a riskless arbitrage between the price of Asset XYZ in the cash or spot market and the price of Asset XYZ in the futures market. Obviously, in a well-functioning market, arbitrageurs who could get this riskless gain for a zero investment would sell the futures and buy Asset XYZ, forcing the futures price down and bidding up Asset XYZ's price so as to eliminate this profit.

This strategy that resulted in the capturing of the arbitrage profit is referred to as a **cash and carry trade**. The reason for this name is that it involves borrowing cash to purchase a security and "carrying" that security to the futures settlement date.

Suppose instead that the futures price is $92 and not $107. Let's consider this strategy:

Buy the futures contract at $92.
Sell (short) Asset XYZ for $100.
Invest (lend) $100 for three months at 8% per year.[1]

Once again, there is no initial cash outlay for the strategy: The cost of the long position in the futures contract is zero, and there is no cost to selling the asset short and lending the money. Three months from now, Asset XYZ must be purchased to settle the long position in the futures contract. Asset XYZ accepted for delivery will then be used to cover the short position—to cover the short sale of Asset XYZ in the cash market. Shorting Asset XYZ requires the short seller to pay the lender of Asset XYZ the proceeds that the lender would have earned for the quarter. Therefore, the strategy requires a payment of $3 to the lender of Asset XYZ. The outcome in three months would be as follows:

1. From settlement of the futures contract:

Price paid for purchase of Asset XYZ to settle futures contract	= $ 92
Proceeds to lender of Asset XYZ to borrow the asset	= 3
Total outlay	= $ 95

2. From the loan:

Principal from maturing of investment	= $100
Interest earned on loan ($2 for three months)	= 2
Total proceeds	= $102

3. Profit: $ 7

The $7 profit from this strategy is also a riskless arbitrage profit. This strategy requires no initial cash outlay, but will generate a profit whatever the price of Asset XYZ is at the settlement date. Clearly, this opportunity would lead arbitrageurs to buy futures and short Asset XYZ, and the effect of these two actions would be to raise the futures price and lower the cash price until the profit again disappeared.

This strategy that resulted in the capturing of the arbitrage profit is referred to as a **reverse cash and carry trade.** That is, with this strategy a security is sold short and the proceeds received from the short sale are invested.

At what futures price would the arbitraging stop? Another way to ask this question is this: Is there a futures price that would prevent the opportunity for the riskless arbitrage profit? Yes, there is. There will be no arbitrage profit if the futures price is $99. Let's look at what happens if the two previous strategies (cash and carry trade and reverse cash and carry trade) are followed, now assuming a futures price of $99.

Consider the first strategy (cash and carry), which has these elements:

Sell the futures contract at $99.
Purchase Asset XYZ in the cash market for $100.
Borrow $100 for three months at 8% per year.

[1] Consider the first strategy (cash and carry trade), which had these elements: Technically, a short seller may not be entitled to the full use of the proceeds resulting from the sale. We will discuss this later in this section.

In three months, the outcome will be as follows:

1. From settlement of the futures contract:	
Proceeds from sale of Asset XYZ to settle the futures contract	= $ 99
Payment received from investing in Asset XYZ for 3 months	= 3
Total proceeds	= $102
2. From the loan:	= $100
Repayment of principal of loan	= 2
Interest on loan (2% for three months)	= $102
Total outlay	$ 0
3. Profit:	

If the futures price is $99, the arbitrage profit has disappeared.

Next, consider the strategy consisting of these actions:

Buy the futures contract at $99.
Sell (short) Asset XYZ for $100.
Invest (lend) $100 for three months at 8% per year.

The outcome in three months would be as follows:

1. From settlement of the futures contract:	
Price paid for purchase of Asset XYZ to settle futures contract	= $ 99
Proceeds to lender of Asset XYZ to borrow the asset	= 3
Total outlay	= $102
2. From the loan:	= $100
Principal from maturing of investment	= 2
Interest earned on loan ($2 for three months)	= $102
Total proceeds	$ 0
3. Profit:	

Thus, if the futures price were $99, neither strategy would result in an arbitrage profit. Hence, a futures price of $99 is the equilibrium price because any higher or lower futures price will permit riskless arbitrage profits.

Theoretical Futures Price Based on Arbitrage Model

According to the arbitrage arguments we have just presented, we see that the equilibrium or theoretical futures price can be determined on the basis of the following information:

1. The price of the asset in the cash market.
2. The cash yield earned on the asset until the settlement date. In our example, the cash yield on Asset XYZ is $3 on a $100 investment or 3% quarterly (12% annual cash yield).
3. The financing cost, which is the interest rate for borrowing and lending until the settlement date. In our example, the financing cost is 2% for the three months.

To develop a theory of futures pricing, we will use the following notation:

F = Futures price ($)
P = Cash market price ($)
r = Financing cost (%)
y = Cash yield (%)

Now, consider the cash and carry trade:

Sell (or take a short position in) the futures contract at F.
Purchase Asset XYZ for P.
Borrow P at a rate of r until the settlement date.

The outcome at the settlement date would be:

1. From settlement of the futures contract:

Proceeds from sale of Asset XYZ to settle the futures contract	$= F$
Payment received from investing in Asset XYZ	$= yP$
Total proceeds	$= F + yP$

2. From the loan:

Repayment of principal of loan	$= P$
Interest on loan	$= rP$
Total outlay	$= P + rP$

The profit will equal

$$\text{Profit} = \text{Total proceeds} - \text{Total outlay}$$
$$\text{Profit} = F + yP - (P + rP)$$

The equilibrium futures price is the price that ensures that the profit from this arbitrage strategy is zero. Thus, equilibrium requires that

$$0 = F + yP - (P + rP)$$

Solving for the theoretical futures price gives this equation:

$$F = P + P(r - y)$$

In other words, the equilibrium futures price is simply a function of the cash price, the financing cost, and the cash yield on the asset.

Alternatively, let us consider the reverse cash and carry trade illustrated in our example above, which looks like this:

Buy the futures contract at F.
Sell (short) Asset XYZ for P.
Invest (lend) P at a rate of r until the settlement date.

The outcome at the settlement date would be

1. From settlement of the futures contract:

Price paid for purchase of asset to settle futures contract	$= F$
Payment to lender of asset in order to borrow the asset	$= yP$
Total outlay	$= F + yP$

2. From the loan:

Principal from maturing of investment	$= P$
Interest earned on loan	$= rP$
Total proceeds	$= P + rP$

The profit will equal

$$\text{Profit} = \text{Total proceeds} - \text{Total outlay}$$
$$\text{Profit} = P + rP - (F + yP)$$

Setting the profit equal to zero, so that there will be no arbitrage profit, and solving for the futures price, we obtain the same equation for the futures price as derived earlier:

$$F = P + P(r - y)$$

It is instructive to apply this equation to our previous example to determine the theoretical futures price. In that example, the key variables have these values:

$r = 0.02$
$y = 0.03$
$P = \$100$

Then the theoretical futures price is

$$F = \$100 - \$100\,(0.03 - 0.02)$$
$$= \$100 - \$1 = \$99$$

This agrees with the equilibrium futures price we proposed earlier.

The theoretical futures price may be at a premium to the cash market price (higher than the cash market price) or at a discount from the cash market price (lower than the cash market price), depending on the value of $P(r - y)$. The term $r - y$, which reflects the difference between the cost of financing and the asset's cash yield, is called the **net financing cost.** The net financing cost is more commonly called the **cost of carry**, or simply, **carry**. **Positive carry** means that the yield earned is greater than the financing cost; **negative carry** means that the financing cost exceeds the yield earned. We can summarize the effect of carry on the difference between the futures price and the cash market price in this way:

Carry	Futures Price
Positive ($y > r$)	will sell at a discount to cash price ($F < P$)
Negative ($y < r$)	will sell at a premium to cash price ($F > P$)
Zero ($r = y$)	will be equal to the cash price ($F = P$)

Price Convergence at the Delivery Date

At the delivery date, which is when the futures contract settles, the futures price must equal the cash market price because a futures contract with no time left until delivery is equivalent to a cash market transaction. Thus, as the delivery date approaches, the futures price will converge to the cash market price. This fact is evident from the equation for the theoretical futures price. As the delivery date approaches, the financing cost approaches zero, and the yield that can be earned by holding the investment approaches zero. Hence, the cost of carry approaches zero, and the futures price will approach the cash market price.

A Closer Look at the Theoretical Futures Price

To derive the theoretical futures price using the arbitrage argument, we made several assumptions. When the assumptions are violated, the actual futures price will diverge from the theoretical futures price. That is, the difference between the two prices will differ

from the value of carry. Next, we examine those assumptions and identify practical reasons why the actual prices of all financial futures contracts tend to deviate from their theoretical prices.

Interim Cash Flows

Our theoretical analysis assumes that no interim cash flows arise because of changes in futures prices and the variation margin of the organized exchanges on which futures are traded. In addition, our approach assumes implicitly that any dividends or coupon interest payments are paid at the delivery date rather than at some time between initiation of the cash position and expiration of the futures contract. However, we know that interim cash flows of either type can and do occur in practice.

In the case of stock index futures, incorporating interim dividend payments into the pricing model is necessary because a cash position in a set of 100 or 500 stocks (the number of stocks underlying an index) generates cash flows in the form of dividends from the stocks. The dividend rate and the pattern of dividend payments are not known with certainty. They must be projected from the historical dividend payments of the companies in the index. Once the dividend payments are projected, they can be incorporated into the pricing model. The only problem is that the value of the dividend payments at the settlement date will depend on the interest rate at which the dividend payments can be reinvested from the time they are projected to be received until the settlement date. The lower the dividend, and the closer the dividend payments to the settlement date of the futures contract, the less important the reinvestment income is in determining the futures price.

It is important to note that, in the absence of initial and variation margins, the theoretical price for the contract is technically the theoretical price for a forward contract, not the theoretical price for a futures contract. This is because, unlike a futures contract, a forward contract is not marked to market at the end of each trading day, and therefore does not require variation margin and does not generate cash inflows from gains or outflows from losses.

Differences between Lending and Borrowing Rates

In deriving the theoretical futures price, we assumed that the investor's borrowing rate and lending rate are equal. Typically, however, the borrowing rate is higher than the lending rate. The impact of this inequality is important and easy to identify. We will begin by adopting these symbols for the two rates:

r_B = Borrowing rate
r_L = Lending rate

Now, consider the cash and carry trade:

Sell the futures contract at F.
Purchase the asset for P.
Borrow P until the settlement date at r_B.

Clearly, the futures price that would produce no arbitrage profit is

$$F = P + P(r_B - y)$$

Recall that the reverse cash and carry trade is

Buy the futures contract at F.
Sell (short) the asset for P.
Invest (lend) P at r_L until the settlement date.

The futures price that would prevent a riskless profit is

$$F = P + P(r_L - y)$$

These two equations together provide boundaries between which the futures price w be in equilibrium. The first equation establishes the upper boundary, and the second equa- tion the lower boundary. For example, assume that the borrowing rate is 8% per year, or 2% for three months, while the lending rate is 6% per year, or 1.5% for three months. According to the first equation, the upper boundary is

$$F(\text{upper boundary}) = \$100 + \$100\,(0.02 - 0.03) = \$99$$

The lower boundary according to the second equation is

$$F(\text{lower boundary}) = \$100 + \$100\,(0.015 - 0.03) = \$98.50$$

Thus, equilibrium is achieved if the futures price takes on any value between the two boundaries. In other words, equilibrium requires that $\$98.50 \leq F \leq \$99$.

Transaction Costs

In deriving the theoretical futures price, we ignored transaction costs of the elements in the arbitrage strategies. In actuality, the costs of entering into and closing the cash position as well as round-trip transaction costs for the futures contract do affect the futures price. It is easy to show, as we did previously for borrowing and lending rates, that transaction costs widen the boundaries for the equilibrium futures price. The details need not concern us here.

Short Selling

In the strategy involving short selling of Asset XYZ when the futures price is below its the- oretical value, we explicitly assumed in the reverse cash and carry trade that the proceeds from the short sale are received and reinvested. In practice, for individual investors, the proceeds are not received, and, in fact, the individual investor is required to put up margin (securities margin and not futures margin) to short sell. For institutional investors, the asset may be borrowed, but there is a cost to borrowing. This cost of borrowing can be incorporated into the model by reducing the yield on the asset.

For strategies applied to stock index futures, a short sale of the stocks in the index means that all stocks in the index must be sold simultaneously. The stock exchange rule for the short selling of stock may prevent an investor from implementing the arbitrage strategy. The short selling rule for stocks specifies that a short sale can be made only at a price that is higher than the previous trade (referred to as an uptick), or at a price that is equal to the previous trade (referred to as a zero tick) but higher than the last trade at a different price. If the arbitrage requires selling the stocks in the index simultaneously, and the last transaction for some of the stocks is not an uptick, the stocks cannot be shorted

simultaneously. Thus, an institutional rule may in effect keep arbitrageurs from bringing the actual futures price in line with the theoretical futures price.

Known Deliverable Asset and Settlement Date

Our example illustrating arbitrage strategies assumes that (1) only one asset is deliverable, and (2) the settlement date occurs at a known, fixed point in the future. Neither assumption is consistent with the delivery rules for some futures contracts. The case of U.S. Treasury bond and note futures contracts illustrates the point: An investor in a long position cannot know either the specific Treasury bond to be delivered or the specific date within the contract month when it might be delivered. This substantial uncertainty is a result of the delivery options that the short position in a futures contract has. As a reflection of the short positions' options and advantages, the actual futures price will be less than the theoretical futures price for the Treasury bond and note futures contracts.

The Deliverable Is a Basket of Securities

Some futures contracts involve a single asset, but other contracts apply to a basket of assets or an index. Stock index futures and the municipal bond index futures contracts are examples. The problem in arbitraging these two futures contracts is that it is too expensive to buy or sell every security included in the index. Instead, a portfolio containing a smaller number of assets may be constructed to track the index (which means having price movements that are very similar to changes in the index). Nonetheless, arbitrage based on this tracking portfolio is no longer risk-free because of the risk that the portfolio will not track the index exactly. Clearly, then, the actual price of futures based on baskets of assets may diverge from the theoretical price because of transactions costs as well as uncertainty about the outcome of the arbitrage.

Different Tax Treatment of Cash and Futures Transactions

The basic arbitrage model presented in this chapter ignores not only taxes but also different tax treatment of cash market transactions and futures transactions. Obviously, these factors can keep the actual futures price from being equal to the theoretical price.

Key Points That You Should Understand Before Proceeding

1. The equilibrium or theoretical futures price can be determined through arbitrage arguments.
2. The strategy that can be used to capture the arbitrage profit for an overpriced futures contract is the cash and carry trade; the strategy that can be used to capture the arbitrage profit for an underpriced futures contract is the reverse cash and carry trade.
3. The theoretical futures price depends on the price of the underlying asset in the cash market, the cost of financing a position in the underlying asset, and the cash yield on the underlying asset.
4. At the delivery date, the price of a futures contract converges to the cash market price.
5. The actual futures price will diverge from the theoretical futures price because of interim cash flows, differences between lending and borrowing rates, transaction costs, restrictions on short selling, and uncertainty about the deliverable asset and the date it will be delivered.

PRICING OF OPTIONS

The theoretical price of an option is also derived from arbitrage arguments. However, the pricing of options is not as simple as the pricing of futures contracts.

Basic Components of the Option Price

The option price is the sum of the option's **intrinsic value** and a premium over intrinsic value that is often referred to as the *time value* or *time premium*. While the former term is more common, we will use the term **time premium** to avoid confusion between the time value of money and the time value of the option.

Intrinsic Value

The intrinsic value of an option, at any time, is its economic value if it is exercised immediately. If no positive economic value would result from exercising immediately, the intrinsic value is zero.

Computationally, the intrinsic value of a call option is the difference between the current price of the underlying asset and the strike price. If that difference is positive, then the intrinsic value equals that difference; if the difference is zero or negative, then the intrinsic value is set equal to zero. For example, if the strike price for a call option is $100 and the current asset price is $105, the intrinsic value is $5. That is, an option buyer exercising the option and simultaneously selling the underlying asset would realize $105 from the sale of the asset, which would be covered by acquiring the asset from the option writer for $100, thereby, netting a $5 gain.

When an option has intrinsic value, it is said to be **in the money**. When the strike price of a call option exceeds the current asset price, the call option is said to be **out of the money**; it has no intrinsic value. An option for which the strike price is equal to the current asset price is said to be **at the money**. Both at-the-money and out-of-the-money options have intrinsic values of zero because it is not profitable to exercise them. Our call option with a strike price of $100 would be: (1) in the money when the current asset price is more than $100, (2) out of the money when the current asset price is less than $100, and (3) at the money when the current asset price is equal to $100.

For a put option, the intrinsic value is equal to the amount by which the current asset price is below the strike price. For example, if the strike price of a put option is $100, and the current asset price is $92, the intrinsic value is $8. That is, the buyer of the put option who simultaneously buys the underlying asset and exercises the put option will net $8 by exercising. The asset will be sold to the writer for $100 and purchased in the market for $92. For our put option with a strike price of $100, the option would be: (1) in the money when the current asset price is less than $100, (2) out of the money when the current asset price exceeds $100, (3) at the money when the current asset price is equal to $100.

Time Premium

The time premium of an option is the amount by which the option's market price exceeds its intrinsic value. The option buyer hopes that, at some time prior to expiration, changes in the market price of the underlying asset will increase the value of the rights conveyed by the option. For this prospect, the option buyer is willing to pay a premium above the

intrinsic value. For example, if the price of a call option with a strike price of $100 is $9 when the current asset price is $105, the time premium of this option is $4 ($9 minus its intrinsic value of $5). Had the current asset price been $90 instead of $105, then the time premium of this option would be the entire $9 because the option has no intrinsic value. Clearly, other things being equal, the time premium of an option will increase with the amount of time remaining to expiration.

An option buyer has two ways to realize the value of a position taken in the option. The first way is to exercise the option. The second way is to sell the call option for its market price. In the first example above, selling the call for $9 is preferable to exercising, because the exercise will realize a gain of only $5 but the sale will realize a gain of $9. As this example shows, exercise causes the immediate loss of any time premium. It is important to note that there are circumstances under which an option may be exercised prior to the expiration date. These circumstances depend on whether the total proceeds at the expiration date would be greater by holding the option or exercising and reinvesting any received cash proceeds until the expiration date.

Put–Call Parity Relationship

There is an important relationship between the price of a call option and the price of a put option on the same underlying instrument, with the same strike price and the same expiration date. An example can illustrate this relationship, which is commonly referred to as the **put–call parity relationship**.

Our example assumes that a put option and a call option are available on the same underlying asset (Asset XYZ), and that both options have one month to expiration and a strike price of $100. The example assumes the price of the underlying asset to be $100. The call and put prices are assumed to be $3 and $2, respectively.

To see if the two prices have the right relationship, consider what happens if an investor pursues this strategy:

Buy Asset XYZ at a price of $100.
Sell a call option at a price of $3.
Buy a put option at a price of $2.

This strategy generates these positions:

Long Asset XYZ
Short the call option
Long the put option

Table 1 shows the profit and loss profile at the expiration date for this strategy. Notice that, no matter what Asset XYZ's price is at the expiration date, the strategy will produce a profit of $1. The net cost of creating this position is the cost of purchasing Asset XYZ ($100) plus the cost of buying the put ($2) less the price received from selling the call ($3), which is $99. Suppose that the net cost of creating the position for one month is less than $1. Then, by borrowing $99 to create the position so that no investment outlay is made by the investor, this strategy will produce a net profit of $1 (as shown in the last column of Table 1) less the cost of borrowing $99, which is assumed to be less than $1. This situation cannot exist in an efficient market. As market participants implement the strategy to capture the $1 profit, their actions will have one or more of the following consequences, which

Table 1 Profit/Loss Profile for a Strategy Involving a Long Position in Asset XYZ, Short Call Option Position, and Long Put Option Position

Assumptions:
Price of Asset XYZ: $100
Call option price: $3
Put option price: $2
Strike price 5: 100
Time to expiration: 1 month

Price of Asset XYZ at Expiration Date	Profit from Asset XYZ *	Price Received for Call	Price Paid for Put	Overall Profit
$150	0	3	−2	1
140	0	3	−2	1
130	0	3	−2	1
120	0	3	−2	1
115	0	3	−2	1
110	0	3	−2	1
105	0	3	−2	1
100	0	3	−2	1
95	0	3	−2	1
90	0	3	−2	1
85	0	3	−2	1
80	0	3	−2	1
75	0	3	−2	1
70	0	3	−2	1
65	0	3	−2	1
60	0	3	−2	1

*There is no profit because at a price above $100 Asset XYZ will be called from the investor at a price of $100, and at a price below $100, Assef XYZ will be put by the investor at a price of $100.

will tend to eliminate the $1 profit: (1) the price of Asset XYZ will increase, (2) the call option price will drop, and/or (3) the put option price will rise.

Our example clearly implies that, if Asset XYZ's price does not change, the call price and the put price must tend toward equality. But our example ignores the time value of money (financing and opportunity costs, cash payments, and reinvestment income). Also, our example does not consider the possibility of early exercise of the options. Thus, we have been considering a put–call parity relationship for only European options.

It can be shown that the put–call parity relationship for options where the underlying asset makes cash distributions and where the time value of money is recognized is

$$\text{Put option price} - \text{Call option price} = \text{Present value of strike price} + \text{Present value of cash distribution} - \text{Price of underlying asset}$$

Once more, we note that this relationship is actually the put–call parity relationship for European options. However, the values of puts and calls that are American options do conform approximately to this relationship. If this relationship does not hold, arbitrage opportunities exist. That is, investors will be able to construct portfolios consisting of long and short positions in the asset and related options that will provide an extra return with (practical) certainty.

Factors that Influence the Option Price

Six factors influence the price of an option:

1. current price of the underlying asset
2. strike price
3. time to expiration of the option
4. expected price volatility of the underlying asset over the life of the option
5. short-term, risk-free interest rate over the life of the option
6. anticipated cash payments on the underlying asset over the life of the option

The impact of each of these factors may depend on whether (1) the option is a call or a put, and (2) the option is an American option or a European option. A summary of the effect of each factor on put and call option prices is presented in Table 2. Here we briefly explain why the factors have the particular effects.

Current Price of the Underlying Asset

The option price will change as the price of the underlying asset changes. For a call option, as the price of the underlying asset increases (all other factors constant), the option price increases. The opposite holds for a put option: As the price of the underlying asset increases, the price of a put option decreases.

Strike Price

The strike price is fixed for the life of the option. All other factors equal, the lower the strike price, the higher the price for a call option. For put options, the higher the exercise price, the higher the option price. Table 3 shows this for the price of IBM call and put options on June 6, 2008, expiring in October 2008.

Time to Expiration of the Option

An option is a *wasting asset.* That is, after the expiration date the option has no value. All other factors equal, the longer the time to expiration of the option, the higher the option price. This is because, as the time to expiration decreases, less time remains for the underlying asset's price to rise (for a call buyer) or fall (for a put buyer), and therefore the probability of a favorable price movement decreases. Consequently, for American options, as the time remaining until expiration decreases, the option price approaches its intrinsic value.

Table 2 Summary of Factors that Affect the Price of an Option

	Effect of an increase of factor on	
Factor	Call Price	Put Price
Current price of underlying asset	Increase	Decrease
Strike price	Decrease	Increase
Time to expiration of option	Increase	Increase
Expected price volatility	Increase	Increase
Short-term interest rate	Increase	Decrease
Anticipated cash payments	Decrease	Increase

Table 3 Market Price on June 6, 2008, of IBM Put and Call Options Expiring October 2008

Call Options			Put Options		
Strike	Symbol	Last	Strike	Symbol	Last
70	IBMJN.X	53.8	70	IBMVN.X	0.2
75	IBMJO.X	42.7	75	IBMVO.X	0.2
80	IBMJP.X	44.9	80	IBMVP.X	0.2
85	IBMJQ.X	39.4	85	IBMVQ.X	0.4
90	IBMJR.X	28.0	90	IBMVR.X	0.5
95	IBMJS.X	34.7	95	IBMVS.X	0.7
100	IBMJT.X	28.5	100	IBMVT.X	1.2
105	IBMJA.X	24.5	105	IBMVA.X	1.8
110	IBMJB.X	20.5	110	IBMVB.X	2.5
115	IBMJC.X	15.3	115	IBMVC.X	3.4
120	IBMJD.X	12.1	120	IBMVD.X	5.1
125	IBMJE.X	8.7	125	IBMVE.X	6.2
130	IBMJF.X	6.2	130	IBMVF.X	9.0
135	IBMJG.X	4.1	135	IBMVG.X	12.4
140	IBMJH.X	2.7	140	IBMVH.X	14.8
145	IBMJI.X	1.7	145	IBMVI.X	18.9
145	TSBJI.X	0.3	150	IBMVJ.X	21.7
150	IBMJJ.X	1.2			

This can be seen in Table 4, which shows the price of IBM options on June 6, 2008, with different expiration dates.

Expected Price Volatility of the Underlying Asset over the Life of the Option

All other factors equal, the greater the expected volatility (as measured by the standard deviation or variance) of the price of the underlying asset, the more an investor would be willing to pay for the option, and the more an option writer would demand for it. This occurs because the greater the volatility, the greater the probability that the price of the underlying asset will move in favor of the option buyer at some time before expiration.

Table 4 Market Price on June 6, 2008, of IBM Put and Call Options with a Strike Price of 120 for Different Expiration Dates

	Call Options	Put Options
Expires	Option Price	Option Price
June 2008	6.60	0.44
July 2008	8.30	2.00
October 2008	12.10	5.08
January 2009	14.40	6.90
January 2010	22.90	11.80

Notice that it is the standard deviation or variance, not the systematic risk as measured by beta that is relevant in the pricing of options.

Short-Term, Risk-Free Interest Rate over the Life of the Option

Buying the underlying asset ties up one's money. Buying an option on the same quantity of the underlying asset makes the difference between the asset price and the option price available for investment at an interest rate at least as high as the risk-free rate. Consequently, all other factors constant, the higher the short-term, risk-free interest rate, the greater the cost of buying the underlying asset and carrying it to the expiration date of the call option. Hence, the higher the short-term, risk-free interest rate, the more attractive the call option will be relative to the direct purchase of the underlying asset. As a result, the higher the short-term, risk-free interest rate, the greater the price of a call option.

Anticipated Cash Payments on the Underlying Asset over the Life of the Option

Cash payments on the underlying asset tend to decrease the price of a call option because the cash payments make it more attractive to hold the underlying asset than to hold the option. For put options, cash payments on the underlying asset tend to increase the price.

Option Pricing Models

We have shown that the theoretical price of a futures contract can be determined on the basis of arbitrage arguments. An option pricing model uses a set of assumptions and arbitrage arguments to derive a theoretical price for an option. As we shall see in the following text, deriving a theoretical option price is much more complicated than deriving a theoretical futures price because the option price depends on the expected price volatility of the underlying asset over the life of the option.

Several models have been developed to determine the theoretical value of an option. The most popular one was developed by Fischer Black and Myron Scholes in 1973 for valuing European call options.[2] Several modifications to their model have followed. We use another pricing model called the *binomial option pricing model* to see how arbitrage arguments can be used to determine a fair value for a call option.[3]

Basically, the idea behind the arbitrage argument is that if the payoff from owning a call option can be replicated by (1) purchasing the asset underlying the call option and (2) borrowing funds, the price of the option is then (at most) the cost of creating the replicating strategy.

Deriving the Binomial Option Pricing Model

To derive a one-period binomial option pricing model for a call option, we begin by constructing a portfolio consisting of: (1) a long position in a certain amount of the asset and (2) a short call position in the underlying asset. The amount of the underlying asset purchased is such that the position will be hedged against any change in the price of the asset at

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[2] Fischer Black and Myron Scholes, "The Pricing of Corporate Liabilities," *Journal of Political Economy* (May–June 1973), pp. 637–659.

[3] John C. Cox, Stephen A. Ross, and Mark Rubinstein, "Option Pricing: A Simplified Approach," *Journal of Financial Economics* (September 1979), pp. 229–263; Richard J. Rendleman and Brit J. Bartter, "Two-State Option Pricing," *Journal of Finance* (December 1979), pp. 1093–1110; and William F. Sharpe, *Investments* (Englewood Cliffs, NJ: Prentice Hall, 1981), Chapter 16.

the expiration date of the option. That is, the portfolio consisting of the long position in the asset and the short position in the call option is riskless and will produce a return that equals the risk-free interest rate. A portfolio constructed in this way is called a *hedged portfolio.*

We can show how this process works with an extended illustration. Let us assume first that there is an asset that has a current market price of $80, and that only two possible future states can occur one year from now. Each state is associated with one of only two possible values for the asset, and they can be summarized in this way:

State	Price
1	$100
2	70

We assume further that there is a call option on this asset with a strike price of $80 (the same as the current market price), and that it expires in one year. Let us suppose an investor forms a hedged portfolio by acquiring two-thirds of a unit of the asset and selling one call option. The two-thirds of a unit of the asset is the so-called *hedge ratio* (how we derive the hedge ratio is explained later). Let us consider the outcomes for this hedged portfolio corresponding to the two possible outcomes for the asset.

If the price of the asset one year from now is $100, the buyer of the call option will exercise it. This means that the investor will have to deliver one unit of the asset in exchange for the strike price, $80. As the investor has only two-thirds of a unit of the asset, she has to buy one-third at a cost of $33 1/3 (the market price of $100 times 1/3). Consequently, the outcome will equal the strike price of $80 received, minus the $33 1/3 cost to acquire the one-third unit of the asset to deliver, plus whatever price the investor initially sold the call option for. That is, the outcome will be

$$80 - 33\ 1/3 + \text{Call option price} = 46\ 2/3 + \text{Call option price}$$

If, instead, the price of the asset one year from now is $70, the buyer of the call option will not exercise it. Consequently, the investor will own two-thirds of a unit of the asset. At the price of $70, the value of two-thirds of a unit is $46 2/3. The outcome in this case is then the value of the asset plus whatever price the investor received when she initially sold the call option. That is, the outcome will be

$$46\ 2/3 + \text{Call option price}$$

It is apparent that, given the possible asset prices, the portfolio consisting of a short position in the call option and two-thirds of a unit of the asset will generate an outcome that hedges changes in the price of the asset; hence, the hedged portfolio is riskless. Furthermore, this riskless hedge will hold regardless of the price of the call, which affects only the magnitude of the outcome.

Deriving the Hedge Ratio

To show how to calculate the hedge ratio, we use the notation

S = current asset price
u = 1 plus the percentage change in the asset's price if the price goes up in the next period
d = 1 plus the percentage change in the asset's price if the price goes down in the next period

r = a risk-free one-period interest rate (the risk-free rate until the expiration date)
C = current price of a call option
C_u = intrinsic value of the call option if the asset price goes up
C_d = intrinsic value of the call option if the asset price goes down
E = strike price of the call option
H = hedge ratio, that is, the amount of the asset purchased per call sold

In our illustration, u and d are

$u = 1.250$ ($100/$80)
$d = 0.875$ ($70/$80)

Furthermore, State 1 in our illustration means that the asset's price goes up, and State 2 means that the asset's price goes down.

The investment made in the hedged portfolio is equal to the cost of buying H amount of the asset minus the price received from selling the call option. Therefore, because

$$\text{Amount invested in the asset} = HS$$

then

$$\text{Cost of the hedged portfolio} = HS - C$$

The payoff of the hedged portfolio at the end of one period is equal to the value of the HS amount of the asset purchased minus the call option price. The payoffs of the hedged portfolio for the two possible states are defined in this way:

State 1, if the asset's price goes up: $uHS - C_u$
State 2, if the asset's price goes down: $dHS - C_d$

In our illustration, we have these payoffs:

If the asset's price goes up: $1.250\,H\,\$80 - C_u$ or $\$100\,H - C_u$
If the asset's price falls: $0.875\,H\,\$80 - C_d$ or $\$70\,H - C_d$

If the hedge is riskless, the payoffs must be the same. Thus,

$$uHS - C_u = dHS - C_d \tag{1}$$

Solving equation (1) for the hedge ratio, H, we have

$$H = \frac{C_u - C_d}{(u - d)S} \tag{2}$$

To determine the value of the hedge ratio, H, we must know C_u and C_d. These two values are equal to the difference between the price of the asset and the strike price in the two possible states. Of course, the minimum value of the call option, in any state, is zero. Mathematically, the differences can be expressed as follows:

If the asset's price goes up: $C_u = \text{Max}\,[0, (uS - E)]$
If the asset's price goes down: $C_d = \text{Max}\,[0, (dS - E)]$

As the strike price in our illustration is \$80, the value of uS is \$100, and the value of dS is \$70. Then,

If the asset's price goes up: $C_u = \text{Max}\,[0, (\$100 - \$80)] = \$20$
If the asset's price goes down: $C_d = \text{Max}\,[0, (\$70 - \$80)] = \$0$

To continue with our illustration, we substitute the values of u, d, S, C_u, and C_d into equation (2) to obtain the hedge ratio's value:

$$H = \frac{\$20 - \$0}{(1.25 - 0.875)\$80} = \frac{2}{3}$$

This value for H agrees with the amount of the asset purchased when we introduced this illustration.

Now we can derive a formula for the call option price. Figure 1 diagrams the situation. The top left half of the figure shows the current price of the asset for the current period and at the expiration date. The lower left-hand portion of the figure does the same thing using the notation above. The upper right-hand side of the figure gives the current price of the call option and the value of the call option at the expiration date; the lower right-hand side does the same thing using our notation. Figure 2 uses the values in our illustration to construct the outcomes for the asset and the call option.

Deriving the Price of a Call Option

To derive the price of a call option, we can rely on the basic principle that the hedged portfolio, being riskless, must have a return equal to the risk-free rate of interest. Given that the amount invested in the hedged portfolio is $HS - C$, the amount that should be generated one period from now is

$$(1 + r)(HS - C) \tag{3}$$

Figure 1 One-Period Option Pricing Model

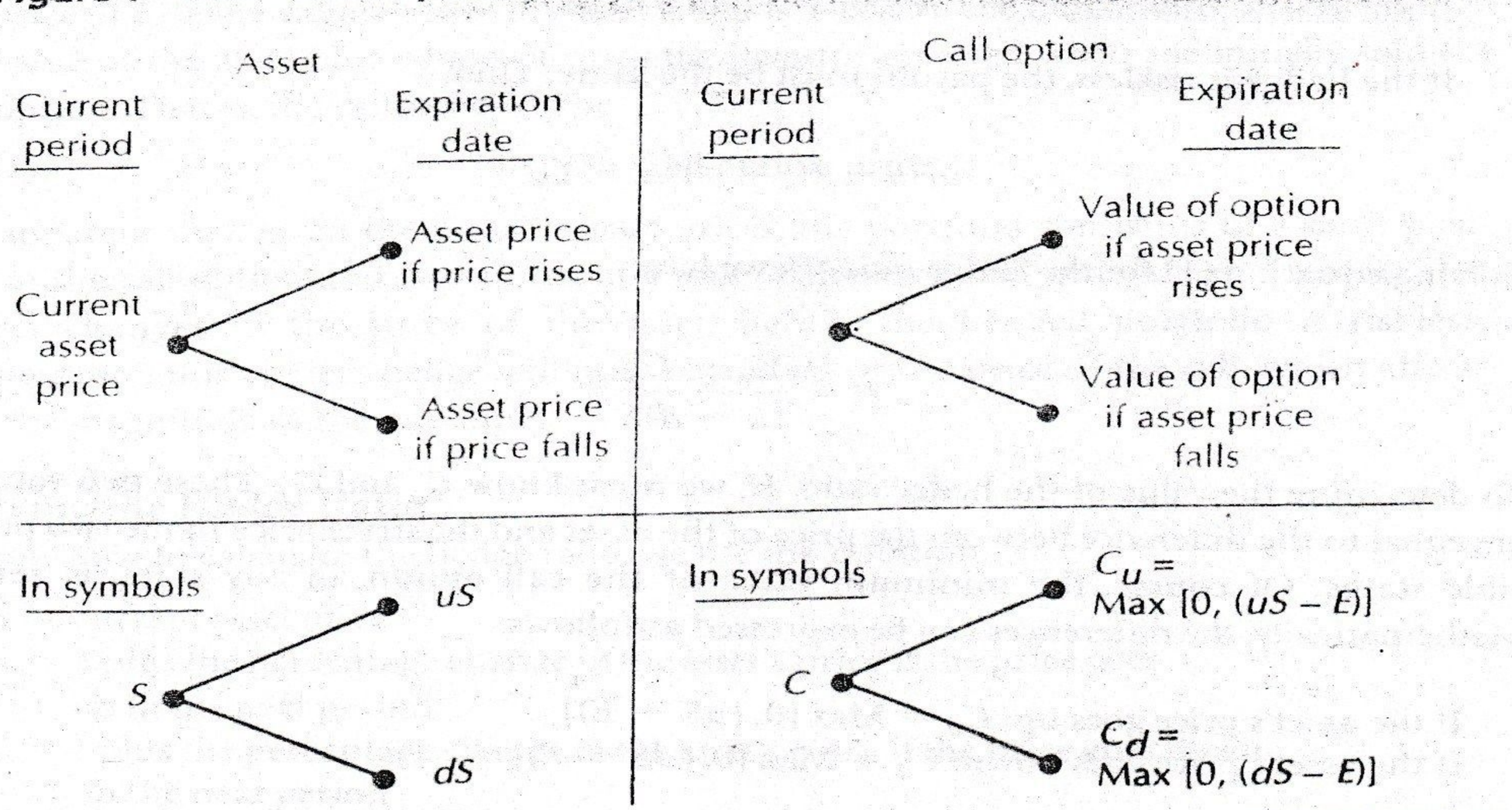
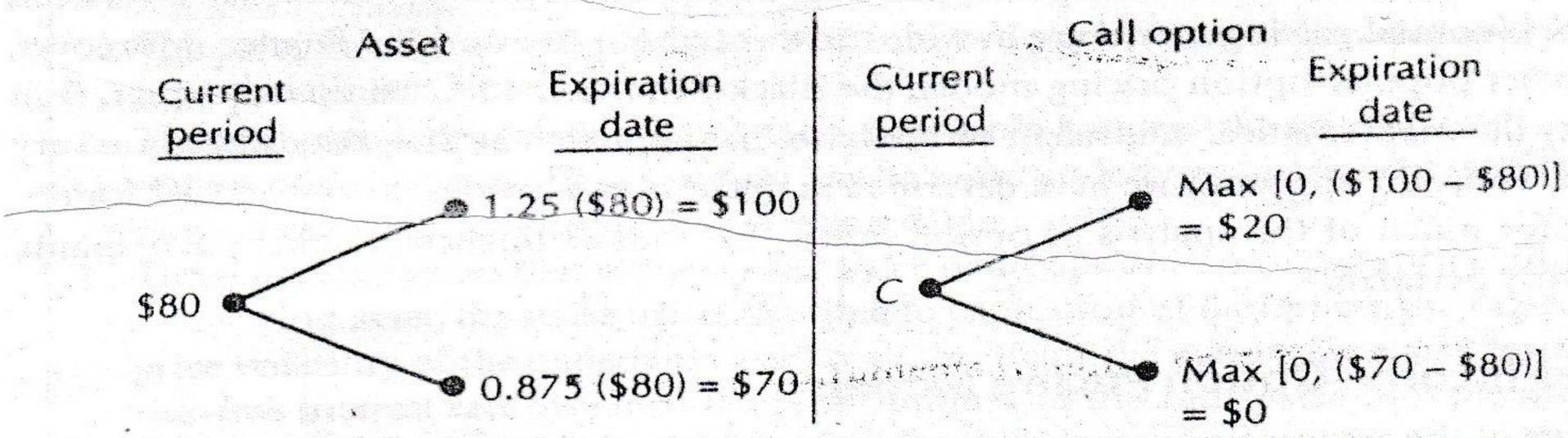


Figure 2 One-Period Option Pricing Model Illustration



We also know what the payoff will be for the hedged portfolio if the asset's price goes up or down. Because the payoff of the hedged portfolio will be the same whether the asset's price rises or falls, we can use the payoff if it goes up, which is

$$uHS - C_u$$

The payoff of the hedged portfolio given above should be the same as the initial cost of the portfolio given by equation (3). Equating the two, we have

$$(1 + r)(HS - C) = uHS - C_u \tag{4}$$

Substituting equation (2) for H in equation (4), and solving for the call option price, C, we find

$$C = \left(\frac{1 + r - d}{u - d}\right)\left(\frac{C_u}{1 + r}\right) + \left(\frac{u - 1 - r}{u - d}\right)\left(\frac{C_d}{1 + r}\right) \tag{5}$$

Equation (5) is the formula for the one-period binomial option pricing model. We would have derived the same formula if we had used the payoff for a decline in the price of the underlying asset. This derivation is left as an exercise for the reader.

Applying equation (5) to our illustration where

$u = 1.250$
$d = 0.875$
$r = 0.10$
$C_u = \$20$
$C_d = \$0$

we get

$$C = \left(\frac{1 + 0.10 - 0.875}{1.25 - 0.875}\right)\left(\frac{\$20}{1 + 0.10}\right) + \left(\frac{1.25 - 1 - 0.10}{1.25 - 0.875}\right)\left(\frac{\$0}{1 + 0.10}\right)$$

$$= \$10.90$$

The approach we present for pricing options may seem oversimplified, given that we assume only two possible future states for the price of the underlying asset. In fact, we can

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extend the procedure by making the period shorter and shorter, and in that way calculate a fair value for an option. It is important to note that extended and comprehensive versions of the binomial pricing model are in wide use throughout the world of finance. Moreover, the other popular option pricing model, the Black-Scholes model mentioned earlier, is in reality the mathematical equivalent of the binomial approach as the periods become very short. Thus, the approach we have described in detail here provides the conceptual framework for much of the analysis of option prices that today's financial market participants regularly perform.

Fixed-Income Option Pricing Models

Because of the assumptions required for the binomial model described above, such models may have limited applicability to the pricing of options on fixed-income securities. More specifically, the binomial model assumes that (1) the price of the security can take on any positive value with some probability—no matter how small, (2) the short-term interest rate is constant over the life of the option, and (3) the volatility of the price of the security is constant over the life of the option.

These assumptions are unreasonable for an option on a fixed-income security. First, the price of a fixed-income security cannot exceed the undiscounted value of the cash flow. Any possibility that the price can go higher than this value implies that interest rates can be negative. Second, the price of an interest rate option will change as interest rates change. A change in the short-term interest rate changes the rates along the yield curve. Therefore, to assume that the short-term rate will be constant is inappropriate for interest rate options. The third assumption, that the variance of prices is constant over the life of the option, is inappropriate because as a bond moves closer to maturity its price volatility declines.

Fortunately, it is possible to avoid the problem of negative interest rates. We can develop a binomial option pricing model that is based on the distribution of interest rates rather than prices. Once a binomial interest rate tree is constructed, it can be converted into a binomial price tree by using its interest rates to determine the prices of the bond at the end of the period. We can apply to these prices the same procedure described earlier to calculate the option price by working backward from the value of the call option at the expiration date.

Although the binomial option pricing model based on yields is superior to models based on prices, it still has a theoretical drawback. All theoretically valid option pricing models must satisfy the put–call parity relationship. The problem with the binomial model based on yields is that it does not satisfy this relationship. It violates the relationship because it fails to take into consideration the yield curve, thereby allowing arbitrage opportunities.

The most elaborate models that take the yield curve into consideration, and as a result eliminate arbitrage opportunities, are called *yield curve option pricing models* or *arbitrage-free option pricing models.* These models can incorporate different volatility assumptions along the yield curve. They are theoretically superior to the other models we have described.[4]

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[4] For a discussion of yield curve or arbitrage-free option pricing models, see Mark Pitts and Frank J. Fabozzi, *Interest Rate Futures and Options* (Chicago: Probus Publishing, 1989), Chapter 9; and Lawrence J. Dyer and David P. Jacob, "Guide to Fixed Income Option Pricing Models," in Frank J. Fabozzi (ed.), *The Handbook of Fixed Income Options* (Chicago: Probus Publishing, 1989).

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Key Points That You Should Understand Before Proceeding

1. The price of an option can be separated into two parts, its intrinsic value and its time premium.
2. The put–call parity relationship is the relationship between the price of a call option and the price of a put option on the same underlying instrument, with the same strike price and the same expiration date.
3. There are six factors that influence the price of an option: the current price of the underlying asset, the strike price, the time to expiration of the option, the expected price volatility of the underlying asset over the life of the option, the short-term, risk-free interest rate over the life of the option, and the anticipated cash payments on the underlying asset over the life of the option.
4. The theoretical price of an option can be determined on the basis of arbitrage arguments, but is much more complicated to determine than the theoretical price of a futures contract because the option price depends on the expected price volatility of the underlying asset over the life of the option.
5. Several models have been developed to determine the theoretical value of an option.
6. The value of an option is equal to the cost of creating a replicating hedge portfolio.

SUMMARY

Using simple arbitrage arguments, the theoretical or equilibrium futures price can be determined. Specifically, to capture the arbitrage profit for an overpriced futures contract a cash and carry trade can be implemented, and to capture the arbitrage profit for an underpriced futures contract a reverse cash and carry trade can be implemented. The ability of market participants to implement these two trades (or arbitrage strategies) results in the theoretical futures price being equal to the cash market price plus the cost of carry. The cost of carry is the net financing cost, that is, the difference between the financing rate and the cash yield on the underlying asset. The theoretical futures price will be less than the cash market price if the cost of carry is positive, equal to the cash market price if the cost of carry is zero, and more than the cash market price if the cost of carry is negative.

Developing the theoretical futures price with arbitrage arguments requires certain assumptions. When these assumptions are violated for a specific futures contract, the theoretical futures price must be modified. Because of the difference between borrowing and lending rates and because of transaction costs, there is not one theoretical futures price but, rather, a boundary around the theoretical futures price. So long as the actual futures price remains within this boundary, arbitrage profits cannot be realized.

The price of an option consists of two components: the intrinsic value and the time premium. The intrinsic value is the economic value of the option if it is exercised immediately. If there is no positive economic value resulting from exercising immediately, the intrinsic value is zero. The time premium is the amount by which the option price exceeds the intrinsic value. Six factors influence the option price: (1) the current price of the underlying asset; (2) the strike price of the option; (3) the time remaining to the expiration of the option; (4) the expected price volatility of the underlying asset; (5) the short-term, risk-free

interest rate over the life of the option; and (6) the anticipated cash payments on the underlying asset.

The relationship among the call option price, the put option price, and the price of the underlying asset is known as the put–call parity relationship. The theoretical option price can be calculated with the binomial option pricing model, which also employs arbitrage arguments. Application of the binomial model to the pricing of options on fixed-income securities poses problems because of the model's underlying assumptions.

KEY TERMS

- At the money
- Cash and carry trade
- Cost of carry (carry)
- Financing cost
- In the money
- Intrinsic value
- Negative carry
- Net financing cost
- Out of the money
- Positive carry
- Put–call parity relationship
- Reverse cash and carry trade
- Time premium

QUESTIONS

1. Models for pricing futures and options are said to be based on arbitrage arguments.
   a. What does arbitrage mean?
   b. What is the investor's incentive to engage in arbitrage?
2. Suppose there is a financial Asset ABC, which is the underlying asset for a futures contract with settlement six months from now. You know the following about this financial asset and the futures contract:
   1. In the cash market, ABC is selling for $80.
   2. ABC pays $8 per year in two semiannual payments of $4, and the next semiannual payment is due exactly six months from now.
   3. The current six-month interest rate at which funds can be loaned or borrowed is 6%.

   a. What is the theoretical (or equilibrium) futures price?
   b. What action would you take if the futures price is $83?
   c. What action would you take if the futures price is $76?
   d. Suppose that ABC pays interest quarterly instead of semiannually. If you know that you can reinvest any funds you receive three months from now at 1% for three months, what would the theoretical futures price for six-month settlement be?
   e. Suppose that the borrowing rate and lending rate are not equal. Instead, suppose that the current six-month borrowing rate is 8% and the six-month lending rate is 6%. What are the boundaries for the theoretical futures price?
3. **a.** Explain why restrictions on short selling of stocks would cause the actual price of a stock index futures contract to diverge from its theoretical price.
   b. Explain why creating a portfolio of stocks in which the number of stocks is less than the number of stocks in the index underlying a stock index futures contract would result in an arbitrage that is not riskless.
4. Why do the delivery options in a Treasury bond futures contract cause the actual futures price to diverge from its theoretical price?
5. "Of course the futures are more expensive than the cash price—there's positive carry." Do you agree with this statement?

6. Consider the following call option with three months to expiration:

   Strike price = $72

   Current price of underlying assets = $87

   Market price of option = $6

   a. What is the intrinsic value for this call option?

   b. What is the time premium for this call option?

7. Suppose the option in the previous question is a put option rather than a call option.

   a. What is the intrinsic value for this put option?

   b. What is the time premium for this put option?

8. You obtain the following price quotes for call options on Asset ABC. It is now December, with the near contract maturing in one month's time. Asset ABC's price is currently trading at $50.

Strike	January	March	June
$40	$11	$12	$11.50
50	6	7	8.50
60	7	8	9.00

   Glancing at the figures, you note that two of these quotes seem to violate some of the rules you learned regarding options pricing.

   a. What are these discrepancies?

   b. How could you take advantage of the discrepancies? What is the minimum profit you would realize by arbitraging based on these discrepancies?

9. Indicate whether you agree or disagree with the following statements:

   a. "To determine the theoretical value of an option, we will need some measure of the price volatility of the underlying asset. Because financial theorists tell us that the appropriate measure of risk is beta (that is, systematic risk), then we should use this value."

   b. "If the expected price volatility of an option increases, the theoretical value of an option decreases."

   c. "It does not make sense that the price of a call option should rise in value if the price of the underlying asset falls."

10. Consider two options with the same expiration date and for the same underlying asset. The two options differ only in the strike price. Option 1's strike price is greater than that of Option 2.

    a. If the two options are call options, which option will have a higher price?

    b. If the two options are put options, which option will have a higher price?

11. Consider two options with the same strike price and for the same underlying asset. The two options differ only with respect to the time to expiration. Option A expires in three months and Option B expires in six months.

    a. If the two options are call options, which option will have the higher intrinsic value (assuming the options are in the money)?

    b. If the two options are call options, which option will have a higher time premium?

    c. Would your answers to (a) and (b) be different if the option is a put rather than a call?

12. In an option pricing model, what statistical measure is used as a measure of the price volatility of the underlying asset?

13. For an asset that does not make cash distributions over the life of an option, it does not pay to exercise a call option prior to the expiration date. Why?

14. Consider two strategies:

    Strategy 1: Purchase one unit of Asset M currently selling for $103. A distribution of $10 is expected one year from now.

    Strategy 2: (a) Purchase a call option on Asset M with an expiration date one year from now and a strike price of $100; and (b) place sufficient funds in a 10% interest-bearing bank account to exercise the option at expiration ($100) and to pay the cash distribution that would be paid by Asset M ($10).

    a. What is the investment required under Strategy 2?

    b. Give the payoffs of Strategy 1 and Strategy 2, assuming that the price of Asset M one year from now is

    (i) $120

    (ii) $103

    (iii) $100

    (iv) $80

    c. For the four prices of Asset M one year from now, demonstrate that the following relationship holds: Call option price $\geq$ Max [0, (Price of underlying asset – Present value of strike price – Present value of cash distribution)].

15. What is meant by a hedge ratio in developing an option pricing model?
16. a. Calculate the option value for a two-period European call option with the following terms:

    Current price of underlying asset = $100
    Strike price = $10
    One-period, risk-free rate = 5%

    The stock price can either go up or down by 10% at the end of one period.

    b. Recalculate the value for the option when the stock price can move either up or down by 50% at the end of one period. Compare your answer with the calculated value in part (a).
17. What is the problem encountered in applying the binomial pricing model to the pricing of options on fixed-income securities?

OTC Interest Rate Derivatives: Forward Rate Agreements, Swaps, Caps, and Floors

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OTC Interest Rate Derivatives: Forward Rate Agreements, Swaps, Caps, and Floors

LEARNING OBJECTIVES

After reading this chapter, you will understand

- what a forward rate agreement is
- what an interest rate swap is
- how an interest rate swap can be used by institutional investors and corporate borrowers
- why the interest rate swap market has grown so rapidly
- the risk/return characteristics of an interest rate swap
- two ways to interpret an interest rate swap
- reasons for the development of an interest rate swap market
- determinants of the swap spread
- what a swaption is
- what a forward start swap is
- what an interest rate/equity swap is
- what an interest rate cap and floor is
- how interest rate caps and floors and forward rate agreements can be used by institutional investors and corporate borrowers
- the relationship between an interest rate cap and floor and an option
- how an interest rate collar can be created

Interest rate futures and options can be used to control interest rate risk. Commercial banks and investment banks also customize other contracts useful for controlling interest rate risk for their clients. These include interest rate swaps, interest rate caps and floors, and

forward rate agreements. In this chapter, we will review each contract and explain the way borrowers and institutional investors use them.

FORWARD RATE AGREEMENTS

A **forward rate agreement (FRA)** is the over-the-counter (OTC) equivalent of the exchange-traded futures contracts on short-term rates. Typically, the short-term rate is the London Interbank Offered Rate (LIBOR).

The elements of an FRA are the contract rate, reference rate, settlement rate, notional amount, and settlement date. The parties to an FRA agree to buy and sell funds on the settlement date. The FRA's *contract rate* is the rate specified in the FRA at which the buyer of the FRA agrees to pay for funds and the seller of the FRA agrees to receive for investing funds. The reference rate is the interest rate used. For example, the *reference rate* could be three-month LIBOR or six-month LIBOR. The benchmark from which the interest payments are to be calculated is specified in the FRA and is called the *notional amount* (or notional principal amount). This amount is not exchanged between the two parties. The *settlement rate* is the value of the reference rate at the FRA's settlement date. The source for determining the settlement rate is specified in the FRA.

The buyer of the FRA is agreeing to pay the contract rate, or equivalently, to buy funds at the settlement date at the contract rate; the seller of the FRA is agreeing to receive the contract rate, or equivalently, to sell funds at the settlement date at the contract rate. So, for example, if the FRA has a contract rate of 5% for three-month LIBOR (the reference rate) and the notional amount is for $10 million, the buyer is agreeing to pay 5% to buy or borrow $10 million at the settlement date and the seller is agreeing to receive 5% to sell or lend $10 million at the settlement date.

If at the settlement date the settlement rate is greater than the contract rate, the FRA buyer benefits because the buyer can borrow funds at a below-market rate. If the settlement rate is less than the contract rate, this benefits the seller, who can lend funds at an above-market rate. If the settlement rate is the same as the contract rate, neither party benefits. This is summarized as follows:

FRA buyer benefits if Settlement rate > Contract rate
FRA seller benefits if Contract rate > Settlement rate
Neither party benefits if Settlement rate = Contract rate

As with the Eurodollar futures contract, FRAs are cash settlement contracts. At the settlement date, the party that benefits based on the contract rate and settlement rate must be compensated by the other. Assuming the settlement rate is not equal to the contract rate, then

Buyer receives compensation if Settlement rate > Contract rate
Seller receives compensation if Contract rate > Settlement rate

To determine the amount one party must compensate the other, the following is first calculated assuming a 360-day count convention:

If Settlement rate > Contract rate:

$$\text{Interest differential} = (\text{Settlement rate} - \text{Contract rate}) \times (\text{Days in contract period}/360) \times \text{Notional amount}$$

If Contract rate > Settlement rate:

$$\text{Interest differential} = (\text{Contract rate} - \text{Settlement rate}) \times (\text{Days in contract period}/360) \times \text{Notional amount}$$

The amount that must be exchanged at the settlement date is not the interest differential. Instead, the present value of the interest differential is exchanged. The discount rate used to calculate the present value of the interest differential is the settlement rate. Thus, the compensation is determined as follows:

$$\text{Compensation} = \frac{\text{Interest differential}}{[1 + \text{Settlement rate} \times (\text{Days to contract period}/360)]}$$

To illustrate, assume the following terms for an FRA: Reference rate is three-month LIBOR, the contract rate is 5%, the notional amount is for $10 million, and the number of days to settlement is 91 days. Suppose the settlement rate is 5.5%. This means that the buyer benefits, since the buyer can borrow at 5% (the contract rate) when the market rate (the settlement rate) is 5.5%. The interest differential is

$$\text{Interest differential} = (0.055 - 0.05) \times (91/360) \times \$10{,}000{,}000 = \$12{,}638.89$$

The compensation or payment that the seller must make to the buyer is

$$\text{Compensation} = \frac{\$12{,}638.89}{[1 + 0.055 \times 91/360]}$$

$$\frac{\$12{,}638.89}{1.0139027} = \$12{,}465.58$$

It is important to note the difference of who benefits when interest rates move in an FRA and an interest rate futures contract. The buyer of an FRA benefits if the reference rate increases and the seller benefits if the reference rate decreases. In a futures contract, the buyer benefits from a falling rate while the seller benefits from a rising rate. This is summarized in Table 1. This is because the underlying for each of the two contracts is different. In the case of an FRA, the underlying is a rate. The buyer gains if the rate increases and loses if the rate decreases. In contrast, in a futures contract the underlying is a fixed-income instrument. The buyer gains if the fixed-income instrument increases in value. This occurs when rates decline. The buyer loses when the fixed-income instrument decreases in value. This occurs when interest rates increase. The opposite occurs for the seller of a futures contract.

Table 1 Effect of Rate Changes on Parties to an FRA and an Interest Rate Futures Contract

	Interest Rates			
	Decrease		Increase	
Party	FRA	Futures	FRA	Futures
Buyer	Loses	Gains	Gains	Loses
Seller	Gains	Loses	Loses	Gains

INTEREST RATE SWAPS

An **interest rate swap** is an agreement whereby two parties (called *counterparties*) agree to exchange periodic interest payments. The dollar amount of the interest payments exchanged is based on some predetermined dollar principal, which is called the notional principal amount. The dollar amount each counterparty pays to the other is the agreed-upon periodic interest rate times the notional principal amount. The only dollars exchanged between the parties are the net interest payments, not the notional principal amount. In the most common type of swap, one party agrees to pay the other party fixed interest payments at designated dates for the life of the contract. This party is referred to as the fixed-rate payer. The other party, referred to as the floating-rate payer, agrees to make interest rate payments that float with some reference interest rate (or, simply, reference rate).

For example, suppose that for the next five years party X agrees to pay party Y 10% per year, while party Y agrees to pay party X six-month LIBOR (London Interbank Offered Rate). Party X is a fixed-rate payer/floating-rate receiver, while party Y is a floating-rate payer/fixed-rate receiver. Assume that the notional principal amount is $50 million, and that payments are exchanged every six months for the next five years. This means that every six months, party X (the fixed-rate payer/floating-rate receiver) will pay party Y $2.5 million (10% times $50 million divided by 2). The amount that party Y (the floating-rate payer/fixed-rate receiver) will pay party X will be six-month LIBOR times $50 million divided by 2. For example, if six-month LIBOR is 7%, party Y will pay party X $1.75 million (7% times $50 million divided by 2). Note that we divide by two because one-half year's interest is being paid.

The reference rates that are commonly used for the floating rate in an interest rate swap are those on various money market instruments: Treasury bills, LIBOR, commercial paper, bankers acceptances, certificates of deposit, federal funds rate, and prime rate.

As we illustrate later, market participants can use an interest rate swap to alter the cash flow character of assets or liabilities from a fixed-rate basis to a floating-rate basis or vice versa.

Risk/Return Characteristics of a Swap

The value of an interest rate swap will fluctuate with market interest rates. To see how, let's analyze our hypothetical swap. Suppose that interest rates change immediately after parties X and Y enter into the swap. First, consider what would happen if the market demanded that the fixed-rate payer must pay 11% in order to receive six-month LIBOR in any five-year swap. If party X (the fixed-rate payer) wants to sell its position, say, to party A, then party A will benefit by only having to pay 10% (the original swap rate agreed upon) rather than 11% (the current swap rate) to receive six-month LIBOR. Party X will want compensation for this benefit. Consequently, the value of party X's position has increased. Thus, if interest rates increase, the fixed-rate payer will realize a profit and the floating-rate payer will realize a loss.

Next, consider what would happen if interest rates decline to, say, 6%. Now a five-year swap would require the fixed-rate payer to pay 6% rather than 10% to receive six-month LIBOR. If party X wants to sell its position to party B, the latter would demand compensation to take over the position. In other words, if interest rates decline, the fixed-rate payer will realize a loss, while the floating-rate payer will realize a profit.

The risk/return profile of the two positions when interest rates change is summarized in Table 2.

Table 2 Risk/Return Profile of Counterparties to an Interest Rate Swap

	Interest Rates Decrease	Interest Rates Increase
Floating-rate payer	Gain	Loss
Fixed-rate payer	Loss	Gain

Interpreting a Swap Position

There are two ways that a swap position can be interpreted: (1) as a package of forward/futures contracts, or (2) as a package of cash flows from buying and selling cash market instruments. We will evaluate both interpretations. Contrast the position of the counterparties in an interest rate swap in Table 2 to the position of the long and short futures or a forward contract shown in Table 1. An interest rate futures contract has an underlying fixed-income instrument. An FRA is one in which the underlying is a rate.

Consider first the FRA. As explained in the previous section, the buyer of an FRA gains if the reference rate rises above the contract rate at the settlem nt date (i.e., the settlement rate is greater than the contract rate) and loses if the reference rate falls below the contract rate at the settlement date (i.e., the settlement rate is less than the contract rate). The opposite is true for the seller of an FRA. Table 3 compares the position of the swap parties and the parties to an FRA if rates increase and decrease. Consequently, the buyer of an FRA realizes the same effect as a fixed-rate payer and the seller of an FRA the same effect as a floating-rate payer.

A swap can be viewed as a package of FRAs. In fact, an FRA can be viewed as a special case of a swap in which there is only one settlement date.

Now let's compare a swap to a futures or forward contract where the underlying is an interest rate instrument such as a Eurodollar CD. The long futures position gains if interest rates decline and loses if interest rates rise—this is similar to the risk/return profile for a floating-rate payer. The risk/return profile for a fixed-rate payer is similar to that of the short futures position: a gain if interest rates increase and a loss if interest rates decrease. Table 4 compares the counterparty positions for a swap, an FRA, and a forward/futures on a fixed-income instrument when rates change.

Consequently, interest rate swaps can be viewed as a package of more basic interest rate control tools, such as forwards. The pricing of an interest rate swap will then depend on the price of a package of forward contracts with the same settlement dates and in which the underlying for the forward contract is the same reference rate.

Table 3 Effect of Rate Changes on Interest Rate Swap Counterparties and FRA Counterparties

Counterparties to		Interest Rates	
Swap	FRA	Decrease	Increase
Floating-rate payer	Seller	Gains	Loses
Fixed-rate payer	Buyer	Loses	Gains

Table 4 Effect of Rate Changes on Interest Rate Swap Counterparties, FRA Counterparties, and Futures and Forwards on Fixed-Income Instrument Counterparties

Counterparties to				
			Interest Rates	
Swap	FRA	Futures/Forward on Fixed-Income Instrument	Decrease	Increase
Floating-rate payer	Seller	Buyer	Gains	Loses
Fixed-rate payer	Buyer	Seller	Loses	Gains

While an interest rate swap may be nothing more than a package of forward contracts, several important reasons suggest that it is not a redundant contract. First, the longest maturity of forward or futures contracts does not extend out as far as that of an interest rate swap. In fact, an interest rate swap with a term of 15 years or longer can be obtained. Second, an interest rate swap is a more transactionally efficient instrument. By this we mean that in one transaction two parties can effectively establish a payoff equivalent to a package of forward contracts. The forward contracts would each have to be negotiated separately. Third, the liquidity of the interest rate swap market has grown since its beginning in 1981; it is now more liquid than forward contracts, particularly long-dated (that is, long-term) forward contracts.

Package of Cash Market Instruments

To understand why a swap can also be interpreted as package of cash market instruments, consider the following. Suppose that an investor enters into a transaction to

- buy $50 million par of a five-year, floating-rate bond that pays six-month LIBOR every six months
- finance the purchase of the five-year, floating-rate bond by borrowing $50 million for five years with a 10% annual interest rate and payments every six months

The cash flow of this transaction is presented in Table 5. The second column of the exhibit sets out the cash flow from purchasing the five-year, floating-rate bond. There is a $50 million cash outlay and then cash inflows. The amount of the cash inflows is uncertain because they depend on future LIBOR. The third column shows the cash flow from borrowing $50 million on a fixed-rate basis. The last column shows the net cash flow from the entire transaction. As can be seen in the last column, there is no initial cash flow (no cash inflow or cash outlay). In all 10 six-month periods, the net position results in a cash inflow of LIBOR and a cash outlay of $2.5 million. This net position, however, is identical to the position of a fixed-rate payer/floating-rate receiver.

The net cash flow in Table 5 reveals that a fixed-rate payer has a cash market position that is equivalent to a long position in a floating-rate bond and borrowing the funds to purchase the floating-rate bond on a fixed-rate basis. But the borrowing can be viewed as issuing a fixed-rate bond, or equivalently, being short a fixed-rate bond. Consequently, the position of a fixed-rate payer can be viewed as being long a floating-rate bond and short a fixed-rate bond.

Table 5 Cash Flow for the Purchase of a Five-Year, Floating-Rate Bond Financed by Borrowing on a Fixed-Rate Basis

Transaction: Purchase for $50 million a five-year, floating-rate bond:
Floating rate = LIBOR, semiannual pay
Borrow $50 million for five years: fixed rate = 10% semiannual payments

	Cash Flow (in millions of dollars) from:		
Six-Month Period	Floating-Rate Bond	Borrowing Cost	Net
0	−$50.0	+$50.0	$ 0
1	+ $(LIBOR_1/2) \times 50$	− 2.5	+ $(LIBOR_1/2) \times 50 - 2.5$
2	+ $(LIBOR_2/2) \times 50$	− 2.5	+ $(LIBOR_2/2) \times 50 - 2.5$
3	+ $(LIBOR_3/2) \times 50$	− 2.5	+ $(LIBOR_3/2) \times 50 - 2.5$
4	+ $(LIBOR_4/2) \times 50$	− 2.5	+ $(LIBOR_4/2) \times 50 - 2.5$
5	+ $(LIBOR_5/2) \times 50$	− 2.5	+ $(LIBOR_5/2) \times 50 - 2.5$
6	+ $(LIBOR_6/2) \times 50$	− 2.5	+ $(LIBOR_6/2) \times 50 - 2.5$
7	+ $(LIBOR_7/2) \times 50$	− 2.5	+ $(LIBOR_7/2) \times 50 - 2.5$
8	+ $(LIBOR_8/2) \times 50$	− 2.5	+ $(LIBOR_8/2) \times 50 - 2.5$
9	+ $(LIBOR_9/2) \times 50$	− 2.5	+ $(LIBOR_9/2) \times 50 - 2.5$
10	+ $(LIBOR_{10}/2) \times 50 + 50$	− 52.5	+ $(LIBOR_{10}/2) \times 50 - 2.5$

Note: *The subscript for LIBOR indicates the six-month LIBOR as per the terms of the floating-rate bond at a particular time.*

What about the position of a floating-rate payer? It can be demonstrated that the position of a floating-rate payer is equivalent to purchasing a fixed-rate bond and financing that purchase at a floating rate, with the floating rate being the reference interest rate for the swap. That is, the position of a floating-rate payer is equivalent to a long position in a fixed-rate bond and a short position in a floating-rate bond.

Applications

So far we have merely described an interest rate swap and looked at its characteristics. With the help of two illustrations, we now explain how swaps can be used. Although we focus on basic or **plain vanilla swaps,** the illustrations will help us understand why other types of interest rate swaps have been developed.

Application to Asset/Liability Management

In the first illustration, we look at how an interest rate swap can be used to alter the cash flow characteristics of an institution's assets so as to provide a better match between assets and liabilities. The two institutions are a commercial bank and a life insurance company.

Suppose a bank has a portfolio consisting of five-year term commercial loans with a fixed interest rate. The principal value of the portfolio is $50 million, and the interest rate on all the loans in the portfolio is 10%. The loans are interest only loans; interest is paid semiannually, and the entire principal is paid at the end of five years. That is, assuming no default on the loans, the cash flow from the loan portfolio is $2.5 million every six months for the next five years and $50 million at the end of five years. To fund its loan portfolio, assume that the bank is relying on the issuance of six-month certificates of deposit. The

interest rate that the bank plans to pay on its six-month CDs is the six-month Treasury bill rate plus 40 basis points (b.p.).

The risk that the bank faces is that the six-month Treasury bill rate will be 9.6% or greater. To understand why, remember that the bank is earning 10% annually on its commercial loan portfolio. If the six-month Treasury bill rate is 9.6%, it will have to pay 9.6% plus 40 basis points to depositors for six-month funds, or 10%, and there will be no spread income. Worse, if the six-month Treasury bill rate rises above 9.6%, there will be a loss; that is, the cost of funds will exceed the interest rate earned on the loan portfolio. The bank's objective is to lock in a spread over the cost of its funds.

The other party in the interest rate swap illustration is a life insurance company that has committed itself to pay a 9% rate for the next five years on a guaranteed investment contract (GIC) it has issued. The amount of the GIC is $50 million. Suppose that the life insurance company has the opportunity to invest $50 million in what it considers an attractive five-year, floating-rate instrument in a private placement transaction. The interest rate on this instrument is the six-month Treasury bill rate plus 160 basis points. The coupon rate is set every six months.

The risk that the life insurance company faces is that the six-month interest rate will fall so that it will not earn enough to realize a spread over the 9% rate that it has guaranteed to the GIC holders. If the six-month Treasury bill rate falls to 7.4% or less, no spread income will be generated. To understand why, suppose that the six-month Treasury bill rate at the date the floating-rate instrument resets its coupon is 7.4%. Then the coupon rate for the next six months will be 9% (7.4% plus 160 basis points). Because the life insurance company has agreed to pay 9% on the GIC policy, there will be no spread income. Should the six-month Treasury bill rate fall below 7.4%, the life insurance company will incur a loss.

We can summarize the asset/liability problem of the bank and life insurance company as follows:

BANK:

1. Has lent long-term and borrowed short-term
2. If the six-month Treasury bill rate rises, spread income declines.

LIFE INSURANCE COMPANY:

3. Has effectively lent short-term and borrowed long-term
4. If the six-month Treasury bill rate falls, spread income declines.

Now let's suppose that an intermediary offers a five-year interest rate swap with a notional principal amount of $50 million to both the bank and life insurance company. The terms offered to the bank are as follows:

1. Every six months, the bank will pay 10% (annual rate) to the intermediary.
2. Every six months, the intermediary will pay the six-month Treasury bill rate plus 155 basis points to the bank.

The terms offered to the insurance company are as follows:

1. Every six months, the life insurance company will pay the six-month Treasury bill rate plus 160 basis points per year to the intermediary.
2. Every six months, the intermediary will pay the insurance company 10% (annual rate).

What has this interest rate contract done for the bank and the life insurance company? Consider first the bank. For every six-month period during the life of the swap agreement, the interest rate spread will be as follows:

Annual Interest Rate Received:	
From commercial loan portfolio	= 10%
From interest rate swap	= 6-month T-bill rate + 155 b.p.
Total	= 11.55% + 6-month T-bill rate
Annual Interest Rate Paid:	
To CD depositors	6-month T-bill rate + 40 b.p.
On interest rate swap	= 10%
Total	= 10.40% + 6-month T-bill rate
Outcome:	
To be received	= 11.55% + 6-month T-bill rate
To be paid	= 10.40% + 6-month T-bill rate
Spread income	= 1.15% or 115 b.p.

Thus, regardless of what happens to the six-month Treasury bill rate, the bank locks in a spread of 115 basis points.

Now let's look at the effect of the interest rate swap on the life insurance company:

Annual Interest Rate Received:	
From floating-rate instrument	= 6-month T-bill rate + 160 b.p.
From interest rate swap	= 10%
Total	= 11.6% + 6-month T-bill rate
Annual Interest Rate Paid:	
To GIC policyholders	= 9%
On interest rate swap	= 6-month T-bill rate + 160 b.p.
Total	= 10.6% + 6-month T-bill rate
Outcome:	
To be received	= 11.6% + 6-month T-bill rate
To be paid	= 10.6% + 6-month T-bill rate
Spread income	= 1.0% or 100 b.p.

Regardless of what happens to the six-month Treasury bill rate, the life insurance company locks in a spread of 100 basis points.

The interest rate swap has allowed each party to accomplish its asset/liability objective of locking in a spread.[1] The swap permits each financial institution to alter the cash flow characteristics of its assets: from fixed to floating in the case of the bank, and from floating

[1] Whether or not the size of the spread is adequate is not an issue to us in this illustration.

to fixed in the case of the life insurance company. This type of transaction is referred to as an **asset swap**. The bank and the life insurance company could have used the swap market instead to change the cash flow nature of their liabilities. Such a swap is called a **liability swap**. While in our illustration we used a bank, an interest rate swap obviously would be appropriate for savings and loan associations that, because of regulation, borrow short term—on a floating-rate basis—and lend long term—on fixed-rate mortgages.

Of course, there are other ways that the two institutions could have chosen to match the cash flow characteristics of their assets and liabilities. The bank might refuse to make fixed-rate commercial loans and insist only on floating-rate loans. This approach has a major pitfall: If borrowers can find another source willing to lend on a fixed-rate basis, the bank would lose these customers. The life insurance company might refuse to purchase a floating-rate instrument. But suppose that the terms offered on the private placement instrument were more attractive than what would have been offered on a floating-rate instrument of comparable credit risk. Thus, by using the swap market, the life insurance company can earn a yield higher than what it would earn if it invested directly in a five-year, fixed-rate security. For example, suppose the life insurance company can invest in a comparable credit risk five-year, fixed-rate security with a yield of 9.8%. Given the funding through the GIC with a 9% rate, this investment would result in spread income of 80 basis points—less than the 100 basis point spread income the life insurance company achieved by purchasing the floating-rate instrument and entering into the swap.

Consequently, an interest rate swap performs two important functions: (1) It can change the risk of a financial position by altering the cash flow characteristics of assets or liabilities, and (2) under certain circumstances, it also can be used to enhance returns. Obviously, this second function arises only if there are market imperfections.

There is a final point to be made in this illustration. Look at the floating-rate payments that the life insurance company makes to the intermediary and the floating-rate payments that the intermediary makes to the bank. The life insurance company pays the six-month Treasury bill rate plus 160 basis points, but the intermediary pays the bank the six-month Treasury bill rate plus only 155 basis points. The difference of 5 basis points represents the fee to the intermediary for the services of intermediation.

Application to Debt Issuance

Our second illustration considers two U.S. entities, a triple-A rated commercial bank and a triple B rated nonfinancial corporation; each wants to raise $100 million for 10 years. For various reasons, the bank wants to raise floating-rate funds, while the nonfinancial corporation wants to raise fixed-rate funds. The interest rates available to the two entities in the U.S. bond market are as follows:

Bank: Floating rate = 6-month LIBOR + 30 b.p.
Nonfinancial corporation: Fixed rate = 12%

Suppose also that both entities could issue securities in the Eurodollar bond market, if they wanted to. Let us assume that the following terms are available in the Eurodollar bond market for 10-year securities for these two entities:

Bank: Fixed rate = 10.5%
Nonfinancial corporation: Floating rate = 6-month LIBOR + 80 b.p.

Notice that we indicate the terms that the bank could obtain on fixed-rate financing and that the nonfinancial corporation could obtain on floating-rate securities. You will shortly see why we did this. First, let us summarize the situation for the two entities in the U.S. domestic and Eurodollar bond markets:

Floating-Rate Securities		
Entity	**Bond Market**	**Rate**
Bank	U.S. domestic	6-month LIBOR + 30 b.p.
Nonfinancial corporation	Eurodollar	6-month LIBOR + 80 b.p.
		Quality spread = 50 b.p.

Fixed-Rate Securities		
Entity	**Bond Market**	**Rate**
Bank	Eurodollar	10.5%
Nonfinancial corporation	U.S. domestic	12.0%
		Quality spread = 150 b.p.

In this table, we use the term *quality spread.* This term simply means the differential borrowing costs that reflect the difference in the creditworthiness of the two entities.

Notice that the quality spread for floating-rate securities (50 basis points) is narrower than the quality spread for fixed-rate securities (150 basis points). This difference in spreads provides an opportunity for both entities to reduce the cost of raising funds. To see how, suppose each entity issued securities in the Eurodollar bond market, and then simultaneously entered into the following 10-year interest rate swap with a $100 million notional principal amount offered by an intermediary:

Bank:
Pay floating rate of 6-month LIBOR + 70 b.p.
Receive fixed rate of 11.3%
Nonfinancial Corporation:
Pay fixed rate of 11.3%
Receive floating rate of 6-month LIBOR + 45 b.p.

The cost of the issue for the bank would then be

Interest Paid:	
On fixed-rate Eurodollar bonds issued	= 10.5%
On interest rate swap	= 6-month LIBOR + 70 b.p.
Total	= 11.2% + 6-month LIBOR
Interest Received:	
On interest rate swap	= 11.3%
Net Cost:	
Interest paid	= 11.2% + 6-month LIBOR
Interest received	= 11.3%
Total	= 6-month LIBOR − 10 b.p.

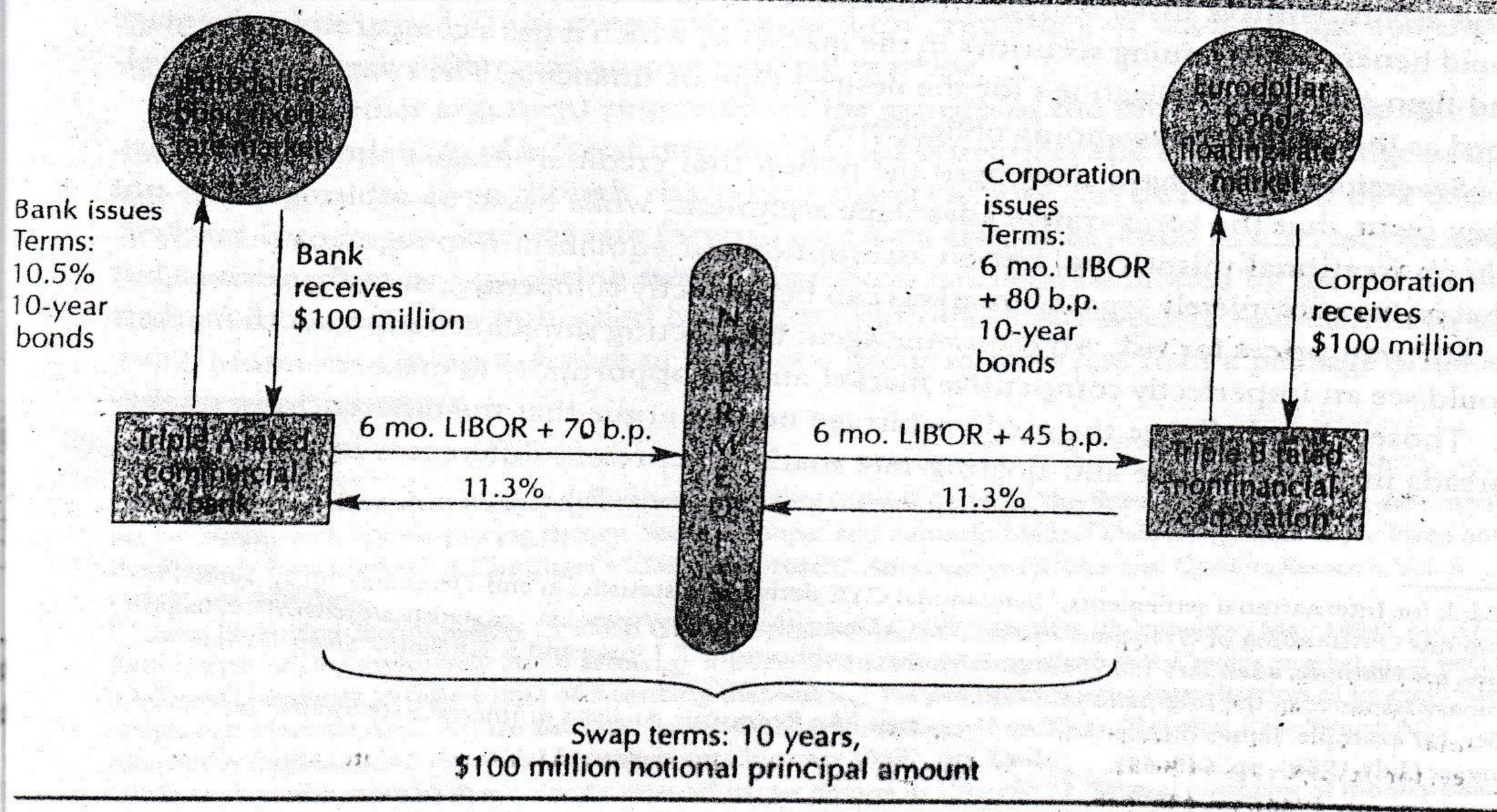
The cost of the issue for the nonfinancial corporation would then be

Interest Paid:	
On floating-rate Eurodollar bonds issued	= 6-month LIBOR + 80 b.p.
On interest rate swap	= 11.3%
Total	= 12.1% + 6-month LIBOR
Interest Received:	
On interest rate swap	= 6-month LIBOR + 45 b.p.
Net Cost:	
Interest paid	= 12.1% + 6-month LIBOR
Interest received	= 6-month LIBOR + 45 b.p.
Total	= 11.65%

The transactions are diagrammed in Figure 1. By issuing securities in the Eurodollar bond market and using the interest rate swap, both entities are able to reduce their cost of issuing securities. The bank was able to issue floating-rate securities for six-month LIBOR minus 10 basis points rather than issue floating-rate securities in the U.S. domestic bond market for six-month LIBOR plus 30 basis points, thereby saving 40 basis points. The nonfinancial corporation saved 35 basis points (11.65% versus 12%) by issuing floating-rate bonds in the Eurodollar bond market and using the interest rate swap.

The point of this illustration is to show that, if differences in quality spreads exist in different sectors of the bond markets, borrowers can use the interest rate swap to arbitrage the inconsistency. Whether these differences do exist is another question, which we address below.

Figure 1: Diagram of Interest Rate Swap for Debt Issuance



Finally, look once again at the intermediary in this transaction. The intermediary pays a floating rate of six-month LIBOR plus 45 basis points to the nonfinancial corporation, and receives six-month LIBOR plus 70 basis points from the bank, realizing 25 basis points for its intermediary services.

Reasons for the Development of the Interest Rate Swap Market

According to the Bank for International Settlements, the interest rate swap market, which began in late 1981, is the largest component of the OTC interests rate derivatives market.[2] As of the end of 2007, the notional amount outstanding of interest rate swaps was $310 trillion of the $393 trillion interest rate OTC derivatives market. (FRAs made up $26 trillion of the market and option made up $57 trillion.)

What is behind this rapid growth? As our two illustrations have demonstrated, an interest rate swap is a quick way for institutional investors and corporate borrowers to change the nature of assets and liabilities or to exploit any perceived capital market imperfection.

The initial motivation for the interest rate swap market was borrower exploitation of what were perceived to be *credit arbitrage* opportunities. These opportunities were attributed to the fact that quality spreads, the difference in yields between lower- and higher-rated credits, were frequently not the same in the fixed-rate market as in the floating-rate market, and often the quality spreads were not the same in the U.S. debt markets as in the Eurodollar bond markets. Note that our second illustration assumes a spread of 50 basis points in the floating-rate markets and 150 basis points in the fixed-rate markets. Publications by dealer firms[3] and academic research have suggested this credit arbitrage motivation.[4]

Basically, this argument for swaps rested on the well-known economic principle of comparative advantage, which was developed in international economics. The argument takes this form: Even though a high credit-rated issuer could borrow at a lower cost in both the fixed-rate and floating-rate markets (that is, have an absolute advantage in both), it will have a comparative advantage relative to a lower credit-rated issuer in one of the markets (and a comparative disadvantage in the other). Under these conditions, each borrower could benefit from issuing securities in the market in which it has a comparative advantage and then swapping obligations for the desired type of financing. The swap market developed as the vehicle for swapping obligations.

Several observers have challenged the notion that credit arbitrage opportunities exist. They insist that the comparative advantage argument, while based on arbitrage, does not rely on irrational mispricing, but on assumptions of equilibrium in segmented markets. That is, two completely separate markets can be perfectly competitive unto themselves, but set different prices for risk. An economic agent transacting simultaneously in both markets would see an imperfectly competitive market and an opportunity to make money.

Those who challenge the credit arbitrage notion argue that the differences in quality spreads in the fixed-rate and floating-rate markets represent differences in the risks that

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[2] Bank for International settlements, "Semiannual OTC derivatives statistics at end-December 2007," Table 19: Amounts Outstanding of Over-the-Counter (OTC) Derivatives, http://www.bis.org/statistics/otcder/dt1920a.pdf.

[3] See, for example, a January 1986 Salomon Brothers publication: T. Lipsky and S. Elhalaski, "Swap-Driven Primary Issuance in the International Bond Market."

[4] See, for example, James Bicksler and Andrew Chen, "An Economic Analysis of Interest Rate Swaps," *Journal of Finance* (July 1986), pp. 645–655.

lenders face in these two markets. Let us consider short- and long-term markets in this regard. The interest rate for a floating-rate note effectively represents a short-term interest rate, and the quality spread on floating-rate notes, therefore, is a spread in the short-term market. In contrast, the quality spread on fixed-rate medium- and long-term notes represents the spread in that maturity sector. There is no reason why the quality spreads across those two markets have to be the same.[5]

A serious obstacle to accepting the credit arbitrage explanation of the swap market is that opportunities for credit arbitrage should be rare in reasonably efficient international credit markets. Moreover, even if such opportunities arose, market participants would quickly exploit and eliminate them. How then can we explain the fact that the number of interest rate swap transactions has grown substantially over the past decade? The May 1984 edition of *Euromoney* contained a Citicorp-sponsored contribution that offered this interesting explanation of the swap market and its reason for being:

> The nature of swaps is that they arbitrage market imperfections. As with any arbitrage opportunity, the more it is exploited, the smaller it becomes. . . .
>
> But some of the causes of market imperfections are unlikely to disappear quickly. For example, insurance companies in many countries are constrained to invest mainly in instruments that are domestic in that country. That requirement, tending to favor domestic issuers artificially, is unlikely to be changed overnight. And even in the world's most liquid markets there are arbitrage opportunities. They are small and exist only briefly, but they exist nevertheless.[6]

As this opinion demonstrates, as early as 1984, some observers attributed the difference in quality spreads among markets to differences in regulations among countries. Similarly, differences in tax treatment across countries also create differences in the price of risk and in expected returns.[7] Thus, swaps can be used for regulatory or tax arbitrage and may be explained by such differences among national markets.

Finally, another argument suggested for the growth of the interest rate swap market is the increased volatility of interest rates that has led borrowers and lenders to hedge or manage their exposure. Even though risk/return characteristics can be replicated by a package of forward contracts, interest rate forward contracts are not as liquid as interest rate swaps. And entering into or liquidating swap transactions has been facilitated by the standardization of documentation published by the International Swap Dealers Association in early 1987. Moreover, a swap to hedge or manage a position costs less than a package of interest rate forward contracts.

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[5] Two researchers demonstrate that differences in quality spreads between the fixed-rate and floating-rate markets are consistent with option-pricing theory. See Ian Cooper and Antonio Mello, "Default Spreads in the Fixed and in the Floating Rate Markets: A Contingent Claims Approach," *Advances in Futures and Options Research*, Vol. 3 (1988), pp. 269–290.

[6] "Swap Financing Techniques: A Citicorp Guide," Special Sponsored Section, *Euromoney* (May 1984), pp. S1–S7. Rather than relying exclusively on an arbitrage argument, one study suggests that the swaps market grew because it allowed borrowers to raise a type of financing that was not possible prior to the introduction of interest rate swaps. See: Marcelle Arak, Arturo Estrella, Laurie Goodman, and Andrew Silver, "Interest Rate Swaps: An Alternative Explanation," *Financial Management* (Summer 1988), pp. 12–18.

[7] This applies even more so to currency swaps, which we discuss in Chapter 32. Several examples of the way swaps can be used to exploit differences in taxes are given in Clifford W. Smith, Charles W. Smithson, and Lee MacDonald Wakeman, "The Evolving Market for Swaps," *Midland Corporate Finance Journal* (Winter 1986), pp. 20–32.

Consequently, we can say that the swap market originally developed around the purpose of exploiting real or perceived imperfections in the capital market, but eventually evolved into a transactionally efficient market for accomplishing asset/liability objectives.

Although there are no publicly available data on the users of swaps, a study by Leslie Lynn Rahl provides some insight into their identity.[8] She found that 25% of the end users of swaps are corporations, 60% are financial institutions that are not swap dealers, and 15% are government agencies and supranationals.

Role of the Intermediary

The role of the intermediary in an interest rate swap sheds some light on the evolution of the market. Intermediaries in these transactions have been commercial banks and investment banks, who in the early stages of the market sought out end users of swaps. That is, commercial banks and investment banking firms found in their client bases those entities that needed swaps to accomplish funding or investing objectives, and they matched the two entities. In essence, the intermediary in this type of transaction performed the function of a broker.

In the early years of this market, the only time that the intermediary would take the opposite side of a swap (that is, would act as a principal) was when it had to do so in order to balance out the transaction. For example, if an intermediary had two clients that were willing to do a swap but one wanted the notional principal amount to be $100 million while the other wanted it to be $85 million, the intermediary might become the counterparty to the extent of $15 million. That is, the intermediary would warehouse or take a position as a principal to the transaction in order to make up the $15 million difference between the clients' objectives. To protect itself against an adverse interest rate movement, the intermediary would hedge its position.

To explain how the intermediary's role developed over time, we need to address an important feature of the swap that we have not yet discussed. The parties to the swaps we have described had to be concerned that the other party would default on its obligation. While a default would not mean any principal was lost (because the notional principal amount had not been exchanged), a default would mean that the objective for which the swap was entered into would be impaired. As the early transactions involved a higher and a lower credit-rated entity, the former would be concerned with the potential for default of the latter. To reduce the risk of default, many early swap transactions required that the lower credit-rated entity obtain a guarantee from a highly rated commercial bank. Often, the intermediary in the swap was a bank of this type. Involvement as insurer or guarantor in this way led banks to accept the role of dealer or counterparty.

As the frequency and the size of the transactions increased, many intermediaries became comfortable with swap transactions and became principals instead of simply acting as brokers. As long as an intermediary had one entity willing to enter into a swap, the intermediary was willing to be the counterparty. Consequently, interest rate swaps became part of an intermediary's inventory of products. Advances in quantitative techniques and futures products for hedging complex positions such as swaps made the protection of large inventory positions feasible.

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[8] Leslie Lynn Rahl, "Who Is Using Swaps?" *Bond Week* (October 14, 1991), p. 4.

Yet another development encouraged intermediaries to become principals rather than brokers in swaps. As more intermediaries entered the swap market, bid–ask spreads on swaps narrowed sharply. To make money in the swaps market, intermediaries had to do a sufficient volume of business, which was possible only if they had (1) an extensive client base willing to use swaps, and (2) a large inventory of swaps. Accomplishing these objectives necessitated that the intermediaries act as principals. A survey by *Euromoney* asked 150 multinationals and supranationals to identify the characteristics that make a swap house efficient.[9] The results indicated that the speed at which a swap could be arranged for a client was the most important criterion. That speed depends on client base and inventory. The same survey also revealed clients to be less interested in brokered deals than in transactions in which the intermediary is a principal.

Market Quotes

The convention that has evolved for quoting swaps levels is for a swap dealer to set the floating rate equal to the index and then quote the fixed rate that will apply. To illustrate this convention, we use the swap in our second example of the application of swaps. The terms for that 10-year swap are as follows:

BANK:

Pay floating rate of 6-month LIBOR + 70 b.p.
Receive fixed rate of 11.3%.

NONFINANCIAL CORPORATION:

Pay fixed rate of 11.3%.
Receive floating rate of 6-month LIBOR + 45 b.p.

The offer price that the dealer would quote to the nonfinancial corporation (the fixed-rate payer) would be to pay 10.85% and receive LIBOR flat. (The term *flat* means with no spread.) The 10.85% is obtained by subtracting from the fixed rate of 11.3% the 45-basis point spread over LIBOR. The bid price that the dealer would quote to the commercial bank would be to pay LIBOR flat and receive 10.6%. The 10.6% represents the payment to be received of 11.3% minus the 70-basis point spread over LIBOR.

The dealer determines or sets the quoted fixed rate by adding some spread to the Treasury yield curve with the same term to maturity as the swap. We refer to this spread as the *swap spread*. In our illustration, suppose that the 10-year Treasury yield is 10.35%. In this case, the offer price that the dealer would quote to the fixed-rate payer is the 10-year Treasury rate plus 50 basis points versus receiving LIBOR flat. For the floating-rate payer, the bid price quoted would be LIBOR flat versus the 10-year Treasury rate plus 40 basis points. In the terminology of the market, the dealer would actually quote this particular swap as "40–50." This swap spread means that the dealer is willing to enter into a swap on either side: to receive LIBOR and pay a fixed rate equal to the 10-year Treasury rate plus 40 basis points, or to pay LIBOR and receive a fixed rate equal to the 10-year Treasury rate plus 50 basis points. The difference between the fixed rate paid and received is the bid–offer spread, which is 40 basis points.

[9] Special Supplement on Swaps, *Euromoney* (July 1987), p. 14.

Primary Determinants of Swap Spreads[10]

Earlier, we provided two interpretations of a swap: (1) a package of futures/forward contracts, and (2) a package of cash market instruments. The swap spread is defined as the difference between the swap's fixed rate and the rate on a Treasury whose maturity matches the swap's maturity. Although a discussion of the valuation of interest rate swaps is beyond the scope of this chapter, it can be shown that they are valued using no-arbitrage relationships relative to instruments (funding or investment vehicles) that produce the same cash flows under the same circumstances.[11]

The swap spread is determined by the same factors that drive the spread over Treasuries on instruments that replicate a swap's cash flows (i.e., produce a similar return or funding profile). As discussed below, the swap spread's key determinant for swaps with maturities of five years or less is the cost of hedging in the Eurodollar futures market.[12] For swaps with a longer maturity, the swap spread is largely driven by credit spreads in the corporate bond market.[13] Specifically, longer-dated swaps are priced relative to rates paid by investment-grade credits in traditional fixed- and floating-rate markets.

Given that a swap is a package of futures/forward contracts, the shorter-term swap spreads respond directly to fluctuations in Eurodollar futures prices. A Eurodollar futures contract is an instrument where a fixed dollar payment (i.e., the futures price) is exchanged for three-month LIBOR. There is a liquid market for Eurodollar futures contracts with maturities every three months for five years. A market participant can create a synthetic fixed-rate security or a fixed-rate funding vehicle of up to five years by taking a position in a bundle of Eurodollar futures contracts (i.e., a position in every three-month Eurodollar futures contract up to the desired maturity date).

For example, consider a financial institution that has fixed-rate assets and floating-rate liabilities. Both the assets and liabilities have a maturity of three years. The interest rate on the liabilities resets every three months based on three-month LIBOR. This financial institution can hedge this mismatched asset/liability position by buying a three-year bundle of Eurodollar futures contracts. By doing so, the financial institution is receiving LIBOR over the three-year period and paying a fixed dollar amount (i.e., the futures price). The financial institution is now hedged because the assets are fixed rate and the bundle of long Eurodollar futures synthetically creates a fixed-rate funding arrangement. From the fixed dollar amount over the three years, an effective fixed rate that the financial institution pays can be computed. Alternatively, the financial institution can synthetically create a fixed-rate funding arrangement by entering into a three-year swap in which it pays fixed and receives

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[10] The discussion in this section is adapted from Chapter 6 in Frank J. Fabozzi and Steven V. Mann, *Floating-Rate Securities* (New Hope, PA: Frank J. Fabozzi Associates, 2000).

[11] For an explanation of the valuation of swaps, see Jeffrey Buetow and Frank J. Fabozzi, *Valuation of Interest Rate Swaps* (New Hope, PA: Frank J. Fabozzi Associates, 2001).

[12] Naturally, this presupposes that the reference rate for the swap is LIBOR. Furthermore, part of the swap spread is attributable simply to the fact that LIBOR for a given maturity is higher than the rate of a comparable-maturity U.S. Treasury. For a discussion of non-LIBOR swaps and their valuation, see Buetow and Fabozzi, *Valuation of Interest Rate Swaps*.

[13] The default risk component of a swap spread will be smaller than for a comparable bond credit spread. There are two reasons for this. First, since only net interest payments are exchanged rather than both principal and coupon interest payments, the total cash flow at risk is lower. Second, the probability of default depends jointly on the probability of the counterparty defaulting and whether or not the swap has a positive value. See John C. Hull, *Introduction to Futures and Options Markets*, 3rd edition (Upper Saddle River, NJ: Prentice Hall, 1998).

three-month LIBOR. Other factors being equal, the financial institution will use the vehicle that delivers the lowest cost of hedging the mismatched position. That is, the financial institution will compare the synthetic fixed rate (expressed as a percentage over U.S. Treasuries) to the three-year swap spread. The difference between the synthetic spread and the swap spread should be within a few basis points under normal circumstances.

For swaps with maturities greater than five years, we cannot rely on the Eurodollar futures since liquid markets do not exist for these contracts at longer maturities. Instead, longer-dated swaps are priced using rates available to investment-grade corporate borrowers in fixed-rate and floating-rate debt markets. Since a swap can be interpreted as a package of long and short positions in a fixed-rate bond and a floating-rate bond, it is the credit spreads in those two market sectors that will be the determinant of the swap spread. Empirically, the swap rate for a given maturity is greater than the yield on U.S. Treasury securities and less than the yield for AA rated banks.[14] Swap fixed rates are lower than AA rated bond yields due to their lower credit due to netting and offsetting of swap positions.

In addition, a number of other technical factors influence the level of swap spreads. While the impact of some of these factors is ephemeral, their influence can be considerable in the short run. Included among these factors are (1) the level and shape of the Treasury yield curve, (2) the relative supply of fixed- and floating-rate payers in the interest rate swap market, (3) the level of asset-based swap activity, and (4) technical factors that affect swap dealers.[15]

Secondary Market for Swaps

There are three general types of transactions in the secondary market for swaps. These include (1) a swap reversal, (2) a swap sale (or assignment), and (3) a swap buy-back (or close-out or cancellation).

In a **swap reversal**, the party that wants out of the transaction will arrange for an additional swap in which (1) the maturity on the new swap is equal to the time remaining of the original swap, (2) the reference rate is the same, and (3) the notional principal amount is the same. For example, suppose party X enters into a five-year swap with a notional principal amount of $50 million in which it pays 10% and receives LIBOR, but that two years later, X wants out of the swap. In a swap reversal, X would enter into a three-year interest rate swap, with a counterparty different from the original counterparty, let's say Z, in which the notional principal amount is $50 million, and X pays LIBOR and receives a fixed rate. The fixed rate that X receives from Z will depend on prevailing swap terms for floating-rate receivers at the initiation of the three-year swap.

Although party X has effectively terminated the original swap in economic terms, there is a major drawback to this approach: Party X is still liable to original counterparty Y, as well as to the new counterparty, Z. That is, party X now has two offsetting interest rate swaps on its books instead of one, and as a result it has increased its default risk exposure.

The **swap sale** or **swap assignment** overcomes this drawback. In this secondary market transaction, the party that wishes to close out the original swap finds another party that is willing to accept its obligations under the swap. In our illustration, this means that X finds another party, say, A, that will agree to pay 10% to Y and receive LIBOR from Y for the next

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[14] For a discussion of this point, see Andrew R. Young, *A Morgan Stanley Guide to Fixed Income Analysis* (New York: Morgan Stanley, 1997).

[15] For a further discussion of these technical factors, see Fabozzi and Mann, *Floating-Rate Securities.*

three years. Party A might have to be compensated to accept the position of X, or A might have to be willing to compensate X. Who will receive compensation depends on the swap terms at the time. For example, if interest rates have risen so that, to receive LIBOR for three years, a fixed-rate payer would have to pay 12%, then A would have to compensate X because A has to pay only 10% to receive LIBOR. The compensation would be equal to the present value of a three-year annuity of 2% times the notional principal amount. If, instead, interest rates have fallen so that, to receive LIBOR for three years, a fixed-rate payer would have to pay 6%, then X would have to compensate A. The compensation would be equal to the present value of a three-year annuity of 4% times the notional principal amount. Once the transaction is completed, it is then A, not X, that is obligated to perform under the swap terms. (Of course, an intermediary could act as principal and become party A.)

In order to accomplish a swap sale, the original counterparty, Y in our example, must agree to the sale. A key factor in whether Y will agree is whether it is willing to accept the credit of A. For example, if A's credit rating is triple B, while X's is double A, Y would be unlikely to accept A as a counterparty.

A **buy-back** or **close-out sale** (or **cancellation**) involves the sale of the swap to the original counterparty. As in the case of a swap sale, one party might have to compensate the other, depending on how interest rates and credit spreads have changed since the inception of the swap.

These methods for getting into or out of a swap leave much to be desired for market participants. It is this illiquidity in the secondary market that will hamper swap market growth. There have been proposals to create a swap clearing corporation, similar to the clearing corporations for futures and options, in which case swaps could be marked to market and credit exposure to a swap could be reduced. So far, these proposals have not been implemented.

Beyond the Plain Vanilla Swap

Thus far we have described the plain vanilla or generic interest rate swap. Nongeneric or individualized swaps have evolved as a result of the asset/liability needs of borrowers and lenders. These include swaps where the notional principal changes in a predetermined way over the life of the swap and swaps in which both counterparties pay a floating rate. There are complex swap structures such as options on swaps (called swaptions) and swaps where the swap does not begin until some future time (called forward start swaps). We discuss all of these swaps below. It may be difficult to fully appreciate the importance of these swap structures as a tool for managing the interest rate risk of a financial institution in this book because of our limited coverage of risk management. What is important to appreciate is that these swap structures are not just "bells and whistles" added to the plain vanilla swap to make them more complicated, but features that managers have found that they need to control interest rate risk.

Varying Notional Principal Amount Swaps

In a generic or plain vanilla swap, the notional principal amount does not vary over the life of the swap. Thus, it is sometimes referred to as a **bullet swap**. In contrast, for amortizing, accreting, and roller-coaster swaps, the notional principal amount varies over the life of the swap.

An **amortizing swap** is one in which the notional principal amount decreases in a predetermined way over the life of the swap. Such a swap would be used where the principal of the asset that is being hedged with the swap amortizes over time. For example, in our

illustration of the asset/liability problem faced by the bank, the commercial loans are assumed to pay only interest every six months and repay principal only at the end of the loan term. However, what if the commercial loan is a typical term loan; that is, suppose it is a loan that amortizes? Or, suppose that it is a typical mortgage loan that amortizes. In such circumstances, the outstanding principal for the loans would decline and the bank would need a swap where the notional principal amount amortizes in the same way as the loans.

Less common than the amortizing swap are the **accreting swap** and the **roller-coaster swap.** An accreting swap is one in which the notional principal amount increases in a predetermined way over time. In a roller-coaster swap, the notional principal amount can rise or fall from period to period.

Basis Swaps and Constant Maturity Swaps

The terms of a generic interest rate swap call for the exchange of fixed- and floating-rate payments. In a **basis rate swap**, both parties exchange floating-rate payments based on a different reference rate. As an example, assume a commercial bank has a portfolio of loans in which the lending rate is based on the prime rate, but the bank's cost of funds is based on LIBOR. The risk the bank faces is that the spread between the prime rate and LIBOR will change. This is referred to as *basis risk.* The bank can use a basis rate swap to make floating-rate payments based on the prime rate (because that is the reference rate that determines how much the bank is receiving on the loans) and receive floating-rate payments based on LIBOR (because that is the reference rate that determines the bank's funding cost).

Another popular swap is to have the floating leg tied to a longer-term rate such as the two-year Treasury note rather than a money market rate. So one of the parties to the swap would pay the two-year Treasury rate, for example, and the counterparty would pay LIBOR. Such a swap is called a *constant maturity swap.* The reference rate for determining the yield on the constant maturity Treasury in a constant maturity swap is typically the Constant Maturity Treasury (CMT) rate published the Federal Reserve. Consequently, a constant maturity swap tied to the CMT is called a *Constant Maturity Treasury swap.*

Swaptions

There are options on interest rate swaps. These swap structures are called swaptions and grant the option buyer the right to enter into an interest rate swap at a future date. The time until expiration of the swap, the term of the swap, and the swap rate are specified. The swap rate is the strike rate for the swaption. The swaption can have any exercise style—American, European, and Bermudian.

There are two types of swaptions—a payer swaption and a receiver swaption. A **payer swaption** entitles the option buyer to enter into an interest rate swap in which the buyer of the option pays a fixed rate and receives a floating rate. For example, suppose that the strike rate is 7%, the term of the swap is three years, and the swaption expires in two years. Also, assume that it is a European-type exercise provision. This means that the buyer of this swaption at the end of two years has the right to enter into a three-year interest rate swap in which the buyer pays 7% (the swap rate which is equal to the strike rate) and receives the reference rate.

In a **receiver swaption**, the buyer of the swaption has the right to enter into an interest rate swap that requires paying a floating rate and receiving a fixed rate. For example, if the strike rate is 6.25%, the swap term is five years, and the option expires in one year, the buyer of this receiver swaption has the right when the option expires in one year (assuming it is a

European-type exercise provision) to enter into a four-year interest rate swap in which the buyer receives a swap rate of 6.25% (i.e., the strike rate) and pays the reference rate.

How is a swaption used? We can see its usefulness in managing interest rate risk if we return to the bank-insurance company example. The bank makes fixed-rate payments on the interest rate swap (10%) using the interest rate it is earning on the commercial loans (10%). Suppose that the commercial loan borrowers default on their obligations. The bank will not receive from the commercial loans the 10% to make its swap payments. This problem can be addressed at the outset of the initial swap transaction by the bank entering into a swaption that effectively gives it the right to terminate or cancel the swap. That is, the bank will enter into a receiver swaption, receiving fixed of 10% so as to offset the fixed rate it is obligated to pay under the initial swap. In fact, the borrowers do not have to fail for the swap to have an adverse impact on the bank. Suppose the commercial loans can be prepaid. Then, the bank has a similar problem. For example, suppose rates on commercial loans decline to 7% and the borrowers prepay. Then the bank would be obligated to make the 10% payments under the terms of the swap. With the proceeds received from the prepayment of the commercial loans, the bank may only be able to invest in similar loans at 7%, for example, a rate that is less than the bank's obligations.

Forward Start Swap

A **forward start swap** is a swap wherein the swap does not begin until some future date that is specified in the swap agreement. Thus, there is a beginning date for the swap at some time in the future and a maturity date for the swap. A forward start swap will also specify the swap rate at which the counterparties agree to exchange payments commencing at the start date.

Key Points That You Should Understand Before Proceeding

1. An interest rate swap is an agreement whereby two counterparties agree to exchange periodic interest payments based on a notional principal amount.
2. A position in an interest rate swap can be interpreted as a position in a package of forward contracts or a package of cash flows from buying and selling cash market instruments.
3. While the initial motivation for the swap market was borrower exploitation of what were perceived to be credit arbitrage opportunities, such opportunities are limited and depend on the presence of market imperfections.
4. The swap market has evolved into a transactionally efficient market for accomplishing asset/liability objectives to alter the cash flow characteristics of assets (an asset swap) or liabilities (a liability swap).
5. Commercial banks and investment banking firms take positions in swaps rather than act as simply intermediaries.
6. For swaps with maturities of less than five years, the swap spread is driven by rates in the Eurodollar futures market, but for swaps with maturities greater than five years, the spread is determined primarily by the credit spreads in the corporate bond market.
7. In addition to the generic swap structure where one party pays fixed and the other floating, there are swaps with varying notional principal amounts, basis swaps (floating payments made by both parties), constant maturity swaps, swaptions, and forward start swaps.

Interest Rate/Equity Swaps

In addition to interest rate swaps, there are currency swaps and interest rate/equity swaps. We will discuss the former in the next chapter. Here, we will explain interest rate/equity swaps.

Illustration of an Interest Rate/Equity Swap

To illustrate this swap, consider the following swap agreement:

- The counterparties to this swap agreement are the Brotherhood of Basket Weavers (a pension sponsor) and the Reliable Investment Management Corporation (a money management firm).
- The notional principal amount is $50 million.
- Every year for the next five years, the Brotherhood agrees to pay Reliable Investment Management Corporation the return realized on the Standard & Poor's 500 stock index for the year minus 200 basis points.
- Every year for the next five years, Reliable Investment Management Corporation agrees to pay the pension sponsor 10%.

For example, if over the past year the return on the S&P 500 stock index is 14%, then the pension sponsor pays Reliable Investment Management Corporation 12% (14% minus 2%) of $50 million, or $6 million, and the money management firm agrees to pay the pension sponsor $5 million (10% times $50 million).

Application to Creation of a Security

Swaps can be used by investment bankers to create a security. To see how this is done, suppose the following. The Universal Information Technology Company (UIT) seeks to raise $100 million for the next five years on a fixed-rate basis. UIT's investment banker, Credit Suisse, indicates that if bonds with a maturity of five years are issued, the interest rate on the issue would have to be 8%. At the same time, there are institutional investors seeking to purchase bonds but that are interested in making a play on the stock market. These investors are willing to purchase a bond whose annual interest rate is based on the actual performance of the S&P's 500 stock market index.

Credit Suisse recommends to UIT's management that it consider issuing a five-year bond whose annual interest rate is based on the actual performance of the S&P 500. The risk with issuing such a bond is that UIT's annual interest cost is uncertain, since it depends on the performance of the S&P 500. However, suppose that the following two transactions are entered into:

1. On January 1, UIT agrees to issue, using Credit Suisse as the underwriter, a $100 million, five-year bond issue whose annual interest rate is the actual performance of the S&P 500 that year minus 300 basis points. The minimum interest rate, however, is set at zero. The annual interest payments are made on December 31.
2. UIT enters into a five-year, $100 million notional principal amount interest rate/equity swap with Credit Suisse in which each year for the next five years UIT agrees to pay 7.9% to Credit Suisse and Credit Suisse agrees to pay the actual performance of the S&P 500 that year minus 300 basis points. The terms of the swap call for the payments to be made on December 31 of each year. Thus, the swap payments coincide with the payments that

must be made on the bond issue. Also, as part of the swap agreement, if the S&P 500 minus 300 basis points results in a negative value, Credit Suisse pays nothing to UIT.

Let's look at what has been accomplished with these two transactions from the perspective of UIT. Specifically, focus on the payments that must be made by UIT on the bond issue and the swap, and the payments that it will receive from the swap. These are summarized here:

Interest payments on bond issue:	S&P 500 return – 300 b.p.
Swap payment from Credit Suisse:	S&P 500 return + 300 b.p.
Swap payment to Credit Suisse:	7.9%
Net interest cost:	7.9%

Thus, the net interest cost is a fixed rate despite the bond issue paying an interest rate tied to the S&P 500. This was accomplished with the interest rate/equity swap.

There are several questions that should be addressed. First, what was the advantage to UIT to entering into this transaction? Recall that if UIT issued a bond, Credit Suisse estimated that UIT would have to pay 8% annually. Thus, UIT has saved 10 basis points (8% minus 7.9%) per year. Second, why would investors purchase this bond issue? As explained in previous chapters, there are restrictions imposed on institutional investors as to types of investments. For example, a depository institution may not be entitled to purchase common stock; however, it may be permitted to purchase a bond of an issuer such as UIT despite the fact that the interest rate is tied to the performance of common stocks. Third, isn't Credit Suisse exposed to the risk of the performance of the S&P 500? While it is difficult to demonstrate at this point, there are ways that Credit Suisse can protect itself.

Although this may seem like a far-fetched application, it is not. In fact, it is quite common. Debt instruments created by using swaps are commonly referred to as structured notes.

INTEREST RATE CAPS AND FLOORS

An interest rate cap and floor is an agreement between two parties in which one party, for an upfront premium, agrees to compensate the other if a designated interest rate, called the **reference rate**, is different from a predetermined level. When one party agrees to pay the other if the reference rate exceeds a predetermined level, the agreement is referred to as an **interest rate cap** or **ceiling**. The agreement is referred to as an **interest rate floor** when one party agrees to pay the other if the reference rate falls below a predetermined level. The predetermined level of the reference interest rate is called the **strike rate**. The terms of an interest rate agreement include:

1. the reference rate
2. the strike rate that sets the ceiling or floor
3. the length of the agreement
4. the frequency of settlement
5. the notional principal amount

For example, suppose that C buys an interest rate cap from D with terms as follows:

1. The reference rate is six-month LIBOR.
2. The strike rate is 8%.

3. The agreement is for seven years.
4. Settlement is every six months.
5. The notional principal amount is $20 million.

Under this agreement, every six months for the next seven years, D will pay C whenever six-month LIBOR exceeds 8%. The payment will equal the dollar value of the difference between six-month LIBOR and 8% times the notional principal amount divided by two. For example, if six months from now six-month LIBOR is 11%, then D will pay C 3% (11% minus 8%) times $20 million divided by 2, or $300,000. If six-month LIBOR is 8% or less, D does not have to pay anything to C.

As an example of an interest rate floor, assume the same terms as the interest rate cap we just illustrated. In this case, if six-month LIBOR is 11%, C receives nothing from D, but if six-month LIBOR is less than 8%, D compensates C for the difference. For example, if six-month LIBOR is 7%, D will pay C $100,000 (8% minus 7%, times $20 million divided by 2).

Interest rate caps and floors can be combined to create an **interest rate collar**. This is done by buying an interest rate cap and selling an interest rate floor. Some commercial banks and investment banking firms now write options on interest rate agreements for customers. Options on caps are called **captions**, and options on floors are called **flotions**.

Risk/Return Characteristics

In an interest rate cap and floor, the buyer pays an upfront fee, which represents the maximum amount the buyer can lose and the maximum amount the writer of the agreement can gain. The only party that is required to perform is the writer of the interest rate agreement. The buyer of an interest rate cap benefits if the underlying interest rate rises above the strike rate because the seller (writer) must compensate the buyer. The buyer of an interest rate floor benefits if the interest rate falls below the strike rate because the seller (writer) must compensate the buyer.

How can we better understand interest rate caps and interest rate floors? In essence, these contracts are equivalent to a package of interest rate options. The question is what type of package of options is a cap and what type is a floor. Recall from our earlier discussion of the relationship between futures, FRAs, and swaps that the relationship depends on whether the underlying is an interest rate or a fixed-income instrument. The same applies to call options, put options, caps, and floors.

If the underlying is considered a fixed-income instrument, its value changes inversely with interest rates. Therefore,

FOR A CALL OPTION ON A FIXED-INCOME INSTRUMENT:

1. interest rates increase → fixed-income instrument's price decreases → call option's value decreases
2. interest rates decrease → fixed-income instrument's price increases → call option's value increases

FOR A PUT OPTION ON A FIXED-INCOME INSTRUMENT:

3. interest rates increase → fixed-income instrument's price decreases → put option's value increases
4. interest rates decrease → fixed-income instrument's price increases → put option's value decreases

To summarize,

	When Interest Rates	
Value of:	Increase	Decrease
Long call	Decrease	Increase
Short call	Increase	Decrease
Long put	Increase	Decrease
Short put	Decrease	Increase

For a cap and floor, the situation is as follows:

	When Interest Rates	
Value of:	Increase	Decrease
Short cap	Decrease	Increase
Long cap	Increase	Decrease
Short floor	Increase	Decrease
Long floor	Decrease	Increase

Therefore, buying a cap (long cap) is equivalent to buying a package of puts on a fixed-income instrument, and buying a floor (long floor) is equivalent to buying a package of calls on a fixed-income instrument.

On the other hand, if an option is viewed as an option on an interest rate (underlying), then buying a cap (long cap) is equivalent to buying a package of calls on interest rates. Buying a floor (long floor) is equivalent to buying a package of puts on interest rates.

It is important to note that, once again, a complex contract can be seen to be a package of basic contracts, or options in the case of interest rate agreements.

Applications

To see how interest rate agreements can be used for asset/liability management, consider the problems faced by the commercial bank and the life insurance company in the illustration in the chapter of the application of interest rate swaps.

Recall that the bank's objective is to lock in an interest rate spread over its cost of funds. Yet, because it raises funds through a variable-rate instrument and is basically borrowing short term, the bank's cost of funds is uncertain. The bank may be able to purchase a cap so that the cap rate plus the cost of purchasing the cap is less than the rate it is earning on its fixed-rate commercial loans. If short-term rates decline, the bank does not benefit from the cap, but its cost of funds declines. The cap, therefore, allows the bank to impose a ceiling on its cost of funds while retaining the opportunity to benefit from a decline in rates. This use of a cap is consistent with the view of an interest rate cap as simply a package of call options.

The bank can reduce the cost of purchasing the cap by selling a floor. In this case, the bank agrees to pay the buyer of the floor if the underlying rate falls below the strike rate. The bank receives a fee for selling the floor, but it has sold off its opportunity to benefit from a decline in rates below the strike rate. By buying a cap and selling a floor, the bank has created a range for its cost of funds (or a collar).

Consider again from that same first example of the application of interest rate swaps the problem of the life insurance company that has guaranteed a 9% rate on a GIC for the next five years and is considering the purchase of an attractive floating-rate instrument in a private placement transaction. The risk that the company faces is that interest rates will fall so that it will not earn enough to realize the 9% guaranteed rate plus a spread. The life insurance company may be able to purchase a floor to set a lower bound on its investment return, yet retain the opportunity to benefit should rates increase. To reduce the cost of purchasing the floor, the life insurance company can sell an interest rate cap. By doing so, however, it gives up the opportunity of benefiting from an increase in the six-month Treasury bill rate above the strike rate of the interest rate cap.

Key Points That You Should Understand Before Proceeding

1. An interest rate agreement is an agreement between two parties in which one party, for an upfront premium, agrees to compensate the other if the reference rate is different from the strike rate.
2. A cap is an interest rate agreement in which one party agrees to pay the other if the reference rate exceeds the strike rate; an interest rate floor is an interest rate agreement in which one party agrees to pay the other if the reference rate falls below the strike rate.
3. A collar is created by buying an interest rate cap and selling an interest rate floor.
4. An interest rate floor can be used by a depository institution to lock in an interest rate spread over its cost of funds but maintain the opportunity to benefit if rates decline.
5. The buyer of a floating-rate asset can use an interest rate floor to establish a lower bound on its investment return, yet retain the opportunity to benefit should rates increase.

SUMMARY

An FRA is the over-the-counter equivalent of the exchange-traded futures contracts on short-term rates and is a cash settlement contract. Typically, the short-term reference rate is LIBOR. The elements of an FRA are the contract rate, reference rate, settlement rate, notional amount, and settlement date. The buyer of the FRA agrees to pay the contract rate and the seller of the FRA agrees to receive the contract rate. The amount that must be exchanged at the settlement date is the present value of the interest differential. In contrast to a position in an interest rate futures contract, the buyer of an FRA benefits if the reference rate increases and the seller benefits if the reference rate decreases.

An interest rate swap is an agreement specifying that the parties exchange interest payments at designated times. In a typical swap, one party will make fixed-rate payments and the other will make floating-rate payments, with payments based on the notional principal amount. There are more complex swap structures such as swaps with a varying notional principal amount, basis swaps, constant maturity swaps, swaptions, and forward start swaps. Participants in financial markets use interest rate swaps to alter the cash flow characteristics of their assets or liabilities, or to capitalize on perceived capital market inefficiencies. A swap has the risk/return profile of a package of forward contracts or a combination of positions in the cash bond market.

An interest rate cap and floor allows one party the right to receive compensation from the writer of the agreement for an upfront premium if a designated interest rate is different from a predetermined level. An interest rate cap calls for one party to receive a payment if a designated interest rate is above the predetermined level. An interest rate floor lets one party receive a payment if a designated interest rate is below the predetermined level. An interest rate cap can be used to establish a ceiling on the cost of funding; an interest rate floor can be used to establish a floor return.

KEY TERMS

- Accreting swap
- Amortizing swap
- Asset swap
- Basis rate swap
- Bullet swap
- Buy-back (close-out sale, cancellation)
- Caption
- Fixed-rate payer
- Floating-rate payer
- Flotion
- Forward rate agreement (FRA)
- Forward start swap
- Interest rate cap (ceiling)
- Interest rate collar
- Interest rate/equity swap
- Interest rate floor
- Interest rate swap
- Liability swap
- Notional principal amount
- Payer swaption
- Plain vanilla swap
- Receiver swaption
- Reference rate
- Roller-coaster swap
- Strike rate
- Swap reversal
- Swap sale (swap assignment)
- Swaption

QUESTIONS

1. Hieber Manufacturing Corporation purchased the following FRA from the First Commercial Bank Corporation: (1) reference rate is three-month LIBOR, (2) contract rate is 6% (3) notional amount is for $20 million, and (4) number of days to settlement is 91 days.
   a. Suppose the settlement rate is 6.5%. Which party must compensate the other at the settlement date?
   b. If the settlement rate is 6.5%, how much will the compensation be?
2. Explain whether you agree or disagree with the following statement: "Both the buyers of an interest rate futures contract and FRA benefit if interest rates decline."
3. At any time in the life of the interest rate swap, does the notional principal become a cash flow to either party or to the intermediary?
4. Consider a swap with these features: maturity is five years, notional principal is $100 million, payments occur every six months, the fixed-rate payer pays a rate of 9.05% and receives LIBOR, while the floating-rate payer pays LIBOR and receives 9%. Now, suppose that at a payment date, LIBOR is at 6.5%. What is each party's payment and receipt at that date?
5. A bank borrows funds by issuing CDs that carry a variable rate equal to the yield of the six-month Treasury bill plus 50 basis points. The bank gets the chance to invest in a seven-year loan that will pay a

B. Fabozzi 4th-41(B)

fixed rate of 7%. So, the bank wants to engage in an interest rate swap designed to lock in an interest spread of 75 basis points. Give the outlines of two possible swaps: one designed to change the asset's cash flow into a variable rate, and the other designed to change the liability's cash flow into a fixed rate.

6. Identify two factors that have contributed to the growth of the interest rate swap market.
7. a. Describe the role of the intermediary in a swap.
   b. What are the two factors that led swap brokers/intermediaries to act as principals or dealers?
8. Suppose a dealer quotes these terms on a five-year swap: fixed-rate payer to pay 9.5% for LIBOR flat and floating-rate payer to pay LIBOR flat for 9.2%.
   a. What is the dealer's bid–ask spread?
   b. How would the dealer quote the terms by reference to the yield on five-year Treasury notes, assuming this yield is 9%?
9. Explain the three major ways in which a party to a swap can reverse that position in the secondary market for swaps.
10. Why can a fixed-rate payer in an interest rate swap be viewed as being short the bond market, and the floating-rate payer be viewed as being long the bond market?
11. a. Why would a depository institution use an interest rate swap?
    b. Why would a corporation that plans to raise funds in the debt market use an interest rate swap?
12. Suppose that a life insurance company has issued a three-year GIC with a fixed rate of 10%. Under what circumstances might it be feasible for the life insurance company to invest the funds in a floating-rate security and enter into a three-year interest rate swap in which it pays a floating rate and receives a fixed rate?
13. A portfolio manager buys a swaption with a strike rate of 6.5% that entitles the portfolio manager to enter into an interest rate swap to pay a fixed rate and receive a floating rate. The term of the swaption is five years.
    a. Is this swaption a payer swaption or a receiver swaption? Explain why.
    b. What does the strike rate of 6.5% mean?
14. The manager of a savings and loan association is considering the use of a swap as part of its asset/liability strategy. The swap would be used to convert the payments of its portfolio of fixed-rate residential mortgage loans into a floating payment.
    a. What is the risk with using a plain vanilla or generic interest rate swap?
    b. Why might a manager consider using an interest rate swap in which the notional principal amount declines over time?
    c. Why might a manager consider buying a swaption?
15. Suppose that a corporation is considering using an interest rate swap in conjunction with the offering of a floating-rate bond issue. That is, the corporation wants to use the swap to change the funding arrangement from a floating rate to a fixed rate.
    a. Would the corporation enter into a swap in which it pays or receives a fixed rate?
    b. Suppose that the corporation does not plan to issue the bond for one year. What type of swap can the firm's management enter into in order to set the terms of the swap today?
16. The Window Wipers Union (a pension sponsor) and the All-Purpose Asset Management Corporation (a money management firm) entered into a four-year swap with a notional principal amount of $150 million with the following terms: Every year for the next four years the Window Wipers Union agrees to pay All-Purpose Asset Management the return realized on the Standard & Poor's 500 stock index for the year minus 400 basis points and receive from All-Purpose Asset Management 9%.
    a. What type of swap is this?
    b. If in the first year when payments are to be exchanged, suppose that the return on the S&P 500 is 7%. What is the amount of the payment that the two parties must make to each other?
17. There are several depository institutions that offer certificates of deposit where the interest

rate paid is based on the performance of the S&P's 500 stock index.

a. What is the risk that a depository institution encounters by offering such certificates of deposit?

b. How do you think that a depository institution can protect itself against the risk you identified in part (a)?

18. Suppose a savings and loan association buys an interest rate cap that has these terms: The reference rate is the six-month Treasury bill rate; The cap will last for five years; payment is semiannual; the strike rate is 5.5%; and the notional principal amount is $10 million. Suppose further that at the end of some six-month period, the six-month Treasury bill rate is 6.1%.

a. What is the amount of the payment that the savings and loan association will receive?

b. What would the writer of this cap pay if the six-month Treasury rate were 5.45% instead of 6.1%?

19. What is the relationship between an interest rate agreement and an interest rate option?

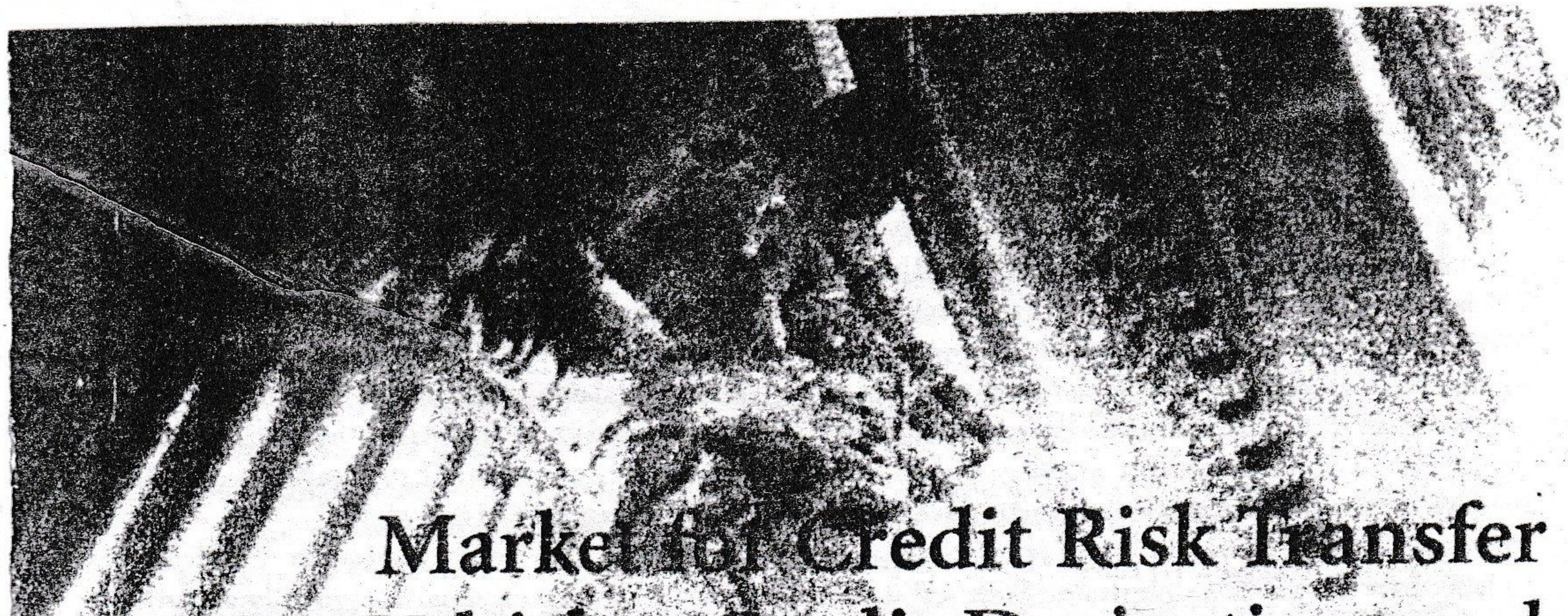
20. How can an interest rate collar be created?

21. Acme Insurance Company has purchased a five-year bond whose interest rate floats with LIBOR. Specifically, the interest rate in a given year is equal to LIBOR plus 200 basis points. At the same time the insurance company purchases this bond, it enters into a floor agreement with Goldman Sachs in which the notional principal amount is $35 million with a strike rate of 6%. The premium Acme Insurance Company agrees to pay Goldman Sachs each year is $300,000.

a. Suppose at the time that it is necessary to determine if a payment must be made by Goldman Sachs, LIBOR is 9%. How much must Goldman Sachs pay Acme Insurance Compar y?

b. Suppose at the time that it is necessary to determine if a payment must be made by Goldman Sachs, LIBOR is 3%. How much must Goldman Sachs pay Acme Insurance Company?

c. What is the minimum interest rate that Acme Insurance Company has locked in each year for the next five years by entering into this floor agreement and buying the five-year bond, ignoring the premium that Acme Insurance Company must make each year?



Market for Credit Risk Transfer Vehicles: Credit Derivatives and Collateralized Debt Obligations

LEARNING OBJECTIVES

After reading this chapter, you will understand

- what a credit risk transfer vehicle is
- what a credit derivative is
- the purpose of a credit derivative
- types and classification of credit derivatives
- how a credit event can be defined
- what a credit default swap is
- the different types of credit default swaps: single-name credit default swap, basket default swap, and credit default swap index
- what is meant by a collateralized debt obligation, collateralized bond obligation, and collateralized loan obligation
- the structure of a collateralized debt obligation
- the difference between an arbitrage and balance sheet transaction
- the economics underlying an arbitrage transaction
- the motivation for a balance sheet transaction
- what a synthetic collateralized debt obligation is and the motivation for its creation
- what a credit-linked note is
- what a structured finance operating company is
- concerns with the new credit risk transfer vehicles

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The development of the derivatives markets prior to the turn of the century provided participants in financial markets with efficient vehicles for the transfer of interest rate, price, and currency risks, as well as enhancing the liquidity of the underlying assets. However, it is only in recent years that the market for the efficient transfer of credit risk has developed. Credit risk is the risk that a debt instrument will decline in value as a result of the borrower's inability (real or perceived) to satisfy the contractual terms of its borrowing arrangement. In the case of corporate debt obligations, credit risk encompasses default, credit spread, and rating downgrade risks.

The most obvious way for a financial institution such as a bank to transfer the credit risk of a loan it has originated is to sell it to another party. Loan covenants typically require that the borrower be informed of the sale. The drawback of a sale in the case of bank loans (more specifically leveraged loans) is the potential impairment of the originating financial institution's relationship with the corporate borrower whose loan is sold. Syndicated loans overcome the drawback of an outright sale because banks in the syndicate may sell their loan shares in the secondary market. The sale may be through an assignment or through participation. While the assignment mechanism for a syndicated loan requires the approval of the borrower, participation does not because the payments are merely passed through to the purchaser and therefore the borrower need not know about the sale.

Another form of credit risk transfer (CRT) vehicle developed in the 1980s is securitization. In a securitization, a financial institution that originates loans pools them and sells them to a special purpose vehicle (SPV). The SPV obtains funds to acquire the pool of loans by issuing securities. Payment of interest and principal on the securities issued by the SPV is obtained from the cash flow of the pool of loans. While the financial institution employing securitization retains some of the credit risk associated with the pool of loans, the majority of the credit risk is transferred to the holders of the securities issued by the SPV.

Two recent credit risk transfer vehicles are credit derivatives and collateralized debt obligations (CDOs). For financial institutions, credit derivatives, particularly credit default swaps, allow the transfer of credit risk to another party without the sale of the loan. A CDO is an application of the securitization technology. Credit derivatives can be used to create credit risk transfer products such as synthetic CDOs. In this chapter, we will describe credit risk transfer vehicles: credit derivatives, CDOs, synthetic CDOs, and credit-linked notes.

Although our focus in this chapter is on the transferring of corporate credit risk, credit derivatives and CDOs have been used to transfer sovereign credit risk and municipal credit risk.[1]

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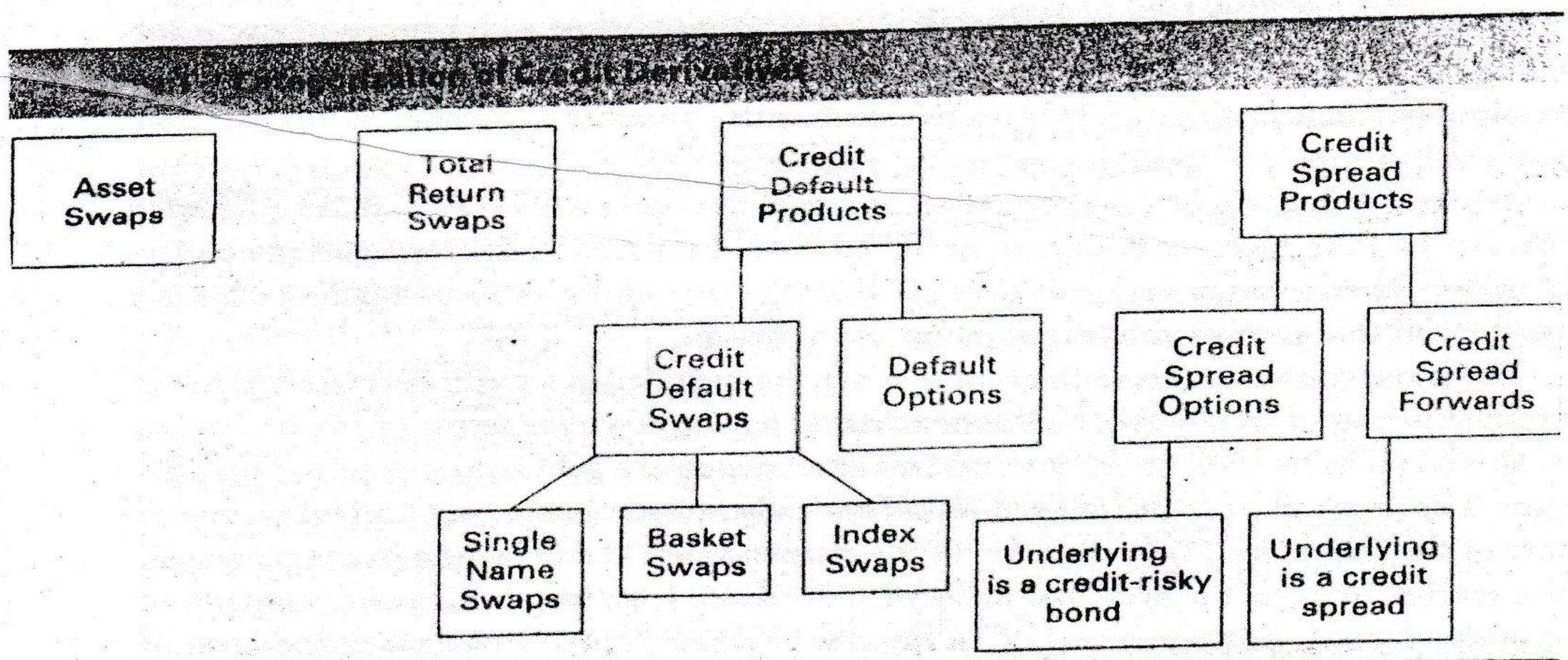
[1] For a discussion of the use of credit derivatives in the municipal bond market, see Frank J. Fabozzi, "Municipal Credit Default Swaps," Chapter 40 in Sylvan G. Feldstein and Frank J. Fabozzi (eds.), *The Handbook of Municipal Bonds* (Hoboken, NJ: John Wiley & Sons, 2008). The creation of CDOs backed by municipal bonds is in Rebecca Manning, Douglas J. Lucas, Laurie S. Goodman, and Frank J. Fabozzi, "Municipal Collateralized Debt Obligations," Chapter 41 in *The Handbook of Municipal Bonds*.

CREDIT DERIVATIVES

Credit derivatives are used by institutional portfolio managers in the normal course of activities to more efficiently control the credit risk of a portfolio or the balance sheet of a financial institution and to more efficiently transact than by transacting in the cash market. For example, credit derivatives allow a mechanism for portfolio managers to more efficiently short a credit-risky security than by shorting in the cash market, which is often difficult to do. For traders and hedge fund managers, credit derivatives provide a means for leveraging an exposure in the credit market.

The growth of the credit derivatives market has been documented by the British Bankers' Association (BBA), which periodically surveys market participants to gather information on the size of the market. According to the BBA surveys, the estimated size of the market was $180 billion in 1996. By the end of 2006, the estimated size of the market was $20.2 trillion, and it was expected to grow to $33.1 trillion by 2008.[2] This growth in the market followed the development of credit risk modeling.

There are several ways to characterize credit derivatives. One such categorization is shown in Figure 1. Some of the derivatives identified in the figure are not true credit derivatives in that they do not only provide protection against credit risk. Rather, they provide protection against both interest rate risk and credit risk. By far, the most popular type of credit derivative is the **credit default swap**. Not only is this form of credit derivative the most commonly used stand-alone product, but it is also used extensively in what is known as **structured credit products**. A credit default swap is probably the simplest form of credit risk transference among all credit derivatives, and according to the BBA it is the dominant form of credit derivative. Because of this, we will look at the different types of credit default swaps later in this chapter. In this section, we will discuss an important market development that fostered the growth of this market: the standardized documentation for the contract.



[2] British Bankers' Association, *Credit Derivatives Report 2006*.

International Swap and Derivatives Association Documentation

Prior to 1998, the development of the credit derivatives market was hindered by the lack of standardization of legal documentation. Every trade (i.e., the buying and selling of a credit derivative contract) had to be customized. In 1998, the **International Swap and Derivatives Association (ISDA)** developed a standardized contract that could be used by parties to trades of a credit derivatives contract. **ISDA documentation** is primarily designed for credit default swaps, but the contract form is sufficiently flexible so that it can be used for other types of credit derivatives.

Reference Entity and Reference Obligation

The documentation will identify the reference entity and the reference obligation. The **reference entity** is the issuer of the debt instrument and hence is also referred to as the **reference issuer.** It could be a corporation or a sovereign government. The **reference obligation,** also referred to as the **reference asset,** is the particular debt issue for which the credit protection is being sought. For example, a reference entity could be Ford Motor Credit Company. The reference obligation would be a specific Ford Motor Credit Company bond issue.

Credit Events

Credit derivative products have a payout that is contingent upon a **credit event** occurring. The ISDA provides definitions of credit events. The *1999 ISDA Credit Derivatives Definitions* (referred to as the "1999 Definitions") provides a list of eight credit events: (1) bankruptcy, (2) credit event upon merger, (3) cross acceleration, (4) cross default, (5) downgrade, (6) failure to pay, (7) repudiation/moratorium, and (8) restructuring. These eight events attempt to capture every type of situation that could cause the credit quality of the reference entity to deteriorate, or cause the value of the reference obligation to decline.

Bankruptcy is defined as a variety of acts that are associated with bankruptcy or insolvency laws. **Failure to pay** results when a reference entity fails to make one or more required payments when due. When a reference entity breaches a covenant, it has defaulted on its obligation.

When a default occurs, the obligation becomes due and payable prior to the scheduled due date had the reference entity not defaulted. This is referred to as an **obligation acceleration.** A reference entity may disaffirm or challenge the validity of its obligation. This is a credit event that is covered by **repudiation/moratorium.**

The most controversial credit event that may be included in a credit derivative product is restructuring of an obligation. A **restructuring** occurs when the terms of the obligation are altered so as to make the new terms less attractive to the debt holder than the original terms. The terms that can be changed would typically include, but are not limited to, one or more of the following: (1) a reduction in the interest rate, (2) a reduction in the principal, (3) a rescheduling of the principal repayment schedule (e.g., lengthening the maturity of the obligation) or postponement of an interest payment, or (4) a change in the level of seniority of the obligation in the reference entity's debt structure.

The reason why restructuring is so controversial is that a protection buyer benefits from the inclusion of restructuring as a credit event and feels that eliminating restructuring as a credit event will erode its credit protection. The protection seller, in contrast, would prefer not to include restructuring because even routine modifications of obligations that occur

in lending arrangements would trigger a payout to the protection buyer. Moreover, if the reference obligation is a loan and the protection buyer is the lender, there is a dual benefit for the protection buyer to restructure a loan. The first benefit is that the protection buyer receives a payment from the protection seller. Second, the accommodating restructuring fosters a relationship between the lender (who is the protection buyer) and its customer (the corporate entity that is the obligor of the reference obligation).

Because of this problem, the *Restructuring Supplement to the 1999 ISDA Credit Derivatives Definitions* (the "Supplement Definition") issued in April 2001 provided a modified definition for restructuring. There is a provision for the limitation on reference obligations in connection with restructuring of loans made by the protection buyer to the borrower that is the obligor of the reference obligation. This provision requires the following in order to qualify for a restructuring: (1) there must be four or more holders of the reference obligation, and (2) there must be a consent to the restructuring of the reference obligation by a supermajority (66 2/3%). In addition, the supplement limits the maturity of reference obligations that are physically deliverable when restructuring results in a payout triggered by the protection buyer.

As the credit derivatives market developed, market participants learned a great deal about how to better define credit events, particularly with the record level of high-yield corporate bond default rates in 2002, and the sovereign defaults, particularly the experience with the 2001–2002 Argentina debt crisis. In January 2003, the ISDA published its revised credit events definitions in the *2003 ISDA Credit Derivative Definitions* (referred to as the "2003 Definitions"). The revised definitions reflected amendments to several of the definitions for credit events set forth in the 1999 Definitions. Specifically, there were amendments for bankruptcy, repudiation, and restructuring.

The major change was to restructuring, whereby the ISDA allows parties to a given trade to select from among the following four definitions: (1) **no restructuring**; (2) **full (old) restructuring**, which is based on the 1999 Definitions; (3) **modified restructuring**, which is based on the Supplement Definition; and (4) **modified modified restructuring**. The last choice is new and was included to address issues that arose in the European market.

Key Points That You Should Understand Before Proceeding

1. Two recent credit risk transfer vehicles are credit derivatives and collateralized debt obligations (CDOs).
2. Credit derivatives are used by institutional portfolio managers to more efficiently control the credit risk of a portfolio or the balance sheet of a financial institution rather than transact in the cash market.
3. A credit default swap is the dominant type of credit derivative.
4. The ISDA has facilitated the growth of the credit derivative market by introducing a standard contract that can be used in credit derivative trades.
5. The ISDA documentation for a credit derivative trade identifies the reference entity and what constitutes a credit event that sets forth when a payout must be made by the protection seller to the protection buyer.
6. There are eight types of credit events possible, the most controversial being restructuring.

CREDIT DEFAULT SWAPS

Credit default swaps are used to shift credit exposure to a credit protection seller. Their primary purpose is to hedge the credit exposure to a particular asset or issuer. A credit default swap in which there is one reference entity is called **a single-name credit default swap**. When there are multiple reference entities (e.g., 10 high-yield corporate bonds of 10 different issuers), it is referred to as a **basket credit default swap**. In a **credit default swap index**, there are multiple entities, as in a basket credit default swap. However, unlike a basket credit default swap, there is a standardized basket of reference entities.

In a credit default swap, the protection buyer pays a fee to the protection seller in return for the right to receive a payment conditional upon the occurrence of a credit event by the reference obligation or the reference entity. Should a credit event occur, the protection seller must make a payment.

The interdealer market has evolved to where single-name credit default swaps for corporate and sovereign reference entities are standardized. While trades between dealers have been standardized, there are occasional trades in the interdealer market where there is a customized agreement. For portfolio managers seeking credit protection, dealers are willing to create customized products. The tenor (i.e., length of time of a credit default swap) is typically five years. Portfolio managers can have a dealer create a tenor equal to the maturity of the reference obligation or have it constructed for a shorter time period to match the manager's investment horizon.

Credit default swaps can be settled in cash or physically. Physical delivery means that if a credit event as defined by the documentation occurs, the reference obligation is delivered by the protection buyer to the protection seller in exchange for a cash payment. Because physical delivery does not rely upon obtaining market prices for the reference obligation in determining the amount of the payment in a single-name credit default swap, this method of delivery is more efficient.

The payment by the credit protection seller if a credit event occurs may be a predetermined fixed amount or it may be determined by the decline in value of the reference obligation. The standard single-name credit default swap when the reference entity is a corporate bond or a sovereign bond is fixed based on a notional amount. When the cash payment is based on the amount of asset value deterioration, this amount is typically determined by a poll of several dealers. If no credit event has occurred by the maturity of the swap, both sides terminate the swap agreement and no further obligations are incurred.

The methods used to determine the amount of the payment obligated of the protection seller under the swap agreement can vary greatly. For instance, a credit default swap can specify at the contract date the exact amount of payment that will be made by the protection seller should a credit event occur. Conversely, the credit default swap can be structured so that the amount of the swap payment by the seller is determined after the credit event. Under these circumstances, the amount payable by the protection seller is determined based upon the observed prices of similar debt obligations of the reference entity in the market. In a typical credit default swap, the protection buyer pays for the protection premium over several settlement dates rather than upfront. A standard credit default swap specifies quarterly payments.

Single-Name Credit Default Swap

Let's illustrate the mechanics of a single-name credit default swap. Assume that the reference entity is XYX Corporation and the underlying is $10 million par value of XYZ bonds. The $10 million is the notional amount of the contract. The swap premium—the payment made by the protection buyer to the protection seller—is 200 basis points.

The standard contract for a single-name credit default swap calls for a quarterly payment of the swap premium. The quarterly payment is determined using one of the day count conventions in the bond market. The day count convention used for credit default swaps is actual/360, the same convention used in the interest rate swap market. A day convention of actual/360 means that to determine the payment in a quarter, the actual number of days in the quarter are used and 360 days are assumed for the year.

Consequently, the swap premium payment for a quarter is

$$\text{quarterly swap premium payment} = \text{notional amount} \times \text{swap rate (in decimal)} \times \frac{\text{actual no. of days in quarter}}{360}$$

For example, assume a hypothetical credit default swap where the notional amount is $10 million and there are 92 actual days in a quarter. Since the swap premium is 200 basis points (0.02), the quarterly swap premium payment made by the protection buyer would be

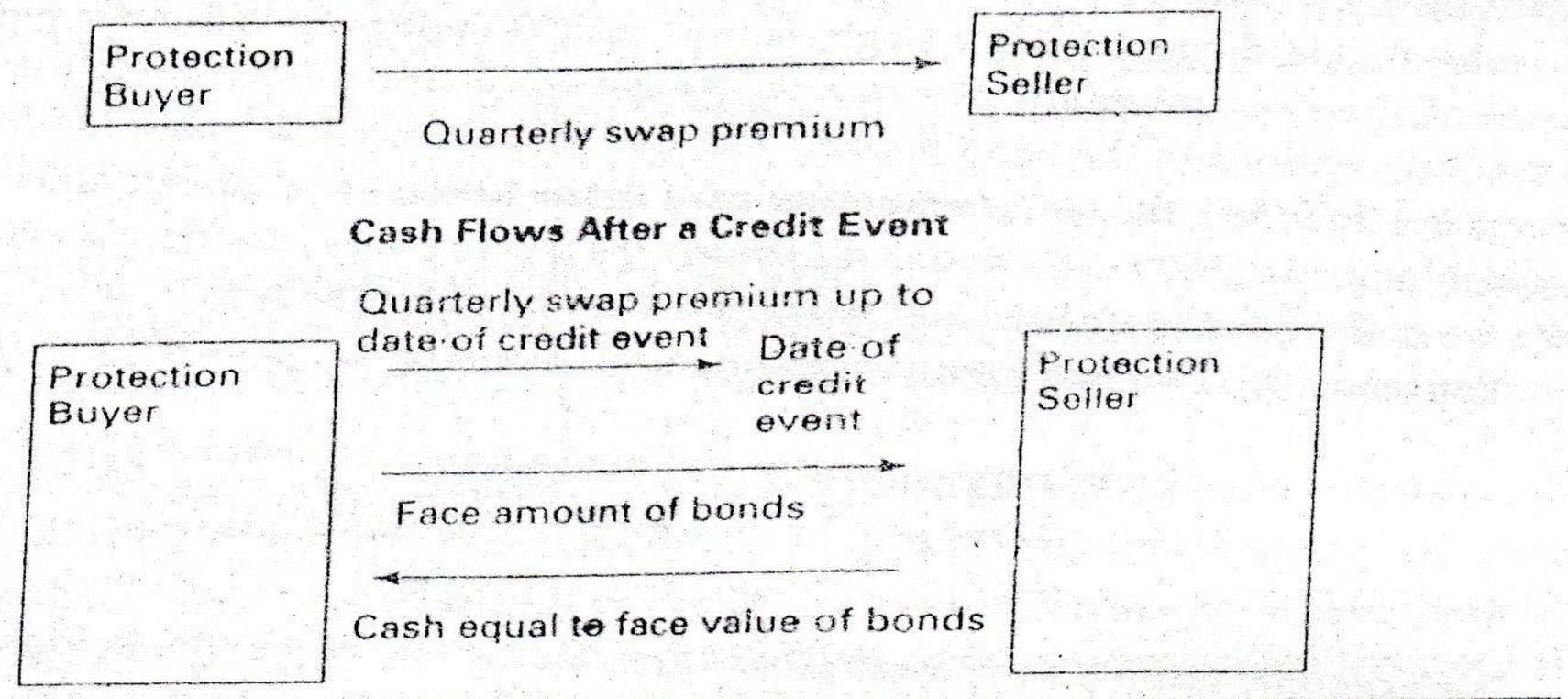
$$\$10{,}000{,}000 \times (0.02) \times \frac{92}{360} = \$51{,}111.11$$

In the absence of a credit event, the protection buyer will make a quarterly swap premium payment over the life of the swap. If a credit event occurs, two things happen. First, there are no further payments of the swap premium by the protection buyer to the protection seller. Second, a **termination value** is determined for the swap. The procedure for computing the termination value depends on the settlement terms provided for by the swap. This will be either physical settlement or cash settlement. The market practice for settlement for single-name credit default swaps is physical delivery.

With **physical settlement** the protection buyer delivers a specified amount of the face value of bonds of the reference entity to the protection seller. The protection seller pays the protection buyer the face value of the bonds. Since all reference entities that are the subject of credit default swaps have many issues outstanding, there will be a number of alternative issues of the reference entity that the protection buyer can deliver to the protection seller. These issues are known as **deliverable obligations**. The swap documentation will set forth the characteristics necessary for an issue to qualify as a deliverable obligation. Recall that for Treasury bond and note futures contracts the short has the choice of which Treasury issue to deliver that the exchange specifies as acceptable for delivery. The short will select the cheapest-to-deliver issue, and the choice granted to the short is effectively an embedded option. The same is true for physical settlement for a single-name credit default swap. From the list of deliverable obligations, the protection buyer will select for delivery to the protection seller the cheapest-to-deliver issue.

Figure 2 shows the mechanics of a single-name credit default swap. The cash flows are shown before and after a credit event. It is assumed in the figure that there is physical settlement.

Figure 2 Mechanics of a Single-Name Credit Default Swap with Physical Delivery



Single-name credit default swaps can be used in the following ways by portfolio managers:

- The liquidity of the swap market compared to the corporate bond market makes it more efficient to obtain exposure to a reference entity by taking a position in the swap market rather than in the cash market. To obtain exposure to a reference entity, a portfolio manager would sell protection and thereby receive the swap premium.
- Conditions in the corporate bond market may be such that it is difficult for a portfolio manager to sell the current holding of a corporate bond of an issuer for which it has a credit concern. Rather than selling the current holding, the portfolio can buy protection in the swap market.
- If a portfolio manager expects that an issuer will have difficulties in the future and wants to take a position based on that expectation, it will short the bond of that issuer. However, shorting bonds in the corporate bond market is difficult. The equivalent position can be obtained by entering into a swap as the protection buyer.
- For a portfolio manager seeking a leveraged position in a corporate bond, this can be done in the swap market. The economic position of a protection buyer is equivalent to a leveraged position in a corporate bond.

Basket Credit Default Swaps

With a basket credit default swap, or simply basket default swaps, when a payout must be made must be specified. For example, if a basket credit default swap has 10 reference obligations, does a credit event for just one of the 10 reference obligations result in the triggering of a payment by the protection seller? It depends. Basket default swaps can be structured in different ways.

The simplest case is that if any of the reference obligations default, there is a payout and then termination of the swap. This type of swap is referred to as a first-to-default basket swap. Similarly, if a payout is triggered only after two reference obligations default, the swap is referred to as a second-to-default basket swap. In general, if it takes *k* reference obligations to trigger a payout, the swap is referred to as a *k*-to-default basket swap.

Unlike a single-name credit default swap, the preferred settlement procedure for a basket default swap is cash settlement. With **cash settlement**, the termination value is equal to the difference between the nominal amount of the reference obligation for which a credit event has occurred and its market value at the time of the credit event. The termination value is then the amount of the payment made by the protection seller to the protection buyer. No bonds are delivered by the protection buyer to the protection seller. The documentation for the basket default swap will set forth how the market value at the time of the credit event is determined.

Credit Default Swap Index

In a credit default swap index, the credit risk of a standardized basket of reference entities is transferred between the protection buyer and protection seller. For North America, the only standardized indexes are those compiled and managed by Dow Jones. For the corporate bond indexes, there are separate indexes for investment-grade and high-grade names. The most actively traded contract as of year-end 2008 is the one based on the North American Investment Grade Index (denoted by DJ.CDX.NA.IG). As the name suggests, the reference entities in this index are those with an investment-grade rating. The index includes 125 corporate names in North America. The index is an equally weighted index. That is, each corporate name (i.e., reference entity) comprising the index has a weight of 0.8%. The index is updated semiannually by Dow Jones.

The mechanics of a credit default swap index are slightly different from that of a single-name credit default swap. As with a single-name credit default swap, a swap premium is paid. However, if a credit event occurs, the swap premium payment ceases in the case of a single-name credit default swap. In contrast, for a credit default swap index, the swap payment continues to be made by the protection buyer. However, the amount of the quarterly swap premium payment is reduced. This is because the notional amount is reduced as the result of a credit event for a reference entity.

For example, suppose that a portfolio manager is the protection buyer for a DJ.CDX.NA.IG and the notional amount is $200 million. Using the following formula for computing the quarterly swap premium payment, the payment before a credit event occurs would be

$$\$200{,}000{,}000 \times \text{swap rate (in decimal)} \times \frac{\text{actual no. of days in quarter}}{360}$$

After a credit event occurs for one reference entity, the notional amount declines from $200 million to $199,840,000. The reduction is equal to 99.2% of the $200 million because each reference entity for the DJ.CDX.NA.IG is 0.8%. Thus, the revised quarterly swap premium payment until the maturity date or until another credit event occurs for one of the other 124 reference entities is

$$\$199{,}840{,}000 \times \text{swap rate (in decimal)} \times \frac{\text{actual no. of days in quarter}}{360}$$

As of year-end 2008, the settlement term for a credit default swap index is physical settlement. However, the market is considering moving to cash settlement. The reason is because of the cost of delivering an odd lot of the bonds of the reference entity in the case of a credit event. For example, consider a credit default swap index with a $10 million notation amount. If there is a credit event, the protection buyer would have to deliver to the protection seller bonds of the reference entity with a face value of $80,000 ($10 million times 0.8%). Neither the protection buyer nor the protection seller would like to deal with such a small position.

Figure 3 Mechanics of a Credit Default Swap Index (Physical Delivery)

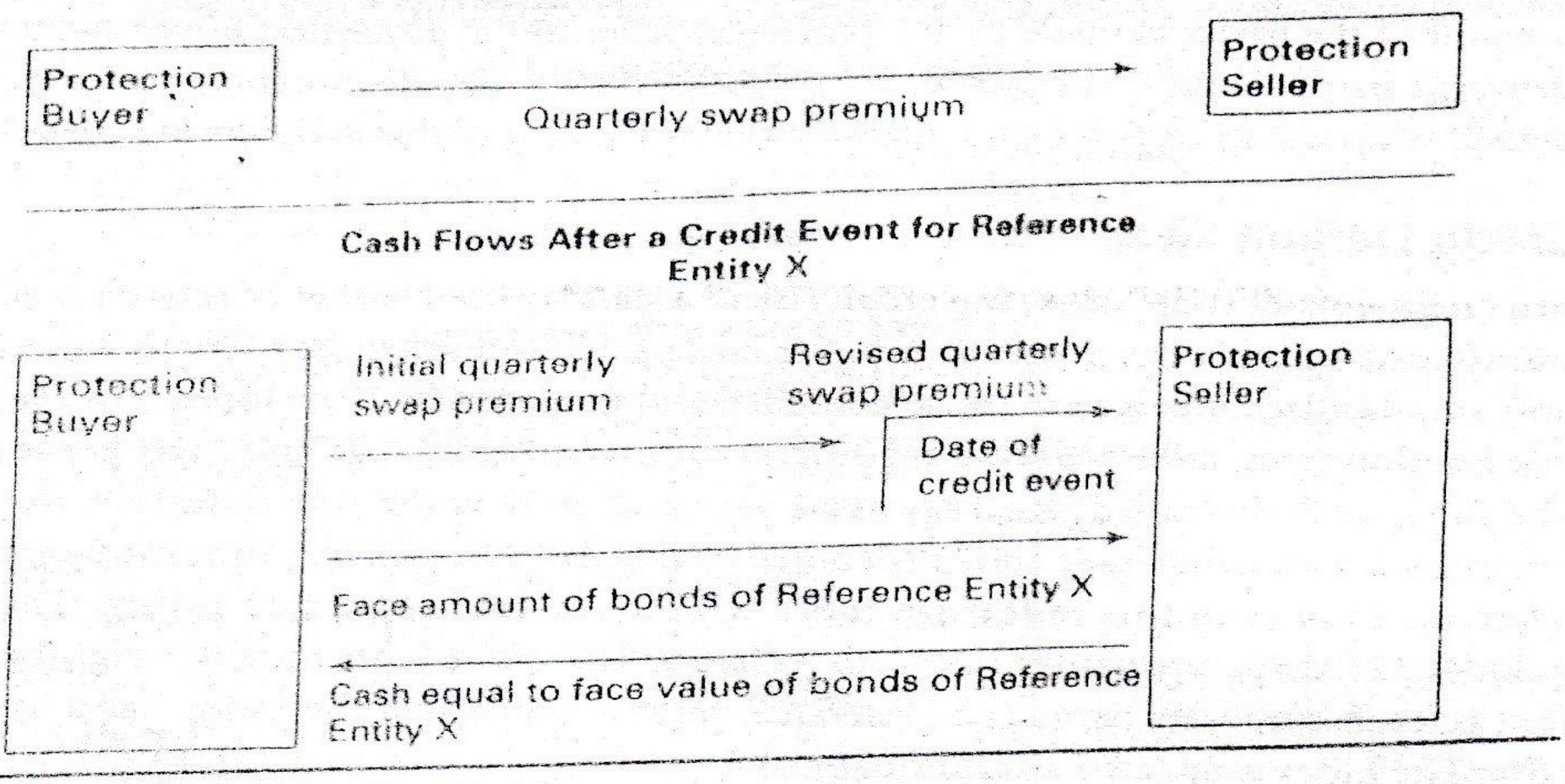


Figure 3 shows the cash flow for a generic credit default swap index after a credit event for one reference entity. Because a credit default swap index, such as the DJ.CDX.NA.IG, provides exposure to a diversified basket of credits, it can be used by a portfolio manager to help adjust a portfolio's exposure to the credit sector of a bond market index. By entering into a credit default swap index as the protection seller, a portfolio manager increases exposure to the credit sector. Exposure to the credit sector is reduced by a portfolio manager being the protection buyer.

Key Points That You Should Understand Before Proceeding

1. The parties to a credit default swap are the credit protection buyer and the credit protection seller, the latter providing protection should a credit event occur for a reference entity or pool of reference entities during the life of the contract and the former making periodic payments for the protection.
2. There are three types of credit default swaps: single-name credit default swaps, basket credit default swaps, and credit default swap indexes.
3. With a single-name credit default swap, there is only one reference entity and once a credit event occurs, the protection seller must compensate the protection buyer (through either physical or cash settlement); payment by the protection buyer to the protection seller ends either when a credit event occurs or the maturity date of the contract is reached.
4. In a basket credit default swap, there are multiple reference entities, with the trigger determining when the protection seller must make a payment to the protection buyer being based on the number of reference entities that must default.
5. In a credit default swap index, the credit risk of a standardized basket of reference entities is transferred between the protection buyer and protection seller, with the contract continuing even if there is a credit event for any of the reference entities in the index but at a lower premium to reflect the credit protection for fewer reference entities.

COLLATERALIZED DEBT OBLIGATIONS

A **collateralized debt obligation** (CDO) is a security backed by a diversified pool of one or more of the following types of debt obligations:

- U.S. domestic investment-grade and high-yield corporate bonds
- U.S. domestic bank loans
- emerging market bonds
- special situation loans and distressed debt
- foreign bank loans
- asset-backed securities
- residential and commercial mortgage-backed securities

When the underlying pool of debt obligations consists of bond-type instruments (corporate and emerging market bonds), a CDO is referred to as a **collateralized bond obligation (CBO)**. When the underlying pool of debt obligations is bank loans, a CDO is referred to as a **collateralized loan obligation (CLO)**.

A CDO is an important credit risk transfer vehicle used by financial institutions and portfolio managers. In this section we explain the basic CDO structure, the reason they are created, and the types of CDOs.[3] The creation of these structures requires the use of derivative instruments, specifically interest rate swaps or credit derivatives, particularly credit default swaps discussed earlier in this chapter.

Structure of a Collateralized Debt Obligation

In a CDO structure, there is a **collateral manager** responsible for managing the portfolio of debt obligations. The portfolio of debt obligations in which the collateral manager invests is referred to as the *collateral*. The individual issues that comprise the collateral are referred to as the *collateral assets*. The funds to purchase the collateral assets are obtained from the issuance of debt obligations. These debt obligations are referred to as *tranches* or *bond classes*. The tranches include

- senior tranches
- mezzanine tranches
- subordinate/equity tranche

A CDO may or may not have a mezzanine tranche.

There will be a rating sought for all but the subordinate/equity tranche. For the senior tranches, at least an A rating is typically sought. For the mezzanine tranches, a rating of BBB but no less than B is sought. The subordinate/equity tranche receives the residual casn flow; hence, no rating is sought for this tranche. There are restrictions imposed as to what the collateral manager may do and certain tests that must be satisfied for the CDO to maintain the credit rating assigned at the time of issuance.

The ability of the collateral manager to make the interest payments to the tranches and pay off the tranches as they mature depends on the performance of the collateral. The proceeds to meet the obligations to the CDO tranches (interest and principal repayment) can come from

- coupon interest payments from the collateral assets
- maturing of collateral assets
- sale of collateral assets

In a typical structure, one or more of the tranches has a floating rate. With the exception of deals backed by bank loans that pay a floating rate, the collateral manager invests in fixed-rate bonds. Now that presents a problem—paying tranche investors a floating rate and investing in assets with a fixed rate. To deal with this problem, the collateral manager uses interest rate swaps to be able to convert a portion of the fixed-rate payments from the assets into floating-rate cash flows to pay floating-rate tranches. An interest rate swap allows a market participant to swap fixed-rate payments for floating-rate payments or vice versa. A rating agency will require the use of swaps to eliminate any cash flow mismatches.

Arbitrage versus Balance Sheet Transactions

CDOs are categorized based on the motivation of the sponsor of the transaction. If the sponsor's motivation is to earn the spread between the yield offered on the collateral and the payments made to the various tranches in the structure, then the transaction is referred to as an **arbitrage transaction**. If the motivation of the sponsor is to remove debt instruments (primarily loans) from its balance sheet, then the transaction is referred to as a **balance sheet transaction**. Sponsors of balance sheet transactions are typically financial institutions such as banks seeking to reduce their capital requirements specified by bank regulators by removing loans from their balance sheet.

Economics of an Arbitrage Collateralized Debt Obligation Transaction

To understand the economics of an arbitrage transaction, we will use an illustration. The key as to whether it is economically feasible to create an arbitrage CDO is whether a structure can offer a competitive return for the subordinate/equity tranche.

To understand how the subordinate/equity tranche generates cash flows, consider the following basic $100 million CDO structure with the coupon rate to be offered at the time of issuance as follows:

Tranche	Par Value	Coupon Type	Coupon Rate
Senior	$80,000,000	Floating	LIBOR + 70 basis points
Mezzanine	$10,000,000	Fixed	Treasury rate + 200 basis points
Subordinate/Equity	$10,000,000	—	—

We will make the following assumptions:

- The collateral consists of bonds that all mature in 10 years.
- The coupon rate for every bond is a fixed rate.
- The fixed rate at the time of purchase of each bond is the 10-year Treasury rate plus 400 basis points.

Suppose the collateral manager enters into an interest rate swap agreement with another party with a notional principal of $80 million in which it agrees to do the following:

- Pay a fixed rate each year equal to the 10-year Treasury rate plus 100 basis points.
- Receive LIBOR.

Recall that an interest rate swap is simply an agreement to periodically exchange interest payments. The payments are benchmarked off a notional amount. This amount is not exchanged between the two parties; it is used simply to determine the dollar interest payment of each party. Keep in mind that the goal is to show how the subordinate/equity tranche can be expected to generate a return.

Let's assume that the 10-year Treasury rate at the time the CDO is issued is 7%. Now we can walk through the cash flows for each year. Look first at the collateral. The collateral will pay interest each year (assuming no defaults) equal to the 10-year Treasury rate of 7% plus 400 basis points. So the interest will be

$$\text{Interest from collateral: } 11\% \times \$100{,}000{,}000 = \$11{,}000{,}000$$

Now let's determine the interest that must be paid to the senior and mezzanine tranches. For the senior tranche, the interest payment will be

$$\text{Interest to senior tranche: } \$80{,}000{,}000 \times (\text{LIBOR} + 70 \text{ bps})$$

The coupon rate for the mezzanine tranche is 7% plus 200 basis points. So, the coupon rate is 9% and the interest is

$$\text{Interest to mezzanine tranche: } 9\% \times \$10{,}000{,}000 = \$900{,}000$$

Finally, let's look at the interest rate swap. In this agreement, the collateral manager is agreeing to pay some third party (called the swap counterparty) 7% each year (the 10-year Treasury rate) plus 100 basis points, or 8%, of the notional amount of the interest rate swap. In our illustration, the notional amount is $80 million. The collateral manager selected the $80 million because this is the amount of principal for the senior tranche. So, the collateral manager pays to the swap counterparty:

$$\text{Interest to swap counterparty: } 8\% \times \$80{,}000{,}000 = \$6{,}400{,}000$$

The interest payment received from the swap counterparty is LIBOR based on a notional amount of $80 million. That is,

$$\text{Interest from swap counterparty: } \$80{,}000{,}000 \times \text{LIBOR}$$

Now we can put this all together. Let's look at the interest coming into the CDO:

$$\begin{aligned}
\text{Interest from collateral} &= \$11{,}000{,}000 \\
\text{Interest from swap counterparty} &= \$80{,}000{,}000 \times \text{LIBOR} \\
\text{Total interest received} &= \$11{,}000{,}000 + \$80{,}000{,}000 \times \text{LIBOR}
\end{aligned}$$

The interest to be paid out to the senior and mezzanine tranches and to the swap counterparty includes:

$$\begin{aligned}
\text{Interest to senior tranche} &= \$80{,}000{,}000 \times (\text{LIBOR} + 70 \text{ bps}) \\
\text{Interest to mezzanine tranche} &= \$900{,}000 \\
\text{Interest to swap counterparty} &= \$6{,}400{,}000 \\
\text{Total interest paid} &= \$7{,}300{,}000 + \$80{,}000{,}000 \times (\text{LIBOR} + 70 \text{ bps})
\end{aligned}$$

Netting the interest payments coming in and going out we have

$$\begin{aligned}
\text{Total interest received} &= \$11{,}000{,}000 + \$80{,}000{,}000 \times \text{LIBOR} \\
\text{Total interest paid} &= \$7{,}300{,}000 + \$80{,}000{,}000 \times (\text{LIBOR} + 70 \text{ bps}) \\
\text{Net interest} &= \$3{,}700{,}000 - \$80{,}000{,}000 \times (70 \text{ bps})
\end{aligned}$$

Since 70 basis points times $80 million is $560,000, the net interest remaining is $3,140,000 ($3,700,000 − $560,000). From this amount any fees (including the asset management fee) must be paid. The balance is then the amount available to pay the subordinate/equity tranche. Suppose that these fees are $634,000. Then the cash flow available to the subordinate/equity tranche is $2.5 million. Since the tranche has a par value of $10 million and is assumed to be sold at par, this means that the potential return is 25%.

In our illustration, some simplifying assumptions were made. For example, it is assumed that there are no defaults. It is assumed that all of the issues purchased by the collateral manager are noncallable (or not prepayable), and, therefore, the coupon rate would not decline because issues are called. Moreover, as explained later, after some period, the collateral manager must begin repaying principal to the senior and mezzanine tranches. Consequently, the interest rate swap must be structured to take this into account since the entire amount of the senior tranche is not outstanding for the life of the collateral.

Despite the simplifying assumptions, the illustration does demonstrate the basic economics of arbitrage CDO structures, the need for the use of an interest rate swap, and how the subordinate/equity tranche will realize a return. In determining whether or not to create a CDO, dealers will look to see if there is a potential return available to the equity tranche of a minimum amount. The threshold return is based on market conditions.

Who are the buyers of the subordinate/equity tranche? In many deals, the sponsor will hold a certain percentage of the tranche. This is done so that the buyers of the other tranches in the structure will see that the sponsor's economic interests are also tied to the performance of the collateral. In addition, hedge fund managers are major buyers. The subordinate/equity tranche in the transaction is an equity-type leveraged security, the type of security that appeals to hedge fund managers. Recall the subprime meltdown in the mortgage market in the summer of 2007. The demand to originate subprime mortgages was driven by the demand from dealers to create subprime residential mortgage–backed securities. In turn, demand for subprime residential mortgage–backed securities came from CDO collateral managers for this product. As we just explained, an arbitrage CDO cannot be done if there is no demand for the subordinate/equity tranche. That demand came from hedge fund managers.

Types of Arbitrage Transactions

Arbitrage transactions can be divided into two types depending on the primary source of the proceeds from the collateral to satisfy the obligation to the tranches. If the primary source is the interest and maturing principal from the collateral, then the transaction is referred to as a **cash flow transaction**. If, instead, the proceeds to meet the obligations depend heavily on the total return generated from the collateral (i.e., interest income, capital gain, and maturing principal), then the transaction is referred to as a **market value transaction**. Most CDOs today are cash flow transactions.

Synthetic Collateralized Debt Obligations

A CDO is classified as a **cash CDO** or a **synthetic CDO**. The adjective *cash* means that the collateral manager purchases cash market instruments. Cash CDOs went a long way in providing banks with the opportunity to better manage their balance sheets. However, there were still two problems with cash CDOs. First, and this is a technical point, regulations allowed for more efficient ways for obtaining credit protection in order to reduce capital

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requirements.[4] Second was the problem of confidentiality. More specifically, if a loan is transferred into a CDO, borrower notification and borrower consent are required. Because borrowers do not always understand the motivation for the bank selling their loan, the potential for deterioration in customer relationships may make a bank reluctant to sell or transfer a customer's loan.

A synthetic CDO deals with these two limitations of a cash CDO. A synthetic CDO is so named because the collateral manager does not actually own the pool of assets on which it has the credit risk exposure. Stated differently, a synthetic CDO absorbs the credit risk, but not the legal ownership, of the reference obligations. Because the loans are not transferred or sold, the problem of confidentiality is overcome. The vehicle that allows institutions to transfer the credit risk, but not the legal ownership, of the reference obligations it may own in a synthetic CDO is a credit default swap. Synthetic CDO deals came to dominate the CDO market. There are both synthetic balance sheet and synthetic arbitrage CDO structures.[5]

A synthetic CDO works as follows: There are liabilities issued as with a cash CDO. The proceeds received from the tranches sold are invested by the collateral manager in assets with low risk. At the same time, the collateral manager enters into a credit default swap with a counterparty. In the swap, the collateral manager will provide credit protection (i.e., the collateral manager is the protection seller) for a basket of reference obligations that have credit risk exposure. Because it is selling credit protection, the collateral manager will receive the credit default swap premium.

On the other side of the credit default swap is a protection buyer who will be paying the swap premium to the collateral manager. This entity will be a financial institution seeking to shed the credit risk of assets that it owns and that are the reference obligations for the credit default swap.

If a credit event does not occur, the return realized by the collateral manager that will be available to meet the payment to the CDO bondholders is the return on the collateral consisting of low-risk assets plus the credit default swap premium. If a credit event occurs that requires a payout, the collateral manager must make a payment to the protection buyer. This reduces the return available to meet the payments to the CDO bondholders.

There are now standard synthetic CDO tranches that can be purchased by investors based on a standardized reference portfolio, the most common being the Dow Jones North American Investment Grade Index. Each tranche is denoted by two percentages. The first percentage is the subordination level. Once the realized losses exceed the subordination level, the investor in that tranche realizes a loss. The second percentage is the upper limit on the credit loss with the loss expressed as a percentage of the size of the underlying reference portfolio. For example, for the standard synthetic CDO in which the underlying is the Dow Jones North American Investment Grade Index, standard tranches are an equity tranche 0% to 3%, followed by a junior mezzanine 3% to 7%, a 7% to 10% senior mezzanine, a 10% to 15% senior, and a 15% to 30% super senior tranche. For example, consider the 7%

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[4] For an explanation, see Chapter 12 in Lucas, Goodman, and Fabozzi. *Collateralized Debt Obligations: Structures & Analysis.*

[5] For a further discussion of synthetic balance sheet CDO structures and synthetic arbitrage CDO structures, see Chapters 12 and 13 in Lucas, Goodman, and Fabozzi, *Collateralized Debt Obligations: Structures and Analysis.* For a comprehensive discussion of the application of synthetic CDOs to balance sheet management for banks, see Chapter 7 in Frank J. Fabozzi, Henry Davis, and Moorad Choudhry, *Introduction to Structured Finance* (Hoboken, NJ: John Wiley & Sons, 2006).

to 10% senior mezzanine tranche. An investor in this tranche will only realize a principal loss if there are a sufficient number of defaults for the losses to exceed the subordination of 7% over the life of the tranche.

Key Points That You Should Understand Before Proceeding

1. A CDO is a security backed by a diversified pool of debt obligations.
2. CLOs and CBOs are types of CDOs.
3. The CDO collateral manager is responsible for managing the portfolio of debt obligations.
4. The funds to purchase the assets for a CDO are obtained from the sale of securities, and these securities include senior tranches, mezzanine tranches, and a subordinate/equity tranche.
5. In a cash flow CDO, payments to the tranches issued are generated from the collateral's coupon interest and principal from maturing or prepaid debt obligations.
6. CDOs are categorized based on the motivation of the sponsor of the transaction: arbitrage transactions and balance sheet transactions.
7. The motivation in an arbitrage transaction is to earn an attractive spread for the equity tranche.
8. The motivation in a balance sheet transaction is to transfer loans on a financial institution's balance sheet and obtain capital relief.
9. A synthetic CDO uses credit derivatives, most commonly credit default swaps, to create exposure to reference entities rather than purchasing the cash instruments of those reference entities themselves.

STRUCTURED FINANCE OPERATING COMPANIES

A **structured finance operating company** (SFOC) is a term used by Moody's to refer to an entity whose business activities and operations as well as its credit rating are based on detailed, predetermined parameters. Basically what an SFOC seeks to do is generate "arbitrage" returns by borrowing funds (i.e., employing leverage) and investing those funds in credit-risky debt instruments in such a way as to earn more than the cost of the funds. The reason we placed the term *arbitrage* in quotation marks is that it is not a true arbitrage where a risk-free return is generated without having to invest any funds. There is risk. Despite this risk, the terminology that has unfortunately been adopted is that arbitrage returns are sought.

An SFOC sounds much like an arbitrage CDO since both use borrowed funds to generate a return from investing in a pool of credit-risky assets. However, unlike a CDO, the manager of an SFOC can increase or decrease its leverage based on its expectation about factors that impact the return on its portfolio.

There are many types of SFOC. The most popular one is the **structured investment vehicle (SIV).**[6] However, the survival of the SFOCs as an investment product is likely given the difficulties they faced in the credit crisis of 2007 and 2008.

[6] For a further discussion, see Garrett Sloan, "Structured Finance Operating Companies," Chapter 26 in Brian Lancaster, Glenn Schultz, and Frank J. Fabozzi (eds.), *Structured Products and Related Credit Derivatives: A Comprehensive Guide for Investors* (Hoboken, NJ: John Wiley & Sons, 2008).

CREDIT-LINKED NOTES[7]

A credit-linked note (CLN) is a security issued by an investment banking firm or another issuer (typically a special purpose vehicle), which has credit risk to a second issuer (called the reference issuer), and the return is linked to the credit performance of the reference issuer.

A CLN can be quite complicated, so we will focus on the basic structure only. The issuer of a CLN is the credit protection buyer; the investor in the CLN is the credit protection seller. The basic CLN is just like a standard bond: It has a coupon rate (fixed or floating), maturity date, and a maturity value. However, in contrast to a standard bond, the maturity value depends on the performance of the reference issuer. Specifically, if a credit event occurs with respect to the reference issuer, then (1) the bond is paid off, and (2) the maturity value is adjusted down. How the adjustment is made is described in the prospectus of a CLN offering. The compensation for the investor accepting the credit risk of the reference issuer is an enhanced coupon payment.

Typically, CLNs have a maturity of anywhere from three months to several years, with one to three years being the most likely term of credit exposure. The short maturity of CLNs reflects the desire of investors to take a credit view for such a time period.

CONCERNS WITH NEW CREDIT RISK TRANSFER VEHICLES[8]

As with any new complex financial product introduced by financial institutions, there are regulatory and supervisory concerns. The introduction of new credit risk transfer (CRT) vehicles, such as cash CDOs and credit derivatives that are employed to create synthetic CDOs, has elicited the same cautious response from overseers of the global banking system. As explained in this section, a good number of these concerns are the same as those identified for other derivatives such as interest rate and equity derivatives and securitized products, such as collateralized mortgage obligations.

Five studies have identified regulatory and supervisory concerns with CRT vehicles, such as credit derivatives and CDOs. The first is a study by the Financial Stability Forum of the Joint Forum (Joint Forum).[9] The Joint Forum consists of the Basel Committee on Banking Supervision, the International Organization of Securities Commissions, and the International Association of Insurance Supervisors. The second study was conducted by the European Central Bank (ECB),[10] which was a market survey based on interviews with more than 100 banks from 15 European Union banks, five large internationally active non-European Union banks, and securities houses operating in London. The last three studies are by rating agencies, two by Fitch Ratings[11] and one by Standard & Poor's.[12] From the five studies, the following four general issues were identified:

- clean risk transfer
- risk of failure of market participants to understand associated risk

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[7] For a more comprehensive discussion of CLNs, see Chapter 9 in Fabozzi, Davis, and Choudhry, *Introduction to Structured Finance*.

[8] This section draws from Douglas J. Lucas, Laurie S. Goodman, and Frank J. Fabozzi, "Collateralized Debt Obligations and Credit Risk Transfer," *Journal of Financial Transformation*, 20 (September 2007), pp. 47–59.

[9] Joint Forum, "Credit Risk Transfer," Bank for International Settlements, 2005.

[10] European Central Bank, "Credit Risk Transfer by ECU Banks: Activities, Risk and Risk Management," May 2004.

[11] Fitch Ratings, "Global Credit Derivatives: A Qualified Success," September 7, 2004; and "Global Credit Derivatives Survey: Single-Name CDS Fuel Growth," September 7, 2004.

[12] Standard & Poor's, "Demystifying Banks' Use of Credit Derivatives," December 2003.

- potentially high concentration of risk
  adverse selection

learly, these concerns have been realized as was painfully evident by the financial crisis in
008 due to bank positions in credit default swaps.

Clean Risk Transfer

As new vehicles for CRT have developed, increasing the market liquidity for corporate debt such as bonds and bank loans, the nature of the risks faced by market participants has changed in several ways. At one time, the focus of an investor in a corporate debt was on the ability of the corporation to meet its obligations. The issue with new CRTs is whether there is a "clean" transfer of credit risk.

The concerns with credit derivatives and, therefore, synthetic CDOs being used as CRT vehicles are threefold. First, there is a concern with counterparty risk—the failure of the counterparty selling credit protection would result in the buyer of credit protection maintaining the credit exposure that it thought it had eliminated. With respect to this concern, studies have noted that there are standard procedures available in risk management that can be employed to reduce counterparty risk. These risk management tools are equally applicable to over-the-counter derivatives used to manage interest rate and currency risk by regulated financial entities.

Second, while the development of standard documentation for credit derivative trades by the ISDA fostered the growth of that market, there remains a concern with legal risks that may arise from a transaction. Legal risk is the risk that a credit derivative contract will not be enforceable or legally binding on the counterparty to the trade or may contain ambiguous provisions that result in a failure of the contract to fulfill its intent. The most prominent example is what the credit derivatives market faced early in its life dealing with the issue of whether a credit event had occurred and, in particular, controversial credit events such as restructuring. The 2004 survey of financial institutions by Fitch investigated the frequency of disputed credit events and found that about 14% of the credit events captured in the survey were reported to involve some form of dispute. As for the resolution of those disputes, Fitch found that at the time the vast majority had been or were being resolved without the involvement of the court system. Another example of legal risk is whether the counterparty has the authority to enter into a credit derivative transaction. This is not unique to credit derivatives, but has been the subject of litigation in other derivative markets. For example, interest rates swaps between various dealers and local U.K. authorities were voided in 1991 because it was ruled the latter did not have the legal authority to enter into the contracts in the first place.

Risk of Failure of Market Participants to Understand Associated Risk

With the development of any market vehicle, there is the concern that market participants will not understand the associated risks. For example, there is evidence in the interest rate swap market of corporate entities allegedly failing to understand these risks, probably the most well-known legal cases being that of Gibson Greetings and Procter & Gamble. The same is true for collateralized mortgage obligations. Both of these instruments have been important

financial innovations, but there were users/investors who experienced financial difficulties/fiascos because product innovation may have run far ahead of product education.

In the case of a financial institution that seeks to make a market in the new CRT vehicles, there is a concern that in selling more complex products, such as synthetic CDOs, they may not be properly hedging their position and, therefore, are increasing the institution's risk. (While we have not discussed the pricing of synthetic CDOs, it fair to say that these instruments are not simple to price.) There is modeling risk. For example, in the case of a single-tranche CDO, the dealer will have an imbalanced position in credit defaults swaps and will try to hedge that position by delta hedging.[13] The risk, of course, is that the dealer has not hedged properly.

With respect to this issue, the recommendations of the report of the Joint Forum concentrated on the need for market participants to continue "improving risk management capabilities and for supervisors and regulators to continue improving their understanding of the associated issues." Given this focus, the report sets forth recommendations for market participants and supervisors in three areas: risk management, disclosure, and supervisory approaches, with particular emphasis on reporting and disclosure.

Potentially High Concentration of Risk

A CRT vehicle can result in either the transfer of the credit risk from one bank to another or from a bank to a nonbank entity. Within the banking system, the concern is whether there has become too much concentration of credit risk. For credit risk transferred out of the banking system, there is the concern with the extent to which credit risk is being transferred to nonbanks, such as monoline or multiline insurance companies and hedge funds. The overall concern is the impact on the financial system resulting from a failure of one or a few major participants in the CRT market.

The two studies by Fitch Rating reported the number of banks (North American and European) and insurance companies active in the CRT market and the relative size of each. In its 2003 market survey, Fitch surveyed about 200 financial institutions (banks, securities firms, and insurance companies), focusing on those it classified as protection sellers. Fitch found that through credit derivatives the global banking system transferred U.S. $229 billion of credit risk outside of the banking system. Most of this was to the insurance industry (monoline insurance companies/financial guarantors, reinsurance, and insurance companies). The insurance industry itself is the largest seller of credit protection. Fitch estimated that the insurance industry sold $381 billion of net credit protection (i.e., credit protection sold less credit protection purchased). Of that amount, insurance companies provided $303 billion in credit protection via the credit derivatives market and the balance, $78 billion in credit protection, by their participation in the cash CDO market. Within the insurance industry, the largest seller of credit protection is financial guarantors, insuring the senior tranches in synthetic CDO deals. Fitch concludes that bank buying of credit protection via credit derivatives "has significantly increased liquidity in the secondary credit market and allowed the efficient transfer of risk to other sectors that lack the ability to originate credit." There was a relatively high concentration of credit protection buying by large, more

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[13] See Douglas J, Lucas, Laurie S. Goodman, Frank J. Fabozzi, and Rebecca Manning, *Developments in the Collateralized Debt Obligations Markets: New Products and Insights* (Hoboken, NJ: John Wiley & Sons, 2007).

sophisticated banks. Smaller and regional banks were net sellers of credit protection despite banks being net buyers of credit protection in the aggregate.

With respect to counterparty concentration, Fitch reported that the market is concentrated among the top 10 global banks and broker-dealers. While having investment-grade ratings, the risk is that the withdrawal of one or more of these firms from the market for financial or strategic reasons could undermine the confidence in the CRT market. This was one of the major concerns of the Federal Reserve in early 2008 in justifying the bailout of the investment banking firm Bear Stearns.

In its 2003 survey, Fitch attempted to collect information on hedge fund activities by writing to the 50 largest hedge funds in the world. None responded. In its 2004 survey, Fitch included questions for the major intermediaries as to their dealings with hedge funds. Fitch found that hedge funds represented between 20% and 30% of credit default swap index trading. Ultimately, counterparty risk exposure to hedge funds depends on the extent of the collateralization of the trades. While most of the intermediaries in the survey responded that their positions with hedge funds were fully collateralized, some stated that it was less than 100% collateralized.

Fitch also found that there is high concentration in the corporations that are the reference obligations in credit default swaps. Settlement problems could occur if there is a credit event for one of these reference entities, leading to a major market disruption. Moreover, because of the higher correlation of default that exists for counterparties and corporate references in the CRT market, in comparison to other derivative markets, there is a concern with the market facing multiple defaults.

Adverse Selection

The ability of originators to transfer credit risk via credit derivatives, CDOs, or securitization has raised concerns that a lending culture based on origination volume rather than prudent lending practices may be inadvertently adopted by banks. This is a concern about securitization in general.

SUMMARY

Interest-rate derivatives can be used to control interest rate risk with respect to changes in the level of interest rates. Credit derivatives can be used to alter the credit risk exposure of a balance sheet, an individual security, or a portfolio. The ISDA has standardized documentation for credit derivative contracts, and the documents define potential credit events. The most controversial credit event is restructuring.

The two most recent introductions into the credit risk transfer market that have made it possible to transfer large amounts of corporate credit risk exposure among banks as well as from the financial sector to the nonfinancial sector are credit derivatives and CDOs. By far, the most dominant type of credit derivative is the credit default swap, wherein the protection buyer makes a payment of the swap premium to the protection seller; however, the protection buyer receives a payment from the protection seller only if a credit event occurs. There are single-name credit default swaps, basket credit default swaps, and credit default swap indexes.

A CDO is a security backed by a diversified pool of one or more debt obligations. A CDO in which the collateral assets are bond-type instruments is called a CBO. A CLO is a CDO where the collateral assets are bank loans. A collateral manager is responsible for

managing the collateral subject to restrictions imposed regarding the composition of the collateral. The funds to purchase the collateral assets come from the issuance of debt obligations. These debt obligations include senior tranches, mezzanine tranches, and a subordinate/equity tranche. The ability of the collateral manager to make the interest payments to the tranches and pay off the tranches as they mature depends on the performance of the collateral.

CDOs are categorized as either arbitrage transactions or balance sheet transactions. The categorization depends on the motivation of the sponsor of the transaction. In an arbitrage transaction, the sponsor seeks to earn the spread between the yield offered on the collateral assets and the payments made to the various tranches in the structure. In a balance sheet transaction, the sponsor's motivation is to remove debt instruments from its balance sheet. Interest-rate swaps are often used in CDO structures due to the mismatch between the characteristics of the collateral cash flow and some of the liabilities.

One variety of the CDO is the synthetic CDO, in which credit risk exposure is transferred via credit default swaps rather than the transfer of ownership of corporate debt obligations. A credit-linked note is a credit derivative that is in the form of a bond.

There are concerns raised by regulators regarding CDOs and credit default swaps, some of these being the usual concerns with the introduction of any new financial innovation.

KEY TERMS

- Arbitrage transaction
- Balance sheet transaction
- Bankruptcy
- Basket credit default swap
- Cash CDO
- Cash flow transaction
- Cash settlement
- Collateralized bond obligation (CBO)
- Collateralized debt obligation (CDO)
- Collateralized loan obligation (CLO)
- Collateral manager
- Credit default swap
- Credit default swap index
- Credit derivative
- Credit event
- Credit-linked note (CLN)
- Deliverable obligations
- Failure to pay
- First-to-default basket swap
- Full (old) restructuring
- International Swap and Derivatives Association (ISDA)
- ISDA Documentation
- *k*-to-default basket swap
- Market value transaction
- Modified restructuring
- Modified modified restructuring
- No restructuring
- Obligation acceleration
- Physical settlement
- Reference entity (reference issuer)
- Reference obligation (reference asset)
- Repudiation/moratorium
- Restructuring
- Second-to-default basket swap
- Structured credit products
- Single-name credit default swap
- Structured finance operating company (SFOC)
- Structured investment vehicle (SIV)
- Swap premium
- Synthetic CDO
- Termination value

QUESTIONS

1. What is the primary purpose of a credit derivative?
2. In a credit default swap, what is meant by
   a. a reference entity?
   b. a reference obligation?
3. What authoritative source is used for defining a "credit event"?
4. Why is "restructuring" the most controversial credit event?
5. Why may a bank be reluctant to sell a commercial loan that it has originated?
6. a. What is a basket default swap?
   b. When does the protection seller have to make a payment to the protection buyer in a basket default swap?
7. For a credit default swap with the following terms, calculate the quarterly premium payment.

	Swap Premium	Notional Amount	Days in Quarter
a.	600 bps	$15,000,000	90
b.	450 bps	$ 8,000,000	91
c.	720 bps	$15,000,000	92

8. All other factors constant, for a given reference obligation and a given scheduled term, explain whether a credit default swap using full or old restructuring or modified restructuring would be more expensive.
9. a. For a single-name credit default swap, what is the difference between physical settlement and cash settlement?
   b. In physical settlement, why is there a cheapest-to-deliver issue?
10. How do the cash flows for a credit default swap index differ from that of a single-name credit default swap?
11. a. Explain how a single-name credit default swap can be used by a portfolio manager who wants to short a reference entity.
    b. Explain how a single-name credit default swap can be used by a portfolio manager who is having difficulty acquiring the bonds of a particular corporation in the cash market.
12. How are credit default swap indexes used by portfolio managers?
13. What is a CLO?
14. What is meant by a balance sheet transaction CDO?
15. Why is the subordinate/equity tranche of a CDO not rated?
16. What are the sources of funds that are used in a CDO to pay bondholders?
17. Consider the following basic $150 million CDO structure with the coupon rate to be offered at the time of issuance as shown:

Tranche	Par Value	Coupon Rate
Senior	$100,000,000	LIBOR + 50 basis points
Mezzanine	$ 30,000,000	Treasury rate + 200 basis points
Subordinated/ equity	$ 20,000,000	None

Assume the following:

- The collateral consists of bonds that all mature in 10 years.
- The coupon rate for every bond is the 10-year Treasury rate plus 300 basis points.
- The collateral manager enters into an interest rate swap agreement with another party with a notional amount of $100 million.
- In the interest rate swap the collateral manager agrees to pay a fixed rate each year equal to the 10-year Treasury rate plus 100 basis points and receive LIBOR.

   a. Why is an interest rate swap needed?
   b. What is the potential return for the subordinate/equity tranche, assuming no defaults?
   c. Why will the actual return be less than the return computed?

18. a. How does a cash CDO differ from a synthetic CDO?

b. What is the advantage of a synthetic CDO over a cash CDO for a bank that wants to use this structure for balance sheet management?

19. a. What is the objective of a structured finance operating company?
    b. What is the most common type of structured finance operating company?

20. In a basic credit-linked note, how does the maturity value differ compared to a standard bond structure?

21. What are the four major concerns that have been identified with new credit risk transfer vehicles?

The Market for Foreign Exchange and Risk Control Instruments

hapter 32 of *Foundations of Financial Markets and Institutions*, 4/e. Frank J. Fabozzi. Franco Modigliani. Frank J. Jones.
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The Market for Foreign Exchange and Risk Control Instruments

LEARNING OBJECTIVES

After reading this chapter, you will understand

- what is meant by a foreign-exchange rate
- the different ways that a foreign-exchange rate can be quoted (direct versus indirect)
- the conventions for quoting foreign-exchange rates
- what foreign-exchange risk is
- a cross rate and how to calculate a theoretical cross rate
- what triangular arbitrage is
- the foreign-exchange market structure
- the fundamental determinants of exchange rates: purchasing power parity and interest rate parity
- the different instruments for hedging foreign-exchange risk: forwards, futures, options, and swaps
- the limitations of forward and futures contracts for hedging long-dated foreign-exchange risk
- how a forward exchange rate is determined and what covered interest arbitrage is
- the basic currency swap structure and the motivation for using currency swaps

The fundamental fact of international finance is that different countries issue different currencies, and the relative values of those currencies may change quickly, substantially, and without warning. The change, moreover, may either reflect economic developments or be a response to political events that make no economic sense. As a result, the risk

that a currency's value may change adversely, which is called **foreign-exchange risk** or **currency risk**, is an important consideration for all participants in the international financial markets. Investors who purchase securities denominated in a currency different from their own must worry about the return from those securities after adjusting for changes in the exchange rate. Firms that issue obligations denominated in a foreign currency face the risk that the value of the cash payments they owe to investors is uncertain. The same is true if a firm is receiving a payment in a foreign currency from a customer.

In this chapter, we provide a review of exchange rates and the instruments that can be used to control the risk of an adverse movement in a foreign currency. These instruments include forward contracts, futures contracts, options, and currency swaps. We begin our discussion with a review of the euro.

THE EURO

The European Union consists of European member countries that engage in European economic and political activities. In February 1992, the Treaty on European Union of 1992 established that monetary union would take place by January 1999. The treaty, also called the Maastricht Treaty because its terms were agreed to at the European Council meeting in Maastricht (Netherlands) in December 1991, called for a single currency and monetary policy for member countries in Europe. Monetary policy was to be administered by the European Central Bank. The Economic and Monetary Union (EMU) represents the member countries that are part of the European Union that have adopted the single currency and monetary policy.

At the time of the treaty, the single currency was to be the **economic currency unit (ECU)**. It was the most widely used composite currency unit for capital market transactions. It was created in 1979 by the European Economic Community (EEC). The currencies included in the ECU were those of members of the European Monetary System (EMS). The weight of each country's currency was figured according to the relative importance of a country's economic trade and financial sector within the EEC. Exchange rates between the ECU and those countries not part of the EEC float freely. The exchange rate between countries in the EEC, however, may fluctuate only within a narrow range.

However, at a meeting of the heads of government in Madrid in December 1995, it was agreed that the name of the single currency would be called the **euro**. The reason that the ECU was not selected as the single currency was due to the opinion of Germans that the ECU was perceived to be a weak currency. The countries of the European Union electing to be members of the EMU are subject to a fixed conversion rate against their national currencies and relative to the euro. However, the value of the euro against all other currencies, including member states of the European Union that did not elect to join the EMU, fluctuates according to market conditions.

Members of the EMU are said to be part of "euroland" or the "euro zone" because the euro became the only legal currency. Initially, the member countries maintained their own physical currencies, although they were fixed in value relative to the euro, and the euro had no physical existence. The actual euro currency physically replaced the individual currencies of the participating countries on January 1, 2002. At that time, the relevant authorities of each member country began to withdraw their old national currency from circulation.

To qualify as a participating country in the EMU requires that a country satisfy certain economic standards. These standards set forth for fiscal policy were that the annual fiscal deficit could be no more than 3% of the gross disposable product (GDP), and total outstanding government indebtedness could be no more than 60% of GDP. Many other economic, political, and even social requirements for entry apply. Moreover, a provision of the treaty mandated that the voters of a country seeking membership had to approve the joining of the EMU by popular referendum. These objectives were also, more or less, achieved, and on January 4, 1999 (a Monday, the first business day of the year), 11 countries adopted the single currency, the euro. Other countries subsequently adopted the euro. The central banks of the 11 participating countries were discontinued and replaced by the European Central Bank.

The birth of the euro on January 4, 1999, was smooth and uneventful in terms of both market volatility and operations. Several notable outcomes resulted from this event. First, despite many skeptics, it worked; it proved viable and fairly stable. Second, it gave birth to a large public and corporate capital market denominated in the euro. With respect to the capital market, the governments of all the participating countries issue their government debt denominated in euros. Thus, the differences in the rate on the government debt are based only on differences in credit risk—because differences in currency risk were eliminated—and are quite small.

On the corporate side, the primary issuance of corporate debt denominated in the euro has become large and liquid. Both European and U.S. investment banks play significant roles in these fundings. The secondary markets in these issues have also become quite liquid.

FOREIGN-EXCHANGE RATES

An **exchange rate** is defined as the amount of one currency that can be exchanged for a unit of another currency. In fact, the exchange rate is the price of one currency in terms of another currency. And, depending on circumstances, one could define either currency as the price for the other. So exchange rates can be quoted "in either direction." For example, the exchange rate between the U.S. dollar and the euro could be quoted in one of two ways:

1. the amount of U.S. dollars necessary to acquire one euro, and this is the dollar price of one euro
2. the number of euros necessary to acquire one U.S. dollar, or the euro price of one dollar

Abbreviations are used for every currency throughout the world. Table 1 provides a list of selected currencies and their abbreviations. The three currency pairs that are most commonly traded are

- Euro against U.S. dollar (EUR/USD)
- U.S. dollar against Japanese yen (USD/JPY)
- British pound against U.S. dollar (GBP/USD)

The most traded currency pair is EUR/USD, which has captured about 30% of the global turnover. The USD/JPY and GBP/USD represent about 20% and 11%, respectively.[1]

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[1] See Shani Shamah, "An Introduction to Spot Foreign Exchange," in Frank J. Fabozzi (ed.), *The Handbook of Finance: Volume I* (Hoboken, NJ: John Wiley & Sons, 2008).

Country	Currency	Abbreviation
Argentina	Pesos	ARS
Australia	Dollars	AUD
Bolivia	Bolivianos	BOB
Brazil	Real	BRL
Bulgaria	Leva	BGN
Canada	Dollars	CAD
Chile	Pesos	CLP
China	Yuan Renminbi	CNY
Colombia	Pesos	COP
Cyprus	Euro	EUR
Czech Republic	Koruny	CZK
Denmark	Kroner	DKK
Egypt	Pounds	EGP
El Salvador	Colones	SVC
Euro Member Countries	Euro	EUR
Hong Kong	Dollars	HKD
Iceland	Kronur	ISK
India	Rupees	INR
Indonesia	Rupiahs	IDR
Iran	Rials	IRR
Iraq	Dinars	IQD
Israel	New Shekels	ILS
Japan	Yen	JPY
Korea (North)	Won	KPW
Korea (South)	Won	KRW
Kuwait	Dinars	KWD
Latvia	Lati	LVL
Lebanon	Pounds	LBP
Malaysia	Ringgits	MYR
Mexico	Pesos	MXN
New Zealand	Dollars	NZD
Norway	Kroner	NOK
Pakistan	Rupees	PKR
Russia	Rubles	RUB
Switzerland	Francs	CHF
Thailand	Baht	THB
Turkey	New Lira	TRY
United Arab Emirates	Dirhams	AED
United Kingdom	Pounds	GBP
United States of America	Dollars	USD

Exchange Rate Quotation Conventions

Exchange rate quotations may be either *direct* or *indirect*. The difference depends on identifying one currency as a local currency and the other as a foreign currency. For example, from the perspective of a U.S. participant, the local currency would be U.S. dollars, and any other currency, such as Swiss francs, would be the foreign currency. From the perspective of a Swiss participant, the local currency would be Swiss francs, and other currencies, such as U.S. dollars, the foreign currency. A **direct quote** is the number of units of a local currency exchangeable for one unit of a foreign currency.

An **indirect quote** is the number of units of a foreign currency that can be exchanged for one unit of a local currency. Looking at it from a U.S. participant's perspective, we see that a quote indicating the number of dollars exchangeable for one unit of a foreign currency is a direct quote. An indirect quote from the same participant's perspective would be the number of units of the foreign currency that can be exchanged for one U.S. dollar. Obviously, from the point of view of a non–U.S. participant, the number of U.S. dollars exchangeable for one unit of a non–U.S. currency is an indirect quote; the number of units of a non–U.S. currency exchangeable for a U.S. dollar is a direct quote.

Given a direct quote, we can obtain an indirect quote (which is simply the reciprocal of the direct quote), and vice versa. For example, on November 21, 2007, a U.S. investor is given a direct quote of 1.4724 U.S. dollars for one euro. That is, the price of a euro is $1.4724. The reciprocal of the direct quote is 0.6792, which would be the indirect quote for the U.S. investor; that is, one U.S. dollar can be exchanged for 0.6792 euros, which is the euro price of a U.S. dollar.

If the number of units of a foreign currency that can be obtained for one dollar—the price of a dollar in that currency or indirect quotation—rises, the dollar is said to appreciate relative to the currency, and the currency is said to depreciate. Thus, appreciation means a decline in the direct quotation.

Foreign-Exchange Risk

From the perspective of a U.S. investor, the cash flows of assets denominated in a foreign currency expose the investor to uncertainty as to the actual level of the cash flow measured in U.S. dollars. The actual number of U.S. dollars that the investor eventually gets depends on the exchange rate between the U.S. dollar and the foreign currency at the time the nondollar cash flow is received and exchanged for U.S. dollars. If the foreign currency depreciates (declines in value) relative to the U.S. dollar (that is, the U.S. dollar appreciates), the dollar value of the cash flows will be proportionately less, leading to foreign exchange risk.

An investor who purchases an asset denominated in a currency that is not the medium of exchange in the investor's country faces foreign-exchange risk. For example, a French investor who acquires a yen-denominated Japanese bond is exposed to the risk that the Japanese yen will decline in value relative to the euro.

Foreign-exchange risk is a consideration for the issuer, too. Suppose that IBM issues bonds denominated in euros. IBM's foreign-exchange risk is that, at the time the coupon interest payments must be made and the principal repaid, the U.S. dollar will have depreciated relative to the euro, requiring that IBM pay more dollars to satisfy its obligation.

SPOT MARKET

The **spot exchange rate market** is the market for settlement of a foreign-exchange transaction within two business days. (The spot exchange rate is also known as the **cash exchange rate**.) Since the early 1970s, exchange rates among major currencies have been free to float, with market forces determining the relative value of a currency.[2] Thus, each day a currency's price relative to that of another freely floating currency may stay the same, increase, or decrease.

A key factor affecting the expectation of changes in a country's exchange rate with another currency is the relative expected inflation rate of the two countries. Spot exchange rates adjust to compensate for the relative inflation rate. This adjustment reflects the so-called **purchasing power parity** relationship, which posits that the exchange rate—the domestic price of the foreign currency—is proportional to the domestic inflation rate, and inversely proportional to foreign inflation.

Let's look at what happens when the spot exchange rate changes between two currencies. Suppose that on day 1 the spot exchange rate between the U.S. dollar and country X is $0.7966 and on the next day, day 2, it changes to $0.8011. Consequently, on day 1, one currency unit of country X costs $0.7966. On day 2, it costs more U.S. dollars, $0.8011, to buy one currency unit of country X. Thus, the currency unit of country X *appreciated* relative to the U.S. dollar from day 1 to day 2, or, what amounts to the same thing, the U.S. dollar *depreciated* relative to the currency of country X from day 1 to day 2. Suppose further that on day 3 the spot exchange rate for one currency unit of country X is $0.8000. Relative to day 2, the U.S. dollar appreciated relative to the currency of country X or, equivalently, the currency of country X depreciated relative to the U.S. dollar.

Although quotes can be either direct or indirect, the problem is defining from whose perspective the quote is given. Foreign exchange conventions in fact standardize the ways quotes are given. Because of the importance of the U.S. dollar in the international financial system, currency quotations are all relative to the U.S. dollar. When dealers quote, they either give U.S. dollars per unit of foreign currency (a direct quote from the U.S. perspective) or the number of units of the foreign currency per U.S. dollar (an indirect quote from the U.S. perspective). Quoting in terms of U.S. dollars per unit of foreign currency is called **American terms**, while quoting in terms of the number of units of the foreign currency per U.S. dollar is called **European terms**. The dealer convention is to use European terms in quoting foreign exchange with a few exceptions. The British pound, the Irish pound, the Australian dollar, the New Zealand dollar, and the euro are exceptions that are quoted in American terms.

Cross Rates

Barring any government restrictio e
between two countries will be th e
rate between two countries other than the United States can be inferred from their

[2] In practice, national monetary authorities can intervene in the foreign market for their currency for a variety of economic reasons, so the current foreign-exchange system is sometimes referred to as a "managed" floating-rate system.

exchange rates with the U.S. dollar. Rates computed in this way are referred to as **theoretical cross rates.** They would be computed as follows for two countries, X and Y:

$$\frac{\text{Quote in American terms of currency X}}{\text{Quote in American terms of currency Y}}$$

To illustrate, let's calculate the theoretical cross rate between the Swiss franc and Japanese yen on November 21, 2007. The spot exchange rate for the two currencies in American terms was $0.8990 per Swiss franc and $0.009089 per Japanese yen. Then, the number of units of yen (currency Y) per unit of Swiss franc (currency X) is

$$\frac{\$0.8990}{\$0.009089} = 99.0098 \text{ yen per Swiss franc}$$

Taking the reciprocal gives the number of Swiss francs exchangeable for one Japanese yen. In our example, it is 0.0101.

In the real world, it is rare that the theoretical cross rate, as computed from actual dealer dollar exchange rate quotes, will differ from the actual cross rate quoted by dealers. When the discrepancy is large by comparison with the transactions costs of buying and selling the currencies, a riskless arbitrage opportunity arises. Arbitraging to take advantage of cross-rate mispricing is called **triangular arbitrage,** so named because it involves positions in three currencies—the U.S. dollar and the two foreign currencies. The arbitrage keeps actual cross rates in line with theoretical cross rates.

Dealers

The foreign-exchange market is an over-the-counter market that operates 24 hours a day. This means that market participants who want to buy or sell a currency must search different dealers to get the best exchange rate on a specific currency. Alternatively, market participants who want to transact can refer to various widely available bank/broker screens such as Bloomberg Financial Markets and Reuters. The prices cited on those screens are for indicative pricing only.

Foreign-exchange dealers, however, do not quote one price. Instead, they quote an exchange rate at which they are willing to buy a foreign currency and one at which they are willing to sell a foreign currency. That is, they quote a bid–ask spread. For example, on November 21, 2007, the bid–ask spread for the U.S. dollar in terms of Swiss francs was 1.1027 bid and 1.1029 ask. What this means is that one could exchange 1 U.S. dollar for 1.1027 Swiss francs or pay 1.1029 Swiss francs and receive 1 U.S. dollar. The bid–ask spread is 0.0002 in terms of Swiss francs.

Dealers in the foreign-exchange market are large international banks and other financial institutions that specialize in making markets in foreign exchange. Commercial banks dominate the market. There is no organized exchange where foreign currency is traded, but dealers are linked by telephone and cable, and by various information transfer services. Consequently, the foreign exchange market can best be described as an interbank over-the-counter market. Most transactions between banks are done through foreign-exchange brokers. Brokers are agents that do not take a position in the foreign currencies involved in the transaction. The normal size of a transaction is $1 million or more.

Dealers in the foreign exchange market realize revenue from one or more sources: (1) the bid–ask spread, (2) commissions charged on foreign exchange transactions, and (3) trading

profits (appreciation of the currencies that dealers hold a long position in, depreciation of the currencies that they hold a long position in, or appreciation of the currencies that they have a short position in).

INSTRUMENTS FOR HEDGING FOREIGN-EXCHANGE RISK

Four instruments are available to borrowers and investors to protect against adverse foreign-exchange rate movements: (1) currency forward contracts, (2) currency futures contracts, (3) currency options, and (4) currency swaps.

Currency Forward Contracts

Recall that in a forward contract one party agrees to buy the underlying, and another party agrees to sell that same underlying, for a specific price at a designated date in the future. Here we consider forward contracts in which the underlying is foreign exchange.

Most forward contracts have a maturity of less than two years. Longer-dated forward contracts have relatively large bid–ask spreads; that is, the size of the bid–ask spread for a given currency increases with the maturity of the contract. Consequently, forward contracts are not attractive for hedging long-dated foreign currency exposure.

Both forward and futures contracts can be used to lock in a certain price, which in this case would be the foreign-exchange rate. By locking in a rate and eliminating downside risk, the user forgoes the opportunity to benefit from any advantageous foreign-exchange rate movement. Futures contracts, which are creations of an exchange, have certain advantages over forward contracts in many cases, such as stock indexes and Treasury securities. For foreign exchange, by contrast, the forward market is the market of choice, and trading there is much larger than trading on exchanges. However, because the foreign-exchange forward market is an interbank market, reliable information on the amount of contracts outstanding at any time, or open interest, is not publicly available.

Pricing Currency Forward Contracts

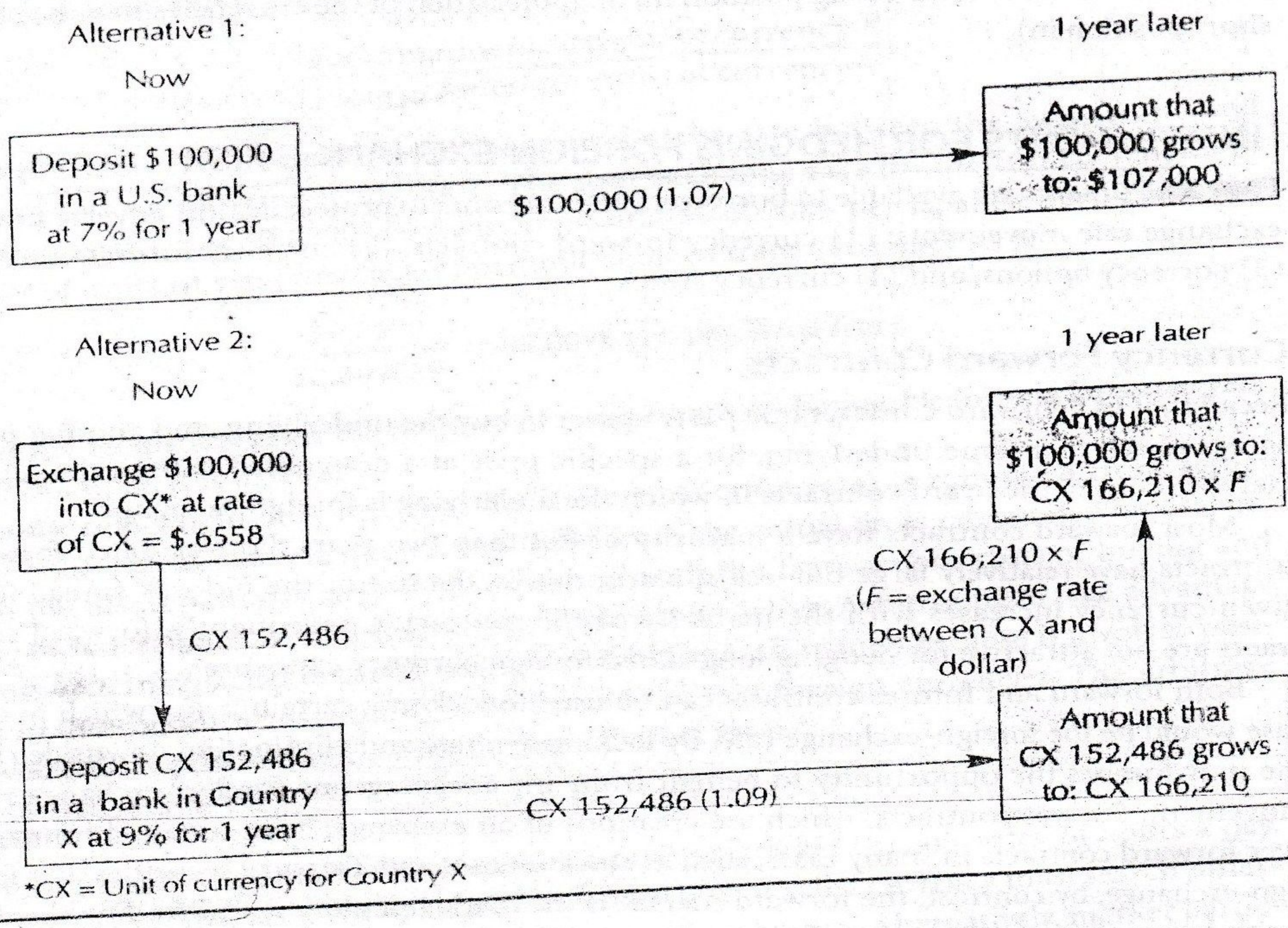
There is a relationship between spot prices and forward prices, and arbitrage ensures that the relationship holds. We now apply similar considerations to the pricing of foreign-exchange futures contracts on the basis of the spot exchange rate, using an extended example.

Consider a U.S. investor with a one-year investment horizon who has two choices:

Alternative 1: Deposit $100,000 in a U.S. bank that pays 7% compounded annually for one year.
Alternative 2: Deposit in a bank in country X the U.S. dollar equivalent of $100,000 in country X's currency that pays 9% compounded annually for one year.

The two alternatives and their outcomes one year from now are depicted in Figure 1. Which is the better alternative? It will be the alternative that produces the most U.S. dollars one year from now. Ignoring U.S. and country X taxes on interest income or any other taxes, we need to know two things in order to determine the better alternative: (1) the spot exchange rate between U.S. dollars and country X's currency, and (2) the spot exchange rate one year from now between U.S. dollars and country X's currency. The former is known; the latter is not.

Figure 1 Outcome of Two Alternatives: Determination of Theoretical Forward Rate



We can determine, however, the spot rate one year from now between U.S. dollars and country X's currency that will make the investor indifferent between the two alternatives.

Alternative 1: The amount of U.S. dollars available one year from now would be $107,000 ($100,000 times 1.07).

Alternative 2: Assume that the spot rate is $0.6558 for one unit of country X's currency at this time. We denote country X's currency as CX. Then, ignoring commissions, $100,000 can be exchanged for CX152,486 ($100,000 divided by 0.6558). The amount of country X's currency available at the end of 1 year would be CX166,210 (CX152,476 times 1.09).

The number of U.S. dollars for which the CX166,210 can be exchanged depends on the exchange rate one year from now. Let F denote the exchange rate between these two currencies one year from now. Specifically, F denotes the number of U.S. dollars that can be exchanged for one CX. Thus, the number of U.S. dollars at the end of one year from the second alternative is

$$\text{Amount of U.S. dollars one year from now} = \text{CX166,210} \times F$$

The investor will be indifferent between the two alternatives if the number of U.S. dollars is $107,000:

$$\$107{,}000 = \text{CX166,210} \times F$$

Solving, we find that F is equal to \$0.6438. Thus, if one year from now the spot exchange rate is \$0.6438 for one unit of country X's currency, then the two alternatives will produce the same number of U.S. dollars. If more than \$0.6438 can be exchanged for one unit of country X's currency, then the investor receives more than \$107,000 at the end of one year. An exchange rate of \$0.6500 for one unit of country X's currency, for example, would produce \$108,037 (CX166,210 times \$0.6500). The opposite is true if less than \$0.6438 can be exchanged for one unit of country X's currency. For example, if the future exchange rate is \$0.6400, the investor receives \$106,374 (CX166,210 times \$0.6400).

Let us now look at this situation from the perspective of an investor in country X. Suppose that an investor in country X with a one-year investment horizon has two alternatives:

Alternative 1: Deposit CX152,486 in a bank in country X that pays 9% compounded annually for one year.
Alternative 2: Deposit the equivalent of CX152,486 in U.S. dollars in a U.S. bank that pays 7% compounded annually for one year.

Once again, assume that the spot exchange rate is \$0.6558 for one unit of country X's currency. The investor in country X will select the alternative that generates the most CX at the end of one year. The first alternative would generate CX166,210 (CX152,486 times 1.09). The second alternative requires that CX be exchanged for U.S. dollars at the spot exchange rate at this time. Given the spot exchange rate assumed, CX152,486 can be exchanged for \$100,000 (CX152,486 multiplied by \$0.6558). At the end of one year, the second alternative would generate \$107,000 (\$100,000 times 1.07). Letting F continue to denote the number of U.S. dollars in country X, following alternative 2 will realize the following amount of country X's currency one year from now:

$$\text{Amount of country X's currency one year from now} = \$107{,}000/F$$

The investor will be indifferent between the two alternatives if

$$\$107{,}000/F = \text{CX}166{,}210$$

The equation yields a value for F of \$0.6438, the same exchange rate that we found when we sought the exchange rate one year from now that would make the U.S. investor indifferent between the two alternatives facing that investor.

Now suppose that a dealer quotes a one-year forward exchange rate between the two currencies. The one-year forward exchange rate fixes today the exchange rate one year from now. Thus, if the one-year forward exchange rate quoted is \$0.6438 for one unit of country X's currency, investing in the bank in country X will provide no arbitrage opportunity for the U.S. investor. If the one-year forward rate quoted is more than \$0.6438 for one unit of country X's currency, the U.S. investor can arbitrage the situation by selling country X's currency forward (and buying U.S. dollars forward for CX).

To see how this arbitrage opportunity can be exploited, suppose that the one-year forward exchange rate is \$0.6500 for one unit of country X's currency. Also, assume that the borrowing and the lending rates within each currency's country are the same. Suppose that the U.S. investor borrows \$100,000 for one year at 7% compounded annually and enters into a forward contract agreeing to deliver CX166,210 at \$0.6500 per CX one year from now. That is, one year from now the investor is agreeing to deliver CX166,210 in exchange for \$108,037 (CX166,210 multiplied by \$0.6500).

The $100,000 that was borrowed can be exchanged for CX152,486 at the spot rate of $0.6558 to one unit of country X's currency, which can be invested in country X at 9%. One year from now, the U.S. investor will have CX166,210 from the investment in country X, which can be delivered against the forward contract. The U.S. investor will receive $108,037 and repay $107,000 to satisfy the bank loan, netting $1,037. Assuming that the counterparty to the forward contract does not default, this riskless arbitrage situation results in a $1,037 profit generated with no initial investment.[3] This riskless profit will prompt many arbitrageurs to follow this strategy and will, obviously, result in the U.S. dollar rising relative to country X's currency in the forward exchange rate market, or possibly some other adjustment.[4]

On the other hand, if the one-year forward exchange rate quoted is less than $0.6438, an investor in country X can arbitrage the situation by buying CX forward (and by selling U.S. dollars forward). This riskless arbitrage again leads arbitrageurs to act, with the result that the forward exchange rate of U.S. dollars relative to CX falls.[5] The conclusion of this argument is that the 1-year forward exchange rate must be $0.6438, because any other forward exchange rate would result in an arbitrage opportunity for either the U.S. investor or the investor in country X.

Thus, the spot exchange rate and the interest rates in two countries determine the forward exchange rate of their currencies. The relationship among the spot exchange rate, the interest rates in two countries, and the forward rate is called **interest rate parity**. The parity relationship implies that an investor, by hedging in the forward exchange rate market, realizes the same sure domestic return whether investing domestically or in a foreign country. The arbitrage process that forces interest rate parity is called **covered interest arbitrage**.

Mathematically, interest rate parity between the currencies of two countries, *A* and *B*, can be expressed in this way:

Let

I = amount of A's currency to be invested for a time period of length t
S = spot exchange rate: price of foreign currency in terms of domestic currency (units of domestic currency per unit of foreign currency)
F = t-period forward rate: price of foreign currency t periods from now
i_A = interest rate on an investment maturing at time t in country A
i_B = interest rate on an investment maturing at time t in country B

Then

$$I(1 + i_A) = (I/S)(1 + i_B)F$$

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[3] An investor in country X could also arbitrage this situation.

[4] Actually, a combination of things may occur when U.S. investors attempt to exploit this situation: (1) The spot exchange rate of U.S. dollars relative to country X's currency will fall as U.S. investors sell dollars and buy CX, (2) U.S. interest rates will rise in the United States as investors borrow in the United States and invest in country X, (3) country X interest rates will fall as more is invested in country X, and (4) the one-year forward rate of U.S. dollars relative to CX will fall. In practice, the last will dominate.

[5] A combination of things may occur when country X investors attempt to exploit this situation: (1) The spot exchange rate of U.S. dollars relative to CX will rise as country X investors buy dollars and sell CX, (2) country X interest rates will fall as more is invested in the United States, and (3) the one-year forward rate of U.S. dollars relative to CX will rise. In practice, the last will dominate.

To illustrate, let country A be the United States and country B represent country X. In our example, we have:

I = \$100,000 for one year
S = \$0.6558
F = \$0.6438
i_A = 0.07
i_B = 0.09

Then, according to interest rate parity, this relationship holds:

$$\$100{,}000(1.07) = (\$100{,}000/\$0.6558)(1.09)(\$0.6438)$$
$$\$107{,}000 = \$107{,}005$$

The \$5 difference is due to rounding.

Interest rate parity can also be expressed as

$$(1 + i_A) = (F/S)(1 + i_B)$$

Rewriting the equation, we obtain the theoretical forward rate implied by the interest rates and spot exchange rate:

$$F = S\left(\frac{1 + i_A}{1 + i_B}\right)$$

Although we referred so far to investors, we could use borrowers as well to illustrate interest rate parity. A borrower has the choice of obtaining funds in a domestic or foreign market. Interest rate parity provides that a borrower who hedges in the forward exchange rate market realizes the same domestic borrowing rate whether borrowing domestically or in a foreign country.

To derive the theoretical forward exchange rate using the arbitrage argument, we made several assumptions. When the assumptions are violated, the actual forward exchange rate may deviate from the theoretical forward exchange rate. First, in deriving the theoretical forward exchange rate, we assumed the investor faced no commissions or bid–ask spread when exchanging in the spot market today and at the end of the investment horizon. In practice, investors incur such costs, which cause the actual forward exchange rate to be plus or minus a small amount of the theoretical rate.

Second, we assumed that the borrowing and lending rates in each currency are the same. Dropping this unrealistic assumption eliminates the possibility of a single theoretical forward exchange rate, and instead implies a band around a level reflecting borrowing and lending rates. The actual rate should be within this band.

Third, we ignored taxes. In fact, the divergence between actual and theoretical forward exchange rates can be the result of the different tax structures of the two countries. Finally, we assumed that arbitrageurs could borrow and invest in another country as much as they wanted in order to exploit mispricing in the exchange market. It should be noted, however, that any restrictions on foreign investing or borrowing in each country impede arbitrage and may cause a divergence between actual and theoretical forward exchange rates.

Link between Eurocurrency Market and Forward Prices

In deriving interest rate parity, we looked at the interest rates in both countries. In fact, market participants in most countries look to one interest rate in order to perform covered interest arbitrage, and that is the interest rate in the Eurocurrency market. The **Eurocurrency market** is the name of the unregulated and informal market for bank deposits and bank loans denominated in a currency other than that of the country where the bank initiating the transaction is located. Examples of transactions in the Eurocurrency market are a British bank in London that lends U.S. dollars to a French corporation, and a Japanese corporation that deposits Swiss francs in a German bank. An investor seeking covered interest arbitrage will accomplish it with short-term borrowing and lending in the Eurocurrency market.

The largest sector of the Eurocurrency market involves bank deposits and bank loans in U.S. dollars and is called the Eurodollar market. The seed for the Eurocurrency market was, in fact, the Eurodollar market. As international capital market transactions increased, the market for bank deposits and bank loans in other currencies developed.

Currency Futures Contracts

Foreign-exchange futures contracts for the major currencies are traded on the International Monetary Market (IMM), a division of the Chicago Mercantile Exchange. The futures contracts traded on the IMM are for the euro, the Canadian dollar, the British pound, the Swiss franc, Japanese yen, and the Australian dollar. The amount of each foreign currency that must be delivered for a contract varies by currency. For example, the British pound futures contract calls for delivery of 62,500 pounds, while the Japanese yen futures contract is for delivery of 12.5 million yen. The maturity cycle for currency futures is March, June, September, and December. The longest maturity is one year. Consequently, as in the case of a currency forward contract, currency futures do not provide a good vehicle for hedging long-dated foreign-exchange risk exposure.

Other exchanges trading currency futures in the United States are the Midamerica Commodity Exchange (a subsidiary of the Chicago Board of Trade) and the Financial Instrument Exchange (a subsidiary of the New York Cotton Exchange). The latter trades a futures contract in which the underlying is a U.S. dollar index. Outside the United States, currency futures are traded on the London International Financial Futures Exchange, the Singapore International Monetary Exchange, the Toronto Futures Exchange, the Sydney Futures Exchange, and the New Zealand Futures Exchange.

Currency Option Contracts

In contrast to a forward or futures contract, an option gives the option buyer the opportunity to benefit from favorable exchange rate movements but establishes a maximum loss. The option price is the cost of arranging such a risk/return profile.

The two types of foreign currency options are options on the foreign currency and futures options. The latter are options to enter into foreign-exchange futures contracts. Futures options are traded on the IMM, the trading location of the currency futures contracts.

Options on foreign currencies have been traded on the Philadelphia Exchange (now owned by Nasdag oms) since 1982. The foreign currencies underlying the options are the same as for the futures. Two sorts of options are traded on the Philadelphia Exchange for

each currency: an American-type option and a European-type option. The former permits exercise at any time up to and including the expiration date, while the latter permits exercise only at the expiration date. The number of units of foreign currency underlying each option contract traded on the Philadelphia Exchange is one-half the amount of the futures contract. For example, the Japanese yen option is for 6.25 million yen and the British pound option is for 31,250 pounds. Options on currencies are also traded on the London Stock Exchange, the London International Financial Futures Exchange, International Securities Exchange, and the NYSE Archipelago.

In addition to the organized exchanges, an over-the-counter market exists for options on currencies. Trading in these products is dominated by commercial banks and investment banking firms. Over-the-counter options are tailor-made products that accommodate the specific needs of clients. Only options on the major currencies are traded on the organized exchanges. An option on any other currency must be purchased in the over-the-counter market.

One key factor that affects the price of any option is the expected volatility of the underlying over the life of the option. In the case of currency options, the underlying is the foreign currency specified by the option contract. So, the volatility that affects the option's value is the expected volatility of the exchange rate between the two currencies from the present time to the expiration of the option. The strike price also is an exchange rate, and it affects the option's value: the higher the strike price, the lower the value of a call, and the higher the value of a put. Another factor that influences the option price is the relative risk-free interest rate in the two countries.[6]

Currency Swaps

Interest rate swaps are transactions in which two counterparties agree to exchange interest payments with no exchange of principal. In a currency swap, both interest and principal are exchanged. The best way to explain a currency swap is with an illustration.

Assume that two companies—a U.S. company and a Swiss company—each seeks to borrow for 10 years in its domestic currency. The U.S. company seeks USD 100 million dollar-denominated debt, and the Swiss company seeks debt in the amount of CHF 127 million. For reasons that we explore later, let's suppose that each wants to issue 10-year bonds in the bond market of the other country, and those bonds are denominated in the other country's currency. That is, the U.S. company wants to issue the Swiss franc equivalent of USD 100 million in Switzerland, and the Swiss company wants to issue the U.S. dollar equivalent of CHF 127 million in the United States.

Let's also assume the following:

1. At the time when both companies want to issue their 10-year bonds, the spot exchange rate between U.S. dollars and Swiss francs is one U.S. dollar for 1.27 Swiss francs.

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[6] To understand why, take a look at the payoff of a call option on an asset. A portion of the asset is purchased with borrowed funds. In the case of a currency option, it involves purchasing a portion of the foreign currency underlying the option. However, the foreign currency acquired can be invested at a risk-free interest rate in the foreign country. Consequently, the pricing of a currency option is similar to the pricing of an option on an income-earning asset such as a dividend-paying stock or an interest-paying bond. At the same time, the amount that must be set aside to meet the strike price depends on the domestic rate. Thus, the option price, just like interest rate parity, reflects both rates.

2. The coupon rate that the U.S. company would have to pay on the 10-year, Swiss franc-denominated bonds issued in Switzerland is 6%.
3. The coupon rate that the Swiss company would have to pay on the 10-year, U.S. dollar-denominated bonds issued in the United States is 11%.

By the first assumption, if the U.S. company issues the bonds in Switzerland, it can exchange the CHF 127 million for USD 100 million. By issuing USD 100 million of bonds in the United States, the Swiss company can exchange the proceeds for CHF 127 million. Therefore, both get the amount of financing they seek. Assuming the coupon rates given by the last two assumptions, and assuming for purposes of this illustration that coupon payments are made annually, the cash outlays that the companies must make for the next 10 years are summarized as follows:

Year	U.S. Company	Swiss Company
1–10	CHF 7,620,000	USD 11,000,000
10	CHF 127,000,000	USD 100,000,000

Each issuer faces the risk that, at the time a payment on its liability must be made, its domestic currency will have depreciated relative to the other currency. Such a depreciation would require a greater outlay of the domestic currency to satisfy the liability. That is, both firms are exposed to foreign-exchange risk.

In a currency swap, the two companies issue bonds in the other's bond market and enter into an agreement requiring that:

1. The two parties exchange the proceeds received from the sale of the bonds.
2. The two parties make the coupon payments to service the debt of the other party.
3. At the termination date of the currency swap (which coincides with the maturity of the bonds), both parties agree to exchange the par value of the bonds.

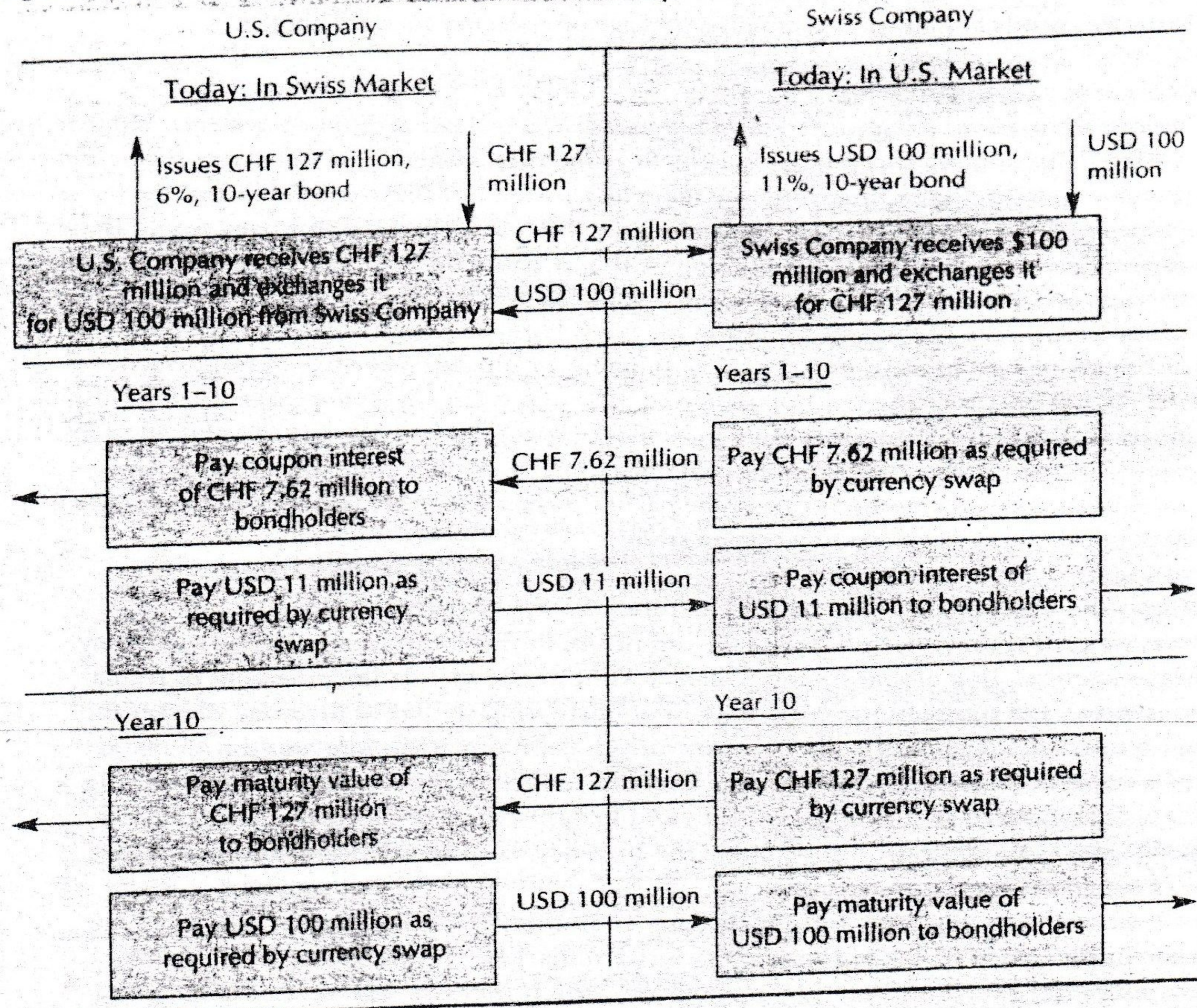
In our illustration, these arrangements result in the following:

1. The U.S. company issues 10-year, 6% coupon bonds with a par value of CHF 127 million in Switzerland and gives the proceeds to the Swiss company. At the same time, the Swiss company issues 10-year, 11% bonds with a par value of USD 100 million in the United States and gives the proceeds to the U.S. company.
2. The U.S. company agrees to service the coupon payments of the Swiss company by paying the USD 11,000,000 per year for the next 10 years to the Swiss company: the Swiss company agrees to service the coupon payments of the U.S. company by paying CHF 7,620,000 for the next 10 years to the U.S. company.
3. At the end of 10 years (the termination date of this currency swap and the maturity of the two bond issues), the U.S. company would pay USD 100 million to the Swiss company, and the Swiss company would pay CHF 127 million to the U.S. company.

This complex agreement is diagrammed in Figure 2.

Now let's assess what this transaction accomplishes. Each party received the amount of financing it sought. The U.S. company's coupon payments are in dollars, not Swiss francs; the Swiss company's coupon payments are in Swiss francs, not U.S. dollars. At the termination date, both parties will receive an amount sufficient in their local currency to pay off the

Figure 2 Illustration of a Currency Swap



holders of their bonds. With the coupon payments and the principal repayment in their local currency, neither party faces foreign-exchange risk.

In practice, the two companies would not deal directly with each other. Instead, either a commercial bank or investment banking firm would function as an intermediary (as either a broker or dealer) in the transaction. As a broker, the intermediary simply brings the two parties together, receiving a fee for the service. If, instead, the intermediary serves as a dealer, it would not only bring the two parties together, but would also guarantee payment to both parties. Thus, if one party were to default, the counterparty would continue to receive its payments from the dealer. Of course, in this arrangement, both parties are concerned with the credit risk of the dealer. When the currency swap market started, transactions were typically brokered. The more prevalent arrangement today is that the intermediary acts as a dealer.

An interest rate swap is nothing more than a package of forward contracts. The same is true for a currency swap; it is simply a package of currency forward contracts.

Currency Coupon Swap

In our illustration, we assumed that both parties made fixed cash flow payments. Suppose instead that one of the parties sought floating-rate rather than fixed-rate financing. Returning to the same illustration, assume that instead of fixed-rate financing, the Swiss company wanted LIBOR-based financing. In this case, the U.S. company would issue floating-rate bonds in Switzerland. Suppose that it could do so at a rate of LIBOR plus 50 basis points. Because the currency swap would call for the Swiss company to service the coupon payments of the U.S. company, the Swiss company would make annual payments of LIBOR plus 50 basis points. The U.S. company would still make fixed-rate payments in U.S. dollars to service the debt obligation of the Swiss company in the United States. Now, however, the Swiss company would make floating-rate payments (LIBOR plus 50 basis points) in Swiss francs to service the debt obligation of the U.S. company in Switzerland.

Currency swaps in which one of the parties pays a fixed rate and the counterparty a floating rate are called **currency coupon swaps.**

Reasons for Development of the Currency Swap Market

Now, we turn to the question of why the companies in this illustration may find a currency swap beneficial. In a global financial market without the market imperfections of regulations, taxes, and transactions costs, the cost of borrowing should be the same whether the issuer raises funds domestically or in any foreign capital market. In a world with market imperfections, it may be possible for an issuer to reduce its borrowing cost by borrowing funds denominated in a foreign currency and hedging the associated exchange rate risk, also known as an arbitrage opportunity. The currency swap allows borrowers to capitalize on any such arbitrage opportunities.

Prior to the establishment of the currency swap market, capitalizing on such arbitrage opportunities required use of the currency forward market. The market for long-dated forward exchange rate contracts is thin, however, which increases the cost of eliminating foreign-exchange risk. Eliminating foreign-exchange risk in our U.S.–Switzerland illustration would have required each issuer to enter 10 currency forward contracts (one for each yearly cash payment that the issuer was committed to make in the foreign currency). The currency swap provides a more transactionally efficient means for protecting against foreign-exchange risk when an issuer (or its investment banker) identifies an arbitrage opportunity and seeks to benefit from it.

As the currency swap market developed, the arbitrage opportunities for reduced funding costs that were available in the early days of the swap market became less common. In fact, it was the development of the swap market that reduced arbitrage opportunities. When these opportunities do arise, they last for only a short period of time, usually less than a day.

As another motivation for currency swaps, some companies seek to raise funds in foreign countries as a means of increasing their recognition by foreign investors, despite the fact that the cost of funding is the same as in the United States. The U.S. company in our illustration might be seeking to expand its potential sources of future funding by issuing bonds today in Switzerland.

SUMMARY

We reviewed the spot exchange rate market and markets for hedging foreign-exchange risk. An exchange rate is defined as the amount of one currency that can be exchanged for another currency. A direct exchange rate quote is the domestic price of a foreign currency; an indirect quote is the foreign price of the domestic currency. An investor or issuer whose cash flows are denominated in a foreign currency is exposed to foreign-exchange risk.

The spot exchange rate market is the market for settlement of a currency within two business days. In the developed countries, and some of the developing ones, exchange rates are free to float. According to the purchasing power parity relationship, the exchange rate between two countries—the price of the foreign currency in terms of the domestic currency—is proportional to the domestic price level and inversely proportional to the price level in the foreign country. Exchange rates are typically quoted in terms of the U.S. dollar.

The foreign-exchange market is an over-the-counter market dominated by large international banks that act as dealers. Foreign-exchange dealers quote one price at which they are willing to buy a foreign currency and one at which they are willing to sell a foreign currency. The difference between those prices is one cost a user of the market must pay; another cost is the explicit fee or commission to brokers arranging the purchase or sale of currency.

Currency forward contracts, currency futures contracts, currency options, and currency swaps are four instruments that borrowers and investors can use to protect against adverse foreign-exchange rate movements.

Interest rate parity gives the relationship among the spot exchange rate, the interest rates in two countries, and the forward rate. The relationship is assured by a covered interest arbitrage. Interest rate parity implies that investors and borrowers who hedge in the forward exchange rate market will realize the same domestic return or face the same domestic borrowing rate whether investing or borrowing domestically or in a foreign country. In implementing covered interest arbitrage, the relevant interest rates are those in the Eurocurrency market, the market for bank deposits and bank loans denominated in a currency other than that of the country where the bank initiating the transaction is located. The Eurodollar market is the largest sector of this market.

Exchange-traded options on major foreign currencies and futures options on the same currencies are traded in the United States. An option on any other currency must be purchased in the over-the-counter market.

A currency swap is effectively a package of currency forward contracts, with the advantage that it allows hedging of long-dated foreign-exchange risk and it is more transactionally efficient than futures or forward contracts. Currency swaps are used to arbitrage the increasingly rare opportunities in the global financial market for raising funds at less cost than in the domestic market.

KEY TERMS

- American terms
- Covered interest arbitrage
- Currency coupon swaps
- Direct quote
- Economic currency unit (ECU)
- Euro
- Eurocurrency market
- European terms
- Exchange rate
- Foreign-exchange risk (currency risk)

- Indirect quote
- Interest rate parity
- Purchasing power parity
- Spot exchange rate market (cash exchange rate)
- Theoretical cross rates
- Triangular arbitrage

QUESTIONS

1. A U.S. life insurance company that buys British government bonds faces foreign-exchange risk. Specify the nature of that risk in terms of the company's expected return in U.S. dollars.
2. Explain the difference between a spot exchange rate and a forward exchange rate.
3. These spot foreign exchange rates were reported on November 21, 2007.

	Japanese Yen	British Pound	Australian Dollar
U.S. Dollars	0.009218	2.0654	0.8709

The exchange rates indicate the number of U.S. dollars necessary to purchase one unit of the foreign currency.

a. From the perspective of a U.S. investor, are the preceding foreign-exchange rates direct or indirect quotes?

b. How much of each of the foreign currencies is needed to buy one U.S. dollar?

c. Calculate the theoretical cross rates between: (1) the Australian dollar and the Japanese yen, (2) the Australian dollar and the British pound, and (3) the Japanese yen and the British pound.

4. a. What is the euro?

b. Comment on the following statement: "The exchange rate between the euro and the currencies of all major economic countries is fixed."

c. Comment on the following statement: "The euro, was the first choice as the single currency for the Economic and Monetary Union."

5. Explain the meaning of triangular arbitrage, and show how it is related to cross rates.
6. On February 8, 1991, the U.S. dollar/British pound spot rate was U.S. $1.9905 per pound and the U.S. dollar/Japanese yen spot rate was U.S. $0.00779 per yen. The following forward rates were also quoted:

	British Pound	Japanese Yen
30 days	1.9908	0.007774
60 days	1.9597	0.007754
90 days	1.9337	0.007736

a. Explain what someone who enters into a 30-day forward contract to deliver British pounds is agreeing to do.

b. Explain what someone who enters into a 90-day forward contract to buy Japanese yen is agreeing to do.

c. What can you infer about the relationship between U.S. and British short-term interest rates and U.S. and Japanese short-term interest rates?

7. What is the drawback of using currency forward contracts for hedging long-dated positions?
8. How does covered interest arbitrage relate to interest rate parity?
9. Why are the interest rates in the Eurocurrency market important in covered interest arbitrage?
10. Suppose you know the following items: You can borrow and lend $500,000 at the one-year interest rate in the United States of 7.5%; in country W both the borrowing and lending rates are 9.2%; the spot exchange rate between the U.S. dollar and country W's currency is now $0.1725 per unit of currency of country W; and the one-year forward exchange rate is $0.2 per unit of currency of country W.

a. Explain how you could make a profit without risk and without investing any of your own money. (Assume commissions, fees, etc., to be equal to zero.)

b. Aside from assuming commissions, fees, and so on, to be zero, several unrealistic assumptions must be made in answering part (a). What are they?

c. Even if we incorporated realistic considerations regarding commissions and so on, the interest rate and exchange rate numbers in this question would probably produce a profit of some size. Why do you think opportunities like the one in this question are unlikely to come along often in the real world?

11. If the one-year borrowing and lending rates in Country ABC are 3%, and 4% in the United States, and if the foreign-exchange rate between dollars and the currency of Country ABC is $0.007576 per currency of Country ABC (i.e., $1 could buy 131.99 units of Country ABC), then what should the spot exchange rate of dollars for the currency of Country ABC be?

12. For which currencies are options and futures traded on organized U.S. exchanges?

13. What is the major difference between a currency swap and an interest rate swap?

14. The following excerpt appeared in the January 14, 1991, issue of *Wall Street Letter*.

> The Philadelphia Stock Exchange plans to list the first nondollar denominated options to trade in the United States, according to sources at the exchange. The Phlx will list cross-currency options based on the relationships between the Deutsche mark and the Japanese yen, as well as British pound/yen and pound/mark options, a spokesman confirmed. . . .
>
> The exchange currently lists currency options that are based on the relationship between that currency and the dollar, one Phlx member explained. "If you're not American," he added, "then the dollar doesn't do it for you." The three new cross-currency options should be attractive to the same banks and broker-dealers that currently trade dollar-based currency options, as well as non-U.S. entities that have interests in other currencies.
>
> Cross-currency options are "a very big part of international trade and international capital markets," and are big over-the-counter products, but none currently trades on an exchange. The advantage of exchange-traded options, the Phlx member said, is that "99% of the customers don't have the credit" to trade such a product over-the-counter with a big bank.

a. Explain what the representative of the Phlx means by saying, "If you're not American, then the dollar doesn't do it for you."

b. Why is the credit of customers critical in the over-the-counter market but not for an exchange-traded contract?

c. When the Philadelphia Stock Exchange filed with the SEC to list cross-currency options, the exchange indicated that the demand for this product has been "spawned by recent large fluctuations and dramatic increases in volatility levels for cross-rate options." Why would this increase the demand for cross-currency options?

R. Fabozzi 4th-44(A)