CHAPTER XIV

SWAPS

Swaps markets have rapidly developed into a huge market. From their initial inception in 1979, notional principal outstanding has grown from virtually zero to more than forty six trillion dollars, in 1999. Annual growth rates have exceeded 30 percent every year. Swaps offer an efficient and flexible means of transforming cash flows streams. The swaps market has little or no government regulation and provides a high degree of privacy. The original swap products have given way to hundreds of different arrangements designed to serve very special purposes. Today, swaps are used by corporations, world organizations, banks, and governments. They are used to reduce the cost of capital, manage risks, arbitrage the world's financial markets, enter new markets, and to create synthetic instruments.

Swaps are one of the most important classes of what have come to be known as derivative instruments. More than any other market, the swaps markets are dependent upon the existence and liquidity of other markets. These other markets include the market for U.S. Treasury debt, the market for corporate debt, the futures and options markets, the spot markets, and the forward markets. It is not surprising that the explosive growth in swap volume has been accompanied by an extraordinary growth in volume in these other markets.

In this chapter, we will study the four basic types of swaps: interest rate swaps, currency swaps, commodity swaps, and equity swaps. We will examine the most basic form of each type. The basic forms are called *plain vanilla* or *generic* swaps. We will study how the swaps market is organized, how to price swaps, and how to use swaps. We will also study how complex financial structures can be built by combining a number of different swaps.

I. Introduction to Swaps

A swap is a very simple contract:

A *swap* is a contract between two parties to deliver one sum of money against another sum of money at periodic intervals.

These two payments are the *legs* or sides of the swap. The legs maybe denominated in different currencies (*currency swap*), or in the same currency. For example, one leg maybe a fixed sum and the other leg a variable or "floating" sum (*interest rate swap*), or in two different currencies where one currency payment is fixed and the other is variable (*cross-currency interest rate swap*).

Typical exchange of payments between two counterparties:

A usual swap contract has to specify:

- Frequency of the payments (f)
- Tenor or duration of the swap (also, referred as maturity, T),
- How the legs (payments) are calculated. (In general, one leg is a *fixed* payment and the other leg is a *floating* (market price) payment.)

There are different types of swaps. They differ in how the legs are indexed or calculated. If the legs are a calculated as function of interest rates, we have an *interest rate swap*. If the legs are a calculated as a function by interest rates denominated in different currency, we have a *currency swap*. If the legs are a function of a commodity price, we have a *commodity swap*. If the legs are a function of an equity index, we have an *equity swap*.

The most common type of swap is a *fixed-for-floating* rate swap. In this swap, the first counterparty agrees to make fixed-rate payments to the second counterparty. In return, the second counterparty agrees to make floating-rate payments to the first counterparty. The fixed rate is called the *swap coupon*. The payments are calculated on the basis of hypothetical quantities of underlying assets called *notionals*. When the notionals take the form of sums of money, they are called *notional principals*. Notional principals are ordinarily not exchanged.

If the counterparties' respective payments to each other are to be made at the same time and in the same currency, then only the *interest differential* between the two counterparties respective payment needs to be exchanged.

1.A <u>How is the market organized?</u>

Swap contracts are tailor-made to meet the needs of the individual counterparties. As such, they are created with the aid of swap specialists who serve either or both the role of broker and market maker. These brokers/market makers are usually large commercial banks, who take the opposite side of any reasonable swap transaction. Swaps done on one side will be warehoused until they can be done on the other. Prices are quoted with respect to a standard, or generic, swap. The terms of a generic interest rate swap are illustrated in Table XIV.A. Since swaps are tailor-made contracts, swaps trade in an over-the-counter type environment, as opposed to the organized exchanges in which highly standardized contracts like futures and options trade.

TABLE XIV.A

Terms of a Generic U.S. Dollar Interest Rate Swap

General Terms: Maturity: 1 to 15 years.

Value date:	5 business days after trade date, corresponding to the beginning of a	
	new fixed and floating coupon periods.	
All-in-cost:	The value of a swap, quoted as the semiannual yield to maturity of the fixed coupons versus the floating index flat	

1. Fixed side

Fixed coupon:	Current market rate, quoted as a credit or "swap" spread over T-bill
	rate.
Payment frequency:	Semiannual or annual.
Day count:	30/360.

2. Floating side

LIBOR, T-Bills, commercial paper, prime, etc.
None.
A publicly quoted source (for example: Reuters).
The term of the floating index.
Actual/360 (actual/actual for T-Bills).
Same as term of floating index (except weekly for T-Bills).
Two business days before beginning of new period.
Current market rate for index.

The *all-in-cost* represents the price of the swap. It is quoted as the rate the fixed-rate payer will pay to the floating-rate payer. It is quoted on a semiannual basis; either as an absolute level ("6% fixed against six-month *LIBOR flat*") or as a basis point spread over government issues with an equivalent tenor ("the 3-year U.S. Treasury yield plus 57 basis points against six-month LIBOR flat"). LIBOR flat means LIBOR is quoted without a premium or discount. The fixed rate is easily calculated: it is the rate that equates the present value of the floating side payments to the present value of the fixed side payments.

The fixed-rate payer receives floating interest, and is said to be *long* or to have "bought" the swap. The long side has conceptually purchased a floating-rate note (because he receives floating interest) and issued a coupon bond (because he pays out fixed interest at periodic intervals). On the other hand, the floating-rate payer is said to be *short* or to have "sold" the swap. The short side has conceptually purchased a coupon bond (because he receives fixed interest) and issued a floating-rate note (because he or she pays floating interest).

A swap dealer quotes a swap with a bid-ask spread. For example, consider Housemann Bank, a U.S. bank dealing in the broadest debt market in the world, the market for U.S. Treasury securities. Housemann Bank (the swap dealer) quotes a swap with a bid-ask spread in terms of yield. Since the market for Treasuries is very liquid, the bid/ask spread is very narrow. Each morning, Housemann Bank's swap staff prepares an *indicative swap pricing schedule*, as shown in Table XIV.B. This schedule specifies the prices at which Housemann Bank will enter into swaps for that day.

TABLE XIV.B Indicative Swap Pricing Schedule

Housemann Bank Receives ("Sell")	Housemann Bank Pays ("Buy")
1-yr TN sa + 40 bps	1-yr TN sa + 35 bps
2-yr TN sa + 46 bps	2-yr TN sa + 40 bps
3-yr TN sa + 54 bps	3-yr TN sa + 48 bps
4-yr TN sa + 65 bps	4-yr TN sa + 59 bps
5-yr TN sa + 77 bps	5-yr TN sa + 71 bps
	Housemann Bank Receives ("Sell") 1-yr TN sa + 40 bps 2-yr TN sa + 46 bps 3-yr TN sa + 54 bps 4-yr TN sa + 65 bps 5-yr TN sa + 77 bps

<u>Note</u>: These quotes are against six-month LIBOR flat and assume bullet transactions (i.e., the principal, either real or notional, is non-amortizing). bps denotes basis points, which usually are semiannual (sa or s.a.).

Consider the 3-year swap quote. Housemann Bank will attempt to sell a 3-year swap to receive the offered spread of 54 and buy it back to pay the bid spread of 48. Housemann Bank will thus earn the difference of 6 basis points.

Example XIV.1: Suppose Goyco Corporation, a U.S. company, is looking to receive fixed-rate payments rather than pay fixed-rate for 3 years. The current ("*on the run*") 3-year Treasury Note rate is 6.53%. From Table XIV.B Goyco obtains the quotation: "6-month LIBOR v. Treasuries plus 48/54 in 3 years."

Goyco Corp. decides to sell a 3-year swap from Housemann Bank. Conceptually, Housemann Bank will pay Goyco Corp. 7.01% (6.53+0.48) semiannually, while Goyco Corp. will pay Housemann Bank 6-month LIBOR. The following graph summarizes the swap transaction:



Since the payments between Goyco Corporation and Housemann Bank are made in the same currency and at the same time, only the interest differential between the respective payments will be exchanged. For example, when at the settlement date 6-month LIBOR exceeds 7.01%, Goyco Corporation will pay to Housemann Bank [6-month LIBOR - 7.01%] semiannually.

<u>Note</u>: The difference between the rate paid by the fixed-rate payer over the rate of the *on the run* Treasuries with the same maturity as the swap is called the *swap spread*. In this example, the swap spread is 54 bps. \P

• Swap Dealers avoid interest rate risk

By entering into the swap, Housemann Bank, the swap dealer, has assumed the risk that the interest rate it pays to Goyco Corp. will change (in this case, increase). This interest rate risk exists because Housemann Bank is paying a floating rate. The swap dealer does not want to face interest rate risk. The solution for Housemann Bank is to enter into another swap with a counterparty, which wants to exchange fixed-rate debt for floating-rate debt for 3 years. This is what swap dealers attempt to do.

If a swap dealer matches the two sides (the buyer and the seller) of a swap is called *back-to-back transaction* (or "matched book" transaction). In practice, a swap dealer may not be able to find an immediate off-setting swap. In these cases, swap dealers will warehouse the swap and use interest rate derivatives to hedge their risk exposure until they can find an off-setting swap.

Even in the case of back-to-back transactions, swap dealer face risk: *credit risk*. Credit risk considerations are very important. Traditionally, only companies with good reputation and creditworthiness can enter into this market. In general, a company needs an investment grade rating to enter into the swap market. \blacklozenge

Swaps are also arranged through brokers. A broker will match a party willing to pay 54 over Treasuries with another willing to receive 54 over Treasuries. The broker's fee is paid up front. This fee is usually 1 basis point per annum from each side of the swap.

According to a December 2014 BIS report on the Global OTC market, the notional amount outstanding of swaps was USD 425.2 trillion. Single currency interest rate swaps were the most popular swap with 90% of the notional amount outstanding. For single currency interest rate swaps 34% involved euro area currencies, 27% involved the USD, and 21% involved the JPY. For currency swaps, around 5% of the notional amount outstanding of swaps, almost 90% involved the USD.

• The Swap Term Structure or Curve and The Swap Spread

Table XIV.B is a typical example of a swap term structure. It is the equivalent of the yield curve. As we will see later, the swap curve will be consistent with the interest rate curve implied by the Eurodollar futures contract, which is used to hedge interest rate swaps that cannot be matched.

The swap term structure is becoming more relevant in fixed-income markets. With the size of government debt shrinking in many countries, the swap term structure is becoming the benchmark for pricing fixed-income products in many markets. The swap term structure is also very valuable to measure the relative value of debt classes and interest rate expectations.

The *swap spread* is the difference between the interest rates paid by the fixed-rate payer the interest rate on the run treasury (with same maturity). We expect to observe positive swap spreads since a negative spread, in theory, signals that banks are viewed as safer than the government.

But, it can be negative during special circumstances. For example, during the 2008-2009 Financial Crisis, swap rates declined to the level of on the run Treasuries (the swap spread was negative for the 30-yr maturity); and during the late months of 2015, a similar negative

1.B <u>Economic motives for swaps</u>

1.B.1 <u>Risk Sharing</u>

A firm has unmatched cash flows in terms of foreign currencies, or in terms of the proportion of variable-rate assets matched by variable-rate liabilities. This company finds a second party with a complimentary mismatch and arranges a swap in such a way that its foreign currency cash flows are now more closely matched (currency swap), or that its variable-interest-rate asset and liability flows are now in line (interest rate swap).

1.B.2 <u>Arbitrage</u>

Arbitrage opportunities may arise from exchange rate or capital controls, tax rules, economics of scale, information problems, or simple inconsistencies in market pricing. This point can be illustrated with the following example.

Suppose a German company wants debt denominated in CHF. There are at least two ways to get CHF debt:

(1) Issue a bond denominated in CHF.

(2) Issue a bond denominated in EUR and swap it, with a Swiss company that wants EUR debt, for CHF debt.

Why might a German company take the second alternative? There is a simple answer: issuing a EUR bond and swapping it may be a cheaper way of getting CHF debt than would a direct issue of a CHF bond. That is, the German company may have a *comparative advantage* in the EUR denominated debt market, while the Swiss company may have a *comparative advantage* in the CHF denominated debt market.

In the same way, firms may have a comparative advantage in the floating-rate debt market. Therefore, for those firms, it may be cheaper to get fixed-rate debt by issuing floating-rate debt first and then swapping it for fixed-rate debt.

The *Quality Spread Differential* (QSD) measures the comparative advantage. The QSD is equal to the difference between the interest rates of debt obligations offered by two parties of different creditworthiness that engage in a swap. The QSD is the key to a swap. It is what can be shared between the parties. The Quality Spread Differential (QSD) is not usually divided equally. In general, the company with the worse credit gets the smaller share of the QSD to compensate the SD for a higher credit risk.

Example XIV.2: Comparative Advantage.

Consider the following situation of a fixed-for-floating rate swap:

Cost of Borrowing

	Floating-rate Market	Fixed-rate Market
AAA Co.	6-mo. T-Bill $+ \frac{1}{4}$ %	111/2%
BBB Co.	6-mo. T-Bill $+ \frac{1}{2}\%$	13%
Spread	1/40/0	11/2%

AAA Co. has an absolute advantage in both markets, but it has comparative advantage in the Fixed-Rate Market. The QSD is 1¹/₄%.

Suppose BBB Co. wants to borrow in the fixed-rate market and AAA Co. is willing to take floatingrate debt. BBB Co. offers AAA Co. a USD 10 million, the 10-year swap arrangement described in Exhibit XIV.1. AAA Co. accepts the swap.





BBB Co. (the fixed-rate payer) bought the swap (i.e., BBB Co. has a long swap position).

Both parties find it cheaper to borrow through a swap. The effective Cost of Borrowing under the swap is:

AAA Co. = 11¹/₂% + T-Bill - 12% = T-Bill - ¹/₂% BBB Co. = T-Bill+¹/₂% + 12% - T-Bill = 12¹/₂%

Every 6 months, BBB Co. pays USD 625,000 (USD 600,000 to AAA Co. and USD 25,000 to bondholders), while AAA Co. pays USD 10,000,000 x (T-Bill- $\frac{1}{2}$ %)/2.

Note: The QSD is unequally shared. AAA Co. gets 3/4%, while BBB Co. gets 1/2.

1.B.3 <u>Market completion</u>

A firm wishes to issue Italian lira debt, but it has had problems in accessing the Italian market. As a result, it may make a deal with a second company that has Italian lira debt and assume the second company's obligation to pay coupons and principal denominated in Italian liras. In exchange, the second firm takes on the first firm's obligation to pay coupons and principal of a different currency. Often a banking intermediary may arrange the deal.

II. Interest Rate Swaps

In a typical interest rate swap, one party issues fixed-rate debt while another issues floatingrate debt, and the two parties swap interest payment obligations based on a notional principal amount.

Example XIV.3: Suppose Ardiles Co. wants to increase its fixed-rate USD debt. Ardiles Co. can borrow at 10% or at 1% above LIBOR. A swap dealer is offering to receive 8% against LIBOR.

	Cost of Borrowing	
	Floating-Rate Market	Fixed-Rate Market
Ardiles Co.	6-mo. LIBOR + 1%	10%

Ardiles Co. enter into a 2-year interest rate swap agreement that involves the following provisions:

(a) Ardiles Co. issues USD 70,000,000 of floating-rate debt at 1% above LIBOR.(b) Ardiles Co. makes coupon payments to the Swap Dealer in the amount of 8% (s.a.), while the Swap Dealer makes LIBOR payments to Ardiles Co. The notional amount of the swap is USD 70,000,000.

Ardiles Co., who is said to have a long swap position, reduces its cost of borrowing to:

(LIBOR + 1%) + 8% - LIBOR = 9% (less than 10%).

Exhibit XIV.2 summarizes Example XIV.3.



<u>Note</u>: The reduction on borrowing costs is not a free lunch. There is a risk, given by the possibility that the other party involved in the swap defaults.

Ardiles Co. could be in a riskier position than if it just borrowed at 10%, because if the swap dealer were to default on its payments, Ardiles would be left with floating-rate debt. In that case, Ardiles Co. would not have the fixed-rate debt it had wanted. \P

2.A <u>Valuation of an Interest Rate Swap</u>

Assume no possibility of default. An interest rate swap can be valued either as a long position in one bond and a short position in another bond, or as a portfolio of forward contracts.

Reconsider Example XIV.3. Ardiles Co. is long a USD 70 million floating-rate bond at 6month LIBOR and short a USD 70 million fixed-rate bond at 8% (s.a.) per year. The value of the swap is the difference between the values of two bonds.

Now, we will use the following notation:
V: Value of swap.
B_{Fixed}: Value of fixed-rate bond underlying the swap.
B_{Float}: Value of floating-rate bond underlying the swap.
Q: Notional amount in swap agreement.

The value of the swap to the fixed-rate payer (Ardiles Co., in Example XIV.3) is

 $V = B_{Float} - B_{Fixed}$.

The discount rates used in valuing the bonds should reflect the level of risk of the cash flows. We suppose that an appropriate discount rate is given by the floating-rate underlying the swap agreement. For example, in Example XIV.3, the riskiness is measured by LIBOR.

<u>Note</u>: At inception, $V\approx 0$. The swap has to be *fair*. That is, the fixed coupon is set in a way that the NPV of both sides is approximately equal.

Example XIV.4: Reconsider the 2-year swap in Example XIV.3. The relevant LIBOR rates for 6-mo, 12-mo, 18-mo, and 24-mo are 6%, 6.25%, 6.25%, and 6.5%. Using an actual/360 day count, we calculate the following values:

- $\mathbf{B_{Fixed}} = 2.8/(1 + .06 * (181/360)) + 2.8 / (1 + .0625 * (365/360)) + 2.8 / (1 + .0625 * (546/360)) + 72.8/(1 + .065 * (730/360)) = \mathbf{USD} 72,521,371.94.$
- $\mathbf{B}_{Float} = 2.1/(1 + .06 * (181/360)) + 2.1875/(1 + .0625 * (365/360)) \\ + 2.1875/(1 + .0625 * (546/360)) + 72.275/(1 + .065 * (730/360)) = \mathbf{USD} 69,951,000.36.$

The value of the swap to Ardiles Co. (the fixed-rate payer) is

V = USD 69,951,000.36 - USD 72,521,371.94 = USD -2,570,368.38.

<u>Note</u>: Today, a similar swap, with T = 2-year, would have a fixed coupon = 6.26% (s.a.); with a s.a. payment of USD 2.191M. Check:

 $B_{\text{Fixed}} = 2.191/[1 + .06 * (181/360)] + 2.191/[1 + .0625 * (365/360)] + 2.191/[1 + .0625 * (546/360)] + 72.191/[1 + .065 * (730/360)] = \textbf{USD 69,972,490}$ $\Rightarrow \text{At inception, V} \approx 0! \P$ Note: Since the discount rate is the floating rate, the value of the B_{Float} is very close to the notional amount of the swap (Q). If continuous compounding is used, B_{Float}=Q.

2.B Market Valuation of an Interest Rate Swap

A firm can always reverse a swap by contacting a swap dealer and taking an opposite position. The benefits of closing a swap deal are related to the current condition in the market for interest rates.

Reconsider the situation in Example XIV.2, presented in Exhibit XIV.3.



Every 6 months, BBB Co. pays USD 625,000 (USD 600,000 to AAA Co. and USD 25,000 to bondholders), while AAA Co. pays USD 10,000,000 x (T-Bill-1/2%)/2.

Now, 5 years into the swap market conditions have changed. The current yield on a 5-year T-Bond is 10%. A swap dealer quotes BBB Co. a 10.9% rate, which means, the swap dealer will pay 10.9% fixed-rate for five years in exchange of receiving 6 mo. T-Bill for five years.

Every 6 months, BBB Co. pays to the dealer USD 10,000,000 x (T-Bill)/2 and receives USD 545,000.

If BBB Co. agrees to sell this swap deal, it will be involved in two swaps for five years. Under the terms of the first swap, BBB Co. is paying 12% for five years and receiving 6 mo. T-bill; in the second swap, BBB Co. is receiving 10.9% for five years and paving 6 mo. T-Bill for five years. Therefore, BBB Co.'s net swap position involves paying 1.1% for five years (USD 55,000 every six months). BBB Co. closes the original swap by agreeing to the dealer's terms.

Exhibit XIV.4 displays the net flows for BBB Co.:

Exhibit XIV.4 Interest Rate Swap: BBB Net Cash flows



The current Market Value of the Swap to BBB Co. is USD -418,393 = PV(USD -55,000, 5.45%, 10 semesters).

You should note that when BBB Co. closes the original swap, BBB Co.'s net position reverts to the original position. That is, BBB Co. is borrowing from the floating-rate market.

There are different alternatives to manage BBB's actual cash flows:

i. BBB may elect to retain all cash flows.

ii. BBB may ask the fixed-rate receipts under the second swap to match exactly the fixed rate obligation under the first swap, then BBB's obligation under the second swap to pay floating interest-rate at 6-mo T-Bill would be increased by 110 bps.

iii. BBB may choose to pay the swap dealer USD 608,571=PV(USD -80,000, 5.45%, 10 semesters). Then, BBB's obligations are reduced to paying 6-mo. T-Bill to debt-holders.

Many banks and investors own Eurobonds with a higher YTM than the current swap rate. By entering into an interest rate swap, a company can profit from that differential. As matter of fact, swap dealers will routinely talk to bond holders to profit from differentials between YTMs on existing bonds and swap rates.

Example XIV.5: An institutional investor owns a USD 50,000,000 3-year ex-warrant Eurobond bearing a low coupon of 4%. On December 10, 1996, the price of the bond is 90.776508% for a YTM of 7.55% p.a. An investment bank proposes to buy the bonds at par and to pay the 4% coupon annually. In exchange, the institutional investor will pay 12-mo LIBOR (12-mo LIBOR is used for simplicity) + 25 bps. The institutional investor will do a swap in the market at 3-year U.S. Treasuries plus 38.6 bps against 12-mo LIBOR. The 3-year U.S. Treasury yields 6.533% s.a. Annually the institutional investor has to make fixed payment at the swap coupon rate of 7.0226% p.a. The annual cash flows for the institutional investor are calculated below:

	Pay to	Pay 25 bps	Receive 4%	
Date	Swap Dealer	to Bank	Coupon	Net
12/10/97	-3,511,300	-125,000	2,000,000	-1,636,300
12/10/98	-3,511,300	-125,000	2,000,000	-1,636,300
12/10/99	-3,511,300	-125,000	2,000,000	-1,636,300

The key to the evaluation of this deal is to obtain the NPV of the swap flows. The discount rate should be the YTM of the 4% Eurobond, 7.55%, which measures the opportunity cost associated with the funds. The NPV of swap losses is **USD 4,251,640**.

On the bond side, the market valuation of Eurobonds for the institutional investor is

.90776508 x USD 50,000,000 = **USD 45,388,254**.

The bank buys the bonds at 100%, that is, the bank pays the institutional investor USD 50,000,000, for a cash gain of **USD 4,611,746**.

The difference between the bond gains and the swap losses is:

USD 4,611,746 - USD 4,251,640 = USD 360,106.

This difference spread back out over 3 years at a discount rate of 7.55% p.a. is equivalent to an annual payment of USD 138,600, or roughly 27.72 bps.

What has happened in this situation? Note that current market conditions have generated a profit margin of 53.74 bps between the underlying yield on the bond (7.55) and the swap rate paid to switch into a floating rate. The margin of 53.74 is split into 25 bps to the bank and 27.74 bps to the institutional investor. (The difference between the above 27.72 bps and the calculated 27.74 bps is due to rounding error.) \P

2.C <u>Euromarkets and interest rate swaps</u>

In Chapter XIII we mentioned that one of the important qualities of issuing houses in the Eurobond market was their knowledge of derivative markets. Sometimes arbitrage opportunities in Eurobond markets exist that can be exploited using interest rate swaps. In this section, we will show how to use interest rate swaps when new issues are introduced into the market. To illustrate this point, we will extend the case of Merotex, presented in section XIV.1.C.

2.C.1 <u>Case Study: Merotex (continuation)</u>

Recall that the Italian firm Merotex issued 5-year 7(5/16)% Eurobonds for USD 200 million. Merotex has indicated to the lead manager a preference for USD floating rate debt. The lead manager of the issue obtains a swap quotation from a swap dealer. The dealer quotes: 6-month LIBOR v. U.S. Treasuries plus 77/71 in 5 years.

In the case of Merotex, Merotex will receive from the swap dealer U.S. Treasuries plus 71 bps and will pay to the swap dealer 6-mo LIBOR. Recall that 5-year U.S. Treasuries have a yield of 6.915% (s.a.). The fixed-rate coupon received by Merotex under the swap is calculated as follows:

6.915% (s.a.) + .71% (s.a.) = 7.625% (s.a.),

or converting into annual $[(1+.07625/2)^2-1] \ge 100 = 7.7700$ (p.a.) annual.

The swap is structured so that the fixed rate payments to Merotex coincide with the bond coupon payments. That is, the first payment is made six months after the date of the start of the swap, which is generally fixed to coincide with the payment, or closing, date on the issue.

The notional principal of the swap is USD 200 million (same amount as in the Euro-USD bond issue).

The effect of the swap is to add two further and separate cash flows. Without taking into account the expenses related to the issue, the issuer's cash flows take the following form:

Year	Bond	Sv	wap
0	196,500,000	-	-
1	-14,625,000	15,540,000	-6-mo LIBOR
2	-14,625,000	15,540,000	-6-mo LIBOR
3	-14,625,000	15,540,000	-6-mo LIBOR
4	-14,625,000	15,540,000	-6-mo LIBOR
5	-214,625,000	15,540,000	-6-mo LIBOR
IRR (bond issue alone)): 7.7479	

The fixed-rate coupon receipts under the swap exceed the payments under the bond issue:

Receipts:	7.7700% (p.a.)
Payments:	7.7479% (p.a.)
Surplus:	0.0221% annual or 2.21 basis points per annum (annual bond basis).

The floating-rate cash flow obligation of 6-mo LIBOR is effectively reduced by this annual surplus. Unlike a fixed-rate issue, LIBOR interest payments are calculated on a money market basis (see Appendix A.XII). To derive the final cost to Merotex, we convert the swap surplus (expressed in annual bond terms) into money market terms, as follows:

7.7700% (p.a.) =	7.6250% (s.a.)
7.7479% (p.a.) =	7.6033% (s.a.)
Surplus =	0.0217% (s.a.) or 2.17 basis points semi annual.

The surplus expressed in semiannual terms is converted to money market as follows:

2.17 x (360/365) = 2.14 basis points.

Therefore, the cost of floating-rate funding is expressed as:

6-mo LIBOR - 2.14 basis points.

The actual cash flows can be managed with different methods:

i.- Merotex may choose to retain all three cash flows.

ii.- Merotex may require the fixed-rate receipts under the swap to match exactly the fixed rate obligation under the bond issue, then Merotex's obligation under the swap to pay floating interest-rate at 6-mo LIBOR would be diminished.

iii.- Merotex may choose to match its debt-service obligations under the bond issue to pay LIBOR flat under the swap and to commute the annual surplus into a single payment by the swap dealer to Merotex on the start date of the swap, which usually coincides with the payment date of the bond issue. To calculate the amount, we create a fictional cash flow -with the same IRR of 7.7479%) as the bond issue but with the first payment unknown, as follows:

Year

0	X
1	15,540,000
2	15,540,000
3	15,540,000
4	15,540,000
5	215,540,000
IRR	: 7.7479%

Solving for *X*, we obtain 201,177,700. Therefore, the closing payment would have been USD 201,177,700, or an excess of USD 3,677,700 against the net proceeds of Merotex's issue of USD 196,500,000.

The same result can be obtained by a present value calculation of the interest payment surpluses of USD 915,000 per year (USD 15,540,000 -14,625,000) discounted at 7.7479%.

Therefore, using this third alternative, Merotex receives a single payment equal to USD 3,677,700 from the swap dealer.

• Below LIBOR funding

The motivation of commercial banks and corporate borrowers such as Merotex to launch fixed-rate issues arises in most cases only because of the attractive below-LIBOR funding derived from attaching a swap to the debt service of the issue. •

Swap quotations are driven by demand and supply for fixed-rate and floating-rate funding. These are generally priced in terms of spread or margin over the redemption yield of government bonds of equivalent maturity. This applies to currency swaps in USD, GBP, EUR, CAD, etc. The swap may not always produce below interbank rates, in which case the issuer may resort directly to issuance in the relevant market. Currency swaps are the subject of the next section.

III. Currency Swaps

As with interest rate swaps, the notionals on currency swaps take the form of notional principals. However, since in currency swaps the principals are often actually exchanged, it is not really correct to call the principals on a currency swap "notional principals." In a typical currency swap, one party issues fixed-rate debt in one currency while the counterparty issues fixed-rate debt in a different currency and the two parties swap interest and principal payment obligations. This exchange of fixed interest payments and principals denominated in two different currencies is implicitly fixing an exchange rate between the two currencies exchange. This exchange rate is fixed for the life of the swap. Usually, a swap dealer, a large bank, is one of the counterparties.

Example XIV.6: Simeone Insurance, a U.S. financial institution, is interested in lending DKK for 3 years (Danish crowns=DKK). Simeone Insurance decides to enter into a three-year currency swap, receiving DKK and paying USD. A swap dealer offers a currency swap, where Simeone receives 5.5% annually in DKK and Simeone pays 6% annually in USD, once a year. The principals in the two currencies are DKK 53 million and USD 10 million, which are exchanged at the beginning of the swap. At the end of the swap, both parties exchange principals. Simeon

This swap involves three sets of cash flows:

At inception, Simeone receives USD 10 million and the swap dealer receives DKK 53 million:



Then, there are the annual interest payments:



Finally, at the end of the swap, the principals are repaid:



Notes:

- Since at the end both parties are simply returning the notional principals they exchanged at inception, the exchange rate at the end is the same as the initial rate. There is no FX risk involved in the repayments of principals.

- There are currency swaps which do not involve exchange of principals.

In the example above, note that the last two sets of cash flows implicitly fix an exchange rate in the future. That is, currency swap contracts are not any different from the foreign exchange forward contracts. Since forward contracts for certain less-traded currencies may not be available in the interbank market, and, even for widely traded currencies, forward contract maturities are fairly short currency swaps fill these gaps in forward currency contracts. These contracts are, therefore, used to manage currency risk.

Example XIV.7: Levi Strauss Co. has a five-year export contract with a Japanese retailer for USD 5 million a year. Management wants to reduce exchange risk and enters into a long-term contract with a Japanese Bank with a 4 and 5 year forward contract that sets the exchange rate at 112.31 yens and 109.70 respectively.

Currency swaps are also called *cross currency* (*XCCY*) *swaps*. Currency swaps are used for two main purposes. First, they are used to hedge currency risk. Second, they provide a way for firms to enter into foreign markets that it might not otherwise be easy or legal to enter.

3.A <u>Types of Currency Swaps</u>

Companies have become accustomed to satisfying their debt financing requirements all over the world, becoming indifferent as to whether they borrow in USD, EUR, CAD or AUD, as long as currency swaps provide them with the currency they ultimately need at a convenient price. It is easy to think of currency swaps as flexible tools that allow companies to borrow in any currency. Depending on the motivation or the details, swaps can have different forms.

3.A.1 Back-to-Back and Parallel Loans

Currency swaps evolved from back-to-back and parallel loans. Back-to-back loans are loans between two companies in different countries, each of which makes the other a loan in its respective currency. Parallel Loans involve two companies in different countries, each of which has a subsidiary in the other's country. During the duration of the loan, both companies pay interest to the counterparty. At the end of the loan, both companies repay the loan –i.e., they swap currencies again.

Example XIV.8: IBM lends USD to the U.S. subsidiary of Bunge & Born, a Brazilian company, while Bunge & Born lends reais (BRL) to IBM Brazil. This arrangement lasts for 3 years. Interest payments are paid semiannually in both currencies.

Parallel loans got started because of market regulation. At one time, if U.K. companies went through the London Foreign Exchange market, they had to pay a premium over the market rate for USD in order to finance their foreign subsidiaries. To avoid this tax on dollar purchases, U.K. companies arranged parallel loans with U.S. companies.

Often the loan agreement includes a quasi-futures contract: If one currency depreciates in value relative to the other currency, the lender of the depreciated currency has to increase its loan to offset the changes in the loan's value due to exchange rate changes.

The typical futures contract in this case, however, does not involve a cash flow for every small change in the exchange rate. Rather, it is a step function:

Only if the exchange rate moves beyond certain limit points. For example, in Example XIV.8, if the BRL goes above 2.60 BRL/USD or below 2.20 BRL/USD, additional lending or repayment will take place. (This is a "first passage option.")

Since the establishment of an active currency swaps, back-to-back and parallel loans are no longer frequently used.

3.A.2 <u>Straight Currency Swap</u>

A straight currency swap is the exchange of two currencies at the current exchange rate with an agreement to reverse the trade -at the same exchange rate- at some date in the future. One of the parties will pay the other annual interest payments, which are agreed upon on the basis of the interest parity relation.

Example XIV.9: A USD 1,000,000 is swapped for JPY 82,000,000. USD pays 3% higher interest than JPY, then the party getting USD might pay the other party annual interest in the amount of USD 30,000. ¶

Central banks often engage with other central banks in these types of currency swaps, creating *bilateral currency swap agreements*, where Central Bank A sells a specified amount of currency, say, FC₁, to Central Bank B in exchange for another currency, say, FC₂, at the prevailing market exchange rate. Central bank A agrees to buy back its currency, FC₁, at the same exchange rate on a specified future date.

3.A.3 Swap of Debt Payments

In this type of currency swap, each company (or other party) issues fixed-rate debt in a currency that is available to it; then, the companies swap the proceeds of the debt issue and also assume each other's obligation to make interest and principal payments.

Example XIV.10: Exxon, a U.S. company, can borrow in EUR at a rate of 8% or in USD at a rate of 8.25%. Repsol-YPF, a Spanish oil company, can borrow in USD at a rate of 8.35% or in EUR at 7.75%. The exchange rate is 1.25 USD/EUR (or .80 EUR/USD). Exxon wants to finance a project

in EUR, while Repsol wants to increase its USD debt to have a better match between its USD outflows and USD inflows. A swap dealer familiar with the situation of Exxon and Repsol arranges a currency swap that solves the financial needs of both companies at beneficial terms.

Under the terms of the currency swap, Exxon issues 10,000 4-year bonds with a face value of USD 1,000 and a coupon rate of 8.25%, while Repsol issues 8,000 4-year bonds with a face value of EUR 1,000 and a coupon rate of 7.75%.

The two companies then swap currencies and in addition assume each other's obligation to make interest payments and principal repayments. Exxon will make semiannual payments to Repsol for EUR 38.026975 per bond (then, Repsol will make annual coupon payments of EUR 77.5 per bond), while Repsol will make semiannual payments to Exxon (semiannual coupon) for USD 41.25 per bond. Graphically, the semiannual payments are as follows:



Note that Exxon and Repsol have fixed the exchange rate for four years at:

 $S_t = USD \ 412,500/EUR \ 304,215.80 = 1.3559 \ USD/EUR. \P$

• Swap Dealers are usually in the middle

All payments are usually made through an intermediary (a commercial or investment bank), which is exposed to currency risk (which they usually hedge). •

3.A.4 Case Study: IBM and The World Bank

An early example of a swap in different currencies took place between IBM and the World Bank in August 1981, with Salomon Brothers as the intermediary. The complete details of the swap have never been published in full; the following outline follows the description made by D.R. Bock in <u>Swap Finance</u>, published by **Euromoney Publications**.

In previous years, IBM had issued bonds in DEM and CHF. The bonds matured on March 30, 1986. The issued amount of the CHF bond was CHF 200 million and it had a coupon of 6(3/16)%. The issue amount of the DEM bond was DEM 300 million and it had a coupon of 10%. When the USD appreciated sharply against these two currencies during 1981, IBM enjoyed a capital gain from the reduced USD value of its foreign debt liabilities. The DEM, for example, fell in value from .5181 USD/DEM in March 1980 to .3968 USD/DEM in August 1981. Thus, coupon payments of DEM 100 had fallen in USD cost from USD 51.81 to USD 39.68.

The World Bank wanted to borrow in DEM and CHF. The World Bank had issued comparatively little USD paper and could raise funds at an attractive rate in the U.S. market. The solution benefiting both parties was for The World Bank to issue a USD bond and swap the proceeds with IBM. The bond was launched on August 11, 1981, settling on

August 25, 1981. August 25 became the settlement date for the swap. The first annual exchange under the swap was to be on March 30, the next coupon date on IBM's bonds, i.e., 215 days (rather than 360) from the start date.

The first step was to calculate the value of the CHF and DEM cash flows. The yields for similar bonds were at 8% and 11% p.a. respectively. The initial 215-day period meant that the discount factors were:

Date	CHF	DEM
3/30/82	$1/(1.08)^{215/360} = .95507746$	$1/(1.11)^{215/360} = .9395764$
3/30/83	$1/(1.08)^{575/360} = .88433099$	$1/(1.11)^{575/360} = .8464652$
3/30/84	$1/(1.08)^{935/360} = .81882499$	$1/(1.11)^{935/360} = .76258132$
3/30/85	$1/(1.08)^{1295/360} = .75818128$	$1/(1.11)^{1295/360} = .68701020$
3/30/86	$1/(1.08)^{1655/360} = .70201045$	$1/(1.11)^{1655/360} = .61892811.$

Salomon Brothers calculated the following NPVs for the IBM bonds:

 $NPV_{CHF} = 12.375 \text{ x } .95507746 + 12.375 \text{ x } .88433099 + 12.375 \text{ x } .81882499 + 12.375 \text{ x } .75818128 + 212.375 \text{ x } .70201045 = CHF 191,367,478.$

 $NPV_{DEM} = 30 \text{ x } .93957644 + 30 \text{ x } .84646526 + 30 \text{ x } .68701020 \text{ .76258132} +$ + 30 x .68701020 + 330 x .61892811 = DEM 301,315,273.

Since the terms of the swap were agreed on August 11, The World Bank would have been exposed to currency risk for two weeks. The World Bank decided to hedge the NPV amounts derived above, using two-week forward currency contracts. Assuming that these contracts were at .45872 USD/CHF and .390625 USD/DEM, The World Bank needed USD 87,783,247 to buy the CHF and USD 117,701,753 to buy the DEM, totaling USD 205,485,000.

Finally, Salomon Brothers worked out the USD amount of the bond to be issued. Assuming a coupon of 16% with commissions and fees totaling 2.15% (i.e., net proceeds of 97.85), the USD amount of the bond issue had to be USD 205,485,000/0.9785 =USD 210,000,000. The YTM on the World Bank bond was 16.8%. The first coupon payment involved a short period, only 215 days. Therefore, the first coupon payment was equal to:

USD 210,000,000 * (16/100) * 215/360 = USD 20,066,667.

The final cash flows are summarized in the following table.

Exchange date	CHF CF	DEM CF	USD CF
30/3/82	12,375,000	30,000,000	20,066,667
30/3/83	12,375,000	30,000,000	33,600,000
30/3/84	12,375,000	30,000,000	33,600,000
30/3/85	12,375,000	30,000,000	33,600,000
30/3/86	212,375,000	330,000,000	243,600,000

YTM	8%	11%	16.8%
NPV	CHF 191,367,478	DEM 301,315,273	USD 205,485,000

By swapping its foreign interest payment obligations for USD obligations, IBM was no longer exposed to currency risk and could realize this capital gain immediately. (This is similar to closing out a foreign exchange forward contract after a profit has accumulated.)

3.B <u>Valuation of Currency Swaps</u>

Ignoring default risk, a currency swap can be decomposed into a position in two bonds in a similar way to an interest rate swap. For example, consider the position of Exxon in Example XIV.10: it is long a USD bond that pays interest at 8.25% and short an EUR bond that pays interest at 7.75%.

In general, if V is the value of a swap such as the one in Example XIV.9 to the party paying USD interest rates (Repsol),

$$V = B_F S - B_D, \qquad (XIV.1)$$

where B_F is the value, measured in the foreign currency, of the foreign denominated bond underlying the swap, B_D is the value of the domestic currency bond underlying the swap, and S is the spot exchange rate (number of units of domestic currency per unit of foreign currency). From the equation (XIV.1), we can see that the value of a swap can be determined from the term structure of interest rates in the domestic currency, the term structure of interest rates in the foreign currency, and the spot exchange rate.

Example XIV.11: Let's go back to Example XIV.6. Suppose the term structure in Denmark and the U.S. is flat. The annual DKK interest rate is 5% and the annual USD rate is 6.5%. Simeone Insurance entered into a swap where it receives 5.5% annually in DKK and it pays 6% annually in USD, once a year. The exchange rate is .18868 USD/DKK (5.3 DKK/USD). The principals in the two currencies are DKK 53 million and USD 10 million. Below, we show the annual payments:



At the end of the third year, the principals are exchanged. The value of the swap can be obtained by calculating the present value of the exchanged sums.

 $B_D = USD .6M/(1+.065) + USD .6M/(1+.065)^2 + USD 10.6M/(1+.065)^3 = USD 9,867,577.$

 $B_F = DKK 2.915M/(1+.05) + DKK 2.915M/(1+.05)^2 + DKK 55.915M/(1+.05)^3 = DKK 53,721,661.$

Using (XIV.1), we calculate the value (to Simeone) of the swap. That is,

 $V_{Sim} = (DKK 53,721,661)x(.18868 USD/DKK) - USD 9,867,577 = USD 268,585.45.$

The value of the currency swap for the swap dealer is the opposite of Simeone's value. That is, USD -268,585.45. \P

3.B.1 Decomposition into Forward Contracts

A different decomposition of the currency swap is into a series of forward contracts. In Example XIV.11, Simeone Insurance has agreed to exchange an annual inflow of DKK 2,915,000 for an outflow of USD 600,000. At the final payment date, it has agreed to exchange a DKK 53 million inflow, for a USD 10 million outflow. Each of these payments represents a forward contract, setting the following forward FX rates:

- Swap forward rate fixed by the annual exchanges of interest payments:
 - USD 0.6M/ DKK 2,915,000 = 0.2058319 USD/DKK.
- Swap forward rate fixed by the last exchange of principals at T=3 yrs: USD 10M/ DKK 53M = **0.1886792 USD/DKK**.

We can value each of the implicit swap forward rates relative to the forward rates determined by IRPT, $\mathbf{F}_{t,T}$. Using our usual notation, $F_{t,T}$ is given by: $\mathbf{F}_{t,T} = S_t (1 + i_d x T/360)/(1 + i_f x T/360).$

Suppose in the swap, we are long the FC (for Simeone, DKK). Then, the PV, using id as the discount rate, of each annual payment j is:

 $(\mathbf{F}_{t,j} - \mathbf{S}_{wap} \text{ forward rate at time } j) \times \mathbf{A}_{mount of FC}/(1+i_d)^j$

Example XIV.12: (continuation): Simeone's value of the exchange of principals at T=3 years (Value_{SI,Principals}).

 $F_{t,T=3-yr} = .18868 \text{ USD/DKK} * (1+.065)^3/(1+.05)^3 = .19688 \text{ USD/DKK}$

Swap forward rate = USD 10M/DKK 53M = 0.1886792 USD/DKK.

Value_{SI,Principals} = $(.19688 - 0.1886792)*53M/(1+.065)^3 = USD 0.35982M$

Simeone would be willing to sell the exchange of principals for USD 0.35982M.

Note: We can do the same for each exchange of CFs. ¶

Alternatively, we can value the CFs in terms of forward domestic currency.

Suppose t_j is the time of the jth settlement date, r_j is the interest rate applicable to time t_j , and $F_{t,j}$ is the forward exchange rate applicable to time t_j .

Recall that the value of a long forward contract is the present value of the amount by which the forward price exceeds the delivery price. Hence, the present value to Simeone of Example XIV.11 of the forward contract corresponding to the exchange of interest payments at time t_j is,

 $(DKK 2,915,000 F_{t,j} - USD 600,000)/(1+r_j)^{t_j}$.

The value to the financial institution of the forward contract corresponding to the exchange of principal payments at time T (maturity) is:

 $(DKK 53,000,000 F_{t,T} - USD 10,000,000)/(1+r_T)^T$.

Therefore, the value of a currency swap can always be calculated from the term structure of forward rates and the term structure of domestic interest rates.

Example XIV.13: Reconsider Example XIV.11, the exchange rate is .18868 USD/DKK or 5.3 DKK/USD. The difference between USD and DKK interest rates is 1.5% per year. Using IPT, the one-, two- and three-year forward exchange rates are, respectively:

.18868 USD/DKK * (1+.065) /(1+.05) = .**19137 USD/DKK**. .18868 USD/DKK * (1+.065)²/(1+.05)² = **.19411 USD/DKK**. .18868 USD/DKK * (1+.065)³/(1+.05)³ = .**19688 USD/DKK**.

The exchange of interest involves receiving DKK 2.915 million and paying USD .6 million. The risk-free USD interest rate is 6.5% per year. The value of the forward contracts corresponding to the exchange of interest is (in millions of USD):

 $(DKK 2.915 * .19137 USD/DKK - USD 0.6)/(1+.065)^1 = USD -.03957.$ $(DKK 2.915 * .19411 USD/DKK - USD 0.6)/(1+.065)^2 = USD -.03013.$ $(DKK 2.915 * .19688 USD/DKK - USD 0.6)/(1+.065)^3 = USD -.02160.$

The final exchange of principal involves receiving DKK 53 million and paying USD 10 million. The value of the forward contract is (in million USD)

 $(DKK 53 * .19688 USD/DKK - USD 10)/(1+.065)^3 = USD 0.359816M.$

The total value of the swap is:

USD 359,816 - USD 39,570 - USD 30,130 - USD 21,600 = USD 268,516,

which is in line with the result in Example XIV.10. That is, Simeone would be willing to sell this swap for USD 268,516.

Currency Swaps and Exposure

In Example XIV.13, Simeone Insurance is able to reduce its exposure to currency risk, by fixing the forward exchange rate through the currency swap. •

It can be shown that, when the interest rates in two currencies are significantly different, the payer of the low-interest currency is in the position where the forward contracts corresponding to the early exchanges of cash flows have positive values and the forward contract corresponding to final exchange of principal has a negative expected value.

Conversely, the payer of the high-interest rate currency (as in Example XIV.10) is likely to be in the opposite position; the early exchanges of cash flows have negative values and the final exchange has a positive expected value.

These results are relevant when the credit risk in the swap is being evaluated.

3.C <u>Eurobonds and currency swaps</u>

As pointed out in chapter XII, the growth of the Eurobond market was dependent on the development and growth of swap markets. As a matter of fact, the significant growth in secondary currency (AUD, CAD) issues was almost completely due to the existence of the swap market. Significant arbitrage opportunities appear by combining a Eurobond issue and swaps. For example, in Section 2.C.1, we showed how Merotex was able to obtain below LIBOR financing by issuing Euro-USD bonds and entering into an interest rate swap. Currency swaps can also be used to exploit arbitrage opportunities. Now, we will illustrate how currency swaps can also be used to reduce financing costs.

Example XIV.14: In July 1987 Hamburgische Landesbank issued a 5-year Euro-AUD zero-coupon bond. The lead-manager of the issue, Hambros, immediately arranged a swap into USD with the Commonwealth Bank of Australia. The Commonwealth Bank designed two swaps to hedge the implied cash flows of the zero coupon bond, priced against bank bills, which it normally uses for funding.

The transaction ends up with Hamburgische Landesbank paying 6-mo to Commonwealth Bank. Commonwealth Bank at the end of five years pays AUD 75 million to Hamburgische Landesbank to repay the zero coupon bond. The LIBOR is swapped with State Bank of Victoria for the bank bill rate, as a hedge; the bank bill rate is then swapped with a variety of counterparties for fixed rate AUD.

Exhibit XIV.5

The complete transaction can be seen in Exhibit XIV.5:



Commonwealth Bank made about 60 basis points on its swap, while Hamburgische Landesbank obtained financing at LIBOR-55 basis points.

Example XIV.15: On April 23, 1998, the Russian Federation took advantage of the success of its July 2003 9% ITL 500 billion bond offering, issued the previous week, and added another ITL 250 billion. The issue was launched at a spread of 435 basis points over U.S. Treasuries on a swap basis. The swap was arranged by the lead-managers, J.P. Morgan and Credito Italiano. ¶

3.D <u>Other currency swaps</u>

We have discussed fixed-for-fixed currency swaps. *Fixed-for-floating* currency swaps (also called "*circus swaps*") and *floating-for-floating* currency swaps (also called "*XCCY basis swaps*") are also frequently used.

XCCY basis swaps are quoted as USD Libor versus a foreign currency benchmark rate, say Euribor, plus/minus a spread. That is, a basis swap spread of x basis points indicates that a counterparty wanting to swap USD for a foreign currency loan must pay x basis points above/below the benchmark floating rate on foreign currency funds in return for USD Libor. On the other side, a non-US borrower will swap foreign currency for USD paying USD Libor and receiving x basis points above/below the foreign currency benchmark rate.

There is an active EUR/USD XCCY basis swap market. Suppose x is -40. That is, a company wanting to swap USD for a EUR loan must pay (Euribor - 40 bps) in return for USD Libor. On the contrary, a non-US borrower will swap EUR for USD paying USD Libor and receiving Euribor – 40 bps.

Example XIV.16: A European company issues a straight 5-year Yankee bond (a USD bond) and wants to change the exposure to floating EUR.

Since the fixed-for-fixed currency swap market tend to be illiquid for durations longer than 18 months, the European company first enters into a 5-year plain vanilla interest swap, paying fixed USD and receiving USD Libor. Then, the European company enters into a 5-year XCCY basis swap, paying USD Libor and receiving Euribor + x.

The XCCY basis spread usually reflects the credit needs of different markets. For example, if European banks need USD funds, the EUR/USD XCCY basis spread will decrease. This can be seen in Figure XIV.1. During the 2008-2009 financial crisis and the 2011 banking crisis, European banks needs for USD drove the EUR/USD XCCY basis spread significantly down.

FIGURE XIV.1 EUR/USD XCCY basis swap spread and the EUR/USD exchange rate (2004-2015)



Since the XCCY basis spread is an interest rate differential between two currencies, in general, we expect it to be related to the forward premium. Recall, that covered interest rate parity implies:

$$p = [(F_{t,T} - S_t)/S_t] \ge 360/T \approx (i_d - i_f).$$

In Example XIV.15, i_d represents USD Libor and i_f represents Euribor + x. It is possible to observe, however, the XCCY basis swap spread and the forward premium moving independently of each other. This can happen when the IRPT assumptions are violated. For example, during the financial crisis of 2008, USD shortages –i.e., funding problemsand credit risk created the conditions under which the XCCY basis swap spread and the forward premium moved in different directions.

♦ Applied Corner: TMCC

During the first semester of the year 2000, the cost of swapping a medium term Eurobond to USD was 5bp to 6bp, which was considered too high for many USD borrowers. While increased EUR exposure was attractive for U.S. companies, the cost was considered too high. In early June 2000, liquidity improved in the currency swap market and U.S. borrowers took advantage of the diminished costs between the EUR and USD. Toyota Motor Credit Corporation (TMCC) raises USD 7 billion to USD 8 billion annually to fund its leasing programmes. It is a regular in the international markets, and swaps all debt back to floating dollars. Despite a rating of Aa1/AAA, TMCC has seen its costs rise appreciably in the last couple of years in the wake of the downturn in the Asian markets, and now finds sub-LIBOR funding very difficult to attain in the mainstream markets. For much of 1999, the basis swap between EUR and USD made costs in the euro-market unacceptable, despite the strategic advantages offered.

On June 15, 2000, TMCC priced EUR 300 million of four-year EMTN debt via CSFB and ING Barings. The proceeds were swapped into floating USD. The Euronotes yielded 5.39% annually re-offered and 5.45% all-in-cost.

With interest-rate swap bids around 5.41% at the time, TMCC could have achieved around Euribor plus 4bp. The basis swap to USD was 1bp at most, and perhaps even flat. The borrower confirmed that LIBOR plus 5bp had been achieved --several basis points better than TMCC would have been able to hit just a week earlier. **Source:** Risk Publications, July 2000. ◆

3.E <u>Credit Risk</u>

Credit risk in the swap market refers to the potential loss to a counterparty of the present value of a swap position if the swap party defaults. Thus, a firm (firm A) only has credit risk exposure from a swap when the value of the swap to the firm is positive.

In theory, when the swap has a negative value and the counterpart (firm B) gets into financial problems, the firm could realize a windfall gain since default would lead to it getting rid of a liability. In this case, however, the counterpart would choose to sell the contract to a third party, since the swap has a positive value for the counterpart.

The most realistic assumption for firm A is as follows:

If the counterpart goes bankrupt there will be a loss if the value of the swap to firm A is positive, and there will be no effect on the firm A's position if the value of the swap to firm A is negative.

It is very important for a firm to evaluate the expected creditworthiness of the counterpart when the value of the swap is negative for the counterpart.

Example XIV.17: In Example XIV.10, Exxon pays the low-interest rate, therefore as time goes by, the value of the swap will become negative to Exxon and positive to Repsol. Repsol should be concerned of the creditworthiness of Exxon at the end of the swap contract.

3.E.1 <u>Credit Default Swap</u>

The traditional way of reducing credit risk in the swap market is to only allow as participants, companies with excellent reputations and very clean balance sheets. In the early 1990s, a variety of credit-enhancement mechanisms have been developed to reduce credit risk. But, as the 2008 financial crisis showed, companies with good reputation can default.

Now, there is a developed market for credit risk derivatives, such as *credit default swaps* (*CDS*). A CDS is an agreement between two parties. One party buys protection against specific risks associated with credit events -i.e., defaults, bankruptcy or credit rating

downgrades-, while the other sells protection against the same credit events. The long side pays a periodic fee, the premium or *spread*, usually quarterly. The short side pays the long side an agreed sum in the case of a credit event, for example, a default in bond payments. Exhibit XIV.6 summarizes the cash flows for both parties.



Payment if credit event (default) occurs

A CDS contract looks like a typical insurance contract. To buy a CDS, however, it is not necessary to own the underlying asset subject to risk. As expected, a higher risk of a credit event, a higher spread will be charged.

The usual maturities range from 1 to 10 years; 5 years is the most common maturity. Most CDS's cover a nominal amount in the USD 10M to 20M range. CDS contracts are governed by the International Swaps and Derivatives Association (ISDA), which provides standardized definitions of CDS terms, including definitions of what constitutes a credit event. CDS's are the most widely traded credit derivative contract. By the end of 2017, more than USD 9.5 trillion in debt was covered by CDS contracts.

In addition to hedging credit risk, CDS's provides the following benefits:

(1) A short positioning vehicle that does not require an initial cash outlay.

(2) Access to maturity exposures not available in the cash market.

(3) Access to credit risk not available in the cash market due to a limited supply of the underlying bonds.

(4) Investments in foreign credits without currency risk.

(5) Ability to effectively 'exit' credit positions in periods of low liquidity.

Banks routinely use credit default swaps to hedge large loan positions from a big customer. In this situation, a bank pays a counterparty a premium to take on the risk of default. If a borrower defaults on a loan, the counterparty pays up the cash.

Example XIV.18: On April 17, 2015, a CDS dealer provides Bertoni Bank the following 5-year CDS quote for a Czech Republic Eurobond issue: Notional amount = N =**USD 10 million** Premium or Spread = C = **160 bps** (annualized) Maturity: 5 years Frequency: Quarterly Payments Credit event: Default. Calculation of the Spread: (0.0160/4) * USD 10M = USD 40,000.

Bertoni Bank pays every quarter **USD 40,000**, as a premium for protection against default on a loan. If the Czech Republic defaults on the Eurobonds, then the CDS dealer pays Bertoni Bank **USD 10M**. \P

3.E.2 Credit Default Swap: Settlement

Settlement can either be physical or cash.

(1) Physical Settlement

- Protection seller pays buyer par value (N) and receives an acceptable obligation (say, Czech Republic Eurobonds) worth R, from buyer.

– Buyer of protection can choose, within certain limits, what obligation to deliver. Puts buyer in a CDB-like situation (pick lower *R* possible).

(2) Cash Settlement

- Protection seller pays buyer the difference between par value (N) and the market price of a debt obligation of the reference entity (say, market price of similar Czech Republic Eurobonds). That is, seller pays:

(100 - R)% of Notional

- To establish value of reference obligation (R%), a dealer poll or an auction can be used.

Note: Think of what the seller gets in the event of default as *recovery*, R. Given that a credit event happened, R is going to be a low value.

Cash settlement became common after 2006. In 2005, Delphi, the auto parts maker, defaulted. At that time, Delphi had only USD 2 billion in bonds outstanding, but over USD 20 billion in CDS protection. The physical settlement created a run on the defaulted Delphi bonds, causing them to trade at USD 25 over par!.

3.E.3 Credit Default Swap: Pricing

Suppose we want to price a 1-year CDS for a bond, with quarterly payments. Thus, there are 4 events and, thus, 5 possible outcomes in this CDS contract:

- No default (4 premium payments are made by bank to investor until the maturity date) - Default occurs on t_1 , t_2 , t_3 , or t_4



Effective date

To price this CDS, we follow the steps:

1) Assign probability to each event –i.e., default at t1, default at t2, etc.

2) Calculate the Present Value (PV) of the payoffs for each outcome (assuming δ_i [=1/(1+r_i)ⁱ] as the discount rate for period *i*). Recall that the dealer's net default payment is N * (1 - R).

3) Expected NPV of CDS = Sum of PV of five payoffs multiplied by their probability of occurrence. Since at inception, time t_0 , E[NPV]=0 (or close to zero), we determine the "C" paid. In this case, we call C, the CDS spread (or premium), *fair*.

 $\begin{array}{ll} \underline{Notes}: \mbox{ We think of the P_i's as "survival" probabilities over an interval:} \\ Probabilities \implies P_i \qquad [no default at t_i-issuer has survived up to time t_i] \\ \implies 1-P_i \qquad [default at t_i-issuer is "dead" at time t_i] \\ Technically, P_i is the probability of surviving over interval [t_i-t_{i-1}]. \end{array}$

Exhibit XIV.7 summarizes the CDS's payoff with the following diagram, viewing the cash flows from the seller's point of view (red=outflows, blue=inflows):

Exhibit XIV.7 CDS Payoff Diagram: Cash Flows from Seller's Perspective



Then, we can compute the expected NPV of the CDS from the seller's perspective:

 $E[NPV_{CDS \text{ seller}}] = NPV \text{ of premium payments (in blue)}$ - NPV of default payments (in red) $= (P_1 * P_2 * P_3 * P_4) * [N * C/4 * (\delta_1 + \delta_2 + \delta_3 + \delta_4)]$ $\begin{array}{l} -(1-P_1)*N*(1-R)\,\delta_1 \\ -P_1*(1-P_2)*[N*(1-R)*\delta_2-N*C/4*\delta_1] \\ -P_1*P_2*(1-P_3)*[N*(1-R)*\delta_3-N*C/4*(\delta_1+\delta_2)] \\ -P_1*P_2*P_3*(1-P_4)*[N*(1-R)*\delta_4-N*C/4*(\delta_1+\delta_2+\delta_3)] \end{array}$

Note that the above formula has as inputs *N* and C, which are known, since they are determined in the contract; and $P_i = \{P_1, P_2, P_3, P_4\}$; R; and the discount rate for period *i*, $\delta_i = 1/(1+r_i)^i$, which need to be determined.

In general, we use the following methods to determine the undetermined variables:

- (1) There are two main approaches to get P_i's:
- (a) Use a probability distribution, for example, the *exponential*. The higher the risk (and spread), the higher the decay in the survival probability.
- (b) Use no-arbitrage model. After some assumption, we can use market prices of similar bonds (ideally, from same issuer), BJ, and T-bond prices, BRF, to compute expected PV of cost of default loss as (BJ – BRF). Then, we "extract" the implied Pi's.
- (2) R is calculated from historical ("average") recovery rates. In many situations, R = 40% is used as the default input. R may be time-varying.
- (3) We use $\delta_i = 1/(1+r_i)^i$ from term structure. Under assumptions, we use same discount rate for C/4 & *N**(1 R). But, we can use different discount rates for the *defaultable* part (*N*) and *non-defaultable* parts (C).

Recall that using the above formula, we price the CDS. We determine the fair value C by setting it such that $E[NPV] \approx 0$.

Example XIV.19: Pricing Bertoni Bank's CDS, with 2 payments left

Data: Notional amount = N =**USD 10 million** (Czech Republic Eurobonds) Premium or Spread = C = **160 bps** Maturity: 6 months (2 payments left) Frequency: Quarterly Payments Credit event: Default Discount rates: 3-mo = 0.035; & 6-mo = 0.037. Recovery Rate = (1 - R) = 60% Quarterly payments = N * C/4 = **USD 10M * (0.0160**/4) = **USD 40,000** Probability of Default: P₁ = .99; & P₂ = .985.

 $E[\text{NPV of CDS (in USD M)}] = = (1 - .99) * 10 * .60 * 1/(1 + .035/4)^{1} + .99 * .015 * [10 * .60 * 1/(1 + .037/4)^{2} - .040 * 1/(1 + .035/4)^{1}] - (.99 * .985) * [.040 * {1/(1 + .035/4)^{1} + 1/(1 + .037/4)^{2}}] = 0.0694$

<u>Note</u>: At inception the E[NPV of CDS] \approx 0. In this case, we call the spread (or premium) *fair*. In this example, if a similar CDS is issued today with 2 payments left, the *fair spread* becomes C = **303.19 bps**, which we can check:

$$E[\text{NPV of CDS (in USD M)}] = = (1 - .99) * 10 * .60 * 1/(1 + .035/4)^{1} + .99 * .015 * [10 * .60 * 1/(1 + .037/4)^{2} - .075796 * 1/(1 + .035/4)^{1}]$$

$$-(.99*.985)*[.075796*{1/(1+.035/4)^1+1/(1+.037/4)^2}] \approx 0.$$

The quarterly payments are given by:

```
N * C/4 = USD 10M * (0.030319/4) = USD 75,796. \P
```

3.E.4 Credit Default Swap: Risks

CDS are bilateral contracts, often sold and resold among parties. Large market, due to netting, the notional size of the CDS market is approximately $1/10^{th}$ the size of the gross notional market. Given the structure of the market, we have the following risks:

(i) The main risk is *counterparty risk*—i.e., the seller defaults. If a major counterparty (say, AIG, Lehman) defaults a large number of market participants are left un-hedged.

(ii) If a large seller defaults, network domino effects are possible.

(iii) Collateral & margin can spiral out of control. Asset values are correlated with CDS protection sold & the economy. To post more collateral, firms have to de-leverage (sell assets at worst time: *fire sale*.)

(iv) Modeling CDS spreads is complicated:

- The CDS market is illiquid –i.e., it is difficult to trust the observed market prices.
- P_i's are not easy to determine.
- Financial asset returns have fat-tailed and left-skew distributions.
- Difficult to aggregate risks, since it is not trivial how to measure default correlations.

• The Risks of CDS: AIG and the Government Bailout in 2008

In 2005 and early 2006, AIG sold protection on N = USD 500B in assets, including USD 78B on collateralized debt obligations –backed by debt payments from mortgages, home equity loans, etc. At inception:

– P_i's were set very low.

- Default correlations were well not incorporated into model risks.

- Given AIG status, no collateral was required. It was required only under certain events (AIG's credit rating falls below AA-).

As write-downs in real estate grew in 2007-2008, AIG rating was lowered below AA-. By September 2008, margin calls reached USD 32B.

- AAIG started the write-downs (asset prices down) and, then, faced more margin calls.

– Eventually, margin calls rose to USD 50B.

- On September 16, 2008, the Federal Reserve provided a 2-year USD 85B loan in return of 79.9% of AIG's equity. IAG used USD 62B of the Fed's loan to unwind the CDS positions, which was difficult, because at that time the market was extremely illiquid. Later on, the U.S. Treasury modified and increased its AIG's rescue package, totaling USD 182 billion.

<u>Aside</u>: AIG did not help itself by investing the collateral cash received from shorts in subprime mortgage paper. At that time, AIG was a big player in the lending securities market. Then, as shorts returned stock because of AIG's problems, AIG could not give the collateral back. •

IV. Extensions

The basic structure of a swap is very simple. These simple structures, however, can solve complex problems. In this section, with simple examples, we will introduce the other two major components of the swaps market: commodity swaps and equity swaps. Commodity and equity swaps work in the same way as interest rate and currency swaps. We will also outline how to combine different swaps to solve problems and to create financial instruments. That is, we are going to outline some examples of *financial engineering*.

4.A <u>Commodity Swaps</u>

In a commodity swap, one party makes periodic payments to the counterparty at a per-unit fixed price for a given notional quantity of some commodity. The counterparty pays to the first party the corresponding per unit floating price, usually an average price, for a given notional quantity of the same commodity. In general, the commodities are the same, but they do not need to be. All exchanges of commodity, if any, take place in the cash markets. Usually, there is no exchange of notional commodities.

Example XIV.20: Combining swaps: A coffee swap, an interest rate swap and a currency swap. Belabu, a Lituanian gourmet coffee producer, uses **500,000 pounds** of Colombian coffee every six months. Belabu has contracts to sell its output at a fixed price for four years and would like to fix its input costs for the same period. Since coffee is priced in the world's markets in dollars, this exposes Belabu to two forms of price risk: (1) the price of coffee and (2) the price of dollars (USD). Belabu would like to engineer a mechanism, which would allow it to fix the price of coffee in Lituanian Litts (that is, LTT/pound of coffee). The current exchange rate is **4.74 LTT/USD** and the current spot price of Colombian coffee is USD 1.95 per pound.

Belabu approaches a commodity swap dealer. The current mid-price quote for a four-year coffee swap is USD 1.99 per pound. The commodity swap dealer will receive a fixed-price of USD 2.05 per pound and pay Belabu the average market price of coffee. (The dealer adds USD .06 to its mid-price when it is fixed-price receiver.)

Four-year interest rates swaps are available at a rate of **8.2%** against 6-mo. LIBOR. Four-year LTT-for-USD currency swaps are available at a rate of **7.8%** against 6-mo. LIBOR.

The solution for Belabu is to simultaneously enter three carefully constructed swaps. Structuring the swap consists of the following steps:

1. Determine the number of USD Belabu will need every six months.

500,000 x **2.05** = USD 1,025,000.

2. Determine the notional principal required on a USD interest rate swap for the fixed-rate side to generate USD 1,025,000 every six months using the current **8.2%** for USD interest rate swaps.

1,025,000 / (.082/2) = 1,025,000 / .041 = USD 25,000,000.

3. Calculate the present value of the cash flows on the fixed-rate side of the interest rate swap using the current 8.2%.

PV(1,025,000, **.041**,8 periods)= USD 6,872,600.

4. Translate the present value of the dollar cash flows on the fixed-rate side to its equivalent in LTT.

4.74 LTT/USD * USD 6,872,600 = LTT 32,576,124.

5. Determine the LTT cash flow on the fixed-rate side of the LTT-for-USD currency swap having a present value of LTT 32,576,124 at the current rate of **7.8%**.

Coupon(PV=32,576,124, .039, 8 periods) = LTT 4,818,500.

6. Determine the LTT notional principal that would generate the quarterly payments of LTT 4,818,500 at 7.8%.

LTT 4,818,500 / (.078/2) = LTT 4,818,500 / .039 = LTT 123,551,282.10.

Now, we can combine the three swaps that form the structured solution. In Exhibit XIV.8, we present the swap structure.





The structured solution has fixed the price of coffee for four years at

LTT 4,818,500 / 500,000 pounds of coffee = 9.637 LTT/pound of coffee.

4.B Synthetic Instruments and Equity Swaps

Synthetic instruments (or synthetic securities) are not securities at all. They are cash flow streams formed by combining or decomposing the cash flow streams from one set of instruments to replicate the cash flow streams of another set of instruments. Because the cash flow streams replicate or synthesize the cash flow streams of the real instruments, the synthesized cash flow streams can be regarded as synthetic instruments.

When combined with appropriate cash positions, it is possible to use swaps to replicate the cash flow stream associated with virtually any financial instrument.

Example XIV.21: Synthetic dual-currency bonds.

Bertoni Bank issues a 5-year dual currency bond that is sold and redeemed in USD but pays interest in JPY. Bertoni Bank issues 1,000 bonds, with face value equal to USD 1,000 and pays a semiannual coupon rate of JPY 6.5 million. Suppose the current spot rate is 100 JPY/USD.

Such a bond can be synthesize by taking a corporate bond which pays both interest and principal in USD (USD-pay bond) and entering a fixed-for-fixed currency swap. For example, Chase bonds, which mature on 02/01/03, pay a coupon rate of 7.5%. A currency swap dealer offers USD 7.5% against JPY 6.5%, that is, the swap dealer will pay USD 7.5% interest payments and will receive JPY 6.5% interest payments.

Selling short USD 1,000,000 worth of Chase bonds and entering into a fixed-for-fixed currency swap exactly replicates Bertoni Bank's dual currency bond. That is, Bertoni Bank's dual currency bond has been synthesized. \P

Equity swaps are similar to the pure vanilla interest rate swap. In an equity swap, however, the floating rate is pegged to the total return on some stock index. This total return includes both dividend and capital gains. The chosen index can be a broad market index like the Nikkei 225, the FTSE 100, or a narrower market index that trails a specific sector, such as an Internet index.

Example XI.22: Synthetic equity.

Goyco Corporation, a U.S. company, has USD 3 million to invest in equity for two years. The president of Goyco expects the Japanese market to do very well in the near future. Rather than buying Japanese equity directly, she decides to invest in Japan indirectly, by synthesizing equity from a fixed-rate note and equity swap. Goyco buys a USD 3 million face value two-year corporate bond with a coupon rate of 7.8%, which is currently priced at par. At the same time, Goyco enters into a two-year equity swap with an equity dealer. The swap calls for Goyco to pay the swap dealer 6.5 percent annually in exchange for the swap dealer paying Goyco the return on the Nikkei 225. Both payments will be calculated on the basis of a USD 3 million of notional principal.

The swap dealer pays Goyco when the equity return (Nikkei 225) is positive, but Goyco pays the swap dealer when the equity return is negative (this payment is in addition to the 6.5% it pays the swap dealer on the fixed-rate leg of the swap).

Exhibit XIV.8 Structured Solution for Goyco Corporation



It should be obvious that this strategy allows Goyco to have a position with a return equal to the Nikkei 225 plus 130 basis points (see Exhibit XIV.8). The net effect is to create the equivalent of an equity position for Goyco. Before SFAS 133, which became effective on July 1, 2000, this transaction had another advantage: due to the off-balance sheet nature of swaps pre SFAS 133, Goyco only shows its two-year corporate bond on its balance sheet. \P

Whether or not it is profitable to synthesize a financial instrument will depend on whether, by doing so, the investor can earn a return greater than that on a real financial instrument having equal risk.

The swap pricing issue has been ignored in Example XIV.21 and in Example XIV.22. The swap pricing is extremely important in any decision involving a "real" instrument and a synthetic security.

♦ Financial Engineering: All You Need is Swaps

As we have seen in the above examples, swaps are very flexible instruments, which can be used to solve very different problems: fixing prices, replicate instrument, create new positions.

Swaps have been dubbed TRICK ME instruments, where the T stands for technology, the R stands for risk, the I stands for innovation, the C stands for creativity, the K stands for knowledge, the M stands for Marketing, and the E stands for Engineering. •

V. Looking Ahead

In this chapter we have studied the most common types of swaps: interest rate, currency, commodity and equity. Swaps are generally used as medium-term and long-term instruments. Swaps are so flexible that investors can easily hedge almost any underlying risk with swaps. Short-term risks, however, are better hedged with other instruments. In

particular, short-term interest rate risk is usually hedge with short-term instruments, such as eurocurrency futures contracts. Eurocurrency futures are the most liquid futures contracts traded in futures exchanges around the world. Eurocurrency futures and swaps are closely related. Recall that the most popular swap is the interest rate swap. In this chapter the fixed rate of interest rate swaps has been taken as given. The swap rate is determined using successive eurocurrency futures. Eurocurrency futures and option contracts are the topic of the next chapter.

Related readings:

For a complete introduction to the swaps markets, see **The Swaps Market**, by John F. Marshall and Kenneth R. Kapner (some sections of this chapter are based on this book).

For a very simplified introduction to financial engineering, see **Financial Engineering: A Handbook of Derivative Products**, by Eckl, Robinson and Thomas, published by Blackwell.

Exercises:

1.- Suppose that the term structure of interest rates is flat in the U.S. and Mexico. The USD interest rate is 6.5% a year, while the Mexican peso (MXP) interest rate is 11%. The exchange rate is 3.45 MXP/USD. Under the terms of the swap, a financial institution pays 8% per year in MXP and receives 5% a year in USD. The principals in the two currencies are USD 10 million and MXP 20 million. Payments are exchanged every year. There are three more years in the contract. What is the value of the swap to the financial institution?

2.- Lyon D'Or, a Canadian manufacturer, wants to borrow USD at a fixed rate of interest. Carpot, a U.S. company, wants to borrow CAD at a fixed rate of interest. They have been quoted the following annual rates.

	CAD	USD
Lyon D'Or	11.0	7.0%
Carpot	10.6%	6.2%

Design a swap that will net a bank, acting as intermediary 10 basis points per year and which will produce an apparent gain of 15 basis points per year for each of the two companies.

3.- Discuss the difference between credit risk and market risk. Is it possible to hedge credit risk?

4.- Why are the notional principals on a currency swap sometimes exchanged while the notional principals on an interest rate swap never are exchanged?

5.- Explain why some currency swaps often are referred as "exchanges of borrowings." Draw a typical cash flow scenario to illustrate your argument.

6.- In Example XIV.10 assume the swap is for 5 years. The term structure in the U.S. and in Spain is flat. The USD interest rate is 8% a year, while Spain's EUR interest rate is 7.50%.

i. Value the swap by decomposing it into:

a) two bonds.

b) a series of forward contracts.

ii. Three years into the swap the exchange rate changes to 1.1910 USD/EUR. What can you say about the value of the 2-year swap to Exxon?

7.- A Canadian investor would like to hold CAD-pay zero coupon bonds. Can you synthesize such a bond from a U.S. Treasury zero coupon bond?

8.- BKP, a German pension fund, holds a U.S. stock portfolio on which it earns a volatile equity return that is highly correlated with the S&P 500 index. This return is in USD. The manager of BKP, G. Muller, after 10 years at his position, retires. The new manager, Karl Fisher, would like to have its income in the form of fixed-rate EUR. You are the financial

engineer at BKP. Mr. Fisher calls you to structure a solution. Present in an exhibit, similar to Exhibit XIV.5, the structured solution to Mr. Fisher's problem. (Note that Mr. Fisher wants a fixed cash flow in EUR from holding a U.S. stock portfolio.)

9.- Consider the following fixed-for-floating interest rate swap situation:

	Cost of Borrowing	
	Floating-Rate Market	Fixed-Rate Market
Cannigia Co.	6-mo. T-Bill+ 3/8%	91/2%
Balbo Co.	6-mo. T-Bill+ ½%	7%

A.- Suppose Balbo Co. wants to borrow in the Floating-Rate Market and knows that Cannigia might be interested in taking USD 1 million, 20-year Fixed-Rate debt. Balbo Co. decides to approach Cannigia Co. to arrange a deal. Describe a swap arrangement that Cannigia Co. will take. Under your arrangement what is the net cost of borrowing for both parties?

B.- Ten years into the swap, Cannigia Co. wants to close the swap. It approaches a swap dealer that quotes 12%. What is the market value of the swap to Cannigia Co.?

10.- Draw a graph showing the payoff structure of the synthetic instrument described in Example XIV.20.

11.- Sakartvelo Oil, a Georgian firm, exploits oil wells in the Central Asia. Sakartvelo extracts a million barrels of oil a year. Sakartvelo's stock earns a volatile return, which is highly dependent on the price of oil. This return is in USD. The manager of Sakartvelo, Mr. Bagratid, is uneasy about the exchange rate exposure and decides to fix the price of oil in terms of laris (GEL) for two years. You work for Mr. Bagratid. A commodity swap dealer offers a two-year mid-quote price of USD 19.30 per barrel of oil (the dealer spread is USD .05). Two-year swap interest rates are available at a rate of 7.8% against 6-mo. LIBOR. Two-year GEL-for-USD currency swaps are available at a rate of 12.5% against 6-mo. LIBOR. The current exchange rate is .40 USD/GEL. Present in an exhibit your proposed structured solution to Bagratid's problem. Determine the price of a barrel of oil in terms of GEL.

12.- The annual Czech koruna (CZK) interest rate is 10%, while the annual USD interest rate is 6.5%. Bertoni Bank, a U.S. firm, has entered into a currency swap where it receives 7.0% annually in USD and pays 11% annually in CZK. The principals in the two currencies are USD 2 million and CZK 60 million. The swap will last for another three-years. The exchange rate is .030 USD/CZK. For simplicity, assume the term structure in the Czech Republic and in the U.S. is flat.

A.- Value this currency swap using the forward currency contract decomposition.

B.- Two years from now, the exchange rate is .025 USD/CZK. What is the market valuation of the last year of the swap exchanges for Bertoni Bank? (Recall that the market

valuation is the present value of the difference between what is stipulated in the contract and the market valuation of those payments).

13.- A U.K pension fund owns a USD 100,000,000 Eurobond with a coupon of 5%. The bond will mature on January 19, 1999 years. On January 19, 1997, the Euro-USD bond has YTM of 7.23% p.a. An investment bank proposes to buy the bonds at par and to pay the 5% coupon annually. In exchange, the institutional investor will pay 6-mo LIBOR + 46 bps s.a. The institutional investor will do a swap in the market at 2-year U.S. Treasuries plus 46 bps against 6-mo LIBOR. The 2-year U.S. Treasury yields 6.31% s.a. The exchange rate is 1.52 USD/GBP. Is the operation convenient for the U.K. pension fund? That is, what are the profit/loss in GBP of this operation for the U.K. pension fund? Construct a table with all the cash flows (note that some cash flows are semiannual, while others cash flows are annual).

14.- Go back to Section 3.D. With a diagram, show how TMCC got LIBOR plus 5bps funding. Hint: there are two swaps: a currency swap and an interest rate swap.