THE FRANK J. FABOZZI SERIES

the global money markets

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frank j. fabozzi, steven v. mann & moorad choudhry

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The Global money markets

FRANK J. FABOZZI
STEVEN V. MANN
MOORAD CHOUDHRY

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FJF
To my wife, Donna,
and my children, Karly, Patricia, and Francesco

SVM
To my wife Mary and our daughters Meredith and Morgan.

MC
To Olga—like the wild cat of Scotland,
both elusive and exclusive…

The views, thoughts and opinions expressed in this book are those of the authors in their private capacity and should not be taken to be representative of any employing institution or named body. The views of Moorad Choudhry are those of his in his individual capacity and should not in any way be attributed to JPMorgan Chase Bank, or to Moorad Choudhry as a representative, officer or employee of JPMorgan Chase Bank.

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CHAPTER 1
Introduction

The money market is traditionally defined as the market for financial assets that have original maturities of one year or less. In essence, it is the market for short-term debt instruments. Financial assets traded in this market include such instruments as U.S. Treasury bills, commercial paper, some medium-term notes, bankers acceptances, federal agency discount paper, most certificates of deposit, repurchase agreements, floating-rate agreements, and federal funds. The scope of the money market has expanded in recent years to include securitized products such mortgage-backed and asset-backed securities with short average lives. These securities, along with the derivative contracts associated with them, are the subject of this book.

The workings of the money market are largely invisible to the average retail investor. The reason is that the money market is the province of relatively large financial institutions and corporations. Namely, large borrowers (e.g., U.S. Treasury, agencies, money center banks, etc.) seeking short-term funding as well as large institutional investors with excess cash willing to supply funds short-term. Typically, the only contact retail investors have with the money market is through *money market mutual funds*, known as *unit trusts* in the United Kingdom and Europe.

Money market mutual funds are mutual funds that invest only in money market instruments. There are three types of money market funds: (1) general money market funds, which invest in wide variety of short-term debt products; (2) U.S. government short-term funds, which invest only in U.S. Treasury bills or U.S. government agencies; and (3) short-term municipal funds. Money market mutual funds are a popular investment vehicle for retail investors seeking a safe place to park excess cash. In Europe, unit trusts are well-established investment vehicles for retail savers; a number of these invest in short-term assets and thus are termed money market unit trusts. Placing funds in a unit trust is an effective means by which smaller investors can leverage off the market power of larger investors. In the UK money market, unit trusts typically invest in deposits, with a relatively small share of funds placed in money market paper such as government bills or certificates of deposit. Investors can invest in money market funds using one-off sums or save through a regular savings plan.

THE MONEY MARKET

The money market is a market in which the cash requirements of market participants who are *long* cash are met along with the requirements of those that are *short* cash. This is identical to any financial market; the distinguishing factor of the money market is that it provides for only short-term cash requirements. The market will always, without fail, be required because the needs of long cash and short cash market participants are never completely synchronized. The participants in the market are many and varied, and large numbers of them are both borrowers and lenders at the same time. They include:

- the sovereign authority, including the central government ("Treasury"), as well as government agencies and the central bank or *reserve bank*;
- financial institutions such as the large integrated investment banks, commercial banks, mortgage institutions, insurance companies, and finance companies;
- corporations of all types;
- individual private investors, such as high net-worth individuals and small savers;
- intermediaries such as money brokers, banking institutions, etc.;
- infrastructure of the marketplace, such as derivatives exchanges.

A money market exists in virtually every country in the world, and all such markets exhibit the characteristics we describe in this book to some extent. For instance, they provide a means by which the conflicting needs of borrowers and lenders can achieve equilibrium, they act as a conduit for financing of all maturities between one day and one year, and they can be accessed by individuals, corporations, and governments alike.

In addition to national domestic markets, there is the international cross-border market illustrated by the trade in *Eurocurrencies*.[1] Of

[1] A Eurocurrency is a currency that is traded outside of its national border, and can be any currency rather than just a European one.

course, there are distinctions between individual country markets, and financial market culture will differ. For instance, the prevailing financial culture in the United States and United Kingdom is based on a secondary market in tradable financial assets, so we have a developed and liquid bond and equity market in these economies. While such an arrangement also exists in virtually all other countries, the culture in certain economies such as Japan and (to a lesser extent) Germany is based more on banking relationships, with banks providing a large proportion of corporate finance. The differences across countries are not touched upon in this book; rather, it is the similarities in the type of instruments used that is highlighted.

In developed economies, the money market is large and liquid. Exhibit 1.1 illustrates the market growth in the United States during the 1990s. Exhibit 1.2 illustrates the breakdown of the United Kingdom money market by different types of instrument, each of which we cover in detail in this book.

OVERVIEW OF THE BOOK

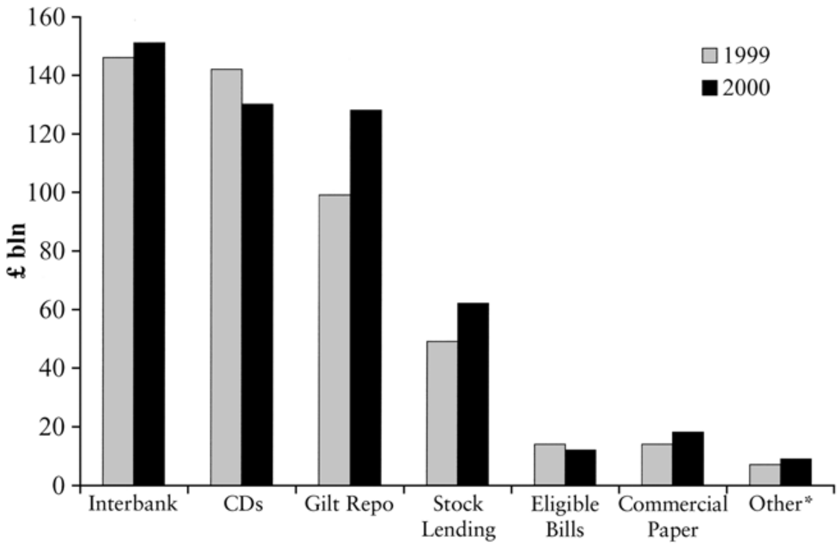
In Chapter 2 we cover money market calculations. The intent of this chapter is to introduce some of the fundamental money market calculations and conventions that will be used throughout this book, including day count conventions, as well as the basic formulae for price and yield. It is essential to understand these calculations since some market instruments are interest bearing while others are discount instruments. Moreover, some instruments calculate interest based on a 360-day year and some money market securities use a 365-day year.

EXHIBIT 1.1 **US Money Market Volumes, $ Billion at Year-End**

Instrument	1990	1995	1999
Treasury bills	527	748	723
Federal agency securities	435	845	1,284
Commercial paper	561	675	1,213
Bankers' acceptances	55	29	21
Fed funds borrowers and repo	409	569	762
Eurodollar borrowings	37	94	167
CDs (min size $100,000)	432	345	634

Source: Federal Reserve Bulletin, 2000, 2001

EXHIBIT 1.2 **Composition of Sterling Money Markets, £ Billion Volume Outstanding**



* Includes Treasury bills, sell/buy-backs and local authority bills
Source: Bank of England *Quarterly Bulletin*, Autumn 2001

Chapters 3 and 4 cover short-term debt instruments issued by some of the largest borrowers in the world—the U.S. Treasury and U.S. federal agencies. U.S. Treasury bills are considered among the safest and most liquid securities in the money market. Treasury bill yields serve as benchmark short-term interest rates for markets around the world. Agency securities are *not* typically backed by the full faith and credit of the U.S. government, as is the case with Treasury bills. However, short-term agency securities are considered safer than other money market instruments except U.S. Treasury bills.

Another large borrower of short-term funds is a corporation using instruments such as commercial paper or short-term medium term notes. These instruments are the subject of Chapter 5. Commercial paper is a short-term unsecured promissory note that is issued in the open market and represents the obligation of the issuing corporation. An important innovation in this market is asset-backed commercial paper. Asset-backed commercial paper is commercial paper issued by either corporations or large financial institutions through a bankruptcy-remote special purpose corporation and is usually issued to finance the purchase of receivables and other similar assets. In contrast, a medium-term note is a corporate debt instrument with the unique characteristic that notes are offered continuously to investors by an agent of the issuer. The maturities of medium-term notes range from 9 months to 30 years or longer. Our focus will be on medium-term notes with original maturities of one year or less.

The largest group of players in the global money markets are financial institutions that include depository institutions, investment banks, and insurance companies. These institutions are simultaneously the biggest investors in and issuers of money market instruments. There are specialized instruments that are unique to this group of borrowers which include certificates of deposits, bankers acceptances, federal funds, and funding agreements. Chapter 6 details these instruments.

Chapter 7 describes short-term floating-rate securities. The term "floating-rate security" covers several different types of instruments with one common feature: the security's coupon rate will vary over the life of the instrument. Approximately, 10% of publicly traded debt issued worldwide possesses a floating coupon. Floating-rate securities are the investment of choice for financial institutions whose funding costs are based on a short-term floating rate.

One of the largest segments of the global money markets is the market for repurchase agreements. The repurchase agreement on one hand is an efficient mechanism used by security dealers to finance bond positions, and on the other a relatively safe investment opportunity for investors such as money market funds and corporations. In Chapter 8, we review repurchase agreements as well as their major uses.

Chapters 9 and 10 cover short-term mortgage-backed and asset-backed securities. Mortgage-backed securities are securities backed by a pool of mortgage loans. The pool of loans is referred to as the collateral. While residential mortgages are by far the largest type of asset that has been securitized, other assets such as consumer loans, business loans and receivables have also been securitized. Securities backed by collateral other the mortgage loans are called asset-backed securities. The largest sectors of the asset-backed securities market in the United States are securities backed by credit card receivables, auto loans, home equity loans, manufactured housing loans, and student loans.

Derivatives are financial instruments that derive their value from some underlying price, index, or interest rate. Money market practitioners use derivatives to control their exposure to risk by taking positions to either diminish or enhance this exposure. In Chapters 11 and 12, we describe these derivative instruments and how they are employed to create advantageous risk and return patterns. Chapter 11 describes forward contracts, futures contracts, and forward rate agreements. Chapter focuses on swap contracts and caps/floors.

The activity of financial institutions in the money market involves an activity known as asset and liability management. Asset and liability management is the term covering tools and techniques used by financial institutions to manage various types of risk while achieving its profit objectives by holding the optimal combination of assets and liabilities. We introduce the fundamental principles of asset and liability management in Chapter 13. An appreciation of these concepts and tools is essential to an understanding of the functioning of the global money markets.

The final chapter of the book, Chapter 14, describes bank regulatory capital issues. As noted, the primary players in the global money markets are large financial institutions, in particular depository institutions. These entities are subject to risk-based capital requirement. The asset allocation decisions by managers of depository institutions are largely influenced by how much capital they are compelled to hold and the capital costs incurred. As a result, these money market participants must risk-based capital issues regardless of the products they trade or else they will not fully understand the cost of their own capital or the return on its use.

CHAPTER 2

Money Market Calculations

The intent of this chapter is to introduce some of the fundamental money market calculations that will be used throughout this book. We will cover such topics as day count conventions, as well as the basic formulas for price and yield.

DAY COUNT CONVENTIONS

To those unfamiliar with the workings of financial markets, it may come as a shock that there is no widespread agreement as to how many days there are in a year. The procedures used for calculating the number of days between two dates (e.g., the number of days between the settlement date and the maturity date) are called *day count conventions*. Day count conventions vary across different types of securities and across countries. In this section, we will introduce the day count conventions relevant to the money markets.

Day Count Basis

The *day count basis* specifies the convention used to determine the number of days in a month and in a year. According to the *Securities Industry Association Standard Securities Calculation Methods* book, Volume 2, the notation used to identify the day count basis is:[1]

(number of days in a month)/(number of days in a year)

[1] See, Jan Mayle, *Standard Securities Calculation Methods, Volume 2* (New York; Securities Industry Association, 1994).

Although there are numerous day count conventions used in the fixed-income markets around the world, there are three basic types.[2] All day count conventions used worldwide are variations of these three types. The first type specifies that each month has the actual number of calendar days in that month and each year has the actual number of calendar days in that year or in a coupon period (e.g., Actual/Actual). The second type specifies that each month has the actual number of calendar days in that month but restricts the number of days in each year to a certain number of days regardless of the actual number of days in that year (e.g., Actual/360). Finally, the third types restricts both the number of days in a month and in a year to a certain number of days regardless of the actual number of days in that month/year (e.g., 30/360). Below we will define and illustrate the three types of day count conventions.

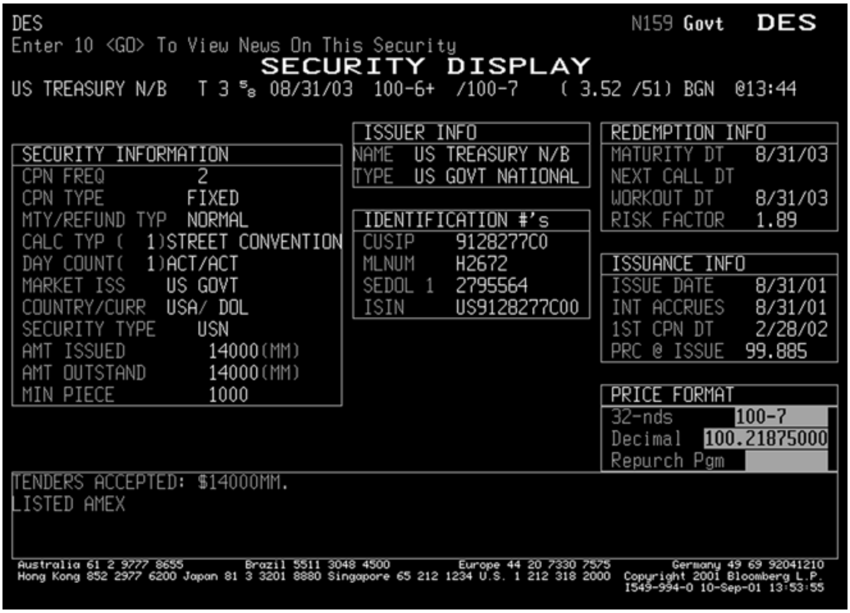
Actual/Actual

Treasury notes, bonds and STRIPS use an Actual/Actual (in period) day count convention. When calculating the number of days between two dates, the Actual/Actual day count convention uses the actual number of calendar days as the name implies. Let's illustrate the Actual/Actual day count convention with a 3.625% coupon, 2-year U.S. Treasury note with a maturity date of August 31, 2003. The Bloomberg Security Display (DES) screen for this security is presented in Exhibit 2.1. In the "Security Information" box on the left-hand side of the screen, we see that the day count is specified as "ACT/ACT." From the "Issuance Info" box on the right-hand side of the screen, we see that interest starts accruing on August 31, 2001 (the issuance date) and the first coupon date is February 28, 2002. Suppose this bond is traded with a settlement date of September 11, 2001. How many days are there between August 31, 2001 and September 11, 2001 using the Actual/Actual day count convention?

To answer this question, we simply count the actual number of days between these two dates.[3] To do this, we utilize Bloomberg's DCX (Days Between Dates) function presented in Exhibit 2.2. The function tells us there are 11 actual days between August 31, 2001 and September 11, 2001.[4] In the same manner, we can also determine the actual number of calendar days in the full coupon period. A full 6-month coupon period can only have 181, 182, 183 or 184 calendar days. For example, the actual number of days between August 31, 2001 and February 28, 2002 is 184.

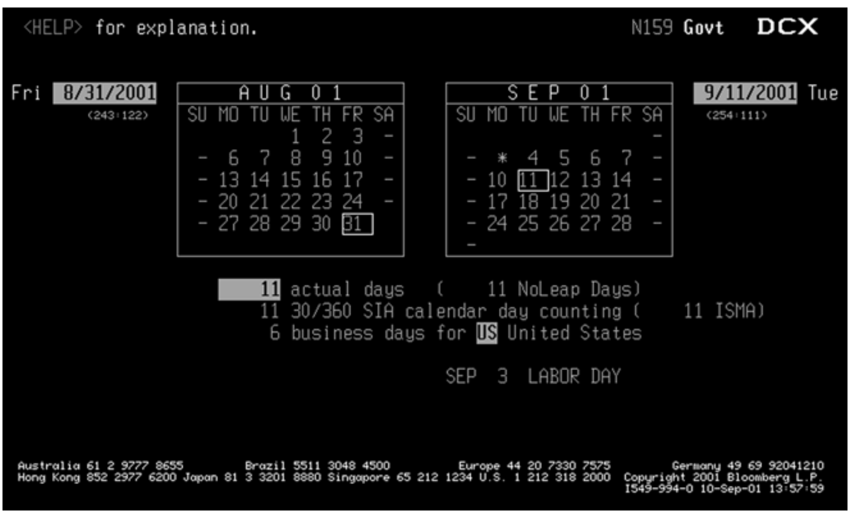
[2] Bloomberg identifies 24 different day count conventions.
[3] This is easy to accomplish using software that can convert a Gregorian date (MM/DD/YY) into a Julian date (the number of days since some base date).
[4] Note that the settlement date (September 11) is not counted.

EXHIBIT 2.1 Bloomberg Security Description Screen for a 2-Year U.S. Treasury Note



Source: Bloomberg Financial Markets

EXHIBIT 2.2 Bloomberg DCX (Days Between Dates) Screen



Source: Bloomberg Financial Markets

EXHIBIT 2.3 **Bloomberg Security Description Screen of a 26-Week U.S. Treasury Bill**

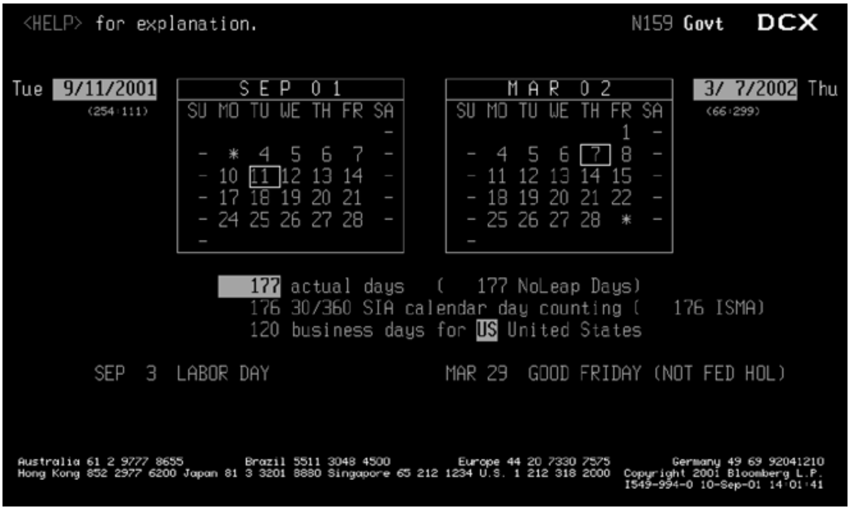
Source: Bloomberg Financial Markets

Actual/360

Actual/360 is the second type of day count convention. Specifically, Actual/360 specifies that each month has the same number of days as indicated by the calendar. However, each year is assumed to have 360 days regardless of the actual number of days in a year. Actual/360 is the day count convention used in U.S. money markets. Let's illustrate the Actual/360 day count with a 26-week U.S. Treasury bill which matures on March 7, 2002. The Bloomberg Security Display (DES) screen for this security is presented in Exhibit 2.3. From the "Security Information" box on the left-hand side of the screen, we see that the day count is specified as "ACT/360." Suppose this Treasury bill is purchased with a settlement date on September 11, 2001 at a price of 98.466. How many days does this bill have until maturity using the Actual/360 day count convention?

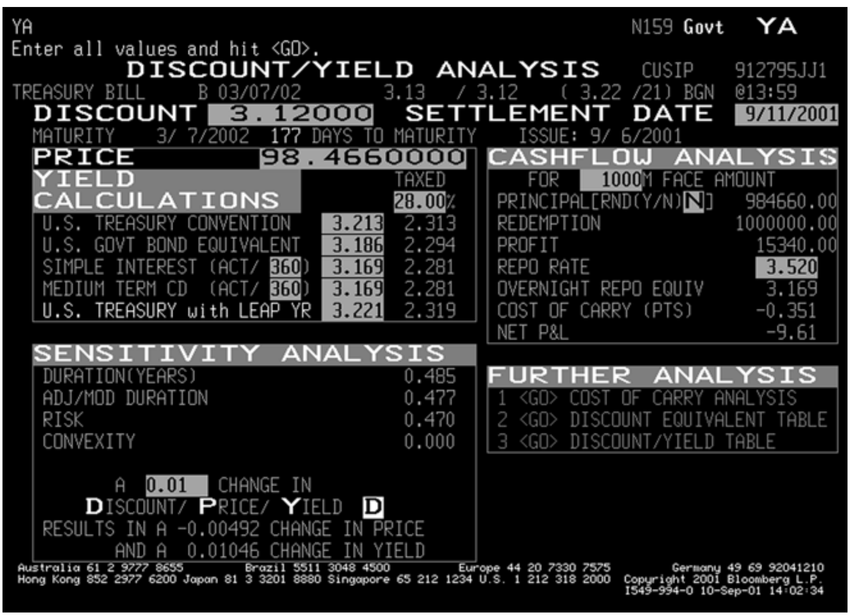
Once again, the question is easily answered using Bloomberg's DCX (Days Between Dates) function and specifying the two dates of interest. This screen is presented in Exhibit 2.4. We see that with a settlement date of September 11, 2001 there are 177 calendar days until maturity on March 7, 2002. This can be confirmed by examining the Bloomberg's YA (Yield Analysis) screen in Exhibit 2.5. We see that with a settlement date of September 11, 2001 this Treasury bill has 177 days to maturity. This information is located just above the "Price" box in the center of the screen.

EXHIBIT 2.4 Bloomberg DCX (Days Between Dates) Screen



Source: Bloomberg Financial Markets

EXHIBIT 2.5 Bloomberg Yield Analysis for a 26-Week U.S. Treasury Bill



Source: Bloomberg Financial Markets

When computing the number of days between two dates, Actual/360 and Actual/Actual will give the same answer. What then is the importance of the 360-day year in the Actual/360 day count? The difference is apparent when we want to compare, say, the yield on 26-week Treasury bill with a coupon Treasury which has six months remaining to maturity. U.S. Treasury bills, like many money market instruments, are discount instruments. As such, their yields are quoted on a bank discount basis which determine the bill's price (which we explain in detail in Chapter 3). The quoted yield on a bank discount basis for a Treasury bill is not directly comparable to the yield on a coupon Treasury using an Actual/Actual day count for two reasons. First, the Treasury bill's yield is based on a face-value investment rather than on the price. Second, the Treasury bill yield is annualized according to a 360-day year while a coupon Treasury's yield is annualized using the actual number of days in a calendar year (365 or 366). These factors make it difficult to compare Treasury bill yields with yields on Treasury notes and bonds. We demonstrate how these yields can be adjusted to make them comparable shortly.

Another variant of this second day count type is the Actual/365. Actual/365 specifies that each month has the same number of days as indicated by the calendar and each year is assumed to have 365 days regardless of the actual number of days in a year. Actual/365 does not consider the extra day in a leap year. This day count convention is used in the UK money markets.

30/360

The 30/360 day count is the most prominent example of the third type of day count convention which restricts both the number of days in a month and in a year to a certain number of days regardless of the actual number of days in that month/year. With the 30/360 day count all months are assumed to have 30 days and all years are assumed to have 360 days. The number of days between two dates using a 30/360 day will usually differ from the actual number of days between the two dates.

To determine the number of days between two dates, we will adopt the following notation:

$Y1$ = year of the earlier date
$M1$ = month of the earlier date
$D1$ = day of the earlier date
$Y2$ = year of the later date
$M2$ = month of the later date
$D2$ = day of the later date

Since the 30/360 day count assumes that all months have 30 days, some adjustments must be made for months having 31 days and February which has 28 days (29 days in a leap year). The following adjustments accomplish this task:[5]

1. If the bond follows the End-of-Month rule[6] and $D2$ is the last day of February (the 28th in a non-leap year and the 29th in a leap year) and $D1$ is the last day of February, change $D2$ to 30.
2. If the bond follows the End-of-Month rule and $D1$ is the last day of February, change $D1$ to 30.
3. If $D2$ is 31 and $D1$ is 30 or 31, change $D2$ to 30.
4. If $D1$ is 31, change $D1$ to 30.

Once these adjustments are made, the formula for calculating the number of days between two dates is as follows:

$$\text{Number of days} = [(Y2 - Y1) \times 360] + [(M2 - M1) \times 30] + (D2 - D1)$$

To illustrate the 30/360 day count convention, let's use a 4% coupon bond which matures on August 15, 2003, issued by Fannie Mae. The Bloomberg Security Description (DES) screen for this bond is presented in Exhibit 2.6. We see that in the "Security Information" box that the bond has a 30/360 day count. Suppose the bond is purchased with a settlement date of September 11, 2001. We see from the lower left-hand corner of the screen that the first coupon date is February 15, 2002 and the first interest accrual date is August 27, 2001. How many days have elapsed in the first coupon period from August 27, 2001 until the settlement date of September 11, 2001 using the 30/360 day count convention?

Referring back to the 30/360 day count rule, we see that adjustments 1 through 4 do not apply in this example so no adjustments to $D1$ and $D2$ are required. Accordingly, in this example,

$$\begin{aligned} Y1 &= 2001 \\ M1 &= 8 \\ D1 &= 27 \\ Y2 &= 2001 \\ M2 &= 9 \\ \mathrm{D2} &= 11 \end{aligned}$$

Inserting these numbers into the formula, we find that the number of days between these two dates is 14, which is calculated as follows:

[5] See, Mayle, *Standard Securities Calculation Methods, Volume 2*.

[6] This is the standard convention for bonds in the U.S. and it states that if a bond's maturity date falls on the last day of the month so do the bond's coupon payments.

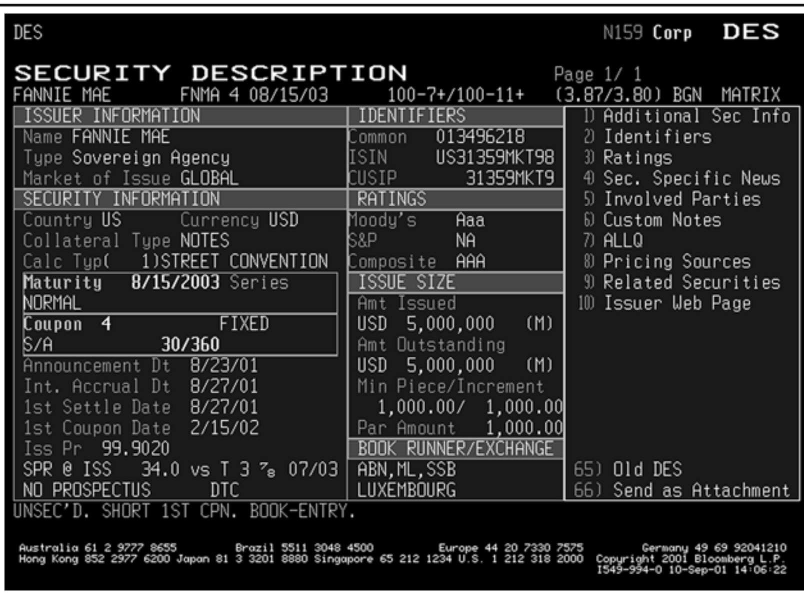
$$\begin{aligned}\text{Number of days} &= [(2000-2000)\times 360]+[(9-8)\times 30]+(11-27)\\ &= 0+30+(-16) = 14\end{aligned}$$

To check this, let's employ Bloomberg's DCX (Days Between Dates) function presented in Exhibit 2.7. The function tells us there are 14 days between August 27, 2001 and September 11, 2001 using a 30/360 day count. Note that the actual number of days between these two dates is 15.

DISCOUNT INSTRUMENTS

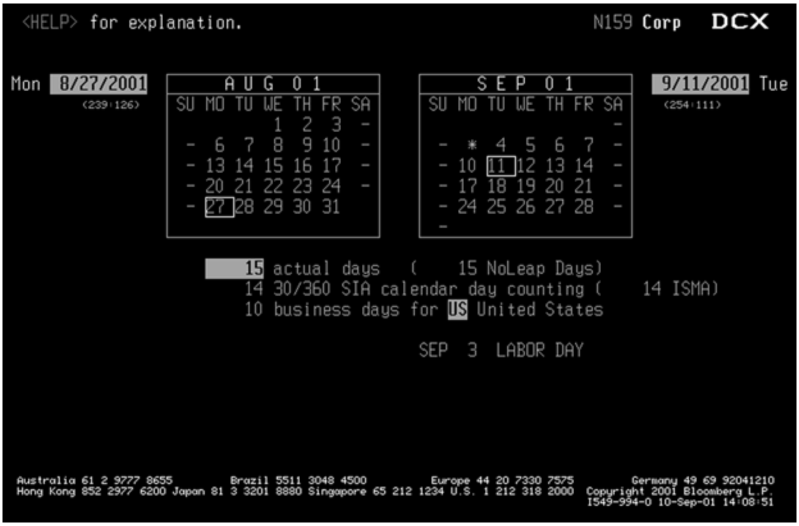
Many money market instruments are discount securities (e.g. U.S. Treasury bills, agency discount notes, and commercial paper). Unlike bonds that pay coupon interest, discount securities are like zero-coupon bonds in that they are sold at a discount from their face value and are redeemed for full face value at maturity. Further, most discount securities use an ACT/360 day count convention. In this section, we discuss how yields on discount securities are quoted, how discount securities are priced, and how the yields on discount securities can be adjusted so that they can be compared to the yields on interest-bearing securities.

EXHIBIT 2.6 **Bloomberg Security Description Screen for a Fannie Mae 2-Year Benchmark Note**



Source: Bloomberg Financial Markets

EXHIBIT 2.7 Bloomberg DCX (Days Between Dates) Screen



Source: Bloomberg Financial Markets

Yield on a Bank Discount Basis

The convention for quoting bids and offers is different for discount securities from that of coupon-paying bonds. Prices of discount securities are quoted in a special way. Bids and offers of these securities are quoted on a *bank discount basis*, not on a price basis. The *yield on a bank discount basis* is computed as follows:

$$Y_d = \frac{D}{F} \times \frac{360}{t}$$

where

Y_d = annualized yield on a bank discount basis (expressed as a decimal)
D = dollar discount, which is equal to the difference between the face value and the price
F = face value
t = actual number of days remaining to maturity

As an example, suppose a Treasury bill with 91 days to maturity and a face value of \$100 trading at a price of \$98.5846. The dollar discount, D, is computed as follows:

$$D = \$100 - \$98.5846 = \$1.4054$$

Therefore, the annualized yield on a bank discount basis (expressed as a decimal)

$$Y_d = \frac{\$1.4054}{\$100} \times \frac{360}{91} = 5.56\%$$

Given the yield on a bank discount basis, the price of a Treasury bill is found by first solving the formula for the dollar discount (D) as follows:

$$D = Y_d \times F \times (t/360)$$

The price is then

$$\text{price} = F - D$$

As an example, suppose a 91-day bill with a face value of \$100 has a yield on bank discount basis of 5.56%, D is equal to

$$D = 0.0556 \times \$100 \times 91/360 = \$1.4054$$

Therefore,

$$\text{price} = \$100 - \$1.4054 = \$98.5946$$

As noted earlier, the quoted yield on a bank discount basis is not a meaningful measure of the potential return from holding a discount instrument for two reasons. First, the measure is based on a face-value investment rather than on the actual dollar amount invested. Second, the yield is annualized according to a 360-day rather than a 365-day year, making it difficult to compare discount yields with the yields on Treasury notes and bonds that pay interest on a Actual/Actual basis. The use of 360 days for a year is a common money market convention. Despite its shortcomings as a measure of return, this is the method that dealers have adopted to quote discount notes like Treasury bills. Many dealer quote sheets and some other reporting services provide two other yield measures that attempt to make the quoted yield comparable to that for a coupon bond and interest-bearing money market instruments—the CD equivalent yield and the bond equivalent yield.

CD Equivalent Yield

The *CD equivalent yield* (also called the *money market equivalent yield*) makes the quoted yield on a bank discount basis more comparable to yield quotations on other money market instruments that pay interest on a 360-day basis. It does this by taking into consideration the price of the discount security (i.e., the amount invested) rather than its face value. The formula for the CD equivalent yield is

$$\text{CD equivalent yield} = \frac{360Y_d}{360 - t(Y_d)}$$

To illustrate the calculation of the CD equivalent, suppose a 91-day Treasury bill has a yield on a bank discount basis is 5.56%. The CD equivalent yield is computed as follows:

$$\text{CD equivalent yield} = \frac{360(0.0556)}{360 - 91(0.0556)} = 0.05639 = 5.639\%$$

Bond-Equivalent Yield

The measure that seeks to make a discount instrument like a Treasury bill or an agency discount note comparable to coupon Treasuries is the *bond-equivalent yield* as discussed earlier in the chapter. This yield measure makes the quoted yield on a bank discount basis more comparable to yields on Treasury notes and bonds that use an Actual/Actual day count convention. The calculations depend on whether the short-term discount instrument has 182 days or less to maturity or more than 182 days to maturity.

Discount Instruments with Less Than 182 Days to Maturity

To convert the yield on a bank discount to a bond-equivalent yield for a bill with less than 182 days to maturity, we use the following formula:

$$\text{Bond-equivalent yield} = \frac{T(Y_d)}{360 - t(Y_d)}$$

where T is the actual number of days in the calendar year (i.e., 365 or 366). As an example, using a Treasury bill with 91 days to maturity yielding 5.56% on a bank discount basis, the bond-equivalent yield is calculated as follows:

$$\text{Bond-equivalent yield} = \frac{365(0.0556)}{360 - 91(0.0556)} = 0.0572 = 5.72\%$$

Note the formula for the bond-equivalent yield presented above assumes that the current maturity of the discount instrument in question is 182 days or less.

Discount Instruments with More Than 182 Days to Maturity

When a discount instrument (e.g., a 52-week Fannie Mae Benchmark bill) has a current maturity of more than 182 days, converting a yield on a bank discount basis into a bond-equivalent yield is more involved. Specifically, the calculation must reflect the fact that a Benchmark bill is a discount instrument while a coupon Treasury delivers coupon payments semiannually and the semiannual coupon payment can be reinvested. In order to make this adjustment, we assume that interest is paid after six months at a rate equal to the discount instrument's bond-equivalent yield (BEY) and that this interest is reinvested at this rate.

To find a discount instrument's bond-equivalent yield if its current maturity is greater than 182 days, we solve for the BEY using the following formula:[7]

---

[7] We can derive this using the following notation:

P = price of the discount instrument
BEY = bond-equivalent yield
t = number of days until the discount instrument's maturity

then,

$P[1 + (\text{BEY}/2)]$ = future value obtained by the investor if \$$P$ is invested for six months at one-half the BEY

$(\text{BEY}/365)[t - (365/2)][1 + (\text{BEY}/2)]P$ = the amount earned by the investor on a simple interest basis if the proceeds are reinvested at the BEY for the discount instrument's remaining days to maturity

Assuming a face value for the discount instrument of \$100, then

$$P[1 + (\text{BEY}/2)] + (\text{BEY}/365)[t - (365/2)][1 + (\text{BEY}/2)]P = 100$$

This expression can be written more compactly as

$$P[1 + (\text{BEY}/2)][(1+(\text{BEY}/2))(2T/365 - 1)] = 100$$

Expanding this expression, we obtain

$$(2t/365 - 1)\text{BEY}^2 + (4t/365)\text{BEY} + 4(1 - 100/P) = 0$$

The expression above is a quadratic equation which is an equation which can be written in the form:

$$ax^2 + bx + c = 0$$

which can be solved as follows:

$$x = \frac{-b \pm (b^2 - 4ac)^{1/2}}{2a}$$

$$\text{BEY} = \frac{\dfrac{-2\times t}{T} + 2\left[\left(\dfrac{t}{T}\right)^2 - \left(\dfrac{2\times t}{T} - 1\right)\times\left(1 - \dfrac{100}{P}\right)\right]^{1/2}}{\dfrac{2\times t}{T} - 1}$$

As an example, let's use a Fannie Mae 52-week Benchmark bill that yields 5.87% on a bank discount basis and suppose there are 350 days remaining until maturity. The price of this bill would be 94.0647 (per $100 of face value). Suppose further that the year in question such that T = 366. Substituting this information in the expression above gives the bond-equivalent yield for this 52-week bill:

$$\begin{aligned}\text{BEY} &= \frac{\dfrac{-2\times 350}{366} + 2\left[\left(\dfrac{350}{366}\right)^2 - \left(\dfrac{2\times 350}{366} - 1\right)\times\left(1 - \dfrac{100}{94.2931}\right)\right]^{1/2}}{\dfrac{2\times 350}{366} - 1}\\ &= 0.0624 = 6.24\%\end{aligned}$$

INTEREST AT MATURITY INSTRUMENTS

In contrast to discount instruments, some money market instruments pay interest at maturity on a simple interest basis. Notable examples include federal funds, repos, and certificates of deposit. Interest accrues for these instruments using an Actual/360 day count convention. We define the following terms:

F = face value of the instrument
I = amount of interest paid at maturity
t = actual number of days until maturity
Y_{360} = yield on a simple interest basis assuming a 360 day year

The following formula is used to calculate the dollar interest on a certificate of deposit:

$$I = F \times Y_{360} \times (t/360)$$

As an illustration, suppose a bank offers a rate of 4% on a 180-day certificate of deposit with a face value of $1 million. Suppose an investor buys this CD and holds it to maturity, how much interest is earned. The interest at maturity is $20,000 and determined as follows:

$$I = \$1{,}000{,}000 \times 0.04 \times (180/360) = \$20{,}000$$

Converting a CD Yield into a Simple Yield on a 365-Day Basis

It is often helpful to convert a CD yield which pays simple interest on a Actual/360 into a simple yield on an Actual/365 basis. The transformation is straightforward and is accomplished using the following formula:

$$Y_{365} = Y_{360}\ (365/360)$$

To illustrate, let's return to the 180-day certificate of deposit yielding 4% on a simple interest basis. We pose the question of what is this investor earning on a ACT/365 basis. The answer is 4.056% and is calculated as follows:

$$Y_{365} = 0.04\ (365/360) = 0.0456$$

Converting a Periodic Interest Rate into an Effective Annual Yield

Suppose that \$100 is invested for one year at an annual interest rate of interest of 4%. At the end of the year, the interest received is \$4. Suppose, instead, that \$100 is invested for one year at an annual rate, but the interest is paid semiannually at 2% (one-half the annual interest rate). The interest at the end of the year is found by first calculating the future value of \$100 one year hence:

$$\$100(1.02)^2 = \$104.04$$

Interest is therefore \$4.04 on a \$100 investment. The interest rate or yield on the \$100 invested is 4.04%. The 4.04% is called the *effective annual yield*.

Investors in certificates of deposit will at once recognize the difference between the annual interest rate and effective annual yield. Typically, both of these interest rates are quoted for a certificate of deposit, the higher interest rate being the effective annual yield.

To obtain the effective annual yield corresponding to a given periodic rate, the following formula is used:

$$\text{Effective annual yield} = (1 + \text{Periodic interest rate})^m - 1$$

where m is equal to the number of payments per year.

To illustrate, suppose the periodic yield is 2% and the number of payments per year is two. Therefore,

$$\begin{aligned}\text{Effective annual yield} &= (1.02)^2 - 1 \\ &= 0.0404 \text{ or } 4.04\%\end{aligned}$$

We can also determine the periodic interest rate that will produce a given effective annual yield. For example, suppose we need to know what semiannual interest rate would produce an effective annual yield of 5.25%. The following formula can be used:

$$\text{Periodic interest rate} = (1 + \text{Effective annual yield})^{1/m} - 1$$

Using this formula to determine the semiannual interest rate to produce an effective annual yield of 5.25%, we find

$$\begin{aligned}\text{Periodic interest rate} &= (1.0525)^{1/2} - 1 \\ &= 0.0259 \text{ or } 2.59\%\end{aligned}$$

CHAPTER 3

U.S. Treasury Bills

The U.S. Treasury is the largest single borrower in the world. As of September 2001, its total marketable securities outstanding totaled \$3.339 trillion. Of this total, \$734.86 billion represents Treasury bills.[1] Treasury bills are short-term discount instruments with original maturities of less than one year. All Treasury securities are backed by the full faith and credit of the U.S. government. This fact, combined with their volume (in terms of dollars outstanding) and liquidity, afford Treasury bills a central place in the money market. Indeed, interest rates on Treasury bills serve as benchmark short-term rates throughout the U.S. economy as well as in international money markets.

This chapter provides an in-depth treatment of Treasury bills. We will describe the types of Treasury bills, how they are auctioned, price and yield calculations, and how the secondary market is organized. We will also discuss the time series behavior of Treasury bill yields relative to other key money market rates. Finally, we will discuss one time-tested portfolio strategy using Treasury bills—*riding the yield curve*.

TYPES OF TREASURY BILLS

Treasury bills are issued at a discount to par value, have no coupon rate, and mature at par value. Currently, the Treasury issues four types of Treasury bills that vary by their original maturity—28 day (1-month), 91 day (3-month), 182 day (6-month), and cash management bills.[2] As discussed in the next section, 1-month, 3-month, and 6-month bills are offered for sale each week.

[1] Source: Treasury Bulletin.
[2] The first six digits of the CUSIP for a Treasury bill are "912795."

Cash management bills are offered from time to time with various maturities. The time between the announcement of an issue, auction, and issuance is usually a week or less. For example, on August 26, 1999, the Treasury invited bids for approximately $33 billion of 15-day cash management bills. These bills were issued on August 31, 1999 at a bank discount rate of 5.18% and matured on September 15, 1999. Cash management bills are issued to bridge seasonal fluctuations in the Treasury's cash position. Owing to their variable issuance and maturity, cash management bills can mature on any business day.

Since August 1998, all Treasury securities are sold and transferable in increments of $1,000. Previously, Treasury bills were available in minimum purchase amounts of $10,000. Treasury bills are issued in book-entry form. This means that the investor receives only a receipt as evidence of ownership instead of a paper certificate. The primary advantage of book entry is ease in transferring ownership of the security. Interest income from Treasury securities is subject to federal income taxes but is exempt from state and local income taxes.

THE TREASURY AUCTION PROCESS

The Public Debt Act of 1942 grants the U.S. Treasury considerable latitude in deciding on the terms for a marketable security.[3] An issue may be sold on an interest-bearing or discount basis and may be sold on a competitive basis or other basis, at whatever prices the Secretary of the Treasury may establish. However, Congress imposes a restriction on the total amount of bonds outstanding. Although Congress has granted an exemption to this restriction, there have been times when the Congress' failure to extend the exemption has resulted in the delay or cancellation of a Treasury security offering.

Auction Schedule

As noted, the U.S. Treasury maintains a regular and predictable schedule for their security offerings. Deviations from normal borrowing patterns are announced ahead of time so that market participants can digest the news. The Treasury believes its borrowing costs will be less if it provides buyers of Treasury securities stable expectations regarding new issues of its debt.

The current auction cycles are as follows. There are weekly 4-week (1-month), 3-month, and 6-month bill auctions. With the exception of holidays and special circumstances, the 4-week bill offering is announced on Mondays and is auctioned on Tuesdays. Correspondingly, 3-month

[3] Nonmarketable Treasury securities are issued directly to U.S. Government accounts and trust funds.

and 6-month bill offerings are announced on Thursdays and are auctioned the following Monday. All bills are issued on Thursday. Because of holidays, the maturities of each bill may be either longer or shorter by one day. Prior to February 2001, 364-day (1-year) bills were issued on a regular cycle. However, due to large U.S. government budget surpluses in the fiscal years 1998 and 1999, the 1-year bill was eliminated.

Exhibit 3.1 contains an announcement dated March 11, 2002, of an offering of 4-week bills. The first 4-week bill issue was auctioned on July 31, 2001.

EXHIBIT 3.1 **Treasury Auction of a 4-Week Bill**
a. Announcement of a 4-Week Bill Auction

DEPARTMENT OF THE TREASURY

TREASURY NEWS

OFFICE OF PUBLIC AFFAIRS • 1500 PENNSYLVANIA AVENUE. N.W. • WASHINGTON. D.C. • 20220 • (202) 622-2960

EMBARGOED UNTIL 11:30 A.M. Contact: Office of Financing
March 11, 2002 202/691-3550

TREASURY OFFERS 4-WEEK BILLS

The Treasury will auction 4-week Treasury bills totaling $23,000 million to refund an estimated $18,000 million of publicly held 4-week Treasury bills maturing March 14, 2002, and to raise new cash of approximately $5,000 million.

Tenders for 4-week Treasury bills to be held on the book-entry records of *TreasuryDirect* will not be accepted.

The Federal Reserve System holds $11,532 million of the Treasury bills maturing on March 14, 2002, in the System Open Market Account (SOMA). This amount may be refunded at the highest discount rate of accepted competitive tenders in this auction up to the balance of the amount not awarded in today's 13-week and 26-week Treasury bill auctions. Amounts awarded to SOMA will be in addition to the offering amount.

Up to $1,000 million in noncompetitive bids from Foreign and International Monetary Authority (FIMA) accounts bidding through the Federal Reserve Bank of New York will be included within the offering amount of the auction. These noncompetitive bids will have a limit of $100 million per account and will be accepted in the order of smallest to largest, up to the aggregate award limit of $1,000 million.

The allocation percentage applied to bids awarded at the highest discount rate will be rounded up to the next hundredth of a whole percentage point, e.g., 17.13%.

This offering of Treasury securities is governed by the terms and conditions set forth in the Uniform Offering Circular for the Sale and Issue of Marketable Book-Entry Treasury Bills, Notes, and Bonds (31 CFR Part 356, as amended).

Details about the new security are given in the attached offering highlights.

oOo

Attachment

For press releases, speeches, public schedules and official biographies, call our 24-hour fax line at (202) 622-2040

Source: U.S. Treasury

EXHIBIT 3.1 (Continued)

b. Highlights of Treasury Offering of 4-Week Bills to be Issued March 14, 2002

March 11, 2002

Offering Amount.....................$23,000 million
Public Offering.....................$23,000 million
NLP Exclusion Amount................$ 7,900 million

Description of Offering:
Term and type of security...........28-day bill
CUSIP number........................912795 JP 7
Auction date........................March 12, 2002
Issue date..........................March 14, 2002
Maturity date.......................April 11, 2002
Original issue date.................October 11, 2001
Currently outstanding...............$30,837 million
Minimum bid amount and multiples....$1,000

Submission of Bids:
Noncompetitive bids: Accepted in full up to $1 million at the highest discount rate of accepted competitive bids.
Foreign and International Monetary Authority (FIMA) bids: Noncompetitive bids submitted through the Federal Reserve Banks as agents for FIMA accounts. Accepted in order of size from smallest to largest with no more than $100 million awarded per account. The total noncompetitive amount awarded to Federal Reserve Banks as agents for FIMA accounts will not exceed $1,000 million. A single bid that would cause the limit to be exceeded will be partially accepted in the amount that brings the aggregate award total to the $1,000 million limit. However, if there are two or more bids of equal amounts that would cause the limit to be exceeded, each will be prorated to avoid exceeding the limit.
Competitive bids:
(1) Must be expressed as a discount rate with three decimals in increments of .005%, e.g., 4.215%.
(2) Net long position (NLP) for each bidder must be reported when the sum of the total bid amount, at all discount rates, and the net long position is $1 billion or greater.
(3) Net long position must be determined as of one half-hour prior to the closing time for receipt of competitive tenders.

Maximum Recognized Bid at a Single Rate...35% of public offering
Maximum Award.............................35% of public offering

Receipt of Tenders:
Noncompetitive tenders:
Prior to 12:00 noon eastern standard time on auction day
Competitive tenders:
Prior to 1:00 p.m. eastern standard time on auction day

Payment Terms: By charge to a funds account at a Federal Reserve Bank on issue date.

Source: U.S. Treasury

Determination of the Results of an Auction

Currently, Treasury bills (and indeed all marketable Treasury securities) are sold in auctions and these auctions are conducted on the basis of yield. For bills, the yields are on a bank discount basis. Noncompetitive bids can be submitted from the public for up to $1 million face amount of Treasury bills. These noncompetitive tenders, along with any non-public purchases (e.g., purchases by the Federal Reserve) are subtracted from the total securities being auctioned. The remainder is the amount to be awarded to the competitive bidders.

The Treasury employs a single-price auction for all marketable securities it issues and has discontinued the use of multiple-price auctions. In a multiple price auction, competitive bidders (e.g., primary dealers) state the amount of the securities desired and the yields they are willing to accept.[4] The yields are then ranked from lowest to highest. This is equivalent to arranging the bids from the highest price to the lowest price. Starting from the lowest yield bid, all competitive bids are accepted until the amount to be distributed to the competitive bidders is completely allocated. The highest yield accepted by the Treasury is called the "stop yield" and bidders at that yield are awarded a percentage of their total tender offer. The single-price auction proceeds in the same fashion except that all accepted bids are filled at the highest yield of accepted competitive tenders (i.e., the stop yield).

The Treasury moved to single-price auctions for all Treasury securities in 1998 after conducting single-price auctions for monthly sales of 2- and 5-year notes since September 1992. Paul Malvey and Christine Archibald conducted a study of the relative performance of the two auction mechanisms.[5] Their empirical results suggest that single-price auctions broaden participation and accordingly reduce concentration of securities at issuance. Moreover, they also present somewhat weaker evidence that the single-price auctions reduce the Treasury's financing costs by encouraging more aggressive bidding. In principle, single-price auctions reduce financing costs by encouraging more aggressive bidding relative to multiple-price auctions. Multiple-price auctions suffer from a so-called "winner's curse" problem because the winner of the auction (i.e., whoever pays highest price/bids the lowest yield) pays a higher price than the market consensus. Conversely, in a single-price auction, all successful bidders pay the same price and have less incentive to bid conservatively.

Exhibit 3.2 presents a Bloomberg screen that contains the results of the 4-week Treasury bill auction on March 12, 2002. These bills were issued on March 14, 2002. The screen provides the relevant data for the

---

[4] Until the move to single-price auctions, Treasury bills had been sold using multiple-price auctions since 1929.

[5] Paul F. Malvey and Christine M. Archibald, "Uniform-Price Auctions: Update of the Treasury Experience," Washington, D.C., U.S. Treasury, October 1998.

current auction and the previous week's auction. Two terms that appear in this exhibit require some explanation. The *bid-to-cover ratio* is simply the ratio of the total par amount of securities bid for by the public divided by the total par amount of securities awarded to the public. The bid-to-cover ratio excludes any bids or awards for accounts of foreign and international monetary authorities at Federal Reserve Banks and for the account of the Federal Reserve Banks. The *investment rate* is simply the bond-equivalent yield (discussed later) for the Treasury bill in question.

Between the auction's announcement and the actual issuance of the securities, trading of bills takes place in the *when-issued* or *wi market*. Essentially, this when-issued market is nothing more than an active forward market in the bills. Many dealers enter a Treasury bill auction with large short positions and hope to cover these positions with bills obtained at the auction. Dealers make commitments with their customers and other dealers to make/take delivery of bills for an agreed upon price with settlement occurring after the bills are issued. In fact, all deliveries on when-issued trades occur on the issue day of the security traded. When-issued yields serve as important indicators for yields that will prevail at the auction.

EXHIBIT 3.2 **Bloomberg Screen for 4-Week Bill Auction Results**

Press 98<GO> to make a copy, 99<GO> to clear news alerts. Govt AUCR

10:27 UNITED STATES AUCTION RESULTS Page 1 / 7

94<GO> View News.

SECURITY	TICKER	CURR VAL	CUR DATE	PREV VAL	PRE DATE	NET CHNG
4 WEEK T-BILLS						
2)4W HIGH YIELD	USB4WHYL	1.770	03/12/02	1.750	03/05/02	.020
3)4W MED YIELD	USB4WDIS	1.760	03/12/02	1.735	03/05/02	.025
4)4W LOW YIELD	USB4WLYL	1.720	03/12/02	1.700	03/05/02	.020
5)4W INVEST RATE	USB4WIR	1.801	03/12/02	1.775	03/05/02	.026
6)4W TENDER	USB4WTAL	73.050	03/12/02	23.070	03/05/02	49.980
7)4W PRICE	USB4WPRC	99.862	03/12/02	99.863	03/05/02	-.001
8)4W COMP BIDS	USB4WCB	49.669	03/12/02	45.249	03/05/02	4.420
9)4W TOTAL SOLD	USB4WAM	23.000	03/12/02	21.000	03/05/02	2.000
10)4W BIDS ACCEPT	USB4WBAC	22.966	03/12/02	20.975	03/05/02	1.991
11)4W NON COMP ACC	USB4WNC	34.286	03/12/02	24.833	03/05/02	9.453
12)4W SOLD FED RSRV	USB4WFR	2099.991	03/12/02	2748.860	03/05/02	-648.869
13)4W BID/COVER	USB4WBC	2.161	03/12/02	2.156	03/05/02	.005
3 MONTH						
16)3M SOLD	USB3MAM	13000.03	03/11/02	14000.07	03/04/02	-1000.04
17)3M NON COMP	USB3MNC	1425.212	03/11/02	1473.116	03/04/02	-47.904
18)3M BID COVER	USB3MBC	2.498	03/11/02	1.924	03/04/02	.574
19)3M MEDIAN DISC	USB3MAY	1.800	03/11/02	1.740	03/04/02	.060
20)3M HIGH DISCOUNT	USB3MTA	1.825	03/11/02	1.760	03/04/02	.065

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 212 1000 U.S. 1 212 318 2000 Copyright 2002 Bloomberg L.P.
6464-30-2 13-Mar-02 10:27:21

Source: Bloomberg Financial Markets

PRICE QUOTES FOR TREASURY BILLS

The convention for quoting bids and offers in the secondary market is different for Treasury bills and Treasury coupon securities. Bids/offers on bills are quoted in a special way. Unlike bonds that pay coupon interest, Treasury bill values are quoted on a *bank discount basis*, not on a price basis. The yield on a bank discount basis is computed as follows:

$$Y_d = \frac{D}{F} \times \frac{360}{t}$$

where:

- Y_d = annualized yield on a bank discount basis (expressed as a decimal)
- D = dollar discount, which is equal to the difference between the face value and the price
- F = face value
- t = number of days remaining to maturity

For example, Exhibit 3.3 presents the PX1 Governments screen from Bloomberg. Data for the most recently issued bills appear in the upper left-hand corner. The first and second columns indicate the security and its maturity date. In the third column, there is an arrow indicating an up or down tick for the last trade. The fourth column indicates the current bid/ask rates. A bond-equivalent yield (discussed later) using the ask yield/price is contained in column 5. The last column contains the change in bank discount yields based on the previous day's closing rates as of the time posted. Exhibit 3.4 presents the same information for all outstanding bills (page PX2). The current/when issued bills' maturity dates are highlighted. Other important market indicators are contained in the lower right-hand corner of the screen.

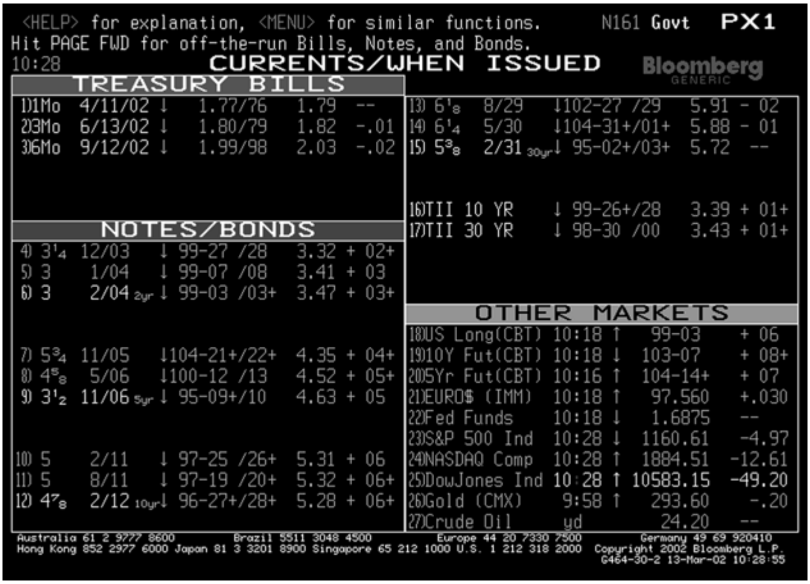
Given the yield on a bank discount basis, the price of a Treasury bill is found by first solving the formula for Y_d to obtain the dollar discount (D), as follows:

$$D = Y_d \times F \times (t/360)$$

The price is then

$$\text{price} = F - D$$

EXHIBIT 3.3 Bloomberg Current Governments Screen



<HELP> for explanation, <MENU> for similar functions. N161 Govt PX1
Hit PAGE FWD for off-the-run Bills, Notes, and Bonds.
10:28 CURRENTS/WHEN ISSUED Bloomberg GENERIC

TREASURY BILLS

1) 1Mo	4/11/02	↓	1.77/76	1.79	--
2) 3Mo	6/13/02	↓	1.80/79	1.82	-.01
3) 6Mo	9/12/02	↓	1.99/98	2.03	-.02

13) 6 1/8	8/29	↓	102-27 /29	5.91	- 02
14) 6 1/4	5/30	↓	104-31+/01+	5.88	- 01
15) 5 3/8	2/31 30yr	↓	95-02+/03+	5.72	--
16) TII 10 YR		↓	99-26+/28	3.39	+ 01+
17) TII 30 YR		↓	98-30 /00	3.43	+ 01+

NOTES/BONDS

4) 3 1/4	12/03	↓	99-27 /28	3.32	+ 02+
5) 3	1/04	↓	99-07 /08	3.41	+ 03
6) 3	2/04 2yr	↓	99-03 /03+	3.47	+ 03+
7) 5 3/4	11/05	↓	104-21+/22+	4.35	+ 04+
8) 4 5/8	5/06	↓	100-12 /13	4.52	+ 05+
9) 3 1/2	11/06 5yr	↓	95-09+/10	4.63	+ 05
10) 5	2/11	↓	97-25 /26+	5.31	+ 06
11) 5	8/11	↓	97-19 /20+	5.32	+ 06+
12) 4 7/8	2/12 10yr	↓	96-27+/28+	5.28	+ 06+

OTHER MARKETS

18) US Long(CBT)	10:18	↑	99-03	+ 06
19) 10Y Fut(CBT)	10:18	↓	103-07	+ 08+
20) 5Yr Fut(CBT)	10:16	↑	104-14+	+ 07
21) EURO$ (IMM)	10:18	↑	97.560	+.030
22) Fed Funds	10:18	↓	1.6875	--
23) S&P 500 Ind	10:28	↓	1160.61	-4.97
24) NASDAQ Comp	10:28	↑	1884.51	-12.61
25) DowJones Ind	10:28	↑	10583.15	-49.20
26) Gold (CMX)	9:58	↑	293.60	-.20
27) Crude Oil	yd		24.20	--

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 212 1000 U.S. 1 212 318 2000 Copyright 2002 Bloomberg L.P.
G464-30-2 13-Mar-02 10:28:55

Source: Bloomberg Financial Markets

EXHIBIT 3.4 Bloomberg Screen of All Outstanding Bills

<HELP> for explanation. N161 Govt PX1

BILL PRICES Page 2/8 10:30

1) 3/14/02	↑	1.73/73		-.01
2) 3/21/02	↓	1.73/72	1.74	-.01
3) 3/28/02	↓	1.72/71	1.73	-.02
4) 4/04/02	↓	1.76/75	1.78	--
5) 4/11/02	↓	1.77/76	1.79	--
6) 4/18/02	↓	1.75/74	1.77	+.01
7) 4/25/02	↓	1.75/74	1.77	--
8) 5/02/02	↓	1.74/73	1.76	-.01
9) 5/09/02	↑	1.75/74	1.77	--
10) 5/16/02	↑	1.76/75	1.78	--
11) 5/23/02	↑	1.76/75	1.78	--
12) 5/30/02	↓	1.78/77	1.80	-.01
13) 6/06/02	↓	1.78/77	1.80	-.01
14) 6/13/02	↓	1.80/79	1.82	-.01
15) 6/20/02	↓	1.80/79	1.82	--
16) 6/27/02	↓	1.79/78	1.81	-.02
17) 7/05/02	↓	1.81/80	1.84	-.01
18) 7/11/02	↓	1.82/81	1.85	-.02
19) 7/18/02	↑	1.83/82	1.86	--
20) 7/25/02	↓	1.84/83	1.87	-.01
21) 8/01/02	↓	1.87/86	1.90	-.01
22) 8/08/02	↓	1.89/88	1.92	-.01
23) 8/15/02	↓	1.90/89	1.93	-.02
24) 8/22/02	↓	1.92/91	1.95	-.01
25) 8/29/02	↓	1.93/92	1.96	-.02
26) 9/05/02	↑	1.96/95	2.00	-.01
27) 9/12/02	↓	1.99/98	2.03	-.02

OTHER MARKETS

28) US Long(CBT)	10:18	↑	99-03	+ 06
29) 10Y Fut(CBT)	10:19	↑	103-07	+ 08+
30) 5Yr Fut(CBT)	10:16	↑	104-14+	+ 07
31) EURO$ (IMM)	10:18	↑	97.560	+.030
32) Fed Funds	10:18	↓	1.6875	--
33) S&P 500 Ind	10:29	↑	1161.03	-4.55
34) NASDAQ Comp	10:30	↑	1884.36	-12.76
35) DowJones Ind	10:30	↓	10588.06	-44.29
36) Gold (CMX)	9:59	↓	293.60	-.20
37) Crude Oil	yd		24.20	--

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Source: Bloomberg Financial Markets

Using the information in Exhibit 3.3, for the current 28-day bill with a face value of \$1,000, if the offer yield on a bank discount basis is quoted as 1.76%, D is equal to

$$D = 0.0176 \times \$1{,}000 \times 28/360 = \$1.3689$$

Therefore,

$$\text{price} = \$1{,}000 - \$1.3689 = \$998.6311$$

The quoted yield on a bank discount basis is not a meaningful measure of the potential return from holding a Treasury bill, for two reasons. First, the measure is based on a face-value investment rather than on the actual dollar amount invested. Second, the yield is annualized according to a 360-day rather than a 365-day year, making it difficult to compare Treasury bill yields with Treasury notes and bonds, which pay interest on a 365-day basis. The use of 360 days for a year is a money market convention for some money market instruments, however. Despite its shortcomings as a measure of return, this is the method that dealers have adopted to quote Treasury bills. Many dealer quote sheets and some other reporting services provide two other yield measures that attempt to make the quoted yield comparable to that for a coupon bond and other money market instruments.

CD Equivalent Yield

The *CD equivalent yield* (also called the *money market equivalent yield*) makes the quoted yield on a Treasury bill more comparable to yield quotations on other money market instruments that pay interest on a 360-day basis. It does this by taking into consideration the price of the Treasury bill (i.e., the amount invested) rather than its face value. The formula for the CD equivalent yield is

$$\text{CD equivalent yield} = \frac{360\,Y_d}{360 - t(Y_d)}$$

For example, using the data from Exhibit 3.3 for the 28-day bill that matures on April 11, 2002, the ask rate on a bank discount basis is 1.76%. The CD equivalent yield is computed as follows:

$$\text{CD equivalent yield} = \frac{360(0.0176)}{360 - 28(0.0176)} = 0.0176 = 1.76\%$$

Because of the low rate, the CD equivalent yield is the same as the yield on a bank discount basis.

Bond-Equivalent Yield

The measure that seeks to make the Treasury bill quote comparable to coupon Treasuries is called the *bond-equivalent yield*. This yield measure makes the quoted yield on a Treasury bill more comparable to yields on Treasury notes and bonds that use an actual/actual day count convention.[6] In order to convert the yield on a bank discount to a bond-equivalent yield, the following formula is used:

$$\text{Bond-equivalent yield} = \frac{T(Y_d)}{360 - t(Y_d)}$$

where T is the actual number of days in the calendar year (i.e., 365 or 366).

As an example, using the same Treasury bill with 28 days to maturity and a face value of $1,000 that would be quoted at 1.76% on a bank discount basis, the bond-equivalent yield is calculated as follows:

$$\text{Bond-equivalent yield} = \frac{365(0.0176)}{360 - 28(0.0176)} = 0.0179 = 1.79\%$$

This number matches the bond-equivalent yield given by the Bloomberg screen in Exhibit 3.3. There are a couple of points to note in this calculation. First, we used 365 in the numerator because the year 2002 is a non-leap year. Second, the formula for the bond-equivalent yield presented above assumes that the current maturity of the Treasury bill in question is 182 days or less.

SECONDARY MARKET

The secondary market for Treasury securities is an over-the-counter market in which a group of U.S. government securities dealers offer continuous bid and ask prices on outstanding issues. There is virtual 24-hour trading of Treasury securities. The three primary trading locations are New York, London, and Tokyo. Trading begins at 8:30 a.m. Tokyo time (7:30 p.m. New York time) and continues to about 4:00 p.m. Tokyo time (3:00 a.m. New York time).[7] Trading then moves to London where trad-

[6] Day count conventions determine the number of days in a coupon period and the number of days from the last coupon payment to the settlement date. For a coupon Treasury, both are equal to the actual number of days. The day count convention is referred to as "actual/actual."

[7] These trading hours apply when New York is on daylight savings time. The main difference when New York is on standard time is that Tokyo starts an hour earlier relative to New York (6:30 P.M. New York time.)

ing commences at 8:00 a.m. London time and then on to New York at 12:30 p.m. London time (7:30 a.m. New York time). In New York, trading starts at 7:30 a.m. and continues until 5:30 p.m.[8]

The most recently auctioned Treasury bill for a particular maturity is referred to as the *on-the-run* issue. Issues auctioned prior to the on-the-run issue are typically referred to as *off-the-run* issues. These issues are not as liquid as an on-the-run issue for a particular maturity. This difference in liquidity manifests itself in wider bid-ask spreads and lower size quotes for off-the-run issues relative to an on-the-run issue.

While the secondary market for Treasury bills is one of the most liquid segment of the global money market, most of the trading activity occurs during New York trading hours. In a 1997 study, Michael J. Fleming finds that while bills represent approximately 27% of trading volume of on-the-run Treasury trading volume in New York, bills comprise only about 1% of the trading volume in London and Tokyo. In fact, on many trading days, not a single bill trade is brokered during overseas hours.[9] One possible explanation for this result is put forward in a study by Michael J. Fleming and Jose A. Lopez. They suggest that a disproportionate share of speculative trading in Treasury securities occurs overseas. Accordingly, longer-term coupon Treasuries (as opposed to bills) are suitable vehicles for this type of trading.[10]

Treasury Dealers and Interdealer Brokers

Any firm can deal in government securities, but when the Federal Reserve engages in trades of Treasuries in order to implement monetary policy, the New York Fed's Open Market Desk will deal directly only with dealers that it designates as primary or recognized dealers. The primary dealer system was established in 1960 and is designed to ensure that firms requesting status as primary dealers have adequate capital relative to positions assumed in Treasury securities and that their trading volume in Treasury securities is at a reasonable level. The Federal Reserve requires primary dealers to participate in both open market operations and Treasury auctions. In addition, primary dealers provide market information and analysis which may be useful to the Open Market Desk in the implementation of monetary policy. Exhibit 3.5 lists the primary dealers as of October 31, 2001. Primary dealers include diversified and specialized firms, money center banks, and foreign-owned financial entities.

[8] Michael J. Fleming, "The Round-the-Clock Market for U.S. Treasury Securities," *Economic Policy Review*, Federal Reserve Bank of New York, July 1997, pp. 9-32.
[9] Fleming, "The Round-the-Clock Market for U.S. Treasuries."
[10] Michael J. Fleming and Jose A. Lopez, "Heat Waves, Meteor Showers and Trading: An Analysis of Volatility Spillovers in the U.S. Treasury Market," July 1999, working paper.

EXHIBIT 3.5 List of the Primary Government Securities Dealers Reporting to the Market Reports Division of the Federal Reserve Bank of New York

ABN AMRO Incorporated	Fuji Securities Inc.
Banc of America Securities LLC	Goldman, Sachs & Co.
Banc One Capital Markets, Inc.	Greenwich Capital Markets, Inc.
Barclays Capital Inc.	HSBC Securities (USA) Inc.
Bear, Stearns & Co., Inc.	J.P. Morgan Securities, Inc.
BMO Nesbitt Burns Corp.	Lehman Brothers Inc.
BNP Paribas Securities Corp.	Merrill Lynch Government Securities Inc.
CIBC World Markets Inc.	Morgan Stanley & Co,. Incorporated
Credit Suisse First Boston Corporation	Nomura Securities International, Inc.
Daiwa Securities America Inc.	Salomon Smith Barney Inc.
Deutsche Banc Alex Brown Inc.	UBS Warburg LLC
Dresdner Kleinwort Wasterstein Securities	Zions First National Bank

Source: Federal Reserve Bank of New York (as of October 31, 2001)

Primary dealers trade with the investing public and with other dealer firms. When they trade with each other, it is through intermediaries known as interdealer brokers. Dealers leave firm bids and offers with interdealer brokers who display the highest bid and the lowest offer in a computer network tied to each trading desk and displayed on a monitor. The dealer responding to a bid or offer by "hitting" or "taking" pays a commission to the interdealer broker. The size and prices of these transactions are visible to all dealers at once. The fees charged are negotiable and vary depending on transaction volume.

Six interdealer brokers handle the bulk of daily trading volume. They include Cantor, Fitzgerald Securities, Inc.; Garban Ltd.; Liberty Brokerage Inc.; RMJ Securities Corp.; Hilliard Farber & Co. Inc.; and Tullett & Tokyo Securities Inc. These six firms serve the primary government dealers and approximately a dozen other large government dealers aspiring to be primary dealers.

Dealers use interdealer brokers because of the speed and efficiency with which trades can be accomplished. With the exception of Cantor, Fitzgerald Securities Inc., interdealer brokers do not trade for their own account, and they keep the names of the dealers involved in trades confidential. The quotes provided on the government dealer screens represent prices in the "inside" or "interdealer" market. Historically, primary dealers have discouraged attempts to allow the general public to have access to them. However, as a result of government pressure, GovPX is a joint venture of five of the six interdealer brokers and the primary dealers in which information on best bids and offers, size, and trade price are distributed via Bloomberg, Reuters and Knight-Ridder. In addition, some dealers have developed an electronic trading system that allows trading between them and investors via Bloomberg. One example is Deutsche Morgan Grenfell's AutoBond System.

THE BEHAVIOR OF TREASURY BILL YIELDS OVER TIME

While U.S. Treasury bills are very important instruments in the money market, there is some evidence which suggests that bill yields no longer serve as benchmark instruments from which other money market instruments are priced. First, the correlation between the 3-month bill rate and the Federal Funds rate has diminished considerably in recent years.[11] To illustrate this, we examine weekly observations of the Federal Funds rate and the 3-month bill rate for the period of January 1, 1987 to December 31, 1999.[12] During the first nine years of this period, the correlation coefficient between the Federal Funds and 3-month bills was 0.99. However, during the period 1996-1999, the correlation drops to 0.64. Second, a study by Gregory R. Duffee suggests that the U.S. Treasury bill market is becoming increasingly segmented and there is a measurable increase in the idiosyncratic variability of the bill yield since the mid-1980s.[13] One possible explanation is that when foreign central banks intervene in currency markets to manage the exchange rate between the dollar and other currencies, they normally buy/sell U.S. Treasury bills.[14] As a result, the yield on bills may not track the yields on other money market instruments as closely as in the past.

Treasury Bill Yields versus LIBOR

LIBOR is the interest rate which major international banks offer each other on Eurodollar certificates of deposit (CD) with given maturities. The maturities range from overnight to five years. So, references to "3-month LIBOR" indicate the interest rate that major international banks are offering to pay to other such banks on a CD that matures in three months. Eurodollar CDs pay simple interest at maturity on an ACT/360 basis. LIBOR serves as a pricing reference for a number of widely traded financial products and derivatives (e.g., floaters, swaps, structured notes, etc.).

[11] The Federal Funds rate is a bank's cost of borrowing immediately available funds from another institution primarily overnight.

[12] Source: Federal Reserve Statistical Release H.15

[13] Gregory R. Duffee, "Idiosyncratic Variation of Treasury Bill Yields," *Journal of Finance* (June 1996), pp. 527–551.

[14] See, Timothy Q. Cook, "Treasury Bills," in *Instruments of the Money Market*, Seventh Edition, (Richmond: Federal Reserve Bank of Richmond), pp. 75–88.

Because of LIBOR's importance in the global money markets, it is instructive to examine the relationship between Treasury bill yields and LIBOR. We expect LIBOR rates to be higher than the yields on bills of the same maturity because investors in Eurodollars CDs are exposed to default risk. Panel a of Exhibit 3.6 presents a Bloomberg graph of the yield curves for U.S. Treasury bills and LIBOR (out to a maturity of 1 year) on March 13, 2002. The Treasury bill yield curve is the lower curve and is represented by a solid black line. Panel b of the exhibit presents the data used in constructing the two yield curves. The fourth column indicates the spread between LIBOR and the Treasury bill yield for a given maturity.

In order to understand the relationship between LIBOR and Treasury bill yields over time, we examine the period January 1, 1987 to December 31, 1999. We focus on the spread (in basis points) between 3-month LIBOR and 3-month Treasury yields each week (Friday) during this time period. Exhibit 3.7 is a time series plot of weekly spreads. Two striking features can be observed. First, there are a handful of prominent spikes in the data that reflect financial/global crises. Second, spreads trend downward over the time period. We will consider each feature in turn.

EXHIBIT 3.6 **Bloomberg Screen of LIBOR and Treasury Bills Yields**

a. LIBOR and Treasury Bill Curves

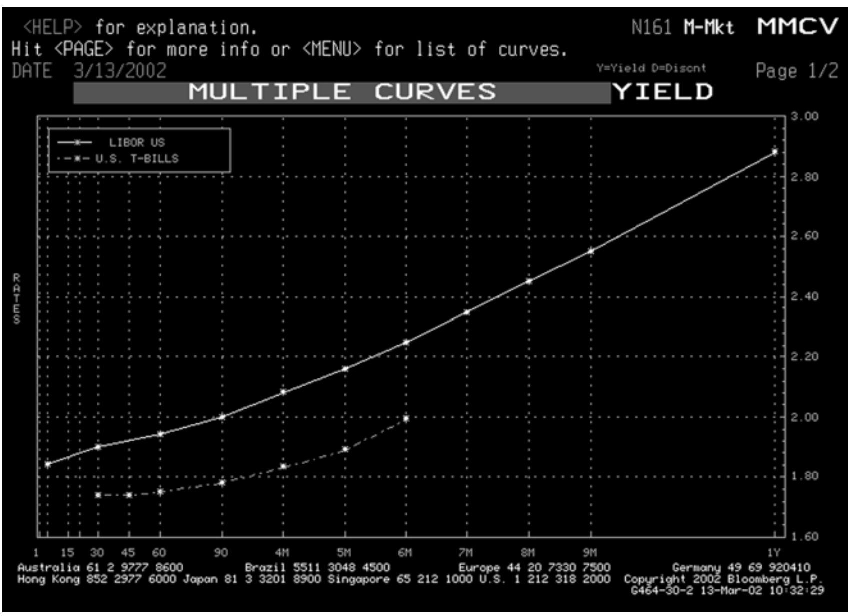

EXHIBIT 3.6 (Continued)

b. Spread between LIBOR and Treasury Bill Yields

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Hit <PAGE> for graph or <MENU> for list of curves.
Page 2/2

2-CURVE SPREAD

DATE 3/13/2002

	09:58 LIBOR US	09:58 U.S. T-BILLS	
	Yield	Yield	Spread
1 DAY			
7 DAY	1.84500		
15 DAY			
21 DAY			
30 DAY	1.90000	1.74000	0.16000
45 DAY		1.74000	
60 DAY	1.94000	1.75000	0.19000
90 DAY	2.00000	1.78000	0.22000
4 MONTH	2.08000	1.83000	0.25000
5 MONTH	2.16000	1.89000	0.27000
6 MONTH	2.24625	1.99000	0.25625
7 MONTH	2.34625		
8 MONTH	2.44625		
9 MONTH	2.55000		
1 YEAR	2.88000		

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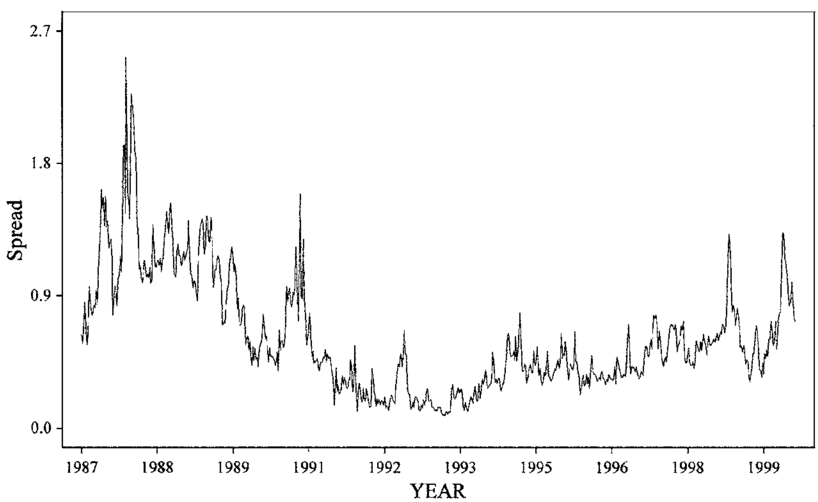
Source: Bloomberg Financial Markets

EXHIBIT 3.7 Spread Between LIBOR and Treasury Bills



Sample period: January 1, 1987-December 31, 1999

U.S. Treasury securities and the U.S. dollar are considered "safe havens" in times of crisis, regardless of their underlying causes. During times of turmoil, the resulting "flight to quality" widens the spread between LIBOR rates and T-bill rates. For instance, the first spike in the data occurs in October 1987. At the end of October 1987, the spread between 3-month LIBOR and 3-month bills was 252 basis points. Five weeks earlier, the spread was 106 basis points. The catalyst, of course, for this huge increase in the spread was the collapse of the world's equity markets. On October 19, 1987, the Dow Jones Industrial Average fell 22.6% while markets tumbled around the world. The total world wide decline in stock values exceeded $1 trillion.[15]

The next spike occurs in the fall of 1990. The precipitant was the invasion of Kuwait by military forces from Iraq on August 2, 1990. During the next several weeks, the combination of rising oil prices and slowing U.S. economy caused a severe drop in U.S. stocks. By the middle of October, U.S. stocks had fallen by 18%. Once again, investors around the world fled to the safety of U.S. Treasuries and the spread widened to 159 basis points at the end of December 1990 (just prior the January 15, 1991 United Nations imposed deadline for Iraq to withdraw from Kuwait).

Another spike in the spread is in the fall of 1998. On August 17, Russia devalued its currency, the rouble, and halted payments on its debt obligations. As a result, bond prices fell across-the-board in markets around the world. In the ensuing weeks, reports surfaced that a very large hedge fund, Long-Term Capital Management, had sustained multi-billion dollar losses. On September 23, the hedge fund received an infusion of $3.65 billion in capital from a consortium of investment banks. The rescue was brokered by the Federal Reserve. During this time, investors fled emerging markets' equity and debt, liquidity in corporate bonds dried up, and money poured into Treasuries. The spread between 3-month LIBOR and 3-month bills was 132 basis points on October 20, 1998. The spread returned to more normal levels as the Federal Reserve cut the Federal Funds rate three times in the following two months to avert a credit crunch.

The final spike in the data occurs in the fall (October/November) of 1999. Although the macroeconomic climate was relatively settled during this time, uncertainty due to the Y2K calendar conversion engendered some portfolio rebalancing and a flight to quality. Once these concerns abated, spreads quickly returned to more normal levels.

Another pattern evident in these data is the downward trend in the spread between 3-month LIBOR and 3-month Treasury bills. To see this, we computed summary statistics for each calendar year: mean, standard

[15] Jeremy J. Siegel, *Stocks for the Long Run* (New York, NY: McGraw-Hill, 1998).

deviation, minimum and maximum. These results are presented in Exhibit 3.8. Two trends are evident: (1) the mean spreads fell over the 1987–1999 period and (2) except for the uptick in volatility in 1998–1999, volatility trends downward as well.[16] The explanation is simple. Over this period, LIBOR became the benchmark global short-term interest rate. The majority of funding for financial institutions is LIBOR-based. As this trend continues, spreads should continue to remain at these lower levels.

RIDING THE YIELD CURVE

Panel a of Exhibit 3.9 presents two Treasury bill yield curves from Bloomberg's C5 screen from the Governments page captured on March 13, 2002. The top graph is constructed using yields from bills maturing from 3 to 6 months. Correspondingly, the bottom graph is constructed using the yields of bills maturing from zero to 6 months. Each bill issue presented in the two graphs is identified with a -0- (on-the-run bill), X (off-the-run bill), or a W (when-issued bill). Panel b of Exhibit 3.9 presents the data Bloomberg used to construct these two bill yield curves.

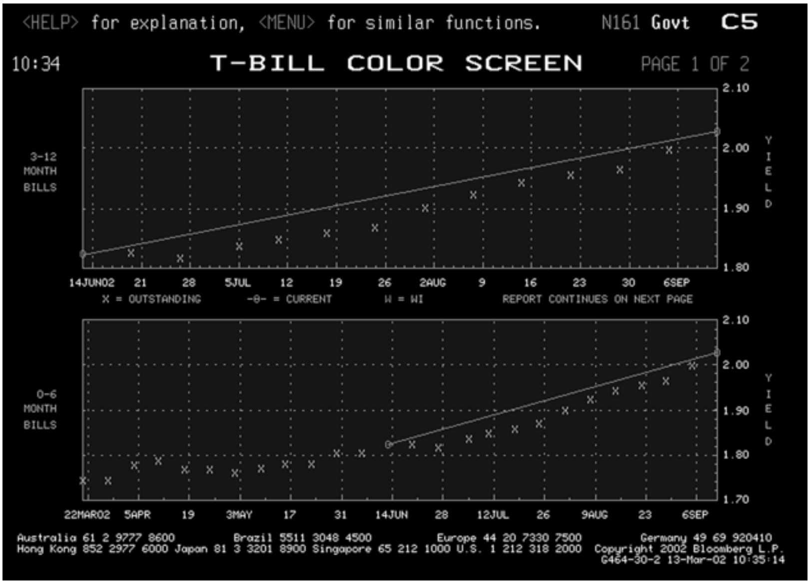
EXHIBIT 3.8 **The Spread Between 3-Month LIBOR and 3-Month Treasury Bills Summary Statistics for 1987-1999 (in basis points)**

Year	Mean	Standard Deviation	Minimum	Maximum
1987	122.42	47.56	56.00	252.00
1988	118.91	16.68	98.00	183.00
1989	104.44	22.99	56.00	144.00
1990	65.77	23.76	38.00	159.00
1991	46.02	20.58	15.00	129.00
1992	25.52	12.75	11.00	66.00
1993	16.23	5.55	8.00	29.00
1994	34.81	15.23	11.00	78.00
1995	41.50	8.40	28.00	65.00
1996	36.40	8.15	22.00	70.00
1997	53.64	12.94	33.00	77.00
1998	64.00	19.08	40.00	132.00
1999	64.72	24.60	31.00	133.00

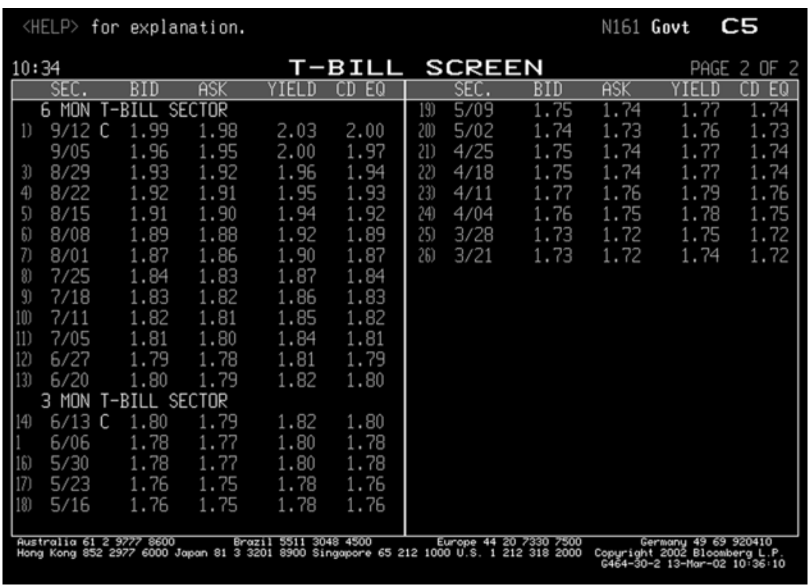
[16] A reasonable explanation for these trends is that the level of interest rates fell during this period. However, the same pattern emerges when yield ratios (i.e., 3-month LIBOR/3-month Treasury-bill) are examined.

EXHIBIT 3.9 Bloomberg Treasury Bill Screens

a. Treasury Bill Curve Screen



b. Treasury Bill Screen



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10:34 T-BILL SCREEN PAGE 2 OF 2

	SEC.		BID	ASK	YIELD	CD EQ
	6 MON T-BILL SECTOR					
1)	9/12	C	1.99	1.98	2.03	2.00
	9/05		1.96	1.95	2.00	1.97
3)	8/29		1.93	1.92	1.96	1.94
4)	8/22		1.92	1.91	1.95	1.93
5)	8/15		1.91	1.90	1.94	1.92
6)	8/08		1.89	1.88	1.92	1.89
7)	8/01		1.87	1.86	1.90	1.87
8)	7/25		1.84	1.83	1.87	1.84
9)	7/18		1.83	1.82	1.86	1.83
10)	7/11		1.82	1.81	1.85	1.82
11)	7/05		1.81	1.80	1.84	1.81
12)	6/27		1.79	1.78	1.81	1.79
13)	6/20		1.80	1.79	1.82	1.80
	3 MON T-BILL SECTOR					
14)	6/13	C	1.80	1.79	1.82	1.80
1	6/06		1.78	1.77	1.80	1.78
16)	5/30		1.78	1.77	1.80	1.78
17)	5/23		1.76	1.75	1.78	1.76
18)	5/16		1.76	1.75	1.78	1.76

	SEC.	BID	ASK	YIELD	CD EQ
19)	5/09	1.75	1.74	1.77	1.74
20)	5/02	1.74	1.73	1.76	1.73
21)	4/25	1.75	1.74	1.77	1.74
22)	4/18	1.75	1.74	1.77	1.74
23)	4/11	1.77	1.76	1.79	1.76
24)	4/04	1.76	1.75	1.78	1.75
25)	3/28	1.73	1.72	1.75	1.72
26)	3/21	1.73	1.72	1.74	1.72

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Source: Bloomberg Financial Markets

EXHIBIT 3.10 Summary Statistics for Differences in Holding-Period Returns (Ride minus Buy-and-Hold) in Basis Points from January 1987 through April 1997

Strategy	Mean	Median	Min	Max	% Positive
Panel A: Three-Month Holding Period					
Ride Using 6-Month	10.6	9.0	–34.9	67.2	82.36
Ride Using 9-Month	16.0	14.2	–69.2	106.4	73.60
Ride Using 12-Month	17.9	17.3	–107.9	139.7	65.56
Panel B: Six-Month Holding Period					
Ride Using 9-Month	16.1	15.8	–19.9	78.8	80.04
Ride Using 12-Month	25.2	27.9	–68.7	144.1	71.23

Both of these yield curves are positively sloped. With a positively sloped Treasury bill curve, an investor receives an additional yield for extending the bill's maturity. This additional yield is compensation for the additional risk of the longer security and reflects the market's implicit forecast of a rise in interest rates. Investors who seek to profit from the tendency for yields to fall relative to this forecast as bills move towards maturity are pursuing a strategy known as "riding the yield curve."

To illustrate this strategy, suppose an investor has a 3-month holding period. Consider two potential vehicles to satisfy this maturity preference. First, buy a 3-month bill and hold it to maturity. Second, buy a 6-month bill, and sell it after three months. If the yield curve is upward-sloping and does not change over the next three months, the 6-month bill will earn a higher return because of the increase in price due to the decrease in yield relative to the forecast at which it was priced. As a result, investors will collect an additional return.

For example, suppose a 91-day bill and a 182-day bill are yielding 5% and 5.25% on a bank discount basis, respectively (5.06% and 5.25% as money market yields). Buying and maturing the 91-day bill will generate a 91-day return of 1.28%. Buying the 182-day bill and selling after 91 days will generate 1.43% return over the same 91-day period if the yield curve remains unchanged.

Robin Grieves, Steven V. Mann, Alan J. Marcus, and Pradipkumar Ramanlal examine the effectiveness of riding the yield curve using Treasury bills for the period January 2, 1987, through April 20, 1997.[17] They find that riding the yield curve *on average* enhances return over a given holding period versus a buy-and-hold strategy. Exhibit 3.10 pre-

[17] See Robin Grieves, Steven V. Mann, Alan J. Marcus, and Pradipkumar Ramanlal, "Riding the Bill Curve," *The Journal of Portfolio Management* (Spring 1999), pp. 74–82.

sents summary statistics for the differences in holding period returns. These return differences are reported in basis points. Panel A presents the mean, median, minimum, maximum, and the percentages of return differences that are positive (i.e., meaning the riding strategy outperforms the buy and hold) for the 3-month holding period. Panel B presents the same information for the 6-month holding period.

For a 3-month holding period, the results in Exhibit 3.10 indicate that riding the yield curve using 6-month bills provides an additional 10 basis points in returns on average and outperforms a buy-and-hold strategy over 82% of the time. Rides using longer bills increase the additional return, with a corresponding decrease in the percentage of rides that beat the buy-and-hold. For the 6-month holding period, the results suggest a similar story. A 6-month ride using the 9-month bill adds approximately 16 basis points on average, is effective 80% of the time, and has the highest (i.e., the most desirable) minimum return of all five riding strategies examined. A ride using the 12-month bill adds about 25 basis points on average and outperforms the buy-and-hold strategy 71% of the time.

Of course, the higher returns generated by the riding strategies come at the expense of higher variability and the possibility of negative returns. However, Grieves, Mann, Marcus, and Ramanlal provide evidence which suggests that only the most risk-averse investors would reject the riding strategy categorically. Further, investors who ride the yield curve during a Federal Reserve tightening cycle will meet with disappointing results because an unexpected rise in short rates can potentially eliminate any term premium present in longer-maturity bills. For example, beginning February 4, 1994 and ending on February 1, 1995, the Federal Reserve Open Market Committee increased the Federal Funds target rate seven times from 3% to 6%. Grieves, Mann, Marcus, and Ramanlal examine the performance of the riding strategy during this period and find that the overall performance of riding the yield curve deteriorates considerably.

TREASURY BILLS WITH SPECIAL VALUE

There is a substantial body of empirical evidence that suggests that certain Treasury bills have special value in addition to the value attributable to their cash flows.[18] This additional value is present in bills whose maturity dates immediately precede calendar dates when corporate treasurers

[18] See, for example, Kenneth D. Garbade, *Fixed Income Analytics* (Cambridge, MA: MIT Press, 1996) and Joseph P. Ogden, "The End of the Month as a Preferred Habitat: A Test of Operational Efficiency in the Money Market," *Journal of Financial and Quantitative Analysis* (September 1987), pp. 329-343.

require cash to make payments. Two prominent examples are *quarter-end* bills and *tax* bills. Quarter-end bills mature immediately prior to the end of the quarter. Similarly, tax bills mature immediately prior to important federal corporate income tax dates (March 15, April 15, June 15, September 15, and December 15). Both quarter-end and tax bills usually trade at a higher price and correspondingly offer a lower yield relative to the Treasury bill curve. As an example, on July 22, 1999, three Treasury bills maturing on September 23, September 30, and October 7 (all in 1999) were yielding 4.48%, 4.43%, and 4.51%, respectively.[19] Thus, in an otherwise upwarding-sloping curve, the September 30 bill looks expensive relative to the two surrounding bills.

The reason for this additional or special value is straightforward. Corporate treasurers may desire to invest excess cash on hand in securities that mature at the end of the quarter and whose cash flows at maturity can be used to liquidate short-term liabilities (e.g., accounts payable) before reporting their quarterly balance sheets. A bill that matures the week after the quarter's end would require the treasurer to sell the security prior to maturity; a bill that matures the week before would require the treasurer to reinvest the maturity payment for an additional week. Accordingly, the bills that mature one week before or after the end of the quarter would not necessarily be viewed as close substitutes for the quarter-end bill. As such, the quarter-end bill possesses a "convenience" value. The reasoning for tax bills is analogous. Kenneth Garbade presents evidence that quarter-end and tax bills trade at lower yields and higher prices relative to nearby bills suggesting the convenience value is priced.[20]

While possessing no special payment dates, *deliverable* bills appear also to have special value. Deliverable bills are those that are deliverable against the Treasury bill futures contract on the IMM. The underlying instrument of the Treasury bill futures contract is a 3-month (13-week) Treasury bill with a face value of $1 million. The short or seller of this contract agrees to deliver to the buyer at the settlement date a Treasury bill with 13 weeks remaining to maturity and a face value of $1 million. The Treasury bill delivered can be newly issued or seasoned (e.g., a 26-week bill that has 13-weeks remaining to maturity on the contract's settlement date). Deliverable bills are usually expensive to the Treasury bill curve prior to the settlement of the futures contract against which it is deliverable.

[19] See, Paul Bennett, Kenneth Garbade, and John Kambhu, "Enhancing the Liquidity of U.S. Treasury Securities in an Era of Surpluses," *FRBNY Economic Policy Review*, forthcoming.

[20] See Garbade, *Fixed Income Analytics*. Garbade finds that "month-end" bills trade cheap to the bill curve but the effect is much smaller.

CHAPTER 4

Agency Instruments

U.S. government agency securities can be classified by the type of issuer—those issued by federal agencies and those issued by government sponsored enterprises. Moreover, U.S. government agencies that provide credit for the housing market issue two types of securities: debentures and mortgage-backed/asset-backed securities. Our focus in this chapter is on debentures. We discuss short-term mortgage-backed securities and asset-backed securities in Chapters 9 and 10, respectively.

Federal agencies are fully owned by the U.S. government and have been authorized to issue securities directly in the marketplace. They include the Export-Import Bank of the United States, the Tennessee Valley Authority (TVA), the Commodity Credit Corporation, the Farmers Housing Administration, the General Services Administration, the Government National Mortgage Association, the Maritime Administration, the Private Export Funding Corporation, the Rural Electrification Administration, the Rural Telephone Bank, the Small Business Administration, and the Washington Metropolitan Area Transit Authority. The only federal agency that is an active issuer of short-term debt obligations is the TVA. With the exception of securities of the Tennessee Valley Authority and the Private Export Funding Corporation, the securities are backed by the full faith and credit of the United States government. Interest income on securities issued by federally related institutions is exempt from state and local income taxes.

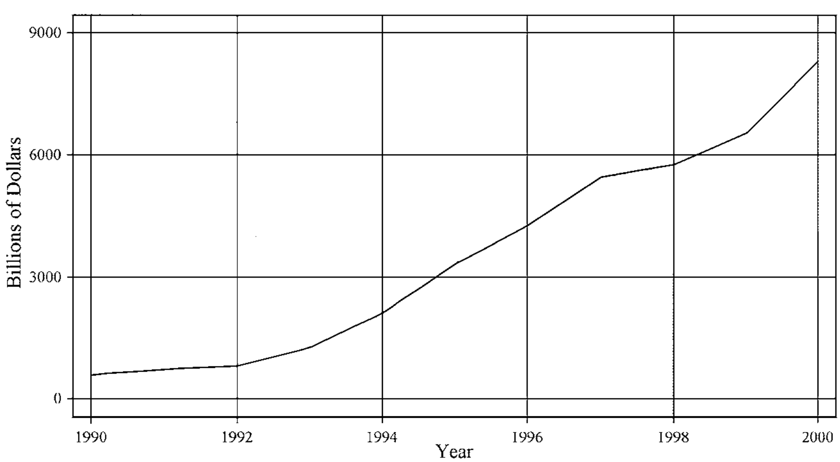
Government sponsored enterprises (GSEs) are privately owned, publicly chartered entities. They were created by Congress to reduce the cost of capital for certain borrowing sectors of the economy deemed to be important enough to warrant assistance. The entities in these privileged sectors include farmers, homeowners, and students. GSEs issue securities directly in the marketplace. Today there are six GSEs that currently issue debentures: Federal National Mortgage Association, Federal Home Loan Mortgage Corporation, Federal Agricultural Mortgage

Corporation, Federal Farm Credit System, Federal Home Loan Bank System, and Student Loan Marketing Association. The interest earned on obligations of the Federal Home Loan Bank System, the Federal Farm Credit System, and the Student Loan Marketing Association are exempt from state and local income taxes.

Although there are differences between federal agency and GSEs, it is common to refer to the securities issued by these entities as *U.S. agency securities* or, simply, *agency securities*. In this chapter we will discuss the short-term debt obligations issued by the six GSEs and the TVA. Exhibit 4.1 presents a graph of the short-term debt obligations of six of the entities discussed in this chapter for the time period 1990–2000. (The Federal Agricultural Mortgage Corporation is not included.)

Note that all of the securities issued by these entities expose an investor to credit risk. Consequently, agency securities offer a higher yield than comparable maturity Treasury securities. Nevertheless, agency securities are considered to be safer than all other fixed-income investments except U.S. Treasuries because of the strong fundamentals of their underlying businesses and because of the agencies' government affiliation. Several of the agencies have authority to borrow directly from the U.S. Treasury. Additionally, there is a perception among investors that the government implicitly backs the agency issues and would be reluctant to let an agency default on its obligations. Agency issuers are also attractive to some investors because their interest income is exempt from state and local taxation for many of the issuers (it is not exempt for Fannie Mae, Freddie Mac or Farmer Mac issues.)

EXHIBIT 4.1 **Short-Term Agency Debt Issuance***



* The Bond Market Association is the source of the data for constructing the exhibit.

FEDERAL NATIONAL MORTGAGE ASSOCIATION

The Federal National Mortgage Association ("Fannie Mae") is a GSE chartered by the Congress of the United States in 1938 to develop a secondary market for residential mortgages. Fannie Mae buys home loans from banks and other mortgage lenders in the primary market and either holds the mortgages until they mature or issues securities backed by pools of these mortgages. In addition to promoting a liquid secondary market for mortgages, Fannie Mae is charged with providing access to mortgage finance for low-income families and underserved segments of the economy. Fannie Mae's housing mission is overseen by the U.S. Department of Housing and Urban Development (HUD), and its safety and soundness is overseen by the Office of Federal Housing Enterprise Oversight (OFHEO). Although it is controversial, Fannie Mae maintains a direct line of credit with the U.S. Treasury.

Discount Notes

Fannie Mae issues short-term debt for following three reasons: (1) to fund purchases of mortgages; (2) to raise working capital; and (3) for asset-liability management purposes. Fannie Mae issued $782.95 billion in discount notes in 2000 and $512.53 billion in the first half of 2001. Discount notes are unsecured general obligations issued at a discount from their face value and mature at their face value. They are issued in book-entry form through the Federal Reserve banks. Discount notes have original maturities that range from overnight to 360 days with the exception of 3-, 6-month, and 1-year maturities. These maturities are available through Fannie Mae's Benchmark Bills® program discussed shortly.

Discount notes are offered every business day via daily posting by Fannie Mae's selling group of discount note dealers. Exhibit 4.2 lists the Fannie Mae discount note dealers as of October 2000. These dealer firms make a market in these discount notes and the secondary market is well-developed. Investors may choose among cash-, regular-, or skip-day settlements.

Benchmark Bills

Fannie Mae introduced the Benchmark Bills® program in early November 1999 as an important component of its discount note program. Benchmark Bills, like discount notes, are unsecured general obligations issued in book-entry form as discount instruments and are payable at par on their maturity date. However, unlike discount notes, Benchmark Bills are issued at regularly scheduled weekly auctions where the size of the issuance is announced in advance. When the program was launched, Benchmark Bills were issued in two maturities—3-month and 6-month. In October 2000, Fannie Mae introduced a one year (360 days) that are auctioned every two weeks.[1]

Fannie Mae announces the size of each weekly auction on Tuesday sometime during mid-morning Eastern time. The amount of securities offered for sale at each auction for 3-month Benchmark Bills is $4 to $8 billion, for 6-month maturities $1.5 to $4 billion and for one-year maturities a minimum of $1 billion. Fannie Mae issued $334 billion of Benchmark Bills in 2000 and $237.86 billion in first six months of 2001.

Exhibit 4.3 presents a Bloomberg news report from September 18, 2001 of a Fannie Mae auction announcement of 3- and 6-month Benchmark Bills. The auction itself is conducted on Wednesdays. Fannie Mae accepts bids from a subset of eight of the dealers from its Selling Group of Discount Note Dealers.[2] These eight dealers (called ACCESS dealers) can submit bids on their own account or on behalf of their customers. The bids may be either competitive or non-competitive. The minimum bid size is $50,000 with additional increments of $1,000. Moreover, bidding dealers are subject to a 35% takedown rule. A takedown rule limits the amount a single buyer can bid on or hold to 35% of the total auction amount.

EXHIBIT 4.2 **Fannie Mae Discount Note Dealers**

Banc of America Securities, LLC	Morgan Stanley & Co. Inc.
Banc One Capital Markets, Inc.	Myerberg & Company, L.P.
Berean Capital, Inc.	Ormes Capital Markets, Inc.
Blaylock & Partners, L.P.	Pryor, McClendon, Counts & Co., Inc.
Credit Suisse First Boston Corp.	Redwood Securities Group, Inc.
Deutsche Bank Securities Inc.	Robert Van Securities
Fuji Securities Inc.	Salomon Smith Barney Inc.
Gardner Rich & Company	Siebert, Branford, Shank & Co., LLC
Goldman, Sachs & Co.	SBK-Brooks Investment Corp.
HSBC Securities (USA) Inc.	UBS Warburg LLC
Jackson Securities, Inc.	Utendahl Capital Partners, L.P.
J.P. Morgan Securities Inc.	Walton Johnson & Company
Lehman Brothers Inc.	The Williams Capital Group, L.P.
Merrill Lynch Government Securities, Inc.	

Source: Fannie Mae

[1] One-year Benchmark Bills mature 360 days from issuance or the first available business day if a weekend day or a holiday occurs 360 days from issuance.
[2] Non-ACCESS dealers may bid in auctions only on behalf of their customers.

EXHIBIT 4.3 **Bloomberg Announcement for a Fannie Mae Benchmark Bill Auction**

Source: Bloomberg Financial Markets

Bids are submitted in the form of yields on a bank discount basis out to three decimal points and are accepted between 8:30 a.m. and 9:30 a.m Eastern time. The submitted bids are ranked from lowest to highest. As noted previously, this is equivalent to arranging the bids from highest price to the lowest price. Starting from the lowest yield bid, all competitive bids are accepted until the amount to be distributed to the competitive bidders is completely allocated.[3] The highest accepted bid is called the *stop out discount rate* and all accepted bids are filled at this price (i.e., a single price auction). Exhibit 4.4 presents a Bloomberg news report of the results of a September 19, 2001 auction of 3-month and 6-month Benchmark Bills. Non-competitive bids are also executed at the stop out discount rate and are allocated on the basis of when the bids were received (i.e., first-come, first-serve).

Although the Benchmark Bills program is a subset of their well-established discount notes program, Fannie Mae has taken steps such that the two programs do not interfere with one another. Specifically,

[3] The total amount of each auction that can be distributed through non-competitive bids is limited to 20%.

Fannie Mae does not issue discount notes in any given week with a maturity date within one week on either side of a Benchmark Bill's maturity date. For example, in a particular week, Fannie Mae will not issue a discount note with a maturity between two months, three weeks to three months, one week. The maturity lockout is in effect for 6-month and 1-year Benchmark Bills as well. However, the two programs are also complementary in that a 3-month Benchmark Bill with two months until maturity may be "reopened" as a 2-month discount note with the same maturity date and CUSIP as the bill.

Exhibit 4.5 presents a Bloomberg DES (security description) screen for a 1-year Benchmark Bill issued on August 28, 2001 and matures on August 23, 2001. As can be seen from the "ISSUE SIZE" box in the center of the screen, $2 billion of these securities were issued. Further, the minimum face value is $1,000. The day count convention—like virtually every security discussed in this book—is Actual/360.

EXHIBIT 4.4 **Bloomberg Announcement of Fannie Mae Benchmark Bill Auction Results**

3 DG8 9a M-Mkt FM

Page 1 of 1

[Results]

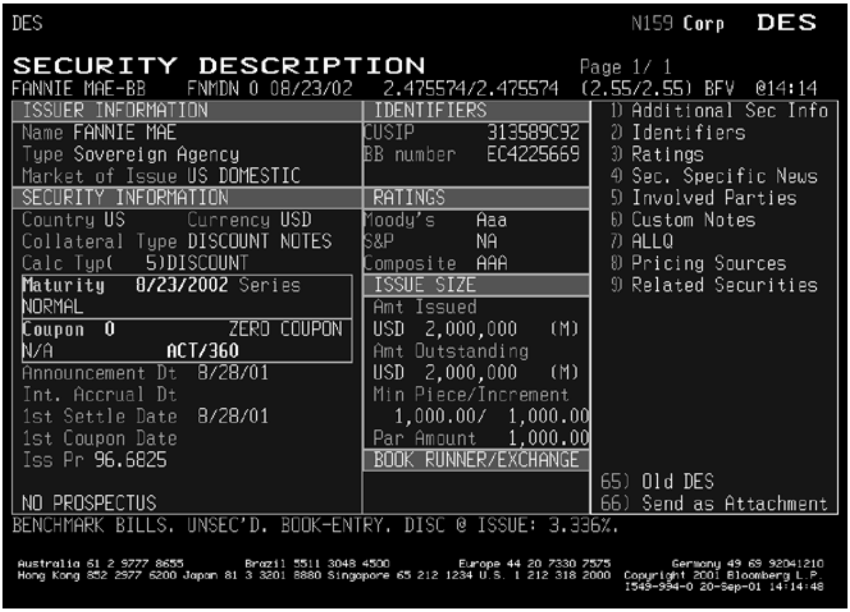
Fannie Mae auctioned $7.0 billion of three-month Benchmark Bills due December 20, 2001. Stop out discount rate: 2.219; Price: 99.4391; Money market yield: 2.232%; CUSIP: 313589QT3. Transaction settles September 19-20, 2001.

Fannie Mae auctioned $2.0 billion of six-month Benchmark Bills due March 21, 2002. Stop out discount rate: 2.300; Price: 98.8308; Money market yield: 2.327%; CUSIP: 313589UN1. Transaction settles September 19-20, 2001..

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
I549-994-0 20-Sep-01 14:06:07

Source: Bloomberg Financial Markets

EXHIBIT 4.5 Bloomberg security Description Screen of a Fannie Mae Benchmark Bill



Source: Bloomberg Financial Markets

Benchmark Bills trade at a spread over comparable maturity U.S. Treasury Bills due to the modicum of credit risk that investors to which Fannie Mae debt investors are exposed. Exhibit 4.6 presents some summary statistics of daily 3-month, 6-month, and 1-year Benchmark Bill yield spreads versus comparable maturity U.S. Treasury Bills for the period August 1, 2000 through July 20, 2001. We present the mean, standard deviation, minimum and maximum. Panels a, b and c of Exhibit 4.7 presents a time series plot of 3-month, 6-month, and 1-year yield spreads, respectively for the same time period. Note that the yield spreads spike the last week of December 2000. This phenomenon is due to unwillingness of money managers to hold spread product around the calendar turn. Instead, for annual reporting purposes, they increase their holdings of U.S. Treasury bills. Moreover, U.S. Treasury bills that mature at the end of a quarter or at the end of the year trade at a higher price and correspondingly offer a lower yield relative to the Treasury bill curve.[4]

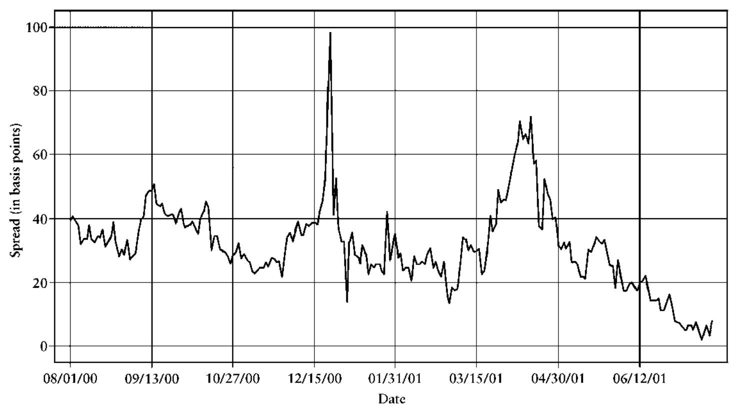
[4] See, Robin Grieves, Steven V. Mann, Alan J. Marcus, and Pradipkumar Ramanlal, "Riding the Bill Curve," *The Journal of Portfolio Management* (Spring 1999), pp. 74-82.

EXHIBIT 4.6 Summary Statistics of the Yield Between Benchmark Bills versus U.S. Treasury Bill Yields

Statistic	3-Month Yield Spread	6-Month Yield Spread	1-Year Yield Spread
Mean	31.307	26.984	37.528
Standard Deviation	13.627	9.626	10.381
Minimum	2.036	6.731	16.552
Maximum	98.504	58.709	77.686

EXHIBIT 4.7 Time Series of Benchmark Bill Spreads

a. 3-Month Benchmark Bill Spread



b. 6-Month Benchmark Bill Spread

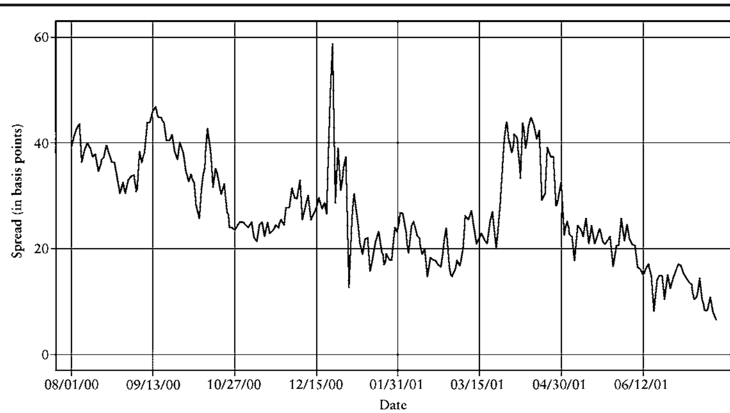
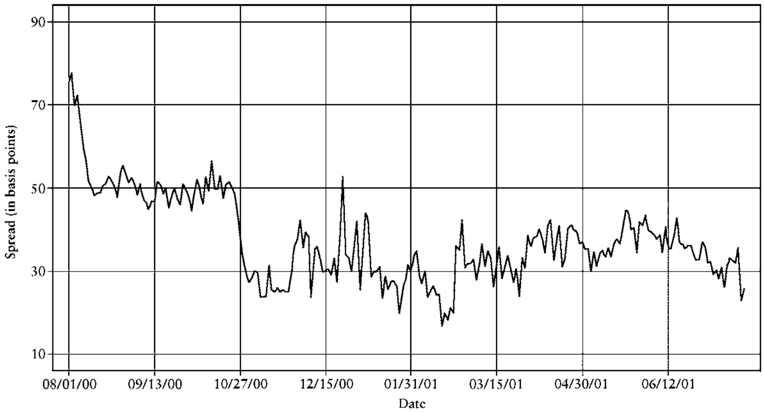


EXHIBIT 4.7 (Continued):
c. 1-Year Benchmark Bill Spread



FEDERAL HOME LOAN MORTGAGE CORPORATION

The Federal Home Loan Mortgage Corporation ("Freddie Mac") is a GSE chartered by the Congress of the United States in 1970 to improve the liquidity of the secondary mortgage market. Freddie Mac purchases mortgage loans from individual lenders and either sells securities backed by the mortgages to investors or holds the mortgages until maturity. Like Fannie Mae, Freddie Mac is similarly charged with providing access to mortgage finance for low-income families and underserved populations. Also like Fannie Mae, Freddie Mac is regulated by HUD for its housing mission and by OFHEO for safety/soundness issues. Freddie Mac maintains a direct line of credit with the U.S. Treasury.

Discount Notes

In 2000, Freddie Mac issued $2.076 trillion in discount notes. While at issuance these notes can range in maturity from overnight to 365 days, half of these notes have maturities of three days or less. The most popular maturities are one month and three months. Freddie Mac discount notes are offered for sale continuously with rates posted 24 hours a day (business days) through a group of investment banks that belong to the Freddie Mac dealer group. These notes are issued in book entry form through the Federal Reserve Bank of New York and a minimum face value of $1,000 with increments of $1,000 thereafter. The pricing conventions are the same as U.S. Treasury bills.

Reference Bills

Freddie Mac's Reference Bills® program was announced November 17, 1999. The program is similar in structure to Fannie Mae's Benchmark Bills. One important difference between the two is that Reference Bills® are offered in more maturities namely, one month (28 days), two months (56 days), three months (91 days), six months (182 days), and one year (364 days).

Like U.S. Treasury bills and Benchmark Bills, Reference Bills are sold weekly using a Dutch auction. 1-month and 2-month Reference Bills are auctioned each week on Monday, while 3-month maturities are auctioned weekly on Tuesday. The 6-month and 1-year Reference Bills are auctioned every four weeks on Tuesday on an alternating schedule such that every two weeks either a 6-month or a 1-year maturity will be auctioned. In order to give their investors flexibility, Freddie Mac offers multiple settlement dates. For Reference bills auctioned on Mondays, investors may choose between cash and regular settlement dates. For those auctioned on Tuesdays, investors may choose between cash, regular, and skip-day settlement dates. Auctions of Reference Bills are announced on Thursday for the following week and have a minimum size of $1 billion.

Exhibit 4.8 presents a Bloomberg DES (Security Description) of a 3-month Reference Bill that was auctioned on September 11, 2001 and matures on September 25, 2001. Exhibit 4.9 presents YA (Discount/Yield Analysis). Note the yield on a bank discount basis for this Reference Bill is 2.28154. Given the yield on a bank discount basis, the price is found the same way as the price of a Treasury bill in Chapter 3 by first solving for the dollar discount (D) as follows:

$$D = Y_d \times F \times (t/360)$$

where

Y_d = discount yield
F = face value
t = number of days until maturity

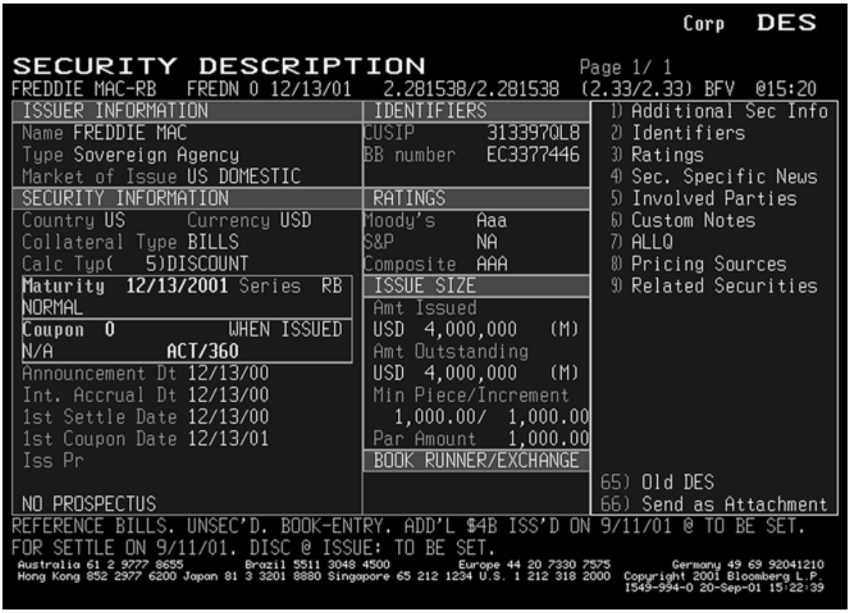
The price is then

$$\text{price} = F - D$$

With a settlement day of September 20, 2001, the Reference Bill has 63 days remaining until maturity. Assuming a face value of $100 and a yield on bank discount basis of 2.28154%, D is equal to

$$D = 0.0228154 \times \$100 \times (84/360) = \$0.532359$$

EXHIBIT 4.8 **Bloomberg Security Description Screen of a Freddie Mac Reference Bill**



Source: Bloomberg Financial Markets

Therefore,

$$\text{price} = \$100 - \$0.532359 = \$99.467641$$

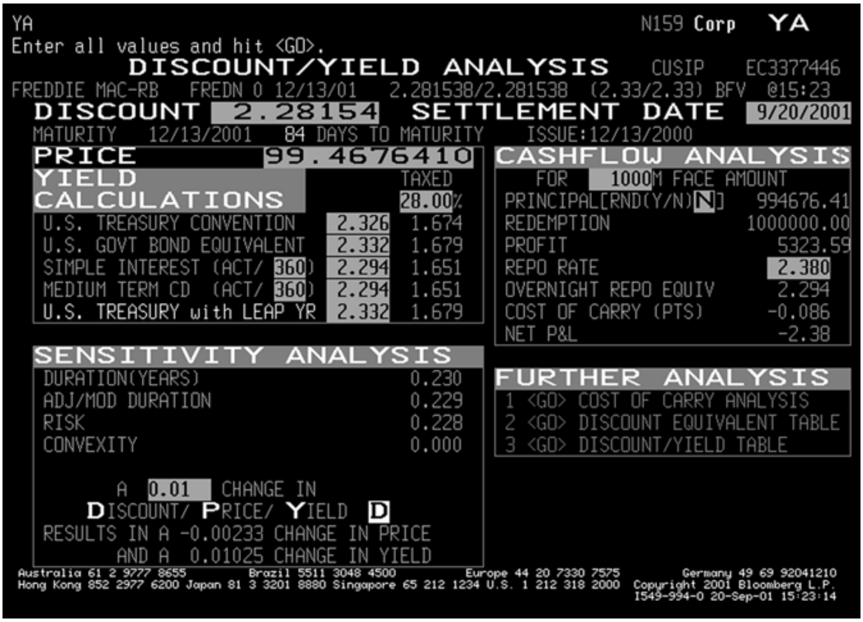
This calculation agrees with the price displayed in the box on the upper left-hand side of the screen in Exhibit 4.9.

Also in the Exhibit 4.9 are various yield calculations located in a box on the left-hand side of the screen. The CD equivalent yield (also called money market equivalent yield) makes the quoted yield on a bank discount basis more comparable on other money market instruments that pay interest on a 360-day basis. Recall, the formula for the CD equivalent yield is

$$\text{CD equivalent yield} = \frac{360\,Y_d}{360 - t(Y_d)}$$

The notation is the same as above.

EXHIBIT 4.9 **Bloomberg Yield Analysis Screen for a Freddie Mac Reference Bill**



Source: Bloomberg Financial Markets

To illustrate the calculation of the CD equivalent yield, once again we use the information from Exhibit 4.9. The yield on a bank discount basis is 2.28154%. The CD equivalent yield is computed as follows:

$$\text{CD equivalent yield} = \frac{360(0.0228154)}{360 - 84(0.0228154)} = 0.02294 = 2.294\%$$

This calculation agrees with the yield presented in the screen.

Just above the CD yield is *simple interest*. Simple interest is the ratio of the cash flow to be received from holding the security until maturity (i.e., the discount) to the security's price annualized on the basis of a 360-day year. Recall from Chapter 2, the simple interest formula is simply

$$\text{Simple Interest(ACT/360)} = \frac{D}{\text{price}} \times (360/t)$$

To illustrate the calculation, let's us continue to use the Reference Bill in Exhibit 4.9. The simple interest (ACT/360) is computed as follows:

$$\text{Simple Interest(ACT/360)} = \frac{0.532359}{99.467641} \times (360/84) = 2.294\%$$

This calculation agrees with the one presented in the screen.

Another frequently used is called the bond-equivalent yield. As discussed in Chapter 3, this yield measure makes a yield quoted on a bank discount basis more comparable to yields on coupon Treasuries that use an actual/actual day count convention. Recall, the calculation of a bond equivalent yield depends on whether the discount instrument has 182 days or less to maturity or more than 182 days. If the maturity is 182 days or less, the calculation of the bond-equivalent yield is very straightforward (see Chapter 3). Let's tackle the more involved case and consider a Reference Bill that has a maturity longer than 182 days.

As discussed in Chapter 3, when a discount instrument like a Reference Bill has a current maturity of more than 182 days, converting a yield on a bank discount basis into a bond-equivalent yield is more involved. Specifically, the calculation must reflect the fact that a Reference Bill does deliver cash flows prior to maturity while a coupon bond delivers coupon payments semiannually and the semiannual coupon payment can be reinvested.

As an example, let's use a 1-year Reference Bill. Exhibit 4.10 presents a Bloomberg YA screen for this Reference Bill issued on September 12, 2001. The price of this bill is 97.5271 (per $100 of face value). This bill matures on September 12, 2002 so as of September 20, 2001 (settlement date) there are 357 days to maturity. Since the year 2002 is a non-leap year, $T = 365$. Substituting this information in the expression above gives the bond-equivalent yield for this 1-year Reference Bill:

$$\text{BEY} = \frac{\dfrac{-2 \times 357}{365} + 2\left[\left(\dfrac{357}{365}\right)^2 - \left(\dfrac{2 \times 357}{365} - 1\right) \times \left(1 - \dfrac{100}{97.5271}\right)\right]^{1/2}}{\dfrac{2 \times 357}{365} - 1}$$

$$= 0.02577 = 2.577\%$$

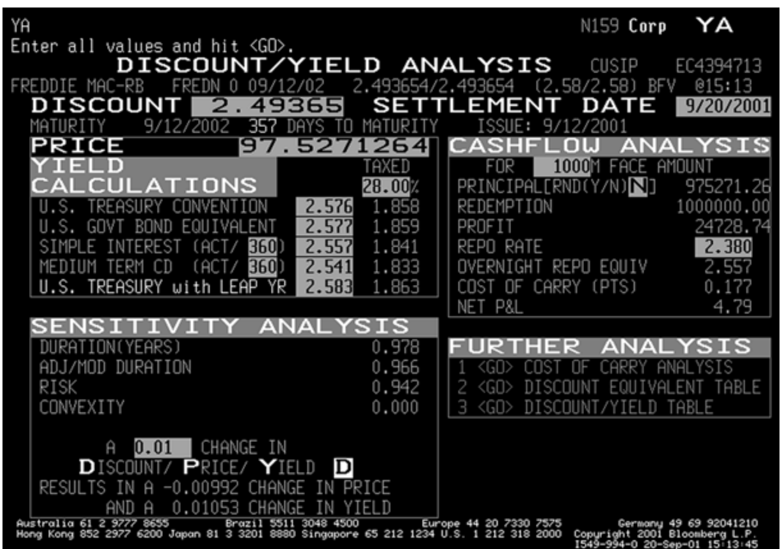
FEDERAL HOME LOAN BANK SYSTEM

The Federal Home Loan Bank System ("FHLBank System") is a GSE created by the U.S. Congress in 1932 whose mission is to support residential mortgage lending and related community investment through its member financial institutions. The System provides member institutions with access to low-cost funding, technical assistance, and special affordable housing programs. As of mid-year 2001, member institutions numbered 7,822, including 5,702 commercial banks, 1,536 thrifts, 530 credit unions, and 54 insurance companies, with collective assets just short of $4.5 trillion. The System consists of 12 federally chartered, member-owned Federal Home Loan Banks. Each regional Federal Home Loan Bank is an individual corporate entity that does not receive any taxpayer assistance. However, the FHLBank System maintains a direct line of credit with the U.S. Treasury. The Federal Housing Finance Board regulates the FHLBank System regarding its mission as well as safety/soundness issues.

Discount Notes

The FHLBank System issued $861 billion in discount notes in 2000 and $494 billion in the first six months of 2001. Like the other discount notes discussed earlier, these securities are unsecured general obligations sold at a discount from par and mature at their face value. Minimum face values are $100,000 with additional increments of $1,000. The maturities range from overnight to 360 days. FHLBank System discount notes are generally offered for sale on a continuous basis generally by one or more of the following ways: (1) auction; (2) sale to dealers as principal; and (3) allocation to selected dealers as agent in accordance with FHLBank System procedures for reoffering the notes to investors.

EXHIBIT 4.10 **Bloomberg Yield Analysis Screen for a Freddie Mac Reference Bill**



Source: Bloomberg Financial Markets

EXHIBIT 4.11 **Bloomberg Announcement of the Federal Home Loan Banks' Discount Note Offerings**

5 DG8 9a **Govt** **FHLB**

FEDERAL HOME LOAN BANK Page 1 of 1

Days	Rate	Target Amount	Days	Rate	Target Amount	19:17 GMT
O/N	.60-1.95	5,875.000	3/25	2.20/22	5.387/3.000	20-Sep-01
9/27	1.25-35	279.577	4/18-22	2.20	2.000	
10/4-11	1.48/55	50.026/.553	5/20-22	2.25	1.000	
10/15-17	1.90	80.905	6/25	2.24	1.000	
10/23-31	1.90	182.240	7/17-22	2.30	1.000	
11/2-6	1.95	1.000	8/16-20	2.32	0.000	
11/14-16	1.95	8.503	9/13	2.36	0.000	
11/19	1.95	25.000	TOTAL		$6,565.300	
11/20-29	1.95/2.00	0.000/6.667				
11/30	2.00	.500				
12/19	2.03/05	3.906/29.690				
12/24-31	2.03/05	.346/3.000				
3/19-20	2.200 CL	5.000				

THIS SCREEN DOES NOT CONSTITUTE
AN OFFER TO SELL OR A SOLICITATION
OF AN OFFER TO BUY ANY SECURITIES.

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000
I549-994-0 20-Sep-01 16:11:52

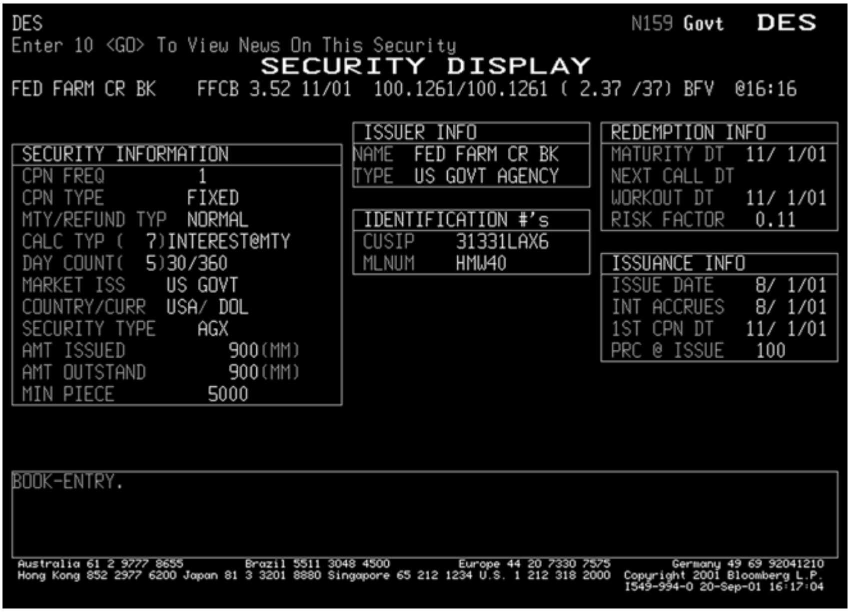
Source: Bloomberg Financial Markets

Exhibit 4.11 presents information provided by the FHLBank System and conveyed to investors on Bloomberg about their discount note program. This screen includes the maturity, rate, and target amount to be borrowed.

FEDERAL FARM CREDIT SYSTEM

The Federal Farm Credit System (FFCS) established by Congress in 1916 is the oldest GSE. Its mission is to provide a steady source of low-cost credit to the U.S. agricultural sector. The FFCS lends money to farmers through a network of borrower-owned financial institutions and related service organizations. Six Farm Credit Banks and one Agricultural Credit Bank make direct long-term real estate loans to farmers through 32 Federal Land Bank Associations. The banks also provide loan funds to various credit associations, which in turn make short-, intermediate-, and long-term loans to farmers. The FFCS is regulated by the Farm Credit Administration. Unlike the agencies discussed to this point, the FFCS does not maintain a direct line of credit with the U.S. Treasury.

EXHIBIT 4.12 **Bloomberg Security Description Screen of a Federal Farm Credit System Security**



Source: Bloomberg Financial Markets

Discount Notes

Under the Farm Credit Act, the FFCS issues debt through the Federal Farm Credit Banks Funding Corporation that serves as the FFCS's fiscal agent. The Funding Corporation currently issues Systemwide Bonds, Discount Notes, Master Notes, and Global Debt Securities. The discount notes are unsecured, joint obligations of the FFCS. As of January 31, 2001, the FFCS had $19.7 billion in discount notes outstanding. By statue, the FFCS is currently authorized to have up to $25 billion in aggregate par amount of discount notes outstanding at any one time. Maturities range from overnight to 365 days with the majority having maturities of less than 90 days. Minimum face values are $5,000 and then in $1,000 increments. All discount notes have cash settlement.

Interest at Maturity Securities

The FFCS also issues short-term securities with maturities less than one year that are issued at par and pay interest at maturity. Exhibit 4.12 presents a Bloomberg DES (Security Description) screen for an interest at maturity security that looks much like the CDs discussed in Chapter 6.

This security was issued by the FFCS on August 1, 2001 and matured on November 1, 2001. Note that unlike most of securities discussed in this book, the day count convention is 30/360.

On the issuance date August 1, 2001, the yield on this security was 3.52% as can be seen from the upper left-hand side of the screen. Accordingly, the interest at maturity is determined by multiplying the face value, the yield at issuance, and the fraction of a year using a 30/360 day count convention. With the 30/360 day count, all months are assumed to have 30 days and all years are assumed to have 360 days. There are 90 days between August 1, 2001 and November 1, 2001 using a 30/360 day count convention.[5]

The interest at maturity is computed as follows assuming a $1 million face value:

$$\$1,000,000 \times 0.0352 \times (90/360) = \$8,800$$

Exhibit 4.13 presents a Bloomberg Yield Analysis (YA) screen for this security. Suppose a $1,000,000 face value is purchased with a settlement day of September 21, 2001 for the full price (i.e., flat price plus accrued interest) of $1,006,150.03 as can be seen from the "PAYMENT INVOICE" box on the right-hand side of the screen. We know the investor receives $1,008,800 at maturity, so the if buyer holds the security until maturity, she will receive the difference of $2,649.97. This calculation agrees with the "GROSS PROFIT" on the right-hand side of the screen.

A yield calculation which may require some explanation is labelled "DISCOUNT EQUIVALENT" in Exhibit 4.13. This security is similar to a discount security in that the security does not pay a cash flow until maturity. The discount equivalent yield puts discount notes which are quoted on a bank discount basis and interest at maturity securities on the same basis. Namely, suppose the face value of the security is $1,008,800 and the security full price's is $1,006,150.03. What is the yield on the bank discount basis? To see this, recall the formula for the dollar discount (D):

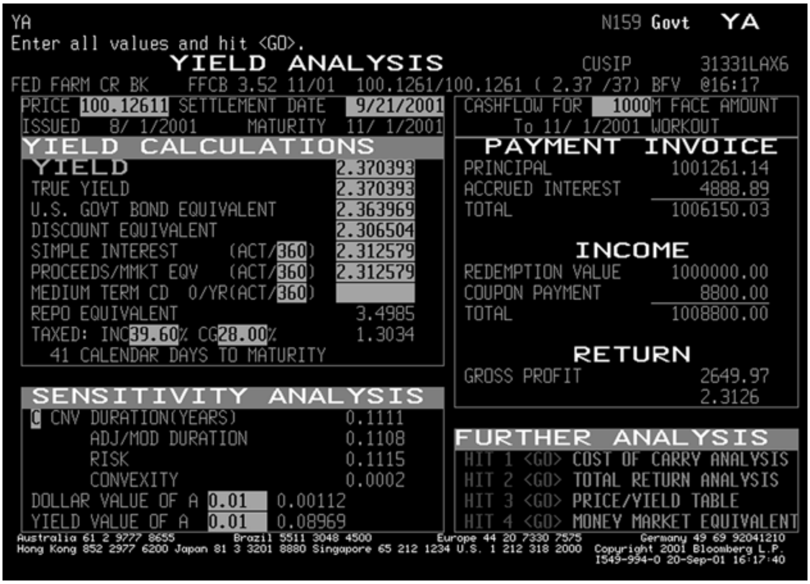
$$D = Y_d \times F \times (t/360)$$

where

Y_d = discount yield
F = face value
t = number of days until maturity

[5] The number of days between two dates using a 30/360 day count convention will usually differ from the actual number of days between the two dates. In this case, there 92 actual days between the two dates.

EXHIBIT 4.13 Bloomberg Yield Analysis Screen of a Federal Farm Credit System Security



Source: Bloomberg Financial Markets

In this case, the face value is \$1,008,800, the dollar discount is \$2,649.97, and the actual number of days until maturity is 41 since discount securities use an Actual/360 day count convention. Inserting these numbers into the formula gives us:

$$\$2,649.97 = Y_d \times \$1,008,800 \times (41/360)$$

Solving for Y_d gives us:

$$Y_d = 0.02306504 = 2.306504\%$$

The calculation agrees with the yield calculation displayed in the "YIELD CALCULATIONS" box on the left-hand side of the screen in Exhibit 4.13.

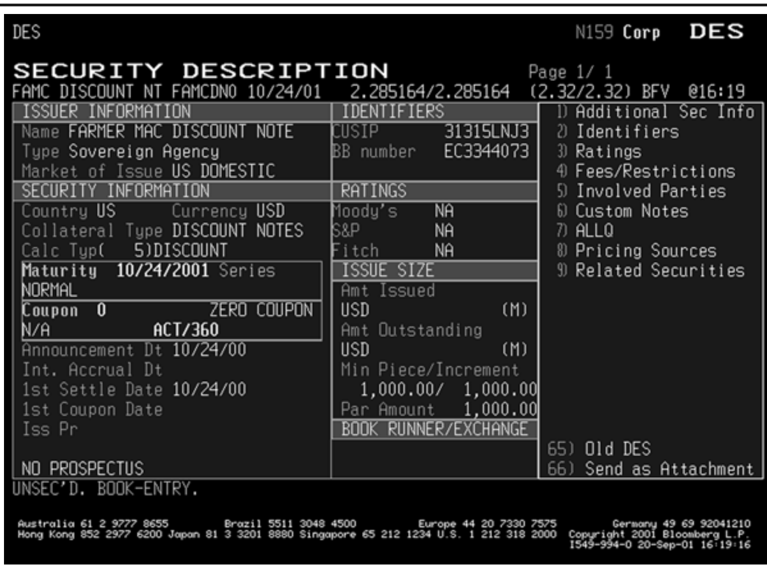
FEDERAL AGRICULTURAL MORTGAGE CORPORATION

The Federal Agricultural Mortgage Corporation ("Farmer Mac") is a GSE created by Congress in 1988 whose mission is to attract capital for the financing of agricultural real estate and to promote a liquid secondary market for agricultural loans. This is accomplished by buying qualified loans from lenders (e.g., mortgage companies, savings institutions, credit unions, commercial banks, etc.) and combining the loans into pools against which Farmer Mac issues securities backed by these loans. Accordingly, Farmer Mac performs a role for the agricultural mortgage market that mirrors what Fannie Mae and Freddie Mac do for the residential mortgage market. Farmer Mac maintains a direct line of credit with the U.S. Treasury.

On December 31, 2000, Farmer Mac had 2.201 billion dollars of debt that was due within one year. The majority of this short-term debt is discount notes. Discount notes are unsecured general obligation securities that are issued in book-entry form through the Federal Reserve Banks. Farmer Mac uses discount notes to meet short-term funding needs. The maturities range from overnight to 365 days and are offered on a continuous basis. Farmer Mac discount notes are available with cash-, regular-, and skip-day settlement dates.

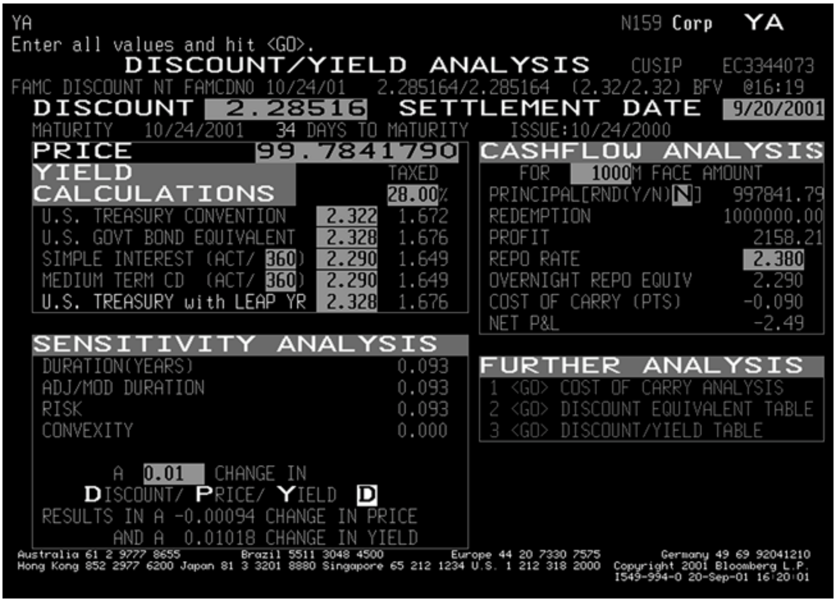
Exhibit 4.14 presents a Bloomberg DES (Security Description) for a Farmer Mac discount note that was issued on October 24, 2000 and matured on October 24, 2001. The maturity for Farmer Mac discount notes will always fall on a business day. As can be seen in the "ISSUE SIZE" box in bottom center of the screen, the minimum face value is $1,000 with additional increments of $1,000 thereafter.

EXHIBIT 4.14 **Bloomberg Security Description Screen of a Farmer Mac Discount Note**



Source: Bloomberg Financial Markets

EXHIBIT 4.15 Bloomberg Yield Analysis Screen of a Farmer Mac Discount Note



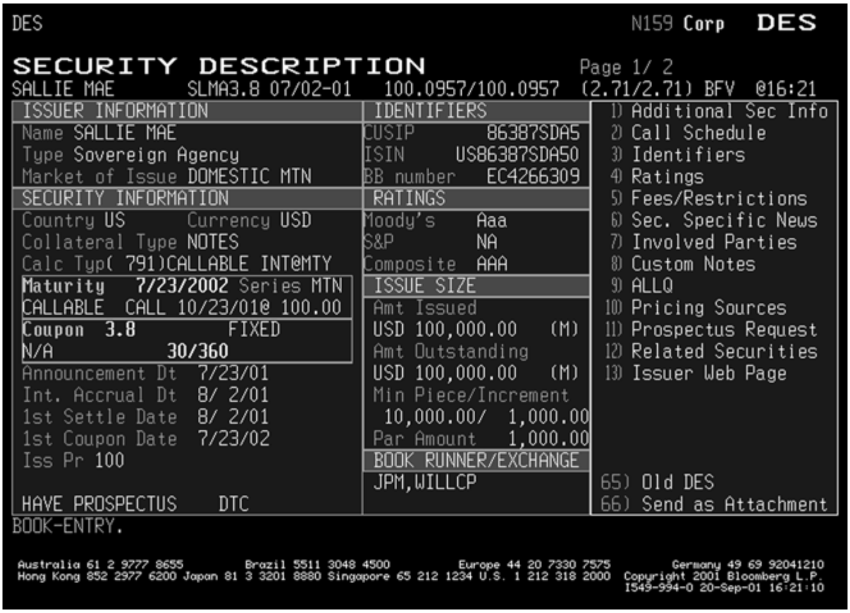
Source: Bloomberg Financial Markets

Exhibit 4.15 is a Bloomberg YA (Yield Analysis) screen for the same Farmer Mac discount note. From this screen, we see that the discount yield is 2.28516% that corresponds to a price of 99.784179 (per $100 of face value) with settlement on September 20, 2001. From the "CASHFLOW ANALYSIS" box on the right-hand side of the screen, it can be seen that an investor can purchase $1 million face value package of notes that mature on October 24, 2001 for $997,841.79. The interest income of $2,158.21 is fully taxable at the federal, state, and local levels.

STUDENT LOAN MARKETING ASSOCIATION

The Student Loan Marketing Association ("Sallie Mae") is a GSE established by Congress in 1972 to increase the availability of student loans. Sallie Mae purchases from lenders guaranteed student loans originated under the Federal Family Education Loan Program (FFELP) and correspondingly makes loans to lenders secured by student loans. Of the approximately $25 billion loaned to students annually, about 70% are provided by private lenders under the FFELP.

EXHIBIT 4.16 **Bloomberg Security Description Screen of a Sallie Mae Callable Security**



Source: Bloomberg Financial Markets

Sallie Mae is a subsidiary of USA Education, Inc. (formerly SLM Holdings). In September 1996, legislation was passed such that Sallie Mae's GSE status will be phased out by September 30, 2008 and it will be fully privatized. Unitl its GSE status terminates, Sallie Mae maintains a direct line of credit with the U.S. Treasury. Moreover, Sallie Mae is under the regulatory aegis of the U.S. Treasury specifically, the Office of Sallie Mae Oversight.

Sallie Mae generally funds its student loan portfolio by issuing floating-rate debt either tied to the 91-day U.S. Treasury bill rate or to a lesser extent 3-month LIBOR. These floating-rate securities will be discussed in Chapter 7. In addition, Sallie Mae has an active discount note program with $6.274 billion in discount notes outstanding as of December 31, 2000. Finally, Sallie Mae issues short-term interest at maturity securities that are also callable. Exhibit 4.16 presents a Bloomberg DES screen for Sallie Mae interest at maturity security that was issued on August 2, 2001 that matures on July 23, 2002. The security is callable at par on October 23, 2001, approximately three months after issuance.

TENNESSEE VALLEY AUTHORITY

The Tennessee Valley Authority (TVA) is a wholly-owned corporate agency and instrumentality of the U.S. government. The TVA was established in 1933 as part of President Franklin Roosevelt's New Deal Program to promote development of the Tennessee River and adjacent areas. Specifically, TVA manages the river system for flood control, navigation, power generation, and other purposes. TVA is the largest producer of electricity in the U.S. Like the other agencies discussed in this chapter, TVA has the authority to borrow from the U.S. Treasury. In particular, TVA may borrow from the U.S. Treasury up to $150 million for a period of one year or less. However, unlike the other agencies discussed previously, TVA's borrowing authority is part of the federal government's budget.

TVA's discount note program is structured similarly to those described above. There are a few differences nonetheless. First, the face value of TVA's discount notes is $100,000 and additional increments of $1,000 thereafter. Second, interest on these securities is exempt from state and local taxes except estate, inheritance, and gift taxes. Third, regulations stipulate that TVA's outstanding short-term debt shall not exceed $5.5 billion at any one time.

CHAPTER 5

Corporate Obligations: Commercial Paper and Medium-Term Notes

A corporation that needs long-term funds can raise those funds in either the bond or equity markets. Alternatively, if a corporation needs short-term funds, it may attempt to acquire funds via bank borrowing. One close substitute to bank borrowing for larger corporations with strong credit ratings is commercial paper. Commercial paper is a short-term promissory note issued in the open market as an obligation of the issuing entity. Commercial paper is sold at a discount and pays face value at maturity. The discount represents interest to the investor in the period to maturity. Although some issues are in registered form, commercial paper is typically issued in bearer form.

The commercial paper market was developed in the United States in the latter days of the nineteenth century and was once the province of larger corporations with superior credit ratings.However, in recent years, many lower-credit-rated corporations have issued commercial paper by obtaining credit enhancements or other collateral to allow them to enter the market as issuers. Issuers of commercial paper are not limited to U.S. corporations; foreign corporations and sovereign issuers also issue commercial paper. Commercial paper was first issued in the United Kingdom in 1986 and was subsequently issued in other European countries.

Although the original purpose of commercial paper was to provide short-term funds for seasonal and working capital needs, it has been issued for other purposes, most prominently for “bridge financing.” For example, suppose that a corporation desires long-term funds to build a plant or acquire equipment. Rather than raising long-term funds immediately, the issuer may choose to postpone the offering until more favorable capital market conditions prevail. The funds raised by issuing commercial paper are employed until longer-term securities are issued. Commercial paper is also used as bridge financing to finance corporate takeovers.

CHARACTERISTICS OF COMMERCIAL PAPER

The maturity of commercial paper is typically less than 270 days; a typical issue matures in less than 45 days. Naturally, there are reasons for this. First, the Securities and Exchange Act of 1933 requires that securities be registered with the Securities and Exchange Commission (SEC). Special provisions in the 1933 act exempt commercial paper from these registration requirements so long as the maturity does not exceed 270 days. To avoid the costs associated with registering issues with the SEC, issuers rarely issue commercial paper with a maturity exceeding 270 days. In Europe, commercial paper maturities range between 2-365 days. To pay off holders of maturing paper, issuers generally "rollover" outstanding issues; that is, they issue new paper to pay off maturing paper.

Another consideration in determining the maturity is whether the paper would be eligible collateral by a bank if it wanted to borrow from the Federal Reserve Bank's discount window. In order to be eligible, the paper's maturity may not exceed 90 days. Because eligible paper trades at a lower cost than paper that is ineligible, issuers prefer to sell paper whose maturity does not exceed 90 days.

The combination of its short maturity and low credit risk make commercial paper an ideal investment vehicle for short-term funds. Most investors in commercial paper are institutional investors. Money market mutual funds are the largest single investor of commercial paper. Pension funds, commercial bank trust departments, state and local governments, and nonfinancial corporations seeking short-term investments comprise most of the balance.

The market for commercial paper is a wholesale market and transactions are typically sizeable. The minimum round-lot transaction is $100,000. Some issuers will sell commercial paper in denominations of $25,000.

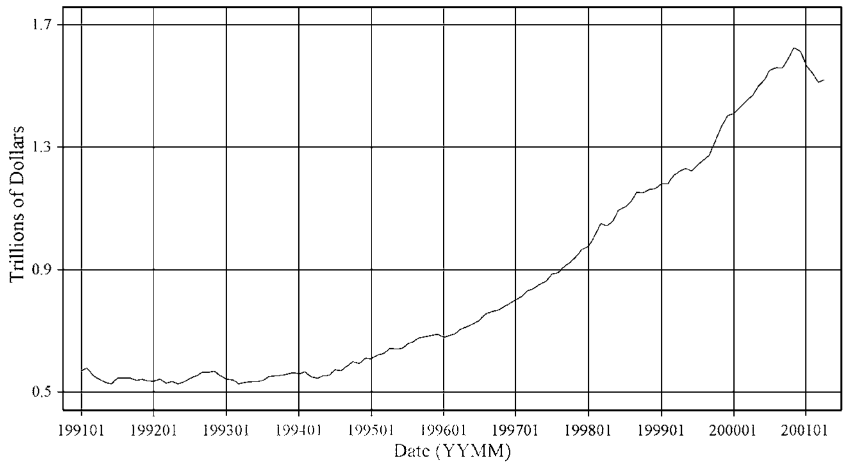
Commercial paper is the largest segment of money market exceeding even U.S. Treasury bills with just over $1.5 billion in commercial paper outstanding at the end of April 2001. Exhibit 5.1 presents a monthly time series of the amount of commercial paper outstanding for the period January 1991 through April 2001. The source of these data is the Federal Reserve. The Federal Reserve Bank of New York collects the data on the amount of commercial paper outstanding from 16 commercial paper dealers and 43 firms that sell commercial paper directly to investors on forms FR 2957a and b. The Federal Reserve Bank of New York also collects, seasonally adjusts, and releases month-end data on outstanding commercial paper from the same respondents.

Direct Paper versus Dealer Paper

Commercial paper is classified as either direct paper or dealer paper. *Direct paper* is sold by an issuing firm directly to investors without using a securities dealer as an intermediary. The vast majority of the issuers of direct paper are financial firms. Because financial firms require a continuous source of funds in order to provide loans to customers, they find it cost effective to have a sales force to sell their commercial paper directly to investors. Direct issuers post rates at which they are willing to sell commercial paper with financial information vendors such as Bloomberg, Reuters, and Telerate.

Although commercial paper is a short-term security, it is issued within a longer term program, usually for three to five years for European firms: U.S. commercial paper programs are often open-ended. For example, a company might establish a 5-year commercial paper program with a limit of $100 million. Once the program is established the company can issue commercial paper up to this amount. The program is continuous and new paper can be issued at any time, daily if required.

EXHIBIT 5.1 **Commercial Paper Outstanding**



Source: Federal Reserve

In the case of dealer placed commercial paper, the issuer uses the services of a securities firm to sell its paper. Commercial paper sold in this manner is referred to as *dealer paper*. Competitive pressures have forced dramatic reductions in the underwriting fees charged by dealer firms.

Historically, the dealer market has been dominated by large investment banking firms because the Glass-Steagall Act prohibited commercial banks from underwriting commercial paper. In June 1987, however, the Federal Reserve granted subsidiaries of bank holding companies the power to underwrite commercial paper. Commercial banks began immediately making inroads into the dealer market that was once the exclusive province of investment banking firms. This process was further accelerated when the Gramm-Leach-Bliley Act was signed into law in November 1999. The reforms enacted in the Gramm-Leach-Bliley Act repealed the Glass-Steagall Act that mandated artificial barriers between commercial banks, investment banks, and insurance companies. Now each is free to expand into the others' businesses.

The Secondary Market

Although commercial paper, as noted, is the largest sector of the money market, there is relatively little trading in the secondary market. The reason being is that most investors in commercial paper follow a "buy and hold" strategy. This is to be expected because investors purchase commercial paper that matches their specific maturity requirements. Any secondary market trading is usually concentrated among institutional investors in a few large, highly rated issues. If investors wish to sell their commercial paper, they can usually sell it back to the original seller either dealer or issuer.

COMMERCIAL PAPER CREDIT RATINGS

All investors in commercial paper are exposed to credit risk. Credit risk is the possibility the investor will not receive the timely payment of interest and principal at maturity. While some institutional investors do their own credit analysis, most investors assess a commercial paper's credit risk using ratings by a nationally recognized statistical rating organizations (NRSROs). The SEC currently designates only Fitch, Moody's, and Standard & Poor's as NRSROs for rating U.S. corporate debt obligations. Exhibit 5.2 presents the commercial paper ratings from the NRSROs.

The risk that the investor faces is that the borrower will be unable to issue new paper at maturity. This risk is referred to as *rollover risk*. As a safeguard against rollover risk, commercial paper issuers secure backup lines of credit sometimes called “liquidity enhancement.” Most commercial issuers maintain 100% backing because the NRSROs that rate commercial paper usually require a bank line of credit as a precondition for a rating. However, some large issues carry less than 100% backing. Backup lines of credit typically contain a “material adverse change” provision that allows the bank to cancel the credit line if the financial condition of the issuing firm deteriorates substantially.[1]

Historically, defaults on commercial paper have been relatively rare. As of mid-2001, the last default of any consequence occurred on January 31, 1997 when Mercury Finance Co.—a sizeable player in the automobile lending business—defaulted on $17 million in commercial paper. The amount of paper in default mushroomed to $315 million by the end of the next month. Fortunately, the Mercury default inflicted minimal damage on the commercial paper market.

The commercial paper market is divided into tiers according to credit risk ratings. The “top top tier” consists of paper rated A1+/P1/F1+. “Top tier” is paper rated A1/ P1, F1. Next, “split tier” issues are rated either A1/P2 or A2/P1. The “second tier” issues are rated A2/P2/F2. Finally, “third tier” issues are rated A3/P3/F3. Exhibit 5.3 presents a Bloomberg MMR screen that presents rates for dealer paper by tier for maturities ranging from 1 day to 270 days. Exhibit 5.4 presents rates for direct issues of commercial paper in the same fashion.

Yields on Commercial Paper

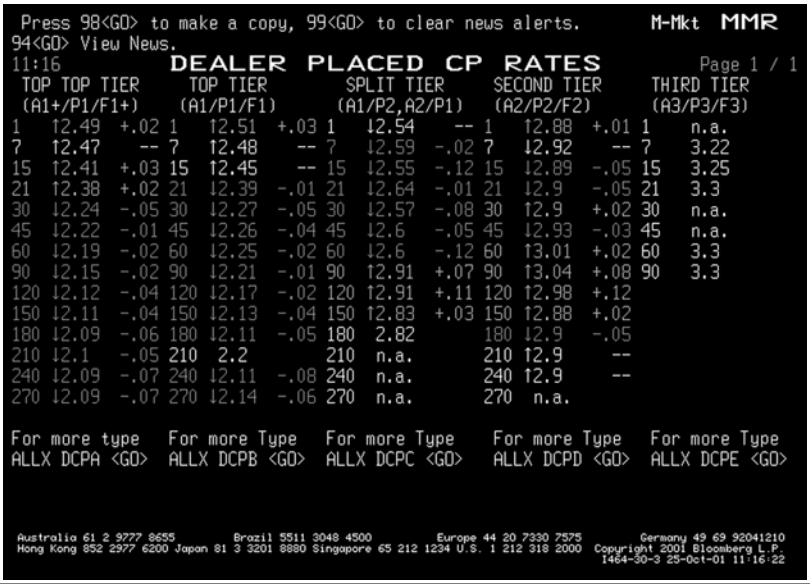
Like Treasury bills, commercial paper is a discount instrument. In other words, it is sold at a price less than its maturity value. The difference between the maturity value and the price paid is the interest earned by the investor, although some commercial paper is issued as an interest-bearing instrument.

EXHIBIT 5.2 Ratings of Commercial Paper

	Fitch	Moody’s	S&P
Superior	F1+/F1	P1	A1+/A1
Satisfactory	F2	P2	A2
Adequate	F3	P3	A3
Speculative	F4	NP	B, C
Defaulted	F5	NP	D

[1] Dusan Stojanovic and Mark D. Vaughan, “Who’s Minding the Shop?” *The Regional Economist*, The Federal Reserve Bank of St. Louis, April 1998, pp. 1-8.

EXHIBIT 5.3 Bloomberg Screen of Dealer Placed Commercial Paper Rates



Press 98<GO> to make a copy, 99<GO> to clear news alerts. M-Mkt MMR
94<GO> View News.
11:16 DEALER PLACED CP RATES Page 1 / 1

TOP TOP TIER (A1+/P1/F1+)			TOP TIER (A1/P1/F1)			SPLIT TIER (A1/P2,A2/P1)			SECOND TIER (A2/P2/F2)			THIRD TIER (A3/P3/F3)	
1	↑2.49	+.02	1	↑2.51	+.03	1	↓2.54	--	1	↑2.88	+.01	1	n.a.
7	↑2.47	--	7	↑2.48	--	7	↓2.59	-.02	7	↓2.92	--	7	3.22
15	↑2.41	+.03	15	↑2.45	--	15	↓2.55	-.12	15	↓2.89	-.05	15	3.25
21	↑2.38	+.02	21	↓2.39	-.01	21	↓2.64	-.01	21	↓2.9	-.05	21	3.3
30	↓2.24	-.05	30	↓2.27	-.05	30	↓2.57	-.08	30	↑2.9	+.02	30	n.a.
45	↓2.22	-.01	45	↓2.26	-.04	45	↓2.6	-.05	45	↓2.93	-.03	45	n.a.
60	↓2.19	-.02	60	↓2.25	-.02	60	↓2.6	-.12	60	↑3.01	+.02	60	3.3
90	↓2.15	-.02	90	↓2.21	-.01	90	↑2.91	+.07	90	↑3.04	+.08	90	3.3
120	↓2.12	-.04	120	↓2.17	-.02	120	↑2.91	+.11	120	↑2.98	+.12		
150	↓2.11	-.04	150	↓2.13	-.04	150	↑2.83	+.03	150	↑2.88	+.02		
180	↓2.09	-.06	180	↓2.11	-.05	180	2.82		180	↓2.9	-.05		
210	↓2.1	-.05	210	2.2		210	n.a.		210	↑2.9	--		
240	↓2.09	-.07	240	↓2.11	-.08	240	n.a.		240	↑2.9	--		
270	↓2.09	-.07	270	↓2.14	-.06	270	n.a.		270	n.a.			

For more type ALLX DCPA <GO> For more Type ALLX DCPB <GO> For more Type ALLX DCPC <GO> For more Type ALLX DCPD <GO> For more Type ALLX DCPE <GO>

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
I464-30-3 25-Oct-01 11:16:22

Source: Bloomberg Financial Markets

EXHIBIT 5.4 Bloomberg Screen of Direct Issue Commercial Paper Rates

Press 98<GO> to make a copy, 99<GO> to clear news alerts. M-Mkt MMR
94<GO> View News.
11:17 DIRECT ISSUE CP RATES Page 1 / 1

	TOP TOP TIER (A1+/P1/F1+)				TOP TIER (A1/P1/F1)				SECOND TIER (A2/P2/F2)		
3)	1	↓2.41	-.01	19)	1	↑2.43	--	35)	1	↑2.88	+.43
4)	7	↓2.43	-.02	20)	7	↓2.44	-.02	36)	7	↑2.8	+.05
5)	15	↓2.33	--	21)	15	↓2.34	-.01	37)	15	↑2.92	+.03
6)	21	↓2.3	--	22)	21	↓2.31	-.06	38)	21	↑2.9	+.08
7)	30	↓2.23	-.05	23)	30	↓2.26	-.03	39)	30	↓2.85	-.06
8)	45	↓2.2	-.03	24)	45	↓2.21	-.03	40)	45	↑2.87	+.02
9)	60	↓2.15	-.05	25)	60	↓2.16	-.05	41)	60	↓2.91	-.09
10)	90	↓2.12	-.03	26)	90	↓2.13	-.05	42)	90	↓2.96	-.09
11)	120	↓2.07	-.05	27)	120	↓2.08	-.08	43)	120	↓2.98	-.04
12)	150	↓2.07	-.04	28)	150	↓2.08	-.07	44)	150	↓2.92	--
13)	180	↓2.07	-.05	29)	180	↓2.08	-.07	45)	180	↑2.93	+.01
14)	210	2.22		30)	210	2.17		46)	210	n.a.	
15)	240	2.23		31)	240	↓2.08	-.08	47)	240	2.78	
16)	270	↓2.07	-.07	32)	270	↓2.08	-.08	48)	270	↓2.92	--

HISTORICAL RATE FOR EACH TIER TYPE:
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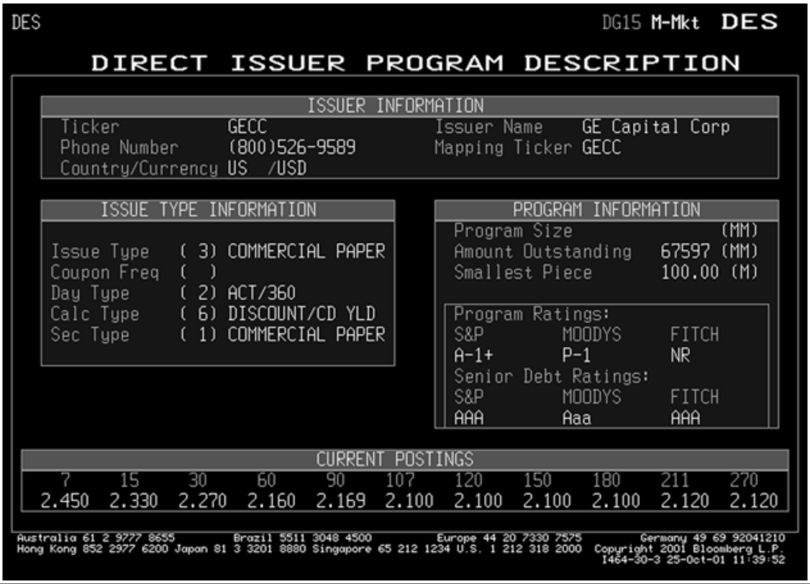
ALLX DIPB <GO>
ALLX DIPC <GO>

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
I464-30-3 25-Oct-01 11:17:23

Source: Bloomberg Financial Markets

EXHIBIT 5.5 **Bloomberg Direct Issuer Program Description Screen for GE Capital Commercial Paper**



Source: Bloomberg Financial Markets

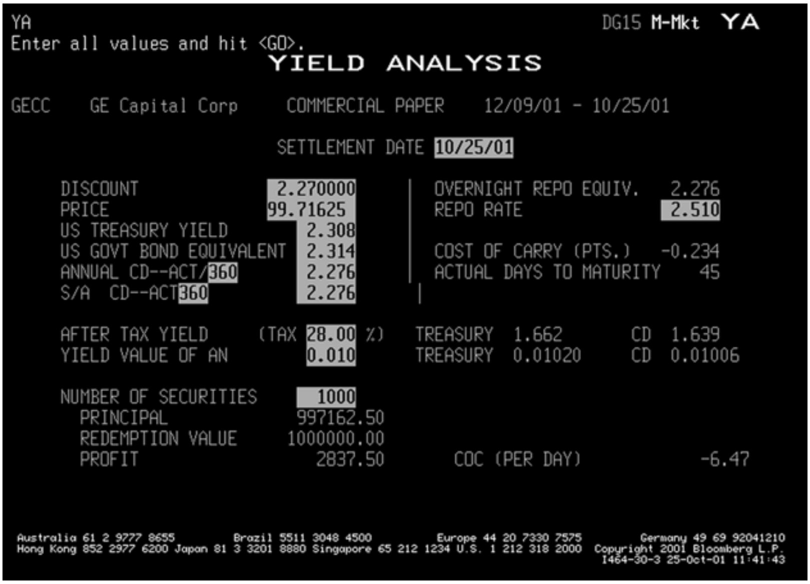
As an example, consider some commercial paper issued by GE Capital. Exhibit 5.5 presents Bloomberg's Direct Issuer Program Description Issuer screen for GE Capital commercial paper. Note at the bottom of the screen are the rates at which GE Capital is willing to issue commercial paper at various maturities. From Bloomberg's Yield Analysis (YA) screen in Exhibit 5.6, we see this commercial paper was issued on October 25, 2001 and matured on December 9, 2001. Moreover, on the left-hand side of the screen, we find that the discount yield is 2.27%. The day count convention in the United States and most European commercial paper markets is Actual/360 with the notable exception being the UK which uses Actual/365. Given the yield on a bank discount basis, the price is found the same way as the price of a Treasury bill in Chapter 3 by first solving for the dollar discount (D) as follows:

$$D = Y_d \times F \times (t/360)$$

where

Y_d = discount yield
F = face value
t = number of days until maturity

EXHIBIT 5.6 Bloomberg Yield Analysis Screen for GE Capital Commercial Paper



Source: Bloomberg Financial Markets

The price is then

$$\text{price} = F - D$$

With a settlement day of October 25, 2001, the GE Capital commercial paper has 45 days to maturity. Assuming a face value of \$100 and a yield on a bank discount basis of 2.27%, D is equal to

$$D = 0.0227 \times \$100 \times 45/360 = \$0.28375$$

Therefore,

$$\text{price} = \$100 - \$0.28375 = \$99.71625$$

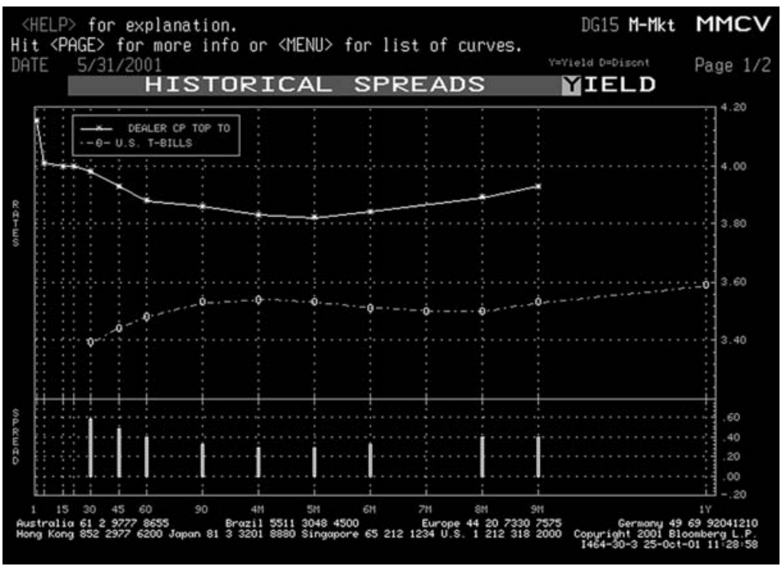
This calculation agrees with the price displayed in the box on the upper left-hand side of the screen in Exhibit 5.6.

The yield on commercial paper is higher than that on Treasury bill yields. Exhibit 5.7 presents a Bloomberg MMCV (money market curves) screen that plots two money market yield curves on May 31, 2001—dealer commercial paper (top top tier) and U.S. Treasury bill yields. There are three reasons for this relationship. First, the investor in commercial paper is exposed to credit risk. Second, interest earned from investing in

Treasury bills is exempt from state and local income taxes. As a result, commercial paper has to offer a higher yield to offset this tax advantage offered by Treasury bills. Finally, commercial paper is far less liquid than Treasury bills. The liquidity premium demanded is probably small, however, because commercial paper investors typically follow a buy-and-hold strategy and therefore they are less concerned with liquidity.

The yields offered on commercial paper track those of other money market instruments. Exhibit 5.8 is a time series plot of weekly observations (Fridays) of three-month commercial paper yields and three-month U.S. Treasury bills for the period of January 1, 1987 to December 31, 2000. The average spread between the two yields over this period was 54.5 basis points with a minimum of 12 basis points and a maximum of 221 basis points. The yield spread between commercial paper rates and Treasury bill rates widens considerably in times of financial crises when the market's risk aversion is piqued. For example, in August 1998 when the Russian government defaulted on its debt and devalued the rouble, the "paper-bill" spread for highly-rated non-financial companies widened from 45 basis points at the beginning of July (pre-crisis) to more than 140 basis points in October.[2]

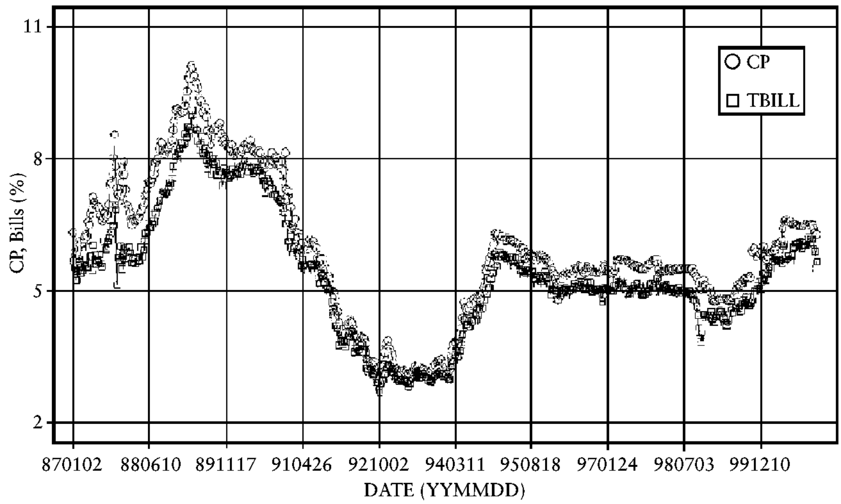
EXHIBIT 5.7 **Bloomberg MMCV Screen of Two Money Market Yield Curves**



Source: Bloomberg Financial Markets

[2] Marc R. Saidenberg and Philip E. Strahan, "Are Banks Still Important for Financing Large Businesses?" *Current Issues in Economics and Finance*, Federal Reserve Bank of New York, August 1999, pp. 1-6.

EXHIBIT 5.8 3-Month CP versus 3-Month T-Bills



ASSET-BACKED COMMERCIAL PAPER

Asset-backed commercial paper (hereafter, ABC paper) is commercial paper issued by either corporations or large financial institutions through a bankruptcy-remote special purpose corporation. Moody's reports that the amount of ABC paper outstanding surpassed half a trillion dollars during the first quarter of 2000.[3] Exhibit 5.9 presents a Bloomberg MMR screen that presents rates for ABC paper by tier for maturities ranging from 1 day to 270 days.

ABC paper is usually issued to finance the purchase of receivables and other similar assets. Some examples of assets underlying these securities include trade receivables (i.e., business-to-business receivables), credit card receivables, equipment loans, automobile loans, health care receivables, tax liens, consumer loans, and manufacturing-housing loans. Historically, trade receivables have been securitized most often.[4] The reason being is that trade receivables have maturities approximating that of the commercial paper. Recently, the list of assets has expanded to include rated asset-backed, mortgage-backed, and corpo-

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[3] Maureen R. Coen, Wanda Lee, and Bernard Maas, "ABCP Market Overview: ABCP Enters the New Millennium," Moody's Investors Service, 2000.
[4] "Understanding Asset-Backed Commercial Paper," Fitch, February 1, 1999.

rate debt securities as ABC paper issuers have attempted to take advantage of arbitrage opportunities in bond markets.[5]

The issuance of ABC paper may be desirable for one or more of the following reasons: (1) it offers lower-cost funding compared with traditional bank loan or bond financing; (2) it is a mechanism by which assets such as loans can be removed from the balance sheet; and (3) it increases a borrower's funding options.

According to Moody's, an investor in ABC paper is exposed to three major risks.[6] First, the investor is exposed to *credit risk* because some portion of the receivables being financed through the issue of ABC paper will default, resulting in losses. Obviously, there will always be defaults so the risk faced by investors is that the losses will be in excess of the credit enhancement. Second, *liquidity risk* which is the risk that collections on the receivables will not occur quickly enough to make principal and interest payments to investors. Finally, there is *structural risk* that involves the possibility that the ABC paper conduit may become embroiled in a bankruptcy proceeding, which disrupts payments on maturing commercial paper.

EXHIBIT 5.9 **Bloomberg Screen of Asset-Backed Commercial Paper Rates**


Press 98<GO> to make a copy, 99<GO> to clear news alerts. M-Mkt MMR
94<GO> View News.
11:18 ASSET BACKED CP RATES Page 1 / 1

TOP TOP TIER (A1+/P1/F1+)			TOP TIER (A1/P1/F1)		
1	↑2.51	--	1	↓2.52	-.01
7	↑2.51	+.01	7	↓2.52	--
15	↑2.49	+.01	15	↑2.51	+.01
21	↓2.42	--	21	↓2.47	--
30	↓2.34	-.06	30	↓2.39	-.03
45	↓2.3	-.04	45	↓2.34	-.03
60	↓2.27	-.04	60	↓2.31	-.03
90	↓2.23	-.04	90	↓2.26	-.04
120	↓2.21	-.03	120	↓2.22	-.05
150	↓2.18	-.04	150	↓2.19	-.06
180	↓2.15	-.06	180	↓2.16	-.07
210	2.21		210	2.27	
240	2.22		240	2.28	
270	2.24		270	2.29	

FOR HISTORICAL RATES TYPE:
ALLX ACPA <GO> ALLX ACPB <GO>

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
1464-30-3 25-Oct-01 11:18:14

Source: Bloomberg Financial Markets

[5] There are three types of securities arbitrage programs in existence at the time of this writing: limited purpose investment companies, market value ABC paper programs, and credit arbitrage ABC paper programs. For a discussion of this process, see Mary D. Dierdorff, "ABCP Market Overview: Spotlight on Changes in Program Credit Enhancement and Growth and Evolution of Securities Arbitrage Programs," Moody's Investors Service, 1999.

[6] Mark H. Adelson, "Asset-Backed Commercial Paper: Understanding the Risks," Moody's Investor Services, April 1993.

Legal Structure

An ABC paper issue starts with one seller or multiple sellers' portfolio of receivables generated by a number of obligors (e.g., credit card borrowers). A corporation using structured financing seeks a rating on the commercial paper it issues that is higher than its own corporate rating. This is accomplished by using the underlying loans or receivables as collateral for the commercial paper rather than the issuer's general credit standing. Typically, the corporation (i.e., the seller of the collateral) retains some interest in the collateral. Because the corporate entity retains an interest, the NRSROs want to be assured that a bankruptcy of that corporate entity will not allow the issuer's creditors access to the collateral. Specifically, there is a concern that a bankruptcy court could redirect the collateral's cash flows or the collateral itself from the ABC paper investors to the creditors of the corporate entity if it became bankrupt.

To allay these concerns, a bankruptcy-remote special purpose corporation (SPC) is formed. The issuer of the ABC paper is then the SPC. Legal opinion is needed stating that in the event of the bankruptcy of the seller of the collateral, counsel does not believe that a bankruptcy court will consolidate the collateral sold with the seller's assets.

The SPC is set up as a wholly-owned subsidiary of the seller of the collateral. Despite this fact, it is established in such a way that it is treated as a third-party entity relative to the seller of the collateral. The collateral is sold to the SPC which it turn resells the collateral to a conduit (i.e., trust). The conduit holds the collateral on the investors' behalf. It is the SPC that holds the interest retained by the seller of the collateral.

The other key party in this process is the conduit's administrative agent. The administrative agent is usually a large commercial bank that oversees all the operations of the conduit. The SPC usually grants the administrative agent power of attorney to take all actions on their behalf with regard to the ABC paper issuance. The administrative agent receives fees for the performance of these duties.

Basic Types of ABC Paper Conduits

ABC paper conduits are categorized on two critical dimensions. One dimension involves their level of program-wide credit support either fully or partially supported. The other dimension is as either a single-seller or a multi-seller program. In this section, we will discuss each type.

Fully versus Partially Supported

In a *fully supported program*, all of the credit and liquidity risk of an ABC paper conduit is assumed by a third-party guarantor usually in the form of a letter of credit from a highly rated commercial bank. The ABC paper investor's risk depends on the financial strength of the third-party guarantor rather than the performance of the underlying assets in the conduit. Thus, investors can expect to receive payment for maturing commercial paper regardless of the level of defaults the conduit experiences. Accordingly, in determining a credit rating, the NRSROs will focus exclusively on the financial strength of the third-party guarantor.

Partially supported programs exposes the ABC paper investors directly to credit and liquidity risk to the extent that losses in the conduit exceed program-wide and pool-specific credit enhancements. The conduit has two supporting facilities. The program-wide credit enhancement facility covers losses attributable to the default of the underlying assets up to a specified amount. Correspondingly, the program-wide liquidity facility provides funds to the conduit to ensure the timely payment of maturing paper for reasons other than defaults (e.g., market disruptions). Since investors are exposed to defaults of the underlying assets, the NRSROs make their expected performance under various scenarios a central focus of the ratings process.

Single-Seller versus Multi-Seller Programs

The other key dimension used to categorize ABC paper conduits is as either single-seller or multiseller. Single-seller conduits securitize assets purchased from a single seller (e.g., a single originator). Conversely, multiseller conduits pool assets purchased from several disparate sellers and the ABC paper issued is backed by the portfolio of these assets.

Credit and Liquidity Enhancement

In a multiseller partially supported ABC paper conduit, there are two levels of credit enhancement. The first line of defense is pool-specific credit enhancement that provides protection from the defaults on assets from a particular seller. Pool-specific credit enhancement may include overcollateralization, third-party credit support, or excess spread. The second line of defense is program-wide credit enhancement that provides protection after the pool-specific credit enhancement is depleted. Program-wide credit enhancement is usually supplied by a third-party in the form of an irrevocable loan facility, letter of credit, surety bond from a monoline insurance company, or cash invested in permitted securities.[7]

Liquidity enhancement is also structured in two levels—pool-specific or program-wide. Liquidity enhancement usually takes the one of two forms. One form of liquidity support is a loan agreement in which the liquidity facility agrees to extend loans to the conduit if maturing paper cannot be rolled over due to say, a disruption in the commercial paper market due to a financial crisis. Note that the liquidity facility is not

[7] "Understanding Asset-Backed Commercial Paper."

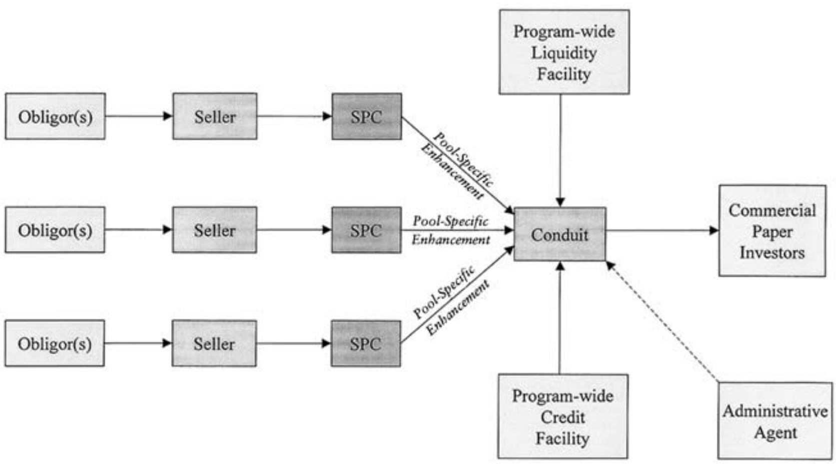
responsible for interjecting needed funds into the conduit due to defaults in the asset portfolio. The other form of liquidity support is an asset purchase agreement in which the liquidity facility agrees to purchase non-defaulted assets if funds are needed.

Exhibit 5.10 presents a flow chart illustrating the basic structure of a partially supported, multiseller ABC paper program. Note the administrative agent invests no cash into the deal but instead provides a flow of services, as a result, the administrative agent's connection to the conduit is represented with a dashed line.

The ABC Paper Market Outside the United States

There are also well-developed ABC paper markets in Europe and Australia. Moody's reports that in the first half of 2000 that the amount of ABC paper issued in Europe amounted to $61.4 billion.[8] The assets underlying these European ABC programs are similar to those in the United States, namely, trade receivables, consumer loans, credit card receivables, equipment leases, etc. Moreover, there are an increasing number of programs designed to engage in arbitrage in the fixed-income market by financing the purchase of asset-backed and mortgage-backed securities with ABC paper. Another expanding area is using structured finance to finance cross-border trade receivables for multinational corporations.

EXHIBIT 5.10 Basic Structure of a Partially Supported, Multiseller ABC Paper Program



[8] Jean Dornhofer and Annick Poulain, "Mid-Year Review European ABCP Market: A Pause in the Race," Moody's Investors Service, 2000.

The ABC paper market in Australia is well-developed but considerably smaller than the market in either Europe or the U.S. Moody's reports that as of October 1999, the amount of ABC paper outstanding exceeded A$10 billion.[9] The key difference in the Australian market is that the majority of ABC paper outstanding is used for arbitrage in the fixed-income market primarily mortgage-backed and asset-backed securities as well as term corporate loans.

Foreign Currency Denominated Commercial Paper

Synthetic foreign currency denominated commercial paper allows investors to earn non-U.S. interest rates without exposure to non-U.S. counterparties or political risk. Two examples are Goldman Sach's Universal Commercial Paper or Merrill Lynch's Multicurrency Commercial Paper. The process works as follows. First, a U.S. borrower issues commercial paper in a currency other than U.S. dollars, say German marks, while simultaneously entering into a currency swap with a dealer. The commercial paper issuer faces no foreign exchange risk because the currency swap effectively allows the issuer to borrow U.S. dollars at German interest rates. Investors can then invest in commercial paper issued by a U.S. counterparty denominated in German marks.

MEDIUM-TERM NOTES

A medium-term note (MTN) is a corporate debt instrument with a characteristic akin to commercial paper in that notes are offered continuously to investors by an agent of the issuer. Investors can select from several maturity ranges: 9 months to 1 year, more than 1 year to 18 months, more than 18 months to 2 years, and so on up to any number of years. Medium-term notes issued in the United States are registered with the Securities and Exchange Commission under Rule 415 (i.e., the shelf registration rule) which gives a corporation the maximum flexibility for issuing securities on a continuous basis. MTNs are also issued by non-U.S. corporations, federal agencies, supranational institutions, and sovereign governments. The MTN market is primarily institutional with individual investors being of little import.

The label "medium-term note" is a misnomer. Traditionally, the term "note" or "medium-term" was used to refer to debt issues with a maturity greater than 1 year but less than 15 years. Certainly this is not

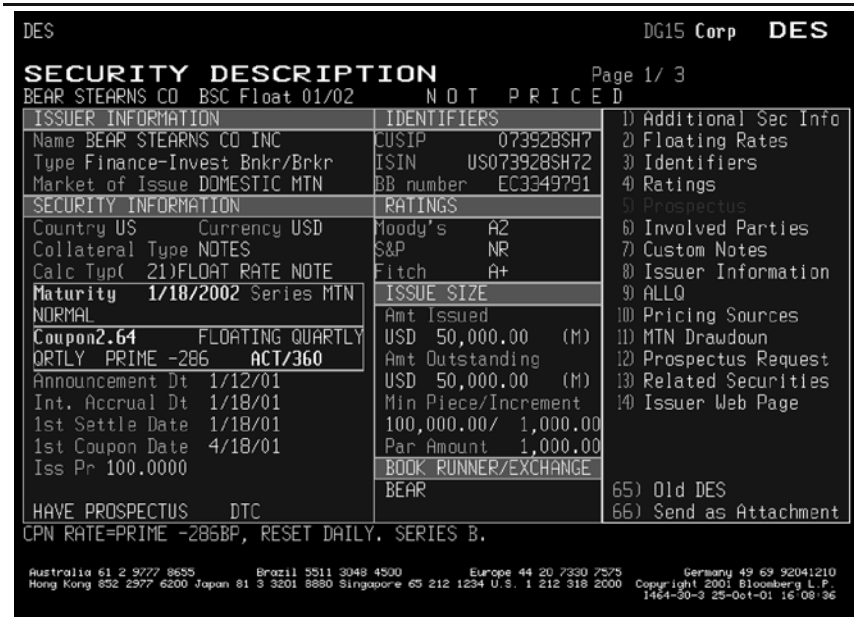
[9] Ian Makovec, "1999 Year in Review and 2000 Outlook: Up, Up and Away—AUSSIE ABCP Programs are Here to Stay," Moody's Investors Services, 1999.

descriptive of MTNs since they have been issued with maturities from 9 months to 30 years, and even longer. The focus in this section is on short-term MTNs with maturities of one year or less.

Borrowers have flexibility in designing MTNs to satisfy their own needs. They can issue fixed- or floating-rate debt. As an illustration, consider a floating-rate MTN issued by Bear Stearns on January 18, 2001 and matures on January 18, 2002. Exhibit 5.11 presents the Bloomberg Security Description screen for this security. The coupon formula is the prime rate minus 286 basis points and the security delivers cash flows quarterly. Note in the "ISSUE SIZE" box in the center of the screen, the minimum piece is $100,000 with $1,000 increments thereafter.

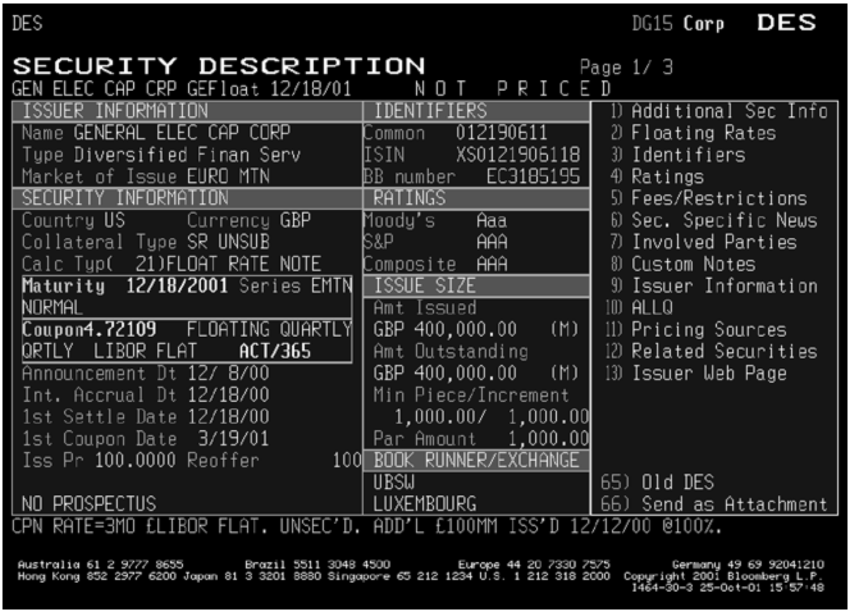
The coupon payments for MTNs can be denominated in U.S. dollars or in another currency. As an example, GE Capital Corporation issued a 1-year floating-rate MTN in December 2000 whose cash flows are denominated in British pounds. Exhibit 5.12 presents the Bloomberg Security Description screen for this security. The coupon formula is 3-month sterling LIBOR flat (i.e., without a spread) with the payments made quarterly. Note on the left-hand side of the screen that the day count convention is Actual/365 which is the day count basis for the UK money market.

EXHIBIT 5.11 **Bloomberg Security Description Screen of a Bear Stearns Medium-Term Note**



Source: Bloomberg Financial Markets

EXHIBIT 5.12 Bloomberg Security Description Screen of a GE Capital Medium-Term Note



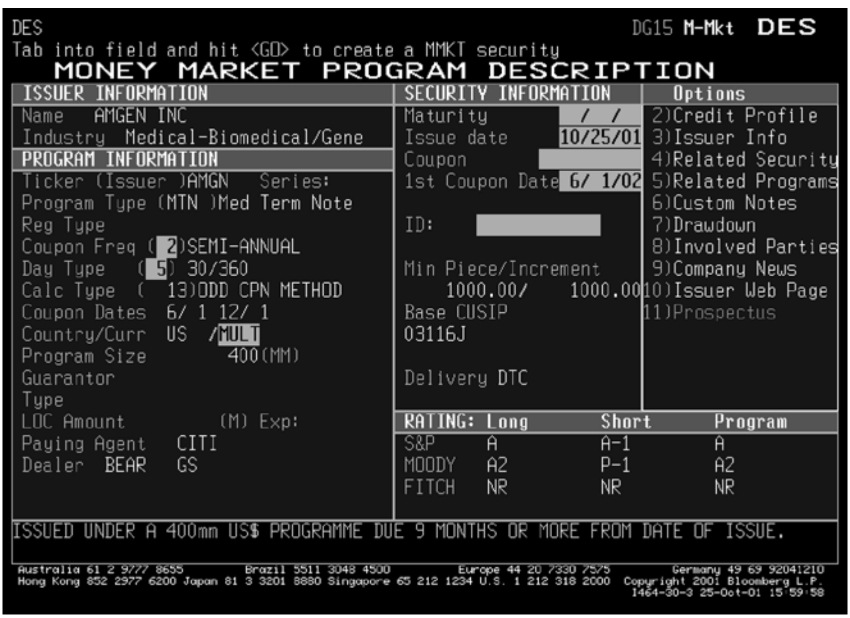
Source: Bloomberg Financial Markets

A corporation that desires an MTN program will file a shelf registration with the SEC for the offering of securities. While the SEC registration for MTN offerings are between \$100 million and \$1 billion, once the total is sold, the issuer can file another shelf registration. The registration will include a list of the investment banking firms, usually two to four, that the corporation has arranged to act as agents to distribute the MTNs. The large New York-based investment banking firms dominate the distribution market for MTNs. As an illustration, Exhibit 5.13 presents a Bloomberg Money Market Program Description screen for Amgen Inc. MTN program. There are three things to note. First, across the bottom of the screen, it indicates this a \$400 million program. Second, as listed on the left-hand side of the screen, the MTNs issued under this program are denominated in multiple currencies. Third, as can be seen at the bottom of the "PROGRAM INFORMATION" box, two investment banking firms—Bear Stearns (BEAR) and Goldman Sachs (GS)—will distribute the issue. Not all MTNs are sold on an agency basis; some have been underwritten.

An issuer with an active MTN program will post rates for the maturity ranges it wishes to sell. Fixed rate interest payments are typically semiannual basis with the same interest payment dates applicable to all of the notes of a particular series of an issuer. Of course, the final interest payment is made at maturity. Floating-rate MTNs may have more frequent coupon payments. If interest rates are volatile, posted rates may change, sometimes more than once per day. The notes are priced at par which appeals to many investors because they do not have to be concerned with either amortizing premiums and accreting discounts. Any change in new rates will not affect the rates on previously issued notes.

The purchaser may usually set the maturity as any business day with the offered maturity range, subject to the borrower's approval. This is a very important benefit of MTNs as it enables a lender to match maturities with its very own specific requirements. As they are continuously offered, an investor can enter the market when portfolio needs require and will usually find suitable investment opportunities. With underwritten issues, the available supply—both in the new issue and secondary markets—might be unsatisfactory for the portfolio's needs. A particular series of MTNs may have many different maturities but all will be issued under the same indenture. The bulk of the notes sold have maturities of less than five years.

EXHIBIT 5.13 **Bloomberg Money Market Program Description Screen for an Amgen Medium-Term Note Program**



Source: Bloomberg Financial Markets

CHAPTER 6

Debt Obligations of Financial Institutions

The largest players in the global money markets are financial institutions—namely depository institutions (i.e., commercial banks, thrifts, and credit unions), insurance companies, and investment banks. These institutions are simultaneously among the biggest buyers and issuers of money markets instruments. Moreover, there are certain short-term debt instruments peculiar to financial institutions such as certificates of deposits, federal funds, bankers acceptances, and funding agreements. These instruments are the focus of this chapter.

LARGE-DENOMINATION NEGOTIABLE CDS

A certificate of deposit (CD) is a financial asset issued by a depository institution that indicates a specified sum of money that has been deposited with them. Depository institutions issue CDs to raise funds for financing their business activities. A CD bears a maturity date and a specified interest rate or floating-rate formula. While CDs can be issued in any denomination, only CDs in amounts of $100,000 or less are insured by the Federal Deposit Insurance Corporation. There is no limit on the maximum maturity but Federal Reserve regulations stipulate that CDs cannot have a maturity of less than seven days.

A CD may be either nonnegotiable or negotiable. If nonnegotiable, the initial depositor must wait until the CD's maturity date for the return of their deposits plus interest. An early withdrawal penalty is imposed if the depositor chooses to withdraw the funds prior to the maturity date. In contrast, a negotiable CD allows the initial depositor (or any subsequent owner of the CD) to sell the CD in the open market prior to the maturity date.

Negotiable CDs were introduced in the United States in the early 1960s. At that time the interest rates banks could pay on various types of deposits were subject to ceilings administered by the Federal Reserve (except for demand deposits defined as deposits of less than one month that could pay no interest). For complex historical reasons and misguided political ones, these ceiling rates started very low, rose with maturity, and remained at below market rates up to some fairly long maturity. Before the introduction of the negotiable CD, those with money to invest for, say, one month had no incentive to deposit it with a bank, for they would earn a below-market rate unless they were prepared to tie up their capital for an extended period of time. With the advent of the negotiable CD, bank customers could buy a three-month or longer negotiable CD yielding a market interest rate and recoup all or more than their investment (depending on market conditions) by selling it in the market.

This innovation was critical in helping depository institutions increase the amount of funds raised in the money market. It also ushered in a new era of competition among depository institutions. There are two types of negotiable CDs. The first is the large-denomination CD, usually issued in denominations of $1 million or more. The second type is the small-denomination CDs (less than $100,000) which is a retail-oriented product. Our focus here is on the large-denomination negotiable CD with maturities of one year or less and we refer to them as simply CDs throughout the chapter.

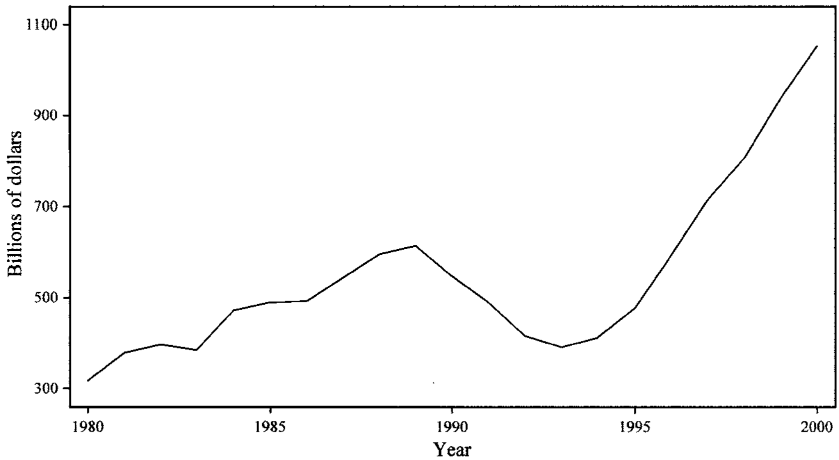
The largest group of CD investors is investment companies, with money market mutual funds purchasing the lion's share. Coming in a distant second are banks/bank trust departments followed by municipal entities and corporations. One indicator of the size of the market available to these investors is the Federal Reserve Board data series of large time deposits. Exhibit 6.1 presents a time series plot of the amount of large time deposits outstanding (in billions of dollars) each year for the period 1980–2000.

CD Issuers

CDs whose cash flows are denominated in U.S. dollars can be classified into four types according to the issuing institution. First are the CDs issued by domestic banks. Second are CDs that are denominated in U.S. dollars but are issued outside the United States. These CDs are called *Eurodollar CDs* or *Euro CDs*. A third type of CD is called a *Yankee CD* which is a CD denominated in U.S. dollars and issued by a non-U.S. bank with a branch in the United States. Finally, thrift CDs are those issued by savings and loans and savings banks.

Money center banks and large regional banks are the primary issuers of domestic CDs. Most CDs are issued with a maturity of less than one year. Those issued with a maturity greater than one year are called *term CDs*.

EXHIBIT 6.1 Large Time Deposits Outstanding



Source: The Bond Market Association

Unlike the discount instruments discussed in this book (e.g., Treasury bills, commercial paper, and bankers acceptances), yields on domestic CDs are quoted on an interest-bearing basis. CDs with a maturity of one year or less pay interest at maturity (i.e., simple interest). The day count convention is Actual/360. Domestic CDs issued in the United Kingdom denominated in pounds are quoted the same way except the day count convention is Actual/365.

Eurodollar CDs are U.S. dollar-denominated CDs issued primarily in London by U.S., Canadian, European, and Japanese banks. The CDs earn a fixed rate of interest related to dollar LIBOR. The term LIBOR comes from the London Interbank Offered Rate and is the interest rate at which one London bank offers funds to another London bank of acceptable credit quality in the form of a cash deposit. The rate is "fixed" by the British Bankers Association every business morning (in practice the fix is usually about 20 minutes later) by the average of the rates supplied by member banks. The LIBID is the market's bid rate—the rate at which banks pay for funds in the London market. The quote spread for a selected maturity is therefore the difference between LIBOR and LIBID.

CD Yields

The yield quoted on a CD is a function of the credit quality of the issuing bank, its expected liquidity level in the market, and of course the CD's maturity as this will be considered relative to the money market yield curve. As CDs are issued by depository institutions as part of their short-term funding and liquidity requirement, issue volumes are driven by the demand for loans and availability of alternative sources for potential borrowers. However, the credit quality of the issuing bank is the primary consideration. In the U.S. market, "prime" CDs—issued by highly rated domestic banks—trade at a lower yield than "non-prime" CDs. Similarly, in the UK market, the lowest yield is paid by "clearer" CDs which are issued by the clearing banks (e.g., RBS NatWest plc, HSBC and Barclays plc). In both markets, CDs issued by foreign financial institutions such as French or Japanese banks will trade at higher yields.

CDs yields are higher than yields on Treasury securities of like maturity. The spread is due primarily to the credit risk that a CD investor is exposed to and the fact that CDs offer less liquidity. The spread due to credit risk will vary with both economic conditions in general and confidence in the banking system in particular, increasing in times when the market's risk aversion is high or when there is a crisis in the banking system.

Eurodollar CDs offer a higher yield than U.S. domestic CDs on average for three reasons. First, there are reserve requirements imposed by the Federal Reserve on CDs issued by U.S. banks in the United States that do not apply to issuers of Eurodollar CDs. The reserve requirement effectively raises the cost of funds to the issuing bank because it cannot invest all the proceeds it receives from the issuance of the CD and the amount that must be kept as reserves will not earn a return for the bank. Because it will earn less on funds raised by selling domestic CDs, the domestic issuing bank will pay less on its domestic CD than a Euro CD. Second, the bank issuing the CD must pay an insurance premium to the FDIC, which again raises the cost of funds. Finally, Euro CDs are dollar obligations that are payable by an entity operating under a foreign jurisdiction, exposing the holders to a risk (called *sovereign risk*) that their claim may not be enforced by the foreign jurisdiction. As a result, a portion of the spread between the yield offered on Euro CDs and domestic CDs reflects what can be thought of as a *sovereign risk premium*. This premium varies with the degree of confidence in the international banking system. Exhibit 6.2 presents a Bloomberg screen of rates for domestic and Eurodollar CDs for various maturities out to one year on November 6, 2001. Note that the yield offered on Eurodollar CDs is higher than the yield on the domestic CD for each maturity.

Since the late 1980s, the liquidity of the Eurodollar CD has increased significantly and the perception of higher risk had diminished. Exhibit 6.3 presents a time series plot of the spread (in basis points) between 3-month LIBOR and 3-month CDs for the period January 1991 to October 2001.[1]

[1] Source: Federal Reserve Statistical Release H.15. The CD rates are an average of dealer offering rates on nationally traded CDs.

EXHIBIT 6.2 Bloomberg Screen of CD and Eurodollar CD Rates


Press 98<GO> to make a copy, 99<GO> to clear news alerts. M-Mkt MMR

9:13 BA / CD RATES Page 1 / 3

94<GO> View News.

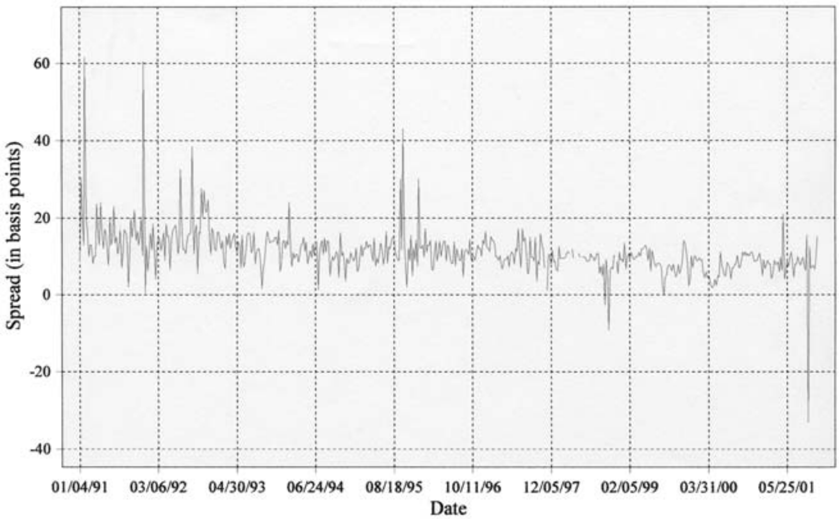
SECURITY	TIME	LAST	CHANGE	OPEN	HIGH	LOW	CLOSE
CD'S							
2)CD 1M	8:40	2.070	-.055	2.070	2.070	2.070	2.125
3)CD 2M	8:40	2.125	+.095	2.125	2.125	2.125	2.030
4)CD 3M	8:40	2.125	+.065	2.125	2.125	2.125	2.060
5)CD 6M	8:40	2.020	+.060	2.020	2.020	2.020	1.960
6)CD 9M	8:40	2.070	--	2.070	2.070	2.070	2.070
7)CD 12M	8:40	2.105	-.085	2.105	2.105	2.105	2.190
EURO CD'S							
10)Euro CD 1M	8:40	2.190	+.045	2.190	2.190	2.190	2.145
11)Euro CD 2M	8:40	2.245	+.195	2.245	2.245	2.245	2.050
12)Euro CD 3M	8:40	2.245	+.165	2.245	2.245	2.245	2.080
13)Euro CD 6M	8:40	2.140	+.160	2.140	2.140	2.140	1.980
14)Euro CD 9M	8:40	2.190	+.100	2.190	2.190	2.190	2.090
15)Euro CD 12M	8:40	2.225	+.015	2.225	2.225	2.225	2.210

PAGE FWD FOR
YANKEE CD'S

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
I464-30-1 06-Nov-01 9:13:27

Source: Bloomberg Financial Markets

EXHIBIT 6.3 Time Series Plot of the Spread between 3-Month LIBOR and 3-Month CD Rates



The rates are sampled every Friday. The patterns evident from the graph are consistent with Eurodollar CDs and domestic CDs being viewed as close substitutes. The mean spread over this time period is 11.09 basis points. The large negative spike (–33 basis points) on the right-hand of the graph is from September 14, 2001 which was the first Friday observation after the terrorist attacks of September 11, 2001. Given the extraordinary circumstances of this week, this observation can be viewed as an outlier.

FEDERAL FUNDS

Depository institutions are required to hold reserves to meet their reserve requirements. The level of the reserves that a depository institution must maintain is based on its average daily deposits over the previous 14 days. To meet these requirements, depository institutions hold reserves at their district Federal Reserve Bank. These reserves are called *federal funds*.

Because no interest is earned on federal funds, a depository institution that maintains federal funds in excess of the amount required incurs an opportunity cost of the interest forgone on the excess reserves. Correspondingly, there are also depository institutions whose federal funds are short of the amount required. The federal funds market is where depository institutions buy and sell federal funds to address this imbalance. Typically, smaller depository institutions (e.g., smaller commercial banks, some thrifts, and credit unions) almost always have excess reserves while money center banks usually find themselves short of reserves and must make up the deficit. The supply of federal funds is controlled by the Federal Reserve through its daily open market operations.

Most transactions involving federal funds last for only one night; that is, a depository institution with insufficient reserves that borrows excess reserves from another financial institution will typically do so for the period of one full day. Because these reserves are loaned for only a short time, federal funds are often referred to as "overnight money."

One way that depository institutions with a required reserves deficit can bring reserves to the required level is to enter into a repurchase agreement (as described in Chapter 8) with a counterparty other than a financial institution. The repurchase agreement (which consists of the sale of a security and an agreement by say a bank to repurchase it later) will provide funds for a short period of time, after which the bank buys back the security as previously agreed. Of course, an alternative to the repo is for the bank to borrow federal funds from a depository institution that holds excess reserves.

Thus, depository institutions view the repo market and the federal funds market as close substitutes.

Federal Funds Rate

The interest rate at which federal funds are bought (borrowed) by depository institutions that need these funds and sold (lent) by depository institutions that have excess federal funds is called the federal funds rate. The federal funds is a benchmark short-term interest. Indeed, other short-term interest rates (e.,g, Treasury bills) often move in tandem with movements in the federal funds rate. The rate most often cited for the federal funds market is known as the *effective federal funds rate*.

The daily effective federal funds rate is volume-weighted average of rates for federal fund trades arranged through the major New York brokers. To illustrate how this averaging is accomplished, suppose only two transactions took place on October 1, one for $50 million at a rate of 2.75% and another for $200 million at rate of 2.875%. The simple arithmetic average would be 2.8125% which is calculated as follows:

$$(2.75 + 2.875)/2$$

By contrast, the transaction-weighted average for that day would be 2.85% which is calculated as follows:

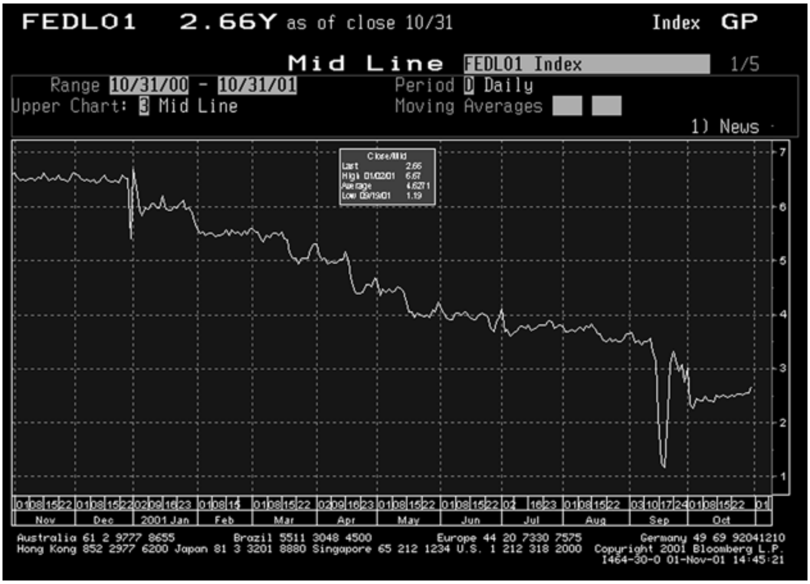
(50/250)(2.75) + (200/250)(02274.275257875\5557\0)\560

The weighted average exceeds the arithmetic average because the larger transaction occurred at the higher rate.

Exhibit 6.4 presents a Bloomberg screen that plots the daily effective federal funds rate over the 1-year period beginning October 31, 2000 and ending October 31, 2001.

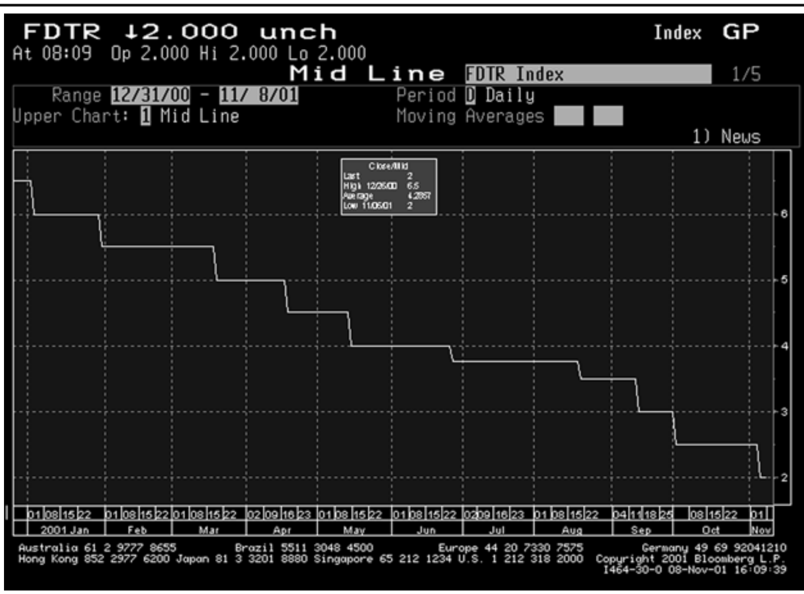
When the Federal Reserve formulates and executes monetary policy, the federal funds rate is frequently a significant operating target. The Federal Open Market Committee (FOMC) sets a target level for the federal funds rate. Announcements of changes in monetary policy specify the changes in the FOMC's target for this rate. For example, due to the sluggish U.S. economy in 2000-2001 and the terrorist attacks on September 11, 2001, the FOMC launched a dramatic easing of monetary policy by lowering the target federal funds ten times through November 8, 2001. Exhibit 6.5 presents a Bloomberg screen of a time series plot of the target federal funds rate for the period December 31, 2000 through November 8, 2001. During that period of time, the target federal funds rate dropped from 6.5% to 2.0%. For this reason, the federal funds rate often exhibits a high level of volatility over short periods of time. To see this, Exhibit 6.6 presents a Bloomberg screen of the daily effective federal funds rate for the period August 14, 2001 through October 31, 2001. The screen also shows the daily range of rates at which federal funds were traded. The volatility is especially pronounced at the end of a quarter as financial institution engage in balance sheet "window dressing."

EXHIBIT 6.4 Bloomberg Screen of a 1-Year Time Series Plot of the Federal Funds Rate



Source: Bloomberg Financial Markets

EXHIBIT 6.5 Bloomberg Screen of a Time Series Plot of the Target Federal Funds Rate



Source: Bloomberg Financial Markets

EXHIBIT 6.6 Bloomberg Screen of the Daily Effective Federal Funds Rate

<HELP> for explanation, <MENU> for similar functions. DG15 M-Mkt FEDL

FEDERAL FUNDS EFFECTIVE RATE

11/ 1/01 Pricing Format 2 Decimal

Date	EFF	Trade Range	Date	EFF	Trade Range	Date	EFF	Trade Range
10/31/01	2.66	2.25-3.00	10/ 4/01	2.45	2.25-2.75	9/ 7/01	3.44	3.31-3.50
10/30/01	2.55	2.38-2.63	10/ 3/01	2.27	.50-2.75	9/ 6/01	3.52	3.25-3.56
10/29/01	2.55	2.50-2.63	10/ 2/01	2.35	.50-2.63	9/ 5/01	3.49	3.00-3.59
10/26/01	2.51	2.38-2.63	10/ 1/01	3.02	.13-3.75	9/ 4/01	3.67	3.25-3.81
10/25/01	2.54	2.50-2.56	9/28/01	2.75	.13-3.50	9/ 3/01	3.66	-
10/24/01	2.53	2.44-3.00	9/27/01	3.08	2.00-3.50	8/31/01	3.66	3.13 3.75
10/23/01	2.48	2.38-2.56	9/26/01	2.96	1.00-3.19	8/30/01	3.58	3.47-4.00
10/22/01	2.52	2.38-2.63	9/25/01	3.11	2.00-3.31	8/29/01	3.50	3.38-4.00
10/19/01	2.47	2.38-2.69	9/24/01	3.31	2.00-3.75	8/28/01	3.50	3.25-3.75
10/18/01	2.50	2.44-2.56	9/21/01	3.11	1.75-6.00	8/27/01	3.54	3.50-3.63
10/17/01	2.51	2.44-2.75	9/20/01	2.22	1.38-4.00	8/24/01	3.51	3.44-3.63
10/16/01	2.47	2.25-2.63	9/19/01	1.19	.25-7.00	8/23/01	3.55	3.50-3.63
10/15/01	2.51	2.00-2.63	9/18/01	1.25	.06-2.50	8/22/01	3.51	3.00-3.75
10/12/01	2.39	2.25-2.50	9/17/01	2.13	.06-3.50	8/21/01	3.53	3.50-3.63
10/11/01	2.42	2.13-2.50	9/14/01	3.13	.06-4.00	8/20/01	3.64	3.38-3.75
10/10/01	2.42	2.00-2.50	9/13/01	3.31	.50-4.50	8/17/01	3.66	3.38-3.75
10/ 9/01	2.50	2.00-2.75	9/12/01	3.56	3.50-3.50	8/16/01	3.75	3.56-3.81
10/ 8/01	2.42	-	9/11/01	3.50	3.50-3.50	8/15/01	3.83	3.50-3.94
10/ 5/01	2.42	2.25-2.75	9/10/01	3.50	3.38-3.56	8/14/01	3.76	3.50-3.81

Note: Federal Funds Effective Rate is one business day behind.

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
1464-30-0 01-Nov-01 14:59:23

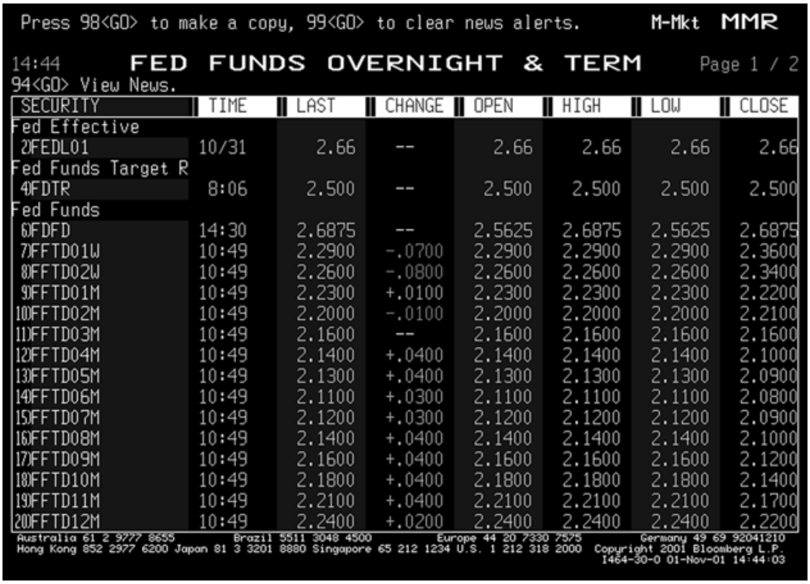
Source: Bloomberg Financial Markets

Market for Federal Funds

Although the term of most federal funds transactions is overnight, there are longer-term transactions that range from one week to one year. As an illustration, Exhibit 6.7 presents a Bloomberg screen the overnight and term federal funds rates on October 31, 2001. Trading typically takes place directly between buyer and seller usually between a large bank and one of its correspondent banks. Some federal funds transactions require the use of a broker. The broker stays in constant touch with prospective buyers/sellers and arranging deals between for a commission. Brokers provide another service to this market in (normally) unsecured loans because they often can give lenders credit analyses of borrowers if the lenders have not done business with them previously.

Although the federal funds market is known to be very large, no precise trading volume numbers are available. One indicator of the level of trading in this market is the Federal Reserve data series for domestically chartered banks in the United States. That series records monthly averages of bank borrowing from other banks in the United States. In the Federal Reserve Bulletin of September 2001, this figure is $362.3 billion as of June 2001. A high percentage of that amount is due to federal funds. The magnitude of this number provides one reason why this market and this borrowing arrangement are so important.

EXHIBIT 6.7 Bloomberg Screen of Overnight and Term Federal Funds Rates



Press 98<GO> to make a copy, 99<GO> to clear news alerts. M-Mkt MMR

14:44 FED FUNDS OVERNIGHT & TERM Page 1 / 2

94<GO> View News.

SECURITY	TIME	LAST	CHANGE	OPEN	HIGH	LOW	CLOSE
Fed Effective							
2)FEDL01	10/31	2.66	--	2.66	2.66	2.66	2.66
Fed Funds Target R							
4)FDTR	8:06	2.500	--	2.500	2.500	2.500	2.500
Fed Funds							
6)FDFD	14:30	2.6875	--	2.5625	2.6875	2.5625	2.6875
7)FFTD01W	10:49	2.2900	-.0700	2.2900	2.2900	2.2900	2.3600
8)FFTD02W	10:49	2.2600	-.0800	2.2600	2.2600	2.2600	2.3400
9)FFTD01M	10:49	2.2300	+.0100	2.2300	2.2300	2.2300	2.2200
10)FFTD02M	10:49	2.2000	-.0100	2.2000	2.2000	2.2000	2.2100
11)FFTD03M	10:49	2.1600	--	2.1600	2.1600	2.1600	2.1600
12)FFTD04M	10:49	2.1400	+.0400	2.1400	2.1400	2.1400	2.1000
13)FFTD05M	10:49	2.1300	+.0400	2.1300	2.1300	2.1300	2.0900
14)FFTD06M	10:49	2.1100	+.0300	2.1100	2.1100	2.1100	2.0800
15)FFTD07M	10:49	2.1200	+.0300	2.1200	2.1200	2.1200	2.0900
16)FFTD08M	10:49	2.1400	+.0400	2.1400	2.1400	2.1400	2.1000
17)FFTD09M	10:49	2.1600	+.0400	2.1600	2.1600	2.1600	2.1200
18)FFTD10M	10:49	2.1800	+.0400	2.1800	2.1800	2.1800	2.1400
19)FFTD11M	10:49	2.2100	+.0400	2.2100	2.2100	2.2100	2.1700
20)FFTD12M	10:49	2.2400	+.0200	2.2400	2.2400	2.2400	2.2200

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
I464-30-0 01-Nov-01 14:44:03

Source: Bloomberg Financial Markets

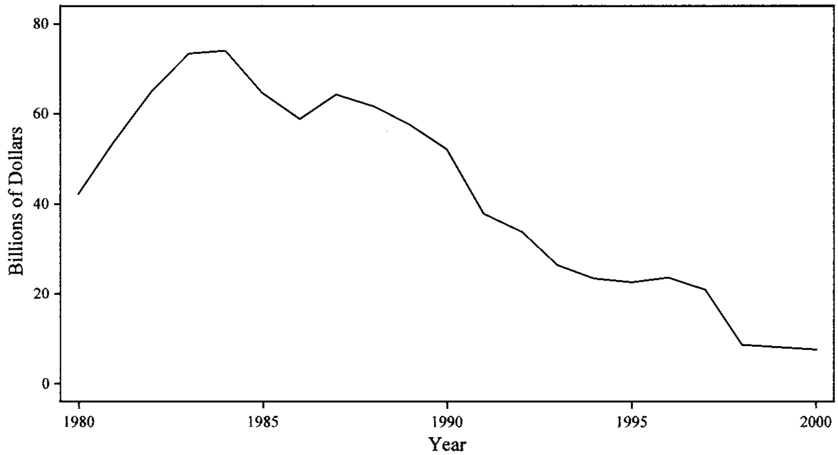
BANKERS ACCEPTANCES

A *bankers acceptance* is a written promise issued by a borrower to a bank to repay borrowed funds. The lending bank lends funds and in return accepts the ultimate responsibility to repay the loan to its holder, hence the name—bankers acceptance. The acceptance is negotiable and can be sold in the secondary market. The investor who buys the acceptance can collect the loan on the day repayment is due. If the borrower defaults, the investor has legal recourse to the bank that made the first acceptance. Bankers acceptances are also know as *bills of exchange*, *bank bills*, *trade bills*, or *commercial bills*.

Essentially bankers acceptances are instruments created to facilitate commercial trade transactions. The use of bankers acceptances to finance commercial transactions is known as *acceptance financing*. The transactions in which acceptances are created for include the import and export of goods, the storage and shipping of goods between two overseas countries where neither the importer nor the exporter is based in the home country,[2] and the storage and shipping of goods between two entities based at home.

[2] A bankers acceptance created to finance such a transaction is known as a *third-party acceptance*.

EXHIBIT 6.8 Bankers Acceptances Outstanding



Source: The Bond Market Association

Bankers acceptances are sold on a discounted basis just like Treasury bills and commercial paper. The rate that a bank charges a customer for issuing a bankers acceptance is a function of the rate at which the bank believes it will be able to sell it in the secondary market. A commission is added to this rate. The major investors in bankers acceptances are money market mutual funds and municipal entities.

Bankers acceptances have declined in importance in recent years in favor of other forms of financing. Exhibit 6.8 presents the total amount of bankers acceptances outstanding in billions of dollars each year for the period 1980-2000. There are several reasons that account for this decline. First, the rise in financial disintermediation has reduced corporations' dependence on bank financing in that they now have access to wider range of funding options (e.g., commercial paper). Second, the vicious circle of low liquidity leads to less issuance and so on. Third, in July 1984, the Federal Reserve discontinued the use of bankers acceptances as collateral for repurchase agreements when conducting open market operations.[3]

The Creation of a Bankers Acceptance

The most efficient way to explain the creation of a bankers acceptance is by an illustration. The following fictitious parties are involved in this process:

[3] In the UK markets, a similar confluence of forces has diminished the bank bills market there.

- PCs For Less plc, a firm in London that sells a wide variety of information appliances;
- Kameto Ltd., a manufacturer of personal computers based in Japan
- ABC Bank plc, a clearing bank based in London
- Samurai Bank, a bank based in Japan
- Palmerston Bank plc, another bank based in London
- Adam Smith Investors plc, a money market fund based in Edinburgh

PCs For Less and Kameto Ltd. are preparing to enter into a deal in which PCs For Less will import a consignment of personal computers (PCs) with a transaction value of £1 million. However, Kameto Ltd. is concerned about the ability of PCs For Less to make payment on the PCs when they are delivered. To get around this uncertainty, both parties decided to fund the transaction using acceptance financing. The terms of the transaction are that payment must be made by PCs For Less within 60 days after the PCs have been shipped to the United Kingdom. In determining whether it is willing to accept the £1 million, Kameto Ltd. must calculate the present value of the amount because it will not be receiving this sum until 60 days after shipment. Therefore, both parties agree to the following terms:

- PCs For Less arranges with its bankers, ABC Bank plc to issue a letter of credit (LOC, also known as a *time draft*). The LOC states that ABC Bank plc will guarantee the payment of £1 million that PCs For Less must make to Kameto 60 days from shipment. The LOC is sent by ABC Bank to Kameto's bankers who are Samurai Bank. On the receipt of the LOC, Samurai Bank notifies Kameto, who will then ship the PCs. After the PCs are shipped, Kameto presents the shipping documents to Samurai and receives the present value of £1 million. This completes the transaction for Kameto Ltd.
- Samurai Bank presents the LOC and the shipping documents to ABC Bank plc. The latter will stamp the LOC as "accepted," thus creating a bankers acceptance. This means that ABC Bank plc agrees to pay the holder of the bankers acceptance the sum of £1 million on the acceptance's maturity date. PCs For Less will receive the shipping documents so that it can then take delivery of the PCs once it signs a note or some other financing arrangement with ABC Bank plc.

At this point, the holder of the bankers acceptance is Samurai Bank and it has the following two choices available: (1) the bank may retain the bankers acceptance in its loan portfolio or (2) it may request that Bank ABC plc make a payment of the present value of £1 million. Let's assume that Samurai Bank elects to request payment of the present value of £1 million. Now the holder of the bankers acceptance is ABC Bank plc. It also has two choices that it can make: (1) it may retain the bankers acceptance as an investment or (2) it may sell it another investor. Once again, assume it chooses the latter, and one its clients, Adam Smith Investors, is interested in a high-quality security with same maturity as the bankers acceptance. Accordingly, ABC Bank plc sells the acceptance to Adam Smith Investors at the present value of £1 million calculated using the relevant discount rate for paper of that maturity and credit quality. Alternatively, it may have sold the acceptance to another bank, such as Palmerston Bank plc that also creates bankers acceptances. In either case, on the maturity of the bankers acceptance, its holder presents it to ABC Bank plc and receives the maturity value of £1 million, which the bank in turn recovers from PCs For Less plc.

The holder of the bankers acceptance is exposed to credit risk on two fronts: the risk that the original borrower is unable to pay the face value of the acceptance and the risk that the accepting bank will not be able to redeem the paper. For this reason, the rate paid on a bankers acceptance will trade at a spread over the comparable maturity risk-free benchmark security (e.g., U.S. Treasury bills). Investors in acceptances will need to know the identity and credit risk of the original borrower as well as the accepting bank.

Eligible Bankers Acceptances

An accepting bank that chooses to retain a bankers acceptance in its portfolio may be able to use it as collateral for a loan obtained from the central bank during open market operations, for example, the Federal Reserve in the United States and the Bank of England in the United Kingdom. Not all acceptances are eligible to be used as collateral in this manner, as the acceptances must meet certain criteria as specified by the central bank. The main requirements for eligibility are that the acceptance's maturity must not exceed a certain maturity (a maximum of six months in the United States and three months in the United Kingdom) and that it must have been created to finance a self-liquidating commercial transaction. In the United States, eligibility is also important because the Federal Reserve imposes a reserve requirement on funds raised via bankers acceptances that are ineligible. Bankers acceptances sold by an accepting bank are potential liabilities of the bank but reserve requirements impose a limit on the amount of eligible bankers acceptances that a bank may issue. Acceptances eligible for deposit at a central bank offer a lower discount rate than ineligible ones and also act as a benchmark for prices in the secondary market.

FUNDING AGREEMENTS

Funding agreements (FAs) are short-term debt instruments issued by insurance companies. Specifically, a funding agreement is a contract issued by an insurance company that provides the policyholder the right to receive the coupon payments as scheduled and the principal on the maturity date. These contracts are guaranteed by the insurer's general account or a separate account. FAs are not publicly traded and therefore are less liquid than other money market instruments such as commercial paper. In recent years, medium-term notes (U.S. MTNs and Global MTNs) have become increasingly popular. These are securitizations whose cash flows are backed by a portfolio of FAs. Moody's estimates in 2000 the amount of securities outstanding backed by FAs was approximately $20 billion.[4]

Coupon rates may be either fixed or floating. Reference rates have included U.S, Treasury rates, LIBOR, commercial paper rates, the federal funds rate, and the prime rate. The unique feature of FAs is that the holder of this security has an embedded put option with a 7, 30, 90, 180 day or year expiration. Therefore, FAs are putable back to the issuer at par. Yields offered on FAs depend on the credit quality of the issuing insurer, the structure of the embedded put option, and the term to maturity.

Like many financial instruments, FAs have had setbacks. Specifically, there is credit risk and a major default increases the concerns of investors about the product. In August 1999, General American Life Insurance Co. failed to meet its required interest and principal redemption when investors put back the FAs the company issued. The option was putable in seven days. The exercise of the put option by investors followed the downgrading of the insurance company by several rating agencies. Investors eventually received their payments when Metropolitan Life Insurance Company Co. acquired General American Life Insurance Co. and satisfied the obligation. Since this incident, life insurance companies issuing FAs have made every effort to address the concerns investors have had with these contracts. Specifically, prior to 1999, most FAs were putable in seven days. The contracts now tend to have longer-dated puts. In addition, there is increased use of FAs backing medium-term notes that are typically sold without puts.

The major investors in FAs are money market mutual funds—both institutional-oriented funds and retail-oriented.[5] Short-dated putable FAs are structured to qualify as 2a-7 eligible money market mutual fund investments because they are illiquid investments since as we noted earlier

[4] Moody's Special Comment "Institutional Investment Products: The Evolution of a Popular Product," April 2000, Moody's Investor Services. New York.

[5] Information in this paragraph was obtain from "Update on Short-Term Putable Funding Agreements," Moody's Investors Service, October 2001.

they are not publicly traded. Seven of the largest institutional money market funds held FAs as of mid 2001. The top four issuers of FAs sold to institutional money market funds are Transamerica Occidental Life, Monumental Life, New York Life, Allstate Life, and Jackson National Life. The major issuers of FAs sold to retail-oriented money market funds are Monumental Life, Travelers, Metropolitan, GE Life and Annuity Assurance Co., and Pacific Life. Five of the top ten retail-oriented money market funds invest in FAs as of mid 2001.

A study by Moody's in October 2001 investigated the reasons why money market mutual funds invest in FAs.[6] The following reasons were cited:

1. FAs are attractive short-term investments.
2. FAs are highly rated and are "stable value"–type products
3. Investors like FAs as an established product.

[6] "Update on Short-Term Putable Funding Agreements," p. 9.

CHAPTER 7

Floating-Rate Securities

Cash managers invest in not only short-term fixed-rate securities but also floating-rate securities that exhibit little price volatility when interest rates change. In this chapter, we will discuss the general features of floating-rate securities (or simply "floaters"), their price volatility characteristics, and "spread" measures used by market participants. There are floaters in the agency debenture and corporate bond markets. There are also floating-rate products created in the mortgage-backed and asset-backed securities markets. These securities will be discussed in Chapters 9 and 10, along with short-term fixed-rate products created in these markets.

GENERAL FEATURES OF FLOATERS

A floater is a debt obligation whose coupon rate is reset at designated dates based on the value of some designated reference rate. The coupon formula for a pure floater (i.e., a floater with no embedded options) can be expressed as follows:

$$\text{coupon rate} = \text{reference rate} \pm \text{quoted margin}$$

The quoted margin is the adjustment (in basis points) that the issuer agrees to make to the reference rate. For example, consider a floating-rate note issued by Enron Corp. that *matured* on March 30, 2000.[1] This floater made quarterly cash flows and had a coupon formula equal to 3-month LIBOR plus 45 basis points.

[1] This illustration will remind the investor that one must always keep credit risk in mind.

Under the rubric of floating-rate securities, there are several different types of securities with the feature that the coupon rate varies over the instrument's life. A floater's coupon rate can be reset semiannually, quarterly, monthly or weekly. The term "adjustable-rate" or "variable-rate" typically refers to those securities with coupon rates reset not more than annually or based on a longer-term interest rate. We will refer to both floating-rate securities and adjustable-rate securities as floaters.

As noted, the reference rate is the interest rate or index that appears in a floater's coupon formula and it is used to determine the coupon payment on each reset date within the boundaries designated by embedded caps and/or floors. Common reference rates are LIBOR (with different maturities), Treasury bills yields, the prime rate, the federal funds rate, and domestic CD rates. There are other reference rates utilized in more specialized taxable fixed-income markets such as the mortgage-backed securities and asset-backed securities markets. For example, the most common reference rates for adjustable-rate mortgages (ARMs) or collateralized mortgage obligation (CMO) floaters include: (1) the 1-year Constant Maturity Treasury rate (i.e., 1-year CMT); (2) the Eleventh District Cost of Funds (COFI); (3) 6-month LIBOR; and (4) the National Monthly Median Cost of Funds Index.

Restrictions on the Coupon Rate

A floater often imposes limits on how much the coupon rate can float. Specifically, a floater may have a restriction on the maximum coupon rate that will be paid on any reset date. This is called a *cap*. Consider a hypothetical floater whose coupon formula is 3-month LIBOR plus 50 basis points with a cap of 7.5%. If 3-month LIBOR at a coupon reset date is 8%, then the coupon formula would suggest the new coupon rate is 8.5%. However, the cap restricts the maximum coupon rate to 7.5%. Needless to say, a cap is an unattractive feature from the investor's perspective.

In contrast, a floater may also specify a minimum coupon rate called a *floor*. For example, First Chicago (now 1st Chicago NBD Corp.) issued a floored floating rate note in July 1993 that matures in July 2003. This issue delivers quarterly coupon payments with a coupon formula of 3-month LIBOR plus 12.5 basis points with a floor of 4.25%. So if 3-month LIBOR ever fell below 4.125% the coupon rate would remain at 4.25%. A floor is an attractive feature from the investor's perspective.

When a floater possesses both a cap and a floor, this feature is referred to as a *collar*. Thus, a collared floater's coupon rate has a maximum and a minimum value. For example, the Economic Development Corporation issued a collared floater in February 1993 that makes semiannual coupon payments and matures in 2003. The coupon formula is 6-month LIBOR flat with a floor of 5% and a cap of 8%.[2]

Inverse Floaters

While a floater's coupon rate typically moves in the same direction as the reference rate, there are floaters whose coupon rate moves in the opposite direction to the change in the reference rate. These securities are called *inverse floaters* or *reverse floaters*. The general coupon formula for an inverse floater is:

$$K - L \times (\text{Reference rate}).$$

From the formula, it is easy to see that as the reference rate goes up (down), the coupon rate goes down (up).

As an example, consider an inverse floater issued by one of the Federal Home Loan Banks in April 1999 due in April 2002. This issue delivers quarterly coupon payments according to the formula:

$$18\% - 2.5 \times (\text{3-month LIBOR})$$

In addition, this inverse floater has a floor of 3% and a cap of 15.5%. Note that for this floater the value for L (called the *coupon leverage*) in the coupon reset formula is 2.5. Assuming neither the cap rate nor the floor rate are binding, this means that for every one basis point change in 3-month LIBOR the coupon rate changes by 2.5 basis points in the opposite direction. When L is greater than 1, the security is referred to as a *leveraged inverse floater.*

Unfortunately, some money market investors have purchased inverse floaters based on the belief that these floating-rate products provide a hedge against a decline in interest rates. While the coupon rate does increase when the reference rate decreases, inverse floaters have the unfavorable property that their durations are typically very high. That is, they typically have high effective durations, a characteristic not understood by managers who still view "duration" in temporal terms (i.e., in terms of years). Certainly, these two features of an inverse floater—higher coupon rate when rates decline and substantial price appreciation due to a high effective duration—are appealing to a manager who wants to bet on a downward movement of rates. But clearly, this is not the approach that should be pursued by a manager who seeks to maintain a stable value for a portfolio when rates change.

[2] Here, the term flat means without a quoted margin or a quoted margin of zero.

Other Types of Floaters

There is a wide variety of floaters that have special features that may appeal to certain types of investors. For example, some issues provide for a change in the quoted margin (i.e., the spread added to or subtracted from the reference in the coupon reset formula) at certain intervals over a floater's life. These issues are called *stepped spread floaters* because the quoted margin can either step to a higher or lower level over time. Consider Standard Chartered Bank's floater due in December 2006. From its issuance in December 1996 until December 2001, the coupon formula is 3-month LIBOR plus 40 basis points. However, from December 2001 until maturity, the quoted margin "steps up" to 90 basis points.

A *range note* is a floater where the coupon payment depends upon the number of days that the specified reference rate stays within a preestablished collar. For instance, Sallie Mae issued a range note in August 1996 (due in August 2003) that makes coupon payments quarterly. For every day during the quarter that 3-month LIBOR is between 3% and 9%, the investor earns 3-month LIBOR plus 155 basis points. Interest will accrue at 0% for each day that 3-month LIBOR is outside this collar.

There are also floaters whose coupon formula contains more than one reference rate. A *dual-indexed floater* is one such example. The coupon rate formula is typically a fixed percentage plus the difference between two reference rates. For example, the Federal Home Loan Bank System issued a floater in July 1993 (due in July 1996) whose coupon rate was the difference between the 10-year Constant Maturity Treasury rate and 3-month LIBOR plus 160 basis points.

Although the reference rate for most floaters is an interest rate or an interest rate index, numerous kinds of reference rates appear in coupon formulas. This is especially true for structured notes. Potential reference rates include movements in foreign exchange rates, the price of a commodity (e.g., gold), movements in an equity index (e.g., the Standard & Poor's 500 Index), or an inflation index (e.g., CPI). Financial engineers are capable of structuring floaters with almost any reference rate. For example, Merrill Lynch issued in April 1983 Stock Market Reset Term Notes which matured in December 1999. These notes delivered semiannual coupon payments using a formula of 0.65 multiplied by the annual return of the Standard & Poor's MidCap 400 during the calendar year. These notes have a cap rate of 10% and a floor rate of 3%.

Of course, with these non-traditional (i.e., non-interest rate reference rates) floaters expose portfolios to different types of risks. Moreover, some of them are not simple to value—an undesirable feature for a cash portfolio.

Call and Prepayment Provisions

Just like fixed-rate issues, a floater may be *callable*. The call option gives the issuer the right to buy back the issue prior to the stated maturity date. The call option may have value to the issuer some time in the future for two reasons. First, market interest rates may fall so that the issuer can exercise the option to retire the floater and replace it with a fixed-rate issue. Second, the required margin decreases so that the issuer can call the issue and replace it with a floater with a lower quoted margin.[3] The issuer's call option is a disadvantage to the investor since the proceeds received must be reinvested either at a lower interest rate or a lower margin. Consequently, an issuer who wants to include a call feature when issuing a floater must compensate investors by offering a higher quoted margin.

For amortizing securities (e.g., mortgage-backed and some asset-backed securities) that are backed by loans that have a schedule of principal repayments, individual borrowers typically have the option to pay off all or part of their loan prior to the scheduled date. Any principal repayment in excess of the scheduled amount is called a *prepayment*. The right of borrowers to prepay is called the *prepayment option*. Basically, the prepayment option is analogous to a call option. However, unlike a call option, there is not a call price that depends on when the borrower pays off the issue. Typically, the price at which a loan is prepaid is its par value.

Put Provisions

Floaters may also include a *put provision* which gives the security holder the option to sell the security back to the issuer at a specified price on designated dates. The specified price is called the *put price*. The put's structure can vary across issues. Some issues permit the holder to require the issuer to redeem the issue on any coupon payment date. Others allow the put to be exercised only when the coupon is adjusted.

The advantage of the put provision to the holder of the floater is that if after the issue date the margin required by the market for a floater to trade at par rises above the issue's quoted margin, absent the put option the price of the floater will decline. However, with the put option, the investor can force the issuer to redeem the floater at the put price and then reinvest the proceeds in a floater with the higher quoted margin.

[3] The required margin is the spread (either positive or negative) the market requires as compensation for the risks embedded in the issue. If the required margin equals the quoted margin, a floater's price will be at par on coupon reset dates.

PRICE VOLATILITY CHARACTERISTICS OF FLOATERS

The change in the price of a fixed-rate security when market rates change is due to the fact that the security's coupon rate differs from the prevailing market rate. So, an investor in a 10-year 7% coupon bond purchased at par, for example, will find that the price of this bond will decline below par value if the market requires a yield greater than 7%. By contrast, for a floater, the coupon is reset periodically, reducing a floater's price sensitivity to changes in rates. For this reason, floaters are said to more "defensive" securities. However, this does not mean that a floater's price will not change.

Factors that Affect the Price of a Floater

A floater's price will change depending on the following factors:

1. time remaining to the next coupon reset date
2. whether or not the market's required margin changes
3. whether or not the cap or floor is reached

Below we discuss the impact of each of these factors.

Time Remaining to the Next Coupon Reset Date

The longer the time to the next coupon reset date, the greater a floater's potential price fluctuation. Conversely, the less time to the next coupon reset date, the smaller the floater's potential price fluctuation.

To understand why, consider a floater with five years remaining to maturity whose coupon formula is the 1-year Treasury bill rate plus 50 basis points and the coupon is reset today when the 1-year Treasury bill rate is 5.5%. The coupon rate will then be set at 6% for the year. One month from now, the investor in this floater would effectively own an 11-month instrument with a 6% coupon. Suppose that at that time, the market wants a 6.2% yield on comparable issues with 11 months remaining to maturity. Then, our floater would be offering a below market rate (6% versus 6.2%). The floater's price must decline below par to compensate for the sub-market yield. Similarly, if the yield that the market requires on a comparable instrument with a maturity of 11 months is less than 6%, the price of a floater will trade above par. For a floater in which the cap is not reached and for which the market does not demand a margin different from the quoted margin, a floater that resets daily will trade at par value.

Whether or Not the Market's Required Margin Changes

At the initial offering of a floater, the issuer will set the quoted margin based on market conditions so that the security will trade near par. If after the initial offering the market requires a higher margin, the floater's price will decline to reflect the higher spread. We shall refer to the margin that is demanded by the market as the required margin. So, for example, consider a floater whose coupon formula is 1-month LIBOR plus 40 basis points. If market conditions change such that the required margin increases to 50 basis points, this floater would be offering a below market quoted margin. As a result, the floater's price will decline below par value. The price can trade above par value if the required margin is less than the quoted margin—less than 40 basis points in our example.

The required margin for a specific issue depends on: (1) the margin available in competitive funding markets, (2) the credit quality of the issue, (3) the presence of the embedded call or put options, and (4) the liquidity of the issue. In the case of floaters, an alternative funding source is a syndicated loan. Consequently, the required margin will be affected by margins available in the syndicated loan market.

The portion of the required margin attributable to credit quality is referred to as the *credit spread*. The risk that there will be an increase in the credit spread required by the market is called *credit spread risk*. The concern for credit spread risk applies not only to an individual issue, but to a sector and the economy as a whole. For example, the credit spread of an individual issuer may change not due to that issuer but to the sector or the economy as a whole.

A portion of the required margin will reflect the call risk associated with the floater. Because the call feature is a disadvantage to the investor, the greater the call risk, the higher the quoted margin at issuance. After issuance, depending on how rates and margins change in the market, the perceived call risk and the margin attributable to this risk will change accordingly. In contrast to call risk due to the presence of the call provision, a put provision is an advantage to the investor. If a floater is putable at par, all other factors constant, its price should trade at par near the put date.

Finally, a portion of the quoted margin at issuance will reflect the perceived liquidity of the issue. The risk that the required margin attributable to liquidity will increase due to market participants' perception of a deterioration in the issue's liquidity is called *liquidity risk*. Investors in non-traditional floater products are particularly concerned with liquidity risk.

Whether or Not the Cap or Floor Is Reached

For a floater with a cap, once the coupon rate as specified by the coupon formula rises above the cap, the floater then offers a below market coupon rate, and its price will decline below par. The floater will trade more and more like a fixed-rate security the further the capped rate is below the prevailing market rate. This risk that the value of the floater will decline because the cap is reached is referred to as cap risk.

On the other side of the coin, if the floater has a floor, once the floor is reached, all other factors constant, the floater will trade at par value or at a premium to par if the coupon rate is above the prevailing rate for comparable issues.

Duration of Floaters

We have just described how a floater's price will react to a change in the required margin, holding all other factors constant. Duration is the measure used by managers to quantify the sensitivity of the price of any security or a portfolio to changes in interest rates. Basically, the duration of a security is the approximate percentage change in a bond's price or a portfolio's value for a 100 basis point change in rates.

Two measures have been developed to estimate the sensitivity of a floater to each component of the coupon formula. *Index duration* is a measure of the price sensitivity of a floater to changes in the reference rate holding the quoted margin constant. *Spread duration* measures a floater's price sensitivity to a change in the "spread" or "quoted margin" assuming that the reference rate is unchanged.

SPREAD MEASURES

Participants in the floater market commonly refer to various "spread" measures that an issue is trading over its reference rate. These measures include spread for life, adjusted simple margin, adjusted total margin, discount margin, and option-adjusted spread. We conclude this chapter with an explanation of these measures along with their limitations. All of these spread measures are available on *Bloomberg's Yield Analysis* (YA) screen. We begin with a discussion of the concept of current yield and how to compare floaters with different reset dates.

Current Yield

The current yield of a floater is calculated by dividing the security's annual dollar cash flow (assuming that the reference rate does not change over the security's life) by the market price. The formula for the current yield is

$$\text{Current yield} = \frac{\text{Annual dollar cash flow}}{\text{Price}} \tag{1}$$

To illustrate the calculation, suppose that the coupon formula for a 6-year floater selling for \$99.3098 is 6-month LIBOR plus 80 basis points (i.e., the quoted margin). The coupon rate is reset every six months. Assume the current value for the reference rate is 10%. The calculation is shown below:

$$\text{Annual dollar cash flow} = \$100 \times 0.1080 = \$10.80$$

$$\text{Current yield} = \frac{\$10.80}{\$99.3098} = 0.10875 = 10.875\%$$

Current yield possesses a number of drawbacks as a potential return measure. First, the measure assumes that the reference rate will not change over the security's life. Second, current yield considers only coupon interest and no other source of return that will affect an investor's yield. Simply put, the current yield assumes that the floater delivers a perpetual annuity. Third, current yield ignores the potential impact of any embedded options.

Comparing Floaters with Different Reset Dates

To compare the current yields of two floaters with different coupon reset dates, an adjustment known as the *weighted average rate* is utilized. The comparison requires two assumptions: (1) the coupon payments of the two floaters are determined using the same reference rate and (2) the frequency with which the coupon payments are reset is the same (e.g., semiannually, monthly, etc.). It is presumed that two floaters that share these attributes will produce the same current yield regardless of their respective terms to maturity.

The weighted average rate is simply the weighted average coupon rate over some anticipated holding period where the weights are the fraction of the holding period prior to the coupon reset date and the fraction of the holding period subsequent to the coupon reset date. (The holding period is assumed to contain only one coupon reset date. Accordingly, it is presumed an investor is considering the purchase of a floater as an alternative to a money market instrument.) On the reset date, it is assumed the new coupon rate is the current value of the reference rate adjusted for a spread. The formula for the weighted average rate is given by:

$$\text{Weighted average rate} = \frac{(\text{Current coupon} \times w) + [\text{Assumed new coupon} \times (1 - w)]}{\text{Number of days in the holding period}} \quad (2)$$

where w is the number of days to the coupon reset date divided by the number of days in the anticipated holding period. The floater's current yield is then determined by dividing the weighted average rate by the market price.

To illustrate the calculation, suppose an investor is considering the purchase of one of two floaters for an anticipated holding period of 180 days. The purchase candidates are two issues with identical coupon formulas of 6-month LIBOR plus 90 basis points. Security A has a current coupon of 6.80%, matures in three years, and is trading at 99.50. Security B has a current coupon of 7%, matures in five years, and is trading at 99.125. These two securities also differ in coupon reset dates: Security A resets in 30 days while Security B resets in 90 days. Suppose the current value of the reference rate (6-month LIBOR) is 6.20%. Accordingly, the assumed new coupon rate for both Securities A and B is 7.10% since they share the same quoted margin.

The weighted average rate for Security A and the accompanying current yield using the weighted average rate is computed below:

$$\text{Weighted average rate} = \frac{(6.80\% \times 30) + (7.10\% \times 150)}{180} = 7.05\%$$

$$\text{Annual dollar cash flow} = \$100 \times 0.0705 = \$7.05$$

$$\text{Current yield using weighted average rate} = \frac{\$7.05}{\$99.50} = 0.07085 = 7.085\%$$

The weighted average rate for Security B and the accompanying current yield using the weighted average rate is computed below:

$$\text{Weighted average rate} = \frac{(7\% \times 90) + (7.10\% \times 90)}{180} = 7.05\%$$

$$\text{Annual dollar cash flow} = \$100 \times 0.0705 = \$7.05$$

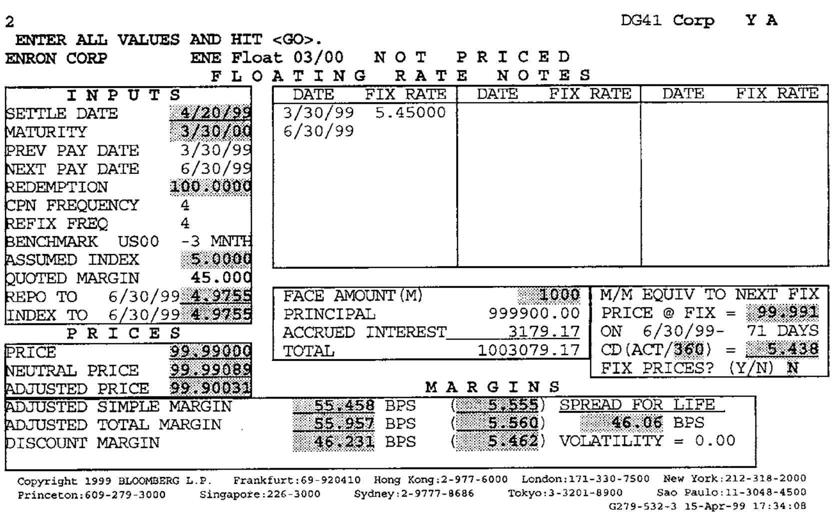
$$\text{Current yield using weighted average rate} = \frac{\$7.05}{\$99.125} = 7.11\%$$

Although Security A carries a lower coupon rate, it resets sooner to the higher rate. As a result, the current yield of the two securities is closer than one would expect.

Margin Measures

There are several yield spread measures or margins that are routinely used to evaluate floaters. The four margins commonly used are spread for life, adjusted simple margin, adjusted total margin, and discount margin. We will illustrate the calculations of these margins with a floating-rate note issued by Enron Corp. (ticker symbol "ENE 03/00") that matured March 30, 2000. This issue contained no embedded options. The floater had a coupon formula equal to 3-month LIBOR plus 45 basis points and delivered cash flows quarterly. The Yield Analysis screen (YA) from Bloomberg is presented in Exhibit 7.1. We will illustrate the calculation of each of the four margin measures in turn.

EXHIBIT 7.1 **Bloomberg's Yield Analysis Screen for Enron Floater**


```
2                                                         DG41 Corp   Y A
 ENTER ALL VALUES AND HIT <GO>.
ENRON CORP          ENE Float 03/00   N O T   P R I C E D
                      F L O A T I N G   R A T E   N O T E S
      I N P U T S           DATE    FIX RATE   DATE   FIX RATE   DATE   FIX RATE
SETTLE DATE        4/20/99  3/30/99  5.45000
MATURITY           3/30/00  6/30/99
PREV PAY DATE      3/30/99
NEXT PAY DATE      6/30/99
REDEMPTION        100.0000
CPN FREQUENCY      4
REFIX FREQ         4
BENCHMARK  US00   -3 MNTH
ASSUMED INDEX      5.0000
QUOTED MARGIN     45.000
REPO TO   6/30/99 4.9755   FACE AMOUNT(M)          1000   M/M EQUIV TO NEXT FIX
INDEX TO  6/30/99 4.9755   PRINCIPAL          999900.00   PRICE @ FIX =  99.991
      P R I C E S          ACCRUED INTEREST     3179.17   ON  6/30/99-  71 DAYS
PRICE             99.99000 TOTAL             1003079.17   CD(ACT/360) =   5.438
NEUTRAL PRICE     99.99089                                FIX PRICES? (Y/N) N
ADJUSTED PRICE    99.90031             M A R G I N S
ADJUSTED SIMPLE MARGIN     55.458 BPS  (  5.555) SPREAD FOR LIFE
ADJUSTED TOTAL MARGIN      55.957 BPS  (  5.560)       46.06 BPS
DISCOUNT MARGIN            46.231 BPS  (  5.462) VOLATILITY = 0.00

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 Princeton:609-279-3000  Singapore:226-3000  Sydney:2-9777-8686  Tokyo:3-3201-8900  Sao Paulo:11-3048-4500
                                                              G279-532-3 15-Apr-99 17:34:08
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Source: Bloomberg Financial Markets

Spread for Life

When a floater is selling at a premium/discount to par, a potential buyer of a floater will consider the premium or discount as an additional source of dollar return. Spread for life (also called *simple margin*) is a measure of potential return that accounts for the accretion (amortization) of the discount (premium) as well as the constant index spread over the security's remaining life. Spread for life is calculated using the following formula:

$$\text{Spread for life} = \left[\frac{100(100 - P)}{\text{Maturity}} + \text{Quoted margin}\right]\frac{100}{P} \tag{3}$$

where P is the market price (per \$100 of par value) and Maturity is in years using the appropriate day count convention. The quoted margin is measured in basis points.

To illustrate this calculation, at the time of the analysis the Enron floater had a current coupon of 5.45, matured in 345 days or 0.9583 of a year using an ACT/360. Although there is no current market quote available for this floater as indicated by the words "NOT PRICED" at the top center of the screen, we will use the Bloomberg default price of 99.99 for the current market price P. The simple margin is calculated as follows

$$\text{Spread for life} = \left[\frac{100(100 - 99.99)}{0.9583} + 45\right]\frac{100}{99.99} = 46.0481 \text{ basis points}$$

At the bottom of the YA screen in Exhibit 7.1 is a box labeled "MARGINS." The Enron floater's spread for life is 46.06. The slight difference between our calculation and Bloomberg's is likely due to rounding error. Note also that spread for life considers only the accretion/amortization of the discount/premium over the floater's remaining term to maturity and considers neither the level of the coupon rate nor the time value of money.

Adjusted Simple Margin

The *adjusted simple margin* (also called *effective margin*) is an adjustment to spread for life. This adjustment accounts for a one-time cost of carry effect when a floater is purchased with borrowed funds. Suppose an investor has purchased \$10 million of a particular floater. A leveraged investor has a number of alternative ways to finance the position, the most common being via a repurchase agreement. Regardless of the method selected, the investor must make a one-time adjustment to the floater's price to account for the cost of carry from the settlement date to next coupon reset date. Given a particular financing rate, a carry-adjusted forward price can be determined as of the next coupon reset date. Once the carry-adjusted price is determined, the floater's adjusted price is simply the carry-adjusted price discounted to the settlement date by the reference rate. As before, the reference rate is assumed to remain constant until maturity. Note the cost of carry adjustment is simply an adjustment to the purchase price of the floater. If the cost of carry is positive (negative), the purchase price will be adjusted downward (upward). A floater's adjusted price is calculated as below:

$$\text{Adjusted price} = P - \frac{[(\text{Coupon rate})100 - (P + AI)rf]w}{[1 + (w)(rr_{\text{avg}})]} \tag{4}$$

where

Coupon rate = current coupon rate of the floater (in decimal)
P = market price (per \$100 of par value)
AI = accrued interest (per \$100 of par value)
rf = financing rate (e.g., the repo rate) (in decimal)

$$w = \frac{\text{Number of days between settlement and the next coupon payent}}{\text{Number of days in a year using the appropriate day-count}}$$

rr_{avg} = assumed (average) value for the reference rate until maturity (in decimal)

To illustrate this calculation, we revisit the Enron floater. The following information is taken from the YA screen in Exhibit 7.1. The market price is 99.99 is taken from the "PRICES" box on the left-hand side of the screen. For the coupon rate, we use 0.0545 (in decimal) which is located under "FIX RATE." The accrued interest is 0.3179 (per \$100 of par value). Under "INPUTS," we find the repo rate (0.049755) to the next coupon reset date. There are 71 days between the settlement date (4/20/99) and the next coupon reset date (6/30/99) and the day count is ACT/360. Given this information, w = 71/360 or 0.1972. Lastly, the assumed value of the reference rate until maturity (rr_{avg}) is simply the current value of the reference rate which is 0.05 (in decimal) and is labeled "ASSUMED INDEX" under the "INPUTS" section.

$$\begin{aligned}&\text{Adjusted price}\\&= 99.99 - \frac{[(0.0545)100 - (99.99 + 0.3179)0.049755]0.1972}{[1 + (0.1972)(0.05)]}\\&= 99.90033\end{aligned}$$

The adjusted price as computed by Bloomberg is 99.90031 and is found under "PRICES."

Once the adjusted price is determined, the adjusted simple margin is computed using the formula below.

$$\text{Adjusted simple margin} = \left[\frac{100(100 - P_A)}{\text{Maturity}} + \text{Quoted margin}\right]\frac{100}{P_A} \qquad (5)$$

where P_A is the adjusted price, Maturity is measured in years using the appropriate day count convention, and Quoted margin is measured in basis points.

To compute the adjusted simple margin for the Enron floater, we gather the following information from Exhibit 7.1. We use the adjusted price of 99.90031 for P_A. There are 345 days between the settlement date (4/20/99) and the maturity date (3/30/00). Since the day count convention is ACT/360, the maturity is 345/360 or 0.9583. The quoted margin of 45 basis points is obtained from the "INPUTS" box. Plugging this information into equation (5), we obtain the adjusted simple margin.

$$\begin{aligned}\text{Adjusted simple margin} &= \left[\frac{100(100 - 99.90031)}{0.9583} + 45\right]\frac{100}{99.90031} \qquad (6)\\&= 55.458 \text{ basis points}\end{aligned}$$

The adjusted simple margin from Bloomberg is 55.458 which is also located in the "MARGINS" box at the bottom of Exhibit 7.1.

Adjusted Total Margin

The *adjusted total margin* (also called *total adjusted margin*) adds one additional refinement to the adjusted simple margin. Specifically, the adjusted total margin is the adjusted simple margin plus the interest earned by investing the difference between the floater's par value and the adjusted price. The current value of the reference rate (i.e., the assumed index) is assumed to be the investment rate. The adjusted total margin is calculated using the following expression:

Adjusted total margin

$$= \left[\frac{100(100 - P_A)}{\text{Maturity}} + \text{Quoted margin} + 100(100 - P_A)rr_{\text{avg}}\right]\frac{100}{P_A} \qquad (7)$$

The notation used is the same as given above.

For the Enron floater we used in previous illustrations, the adjusted total margin is:

Adjusted total margin

$$= \left[\frac{100(100 - 99.90031)}{0.9583} + 45 + 100(100 - 99.90031)0.05\right]\frac{100}{99.90031}$$

$$= 55.957 \text{ basis points}$$

In Exhibit 7.1, Bloomberg's adjusted total margin is 55.957 which is obtained from the "MARGINS" box.

Discount Margin

One common method of measuring potential return that employs discounted cash flows is *discount margin*. This measure indicates the average spread or margin over the reference rate the investor can expect to earn over the security's life given a particular assumption of the path the reference rate will take to maturity. The assumption that the future levels of the reference rate are equal to today's level is the usual assumption. The procedure for calculating the discount margin is as follows:

Step 1. Determine the cash flows assuming that the reference rate does not change over the security's life.
Step 2. Select a margin.
Step 3. Discount the cash flows found in Step 1 by the current value of the reference rate plus the margin selected in Step 2.
Step 4. Compare the present value of the cash flows as calculated in Step 3 to the price. If the present value is equal to the security's price, the discount margin is the margin assumed in Step 2. If the present value is not equal to the security's price, go back to Step 2 and select a different margin.

For a security selling at par, the discount margin is simply the quoted margin.

For example, suppose that a 6-year floater selling for $99.3098 pays the reference rate plus a quoted margin of 80 basis points. The coupon resets every six months. Assume that the current value of the reference rate is 10%.

Exhibit 7.2 presents the calculation of the discount margin for this security. Each period in the security's life is enumerated in Column (1), while Column (2) shows the current value of the reference rate. Column (3) sets forth the security's cash flows. For the first 11 periods, the cash flow is equal to the reference rate (10%) plus the quoted margin of 80 basis points multiplied by 100 and then divided by 2. In last 6-month period, the cash flow is $105.40—the final coupon payment of $5.40 plus the maturity value of $100. Different assumed margins appear at the top of the last five columns. The rows below the assumed margin indicate the present value of each period's cash flow for that particular value of assumed margin. Finally, the last row gives the total present value of the cash flows for each assumed margin.

EXHIBIT 7.2 **Calculation of the Discount Margin for a Floater**

Floater:	Maturity	=	6 years
	Coupon rate	=	Reference rate + 80 basis points
			Resets every 6 months
	Maturity value	=	$100

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Rate	Flow	Assumed Margin				
Period	(%)	($)*	80	84	88	96	100
1	10	5.40	$5.1233	$5.1224	$5.1214	$5.1195	$5.1185
2	10	5.40	4.8609	4.8590	4.8572	4.8535	4.8516
3	10	5.40	4.6118	4.6092	4.6066	4.6013	4.5987
4	10	5.40	4.3755	4.3722	4.3689	4.3623	4.3590
5	10	5.40	4.1514	4.1474	4.1435	4.1356	4.1317
6	10	5.40	3.9387	3.9342	3.9297	3.9208	3.9163
7	10	5.40	3.7369	3.7319	3.7270	3.7171	3.7122
8	10	5.40	3.5454	3.5401	3.5347	3.5240	3.5186
9	10	5.40	3.3638	3.3580	3.3523	3.3409	3.3352
10	10	5.40	3.1914	3.1854	3.1794	3.1673	3.1613
11	10	5.40	3.0279	3.0216	3.0153	3.0028	2.9965
12	10	105.40	56.0729	55.9454	55.8182	55.5647	55.4385
	Present value =		$100.00	$99.8269	$99.6541	$99.3098	$99.1381

* For periods 1-11: Cash flow = 100(Reference rate + 80 basis points) (0.5)
For period 12: Cash flow = 100(Reference rate + 80 basis points) (0.5) + 100

For the five assumed margins, the present value of the cash flows is equal to the floater's price ($99.3098) when the assumed margin is 96 basis points. Accordingly, the discount margin on a semiannual basis is 48 basis points and correspondingly 96 basis points on an annual basis. (Notice that the discount margin is 80 basis points (i.e., the quoted margin) when the floater is selling at par.)

There are several drawbacks of the discount margin as a measure of potential return from holding a floater. First and most obvious, the measure assumes the reference rate will not change over the security's life. Second, the price of a floater for a given discount margin is sensitive to the path that the reference rate takes in the future except in the special case when the discount margin equals the quoted margin.

Option-Adjusted Spread

The spread measures discussed thus far fail to recognize any embedded options that may be present in a floater. A spread measure that takes into account embedded options is the *option-adjusted spread*. A discussion of how this spread measure is computed is beyond the scope of this chapter.[4] Basically, it is a byproduct of a model that is used for valuing a security with an embedded option. The spread is referred to as "option adjusted" because the valuation model adjusts the cash flows based on how changes in the reference rates might be expected to change the cash flows of the security, taking into account any embedded options.

Despite its widespread use, the OAS has a number of limitations. Specifically, the OAS is model-dependent. Changing the assumptions of the valuation model may produce substantial differences in the computed OAS.

[4] See Chapter 4 in Frank J. Fabozzi and Steven V. Mann, *Floating-Rate Securities* (New Hope, PA: Frank J. Fabozzi Associates, 2000).

CHAPTER 8

Repurchase and Reverse Repurchase Agreements

One of the largest segments of the money markets worldwide is the market in repurchase agreements or repos. A most efficient mechanism by which to finance bond positions, repo transactions enable market makers to take long and short positions in a flexible manner, buying and selling according to customer demand on a relatively small capital base. Repo is also a flexible and relatively safe investment opportunity for short-term investors. The ability to execute repo is particularly important to firms in less-developed countries who might not have access to a deposit base. Moreover, in countries where no repo market exists, funding is in the form of unsecured lines of credit from the banking system which is restrictive for some market participants. A liquid repo market is often cited as a key ingredient of a liquid bond market. In the United States, repo is a well-established money market instrument and is developing in a similar way in Europe and Asia.

A repurchase agreement or "repo" is the sale of a security with a commitment by the seller to buy the same security back from the purchaser at a specified price at a designated future date. For example, a dealer who owns a 10-year U.S. Treasury note might agree to sell this security (the "seller") to a mutual fund (the "buyer") for cash today while simultaneously agreeing to buy the same 10-year note back at a certain date in the future (or in some cases on demand) for a predetermined price. The price at which the seller must subsequently repurchase the security is called the *repurchase price* and the date that the security must be repurchased is called the *repurchase date*.[1] Simply put, a repurchase agreement is a collateralized loan where the collateral is the security that is sold and subsequently repur-

[1] As noted, repurchase agreements can be structured such that the transaction is terminable on demand.

chased. One party (the "seller") is borrowing money and providing collateral for the loan; the other party (the "buyer") is lending money and accepting a security as collateral for the loan. To the borrower, the advantage of a repurchase agreement is that the short-term borrowing rate is lower than the cost of bank financing, as we will see shortly. To the lender, the repo market offers an attractive yield on a short-term secured transaction that is highly liquid. This latter aspect is the focus of this chapter.

THE BASICS

Suppose a government securities dealer purchases a 5% coupon Treasury note that matures on August 15, 2011 with a settlement date of Thursday, November 15, 2001. The face amount of the position is $1 million and the note's full price (i.e., flat price plus accrued interest) is $1,044,843.75. Further, suppose the dealer wants to hold the position until the end of the next business day which is Friday, November 16, 2001. Where does the dealer obtain the funds to finance this position?

Of course, the dealer can finance the position with its own funds or by borrowing from a bank. Typically, though, the dealer uses a repurchase agreement or "repo" market to obtain financing. In the repo market, the dealer can use the purchased Treasury note as collateral for a loan. The term of the loan and the interest rate a dealer agrees to pay are specified. The interest rate is called the *repo rate*. When the term of a repo is one day, it is called an *overnight repo*. Conversely, a loan for more than one day is called a *term repo*. The transaction is referred to as a repurchase agreement because it calls for the security's sale and its repurchase at a future date. Both the sale price and the purchase price are specified in the agreement. The difference between the purchase (repurchase) price and the sale price is the loan's dollar interest cost.

Let us return now to the dealer who needs to finance the Treasury note that it purchased and plans to hold it overnight. We will illustrate this transaction using Bloomberg's Repo/Reverse Repo Analysis screen (RRRA) that appears in Exhibit 8.1. The settlement date is the day that the collateral must be delivered and the money lent to initiate the transaction. Likewise, the termination date of the repo agreement is November 16, 2001 and appears in the lower left-hand corner. At this point we need to ask, who is the dealer's counterparty (i.e., the lender of funds). Suppose that one of the dealer's customers has excess funds in the amount of $1,044,843.75 labeled "SETTLEMENT MONEY" in Exhibit 8.1 and is the amount of money loaned in the repo agreement.[2] On November 15,

[2] For example, the customer might be a municipality with tax receipts that it has just collected and no immediate need to disburse the funds.

2001, the dealer would agree to deliver ("sell") $1,044,843.75 worth of Treasury notes to the customer and buy the same Treasury security for an amount determined by the repo rate the next day on November 16, 2001.[3]

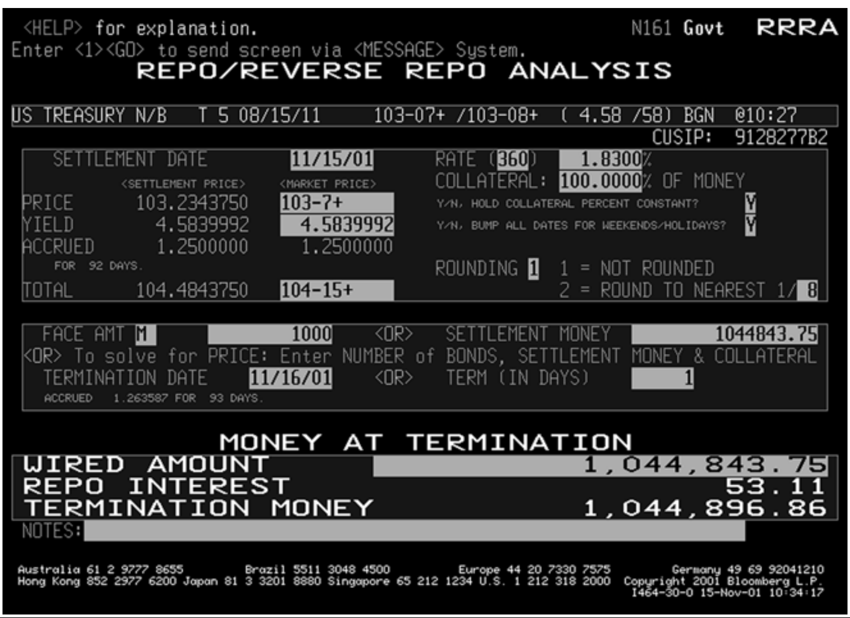
Suppose the repo rate in this transaction is 1.83% which is shown in the upper right-hand corner of the screen. Then, as will be explained below, the dealer would agree to deliver the Treasury note for $1,044,843.75 and repurchase the same security for $1,044,896.86 the next day. The $53.11 difference between the "sale" price of $1,044,843.75 and the repurchase price of $1,044,896.86 is the dollar interest on the financing.

Repo Interest

The following formula is used to calculate the dollar interest on a repo transaction:

$$\text{dollar interest} = (\text{dollar principal}) \times (\text{repo rate}) \times (\text{repo term}/360)$$

EXHIBIT 8.1 Bloomberg Repo/Reverse Repo Analysis Screen



Source: Bloomberg Financial Markets

[3] We are assuming in this illustration that the borrower will provide collateral that is equal in value to the money that is loaned. In practice, lenders require borrowers to provide collateral in excess of the value of money that is loaned. We will illustrate how this is accomplished shortly when we discuss repo margins.

Notice that the interest is computed using a day count convention of Actual/360 like most money market instruments. In our illustration, using a repo rate of 1.83% and a repo term of one day, the dollar interest is \$53.11 as shown below:

$$\$1{,}044{,}843.75 \times 0.0183 \times (1/360) = \$53.11$$

This calculation agrees with repo interest as calculated in the lower right-hand corner of Exhibit 8.1.

The advantage to the dealer of using the repo market for borrowing on a short-term basis is that the rate is lower than the cost of bank financing for reasons explained shortly. From the customer's perspective (i.e., the lender), the repo market offers an attractive yield on a short-term secured transaction that is highly liquid.

Reverse Repo and Market Jargon

In the illustration presented above, the dealer is using the repo market to obtain financing for a long position. Dealers can also use the repo market to cover a short position. For example, suppose a government dealer established a short position in the 30-year Treasury bond one week ago and must now cover the position—namely, deliver the securities. The dealer accomplishes this task by engaging in a reverse repo. In a reverse repo, the dealer agrees to buy securities at a specified price with a commitment to sell them back at a later date for another specified price.[4] In this case, the dealer is making collateralized loan to its customer. The customer is lending securities and borrowing funds obtained from the collateralized loan to create leverage.

There is a great deal of Wall Street jargon surrounding repo transactions. In order to decipher the terminology, remember that one party is lending money and accepting a security as collateral for the loan; the other party is borrowing money and providing collateral to borrow the money. By convention, whether the transaction is called a repo or a reverse repo is determined by viewing the transaction from the *dealer's* perspective. If the dealer is borrowing money from a customer and providing securities as collateral, the transaction is called a repo. If the dealer is borrowing securities (which serve as collateral) and lends money to a customer, the transaction is called a reverse repo.

When someone lends securities in order to receive cash (i.e., borrow money), that party is said to be "reversing out" securities. Correspond-

[4] Of course, the dealer eventually would have to buy the 30-year bonds in the market in order to cover its short position.

ingly, a party that lends money with the security as collateral for the loan is said to be "reversing in" securities.

The expressions "to repo securities" and "to do repo" are also commonly used. The former means that someone is going to finance securities using the securities as collateral; the latter means that the party is going to invest in a repo as a money market instrument.

Lastly, the expressions "selling collateral" and "buying collateral" are used to describe a party financing a security with a repo on the one hand, and lending on the basis of collateral on the other.

Rather than relying on industry jargon, investment guidelines should clearly state what a portfolio manager is permitted to do. For example, a client may have no objections to its portfolio manager using a repo to invest funds short-term (i.e., lend at the repo rate). The investment guidelines should set forth how the loan arrangement should be structured to protect against credit risk. We will discuss these procedures in the next section. Conversely, if a client does not want a portfolio manager to use a repurchase agreement as a vehicle for borrowing funds (thereby, creating leverage), it should state so clearly.

Types of Collateral

While in our illustration, we use a Treasury security as collateral, the collateral in a repo is not limited to government securities. Money market instruments, federal agency securities, and mortgage-backed securities are also used. In some specialized markets, even whole loans are used as collateral.

Documentation

Most repo market participants in the United States use the Master Repurchase Agreement published by Bond Market Association. Paragraphs 1 ("Applicability"), 2 ("Definitions"), 4 ("Margin Maintenance"), 8 ("Segregation of Purchased Securities"), 11 ("Events of Default"), and 19 ("Intent") of this agreement are reproduced in the appendix to this chapter. In Europe, the Global Master Repurchase Agreement published by the Bond Market Association (formerly, the Public Securities Association) and the International Securities Market Association has become widely accepted. The full agreement may be downloaded from www.isma.org.

CREDIT RISKS

Just as in any borrowing/lending agreement, both parties in a repo transaction are exposed to credit risk. This is true even though there may be high-quality collateral underlying the repo transaction. Consider our initial example in Exhibit 8.1 where the dealer uses U.S. Treasuries as collateral to borrow funds. Let us examine under which circumstances each counterparty is exposed to credit risk.

Suppose the dealer (i.e., the borrower) defaults such that the Treasuries are not repurchased on the repurchase date. The investor gains control over the collateral and retains any income owed to the borrower. The risk is that Treasury yields have risen subsequent to the repo transaction such that the market value of collateral is worth less than the unpaid repurchase price. Conversely, suppose the investor (i.e., the lender) defaults such that the investor fails to deliver the Treasuries on the repurchase date. The risk is that Treasury yields have fallen over the agreement's life such that the dealer now holds an amount of dollars worth less then the market value of collateral. In this instance, the investor is liable for any excess of the price paid by the dealer for replacement securities over the repurchase price.[5]

Repo Margin

While both parties are exposed to credit risk in a repo transaction, the lender of funds is usually in the more vulnerable position. Accordingly, the repo is structured to reduce the lender's credit risk. Specifically, the amount lent should be less than the market value of the security used as collateral, thereby providing the lender some cushion should the collateral's market value decline. The amount by which the market value of the security used as collateral exceeds the value of the loan is called *repo margin* or "haircut." Repo margins vary from transaction to transaction and are negotiated between the counterparties based on factors such as the following: term of the repo agreement, quality of the collateral, creditworthiness of the counterparties, and the availability of the collateral. Minimum repo margins are set differently across firms and are based on models and/or guidelines created by their credit departments. Repo margin is generally between 1% and 3%. For borrowers of lower credit worthiness and/or when less liquid securities are used as collateral, the repo margin can be 10% or more.

At the time of this writing, the Basel Committee on Banking Supervision is proposing standards for repo margins for capital-market driven transactions (i.e., repo/reverse repos, securities borrowing/lending, derivatives transactions, and margin lending).[6] These standards would only apply to banks.

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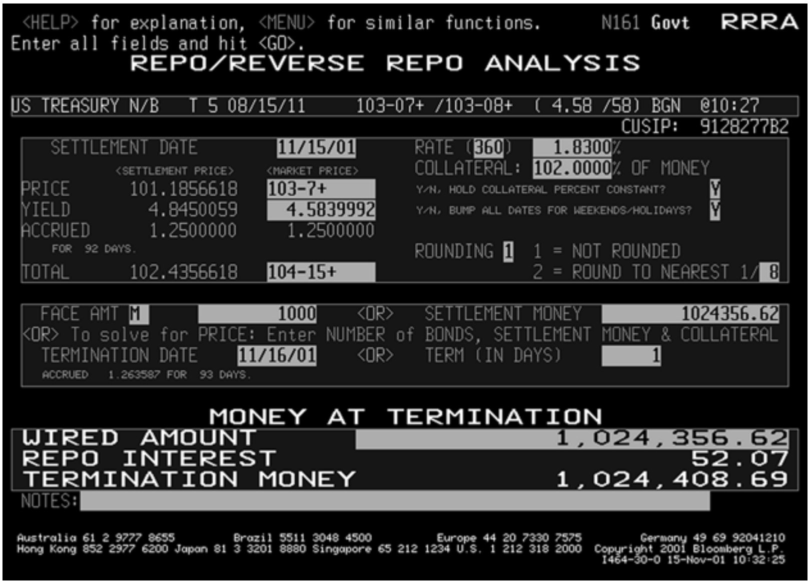
[5] See Section 11 "Events of Default" of the Master Repurchase Agreement reproduced in the appendix to this chapter.

[6] The revised Basel Accord is in exposure draft form until May 31, 2001 and the final document will be published before June 30, 2002.

EXHIBIT 8.2 Bloomberg Repo/Reverse Repo Analysis Screen



Source: Bloomberg Financial Markets

To illustrate the role of a haircut in a repurchase agreement, let us once again return to the government securities dealer who purchases a 5% coupon, 10-year Treasury note and needs financing overnight. Recall, the face amount of the position is $1 million and the note's full price (i.e., flat price plus accrued interest) is $1,044,843.75. As before, we will use Bloomberg's RRRA screen to illustrate the transaction in Exhibit 8.2.

When a haircut is included, the amount the customer is willing to lend is reduced by a given percentage of the security's market value. In this case, the collateral is 102% of the amount being lent. This percentage appears in the box labeled "COLLATERAL" in the upper right-hand corner of the screen. Accordingly, to determine the amount being lent, we divide the note's full price of $1,044,843.75 by 1.02 to obtain $1,024,356.62 which is labeled "SETTLEMENT MONEY" located on the right-hand side of the screen. Suppose the repo rate in this transaction is 1.83%. Then, the dealer would agree to deliver the Treasury notes for $1,024,356.62 and repurchase the same securities for $1,024,408.69 the next day. The $52.07 difference between the "sale" price of $1,024,356.62 and the repurchase price of $1,024,408.69 is the dollar interest on the financing. Using a repo rate of 1.83% and a repo term of 1 day, the dollar interest is calculated as shown below:

$$\$1{,}024{,}356.62 \times 0.0183 \times (1/360) = \$52.07$$

This calculation agrees with repo interest as calculated in the lower right-hand corner of Exhibit 8.2.

Marking the Collateral to Market

Another practice to limit credit risk is to mark the collateral to market on a regular basis. Marking a position to market means simply recording the position's value at its market value. When the market value changes by a certain percentage, the repo position is adjusted accordingly. The decline in market value below a specified amount will result in a margin deficit. [Paragraph 4(a) of the Master Repurchase Agreement (reproduced in the appendix) gives the "Seller" (the dealer/borrower in our example) the option to remedy the margin deficit by either providing additional cash or by transferring "additional Securities reasonably acceptable to Buyer." The Buyer in our example is the investor/lender.] Conversely, suppose instead that the market value rises above the amount required by margin. This circumstance results in a margin excess. If this occurs, Paragraph 4(b) states the "Buyer" will remedy the excess by either transferring cash equal to the amount of the excess or returning a portion of the collateral ("purchased securities") to the "Seller."

Since the Master Repurchase Agreement covers all transactions where a party is on one side of the transaction, the discussion of margin maintenance in Paragraph 4 is couched in terms of "the aggregate Market Value of all Purchased Securities in which a particular party hereto is acting as Buyer" and "the aggregate Buyer's Margin Account for all such Transactions." Thus, maintenance margin is not viewed from an individual transaction or security perspective. However, Paragraph 4(f) permits the "Buyer" and "Seller" to agree to override this provision so as to apply the margin maintenance requirement to a single transaction.

The price used to mark positions to market is defined in Paragraph 2(j)—the definition of "Market Value." The price is one "obtained from a generally recognized source agreed to by the parties or the most recent closing bid quotation from such a source." For complex securities that do not trade frequently, there is considerable difficulty in obtaining a price at which to mark a position to market.

Delivery of the Collateral

One concern in structuring a repurchase agreement is delivery of the collateral to the lender. The most obvious procedure is for the borrower to actually deliver the collateral to the lender or to the cash lender's clearing agent. If this procedure is followed, the collateral is said to be "delivered out." At the end of the repo term, the lender returns collateral to the borrower in exchange for the repurchase price (i.e., the amount borrowed plus interest).

The drawback of this procedure is that it may be too expensive, particularly for short-term repos (e.g., overnight) owing to the costs associated with delivering the collateral. Indeed, the cost of delivery is factored into the repo rate of the transaction in that if delivery is required this translates into a lower repo rate paid by the borrower. If delivery of collateral is not required, an otherwise higher repo rate is paid. The risk to the lender of not taking actual possession of the collateral is that the borrower may sell the security or use the same security as collateral for a repo with another counterparty.

As an alternative to delivering out the collateral, the lender may agree to allow the borrower to hold the security in a segregated customer account. The lender still must bear the risk that the borrower may use the collateral fraudulently by offering it as collateral for another repo transaction. If the borrower of the cash does not deliver out the collateral, but instead holds it, then the transaction is called a *hold-in-custody repo* (HIC repo). Despite the credit risk associated with a HIC repo, it is used in some transactions when the collateral is difficult to deliver (e.g., whole loans) or the transaction amount is relatively small and the lender of funds is comfortable with the borrower's reputation.

Investors participating in a HIC repo must ensure: (1) they transact only with dealers of good credit quality since an HIC repo may be perceived as an unsecured transaction and (2) the investor (i.e., the lender of cash) receives a higher rate in order to compensate them for the higher credit risk involved. In the U.S. market, there have been cases where dealer firms that went into bankruptcy and defaulted on loans were found to have pledged the same collateral for multiple HIC transactions.

Another method for handling the collateral is for the borrower to deliver the collateral to the lender's custodial account at the borrower's clearing bank. The custodian then has possession of the collateral that it holds on the lender's behalf. This method reduces the cost of delivery because it is merely a transfer within the borrower's clearing bank. If, for example, a dealer enters into an overnight repo with Customer A, the next day the collateral is transferred back to the dealer. The dealer can then enter into a repo with Customer B for, say, five days without having to redeliver the collateral. The clearing bank simply establishes a custodian account for Customer B and holds the collateral in that account. In this type of repo transaction, the clearing bank is an agent to both parties. This specialized type of repo arrangement is called a *tri-party repo*. For some regulated financial institutions (e.g., federally chartered credit unions), this is the only type of repo arrangement permitted.

Paragraph 8 ("Segregation of Purchased Securities") of the Master Repurchase Agreement contains the language pertaining to the possession of collateral. This paragraph also contains special disclosure provisions when the "Seller" retains custody of the collateral.

Paragraph 11 ("Events of Default") details the events that will trigger a default of one of the counterparties and the options available to the non-defaulting party. If the borrower files for bankruptcy, the U.S. bankruptcy code affords the lender of funds in a qualified repo transaction a special status. It does so by exempting certain types of repos from the stay provisions of the bankruptcy law. This means that the lender of funds can immediately liquidate the collateral to obtain cash. Paragraph 19 ("Intent") of the Master Repurchase Agreement is included for this purpose.

DETERMINANTS OF THE REPO RATE

Just as there is no single interest rate, there is not one repo rate. The repo rate varies from transaction to transaction depending on a number of factors: quality of the collateral, term of the repo, delivery requirement, availability of the collateral, and the prevailing federal funds rate. Panel A of Exhibit 8.3 presents a Bloomberg screen (MMR) that contains repo and reverse repo rates for maturities of 1 day, 1 week, 2 weeks, 3 weeks, 1 month, 2 months, and 3 months using U.S. Treasuries as collateral on November 15, 2001. Panel B presents repo and reverse repo rates with agency securities as collateral. Note how the rates differ by maturity and type of collateral. For example, the repo rates are higher when agency securities are used as collateral versus governments. Moreover, the rates generally decrease with maturity that mirrors the inverted Treasury yield curve on that date.

Another pattern evident in these data is that repo rates are lower than the reverse repo rates when matched by collateral type and maturity. These repo (reverse repo) rates can viewed as the rates the dealer will borrow (lend) funds. Alternatively, repo (reverse repo) rates are prices at which dealers are willing to buy (sell) collateral. While a dealer firm primarily uses the repo market as a vehicle for financing its inventory and covering short positions, it will also use the repo market to run a "matched book." A dealer runs a matched book by simultaneously entering into a repo and a reverse repo for the same collateral with the same maturity. The dealer does so to capture the spread at which it enters into a repurchase agreement (i.e., an agreement to borrow funds) and a reverse repurchase agreement (i.e., an agreement to lend funds).

EXHIBIT 8.3 Bloomberg Screens Presenting Repo and Reverse Repo rates for Various Maturities and Collateral
Panel A: U.S. Treasuries

Press 98<GO> to make a copy, 99<GO> to clear news alerts. M-Mkt MMR

10:35 REPO/REVERSE RP O/N & TERM Page 1 / 3
94<GO> View News.

SECURITY	TIME	LAST	CHANGE	OPEN	HIGH	LOW	CLOSE
GOVERNMENT							
Repo							
Dealer pays int							
4)RPGT01D	10:05	2.11	+.04	2.11	2.11	2.11	2.07
5)RPGT01W	10:05	1.95	-.02	1.95	1.95	1.95	1.97
6)RPGT02W	10:05	1.93	-.05	1.93	1.93	1.93	1.98
7)RPGT03W	10:05	1.98	-.02	1.98	1.98	1.98	2.00
8)RPGT01M	10:05	1.90	-.05	1.90	1.90	1.90	1.95
9)RPGT02M	10:05	1.90	--	1.90	1.90	1.90	1.90
10)RPGT03M	10:05	1.83	-.05	1.83	1.83	1.83	1.88
Reverse Repo							
Dealer earns int							
13)RVGT01D	10:05	2.15	+.05	2.15	2.15	2.15	2.10
14)RVGT01W	10:05	2.10	+.07	2.10	2.10	2.10	2.03
15)RVGT02W	10:05	2.00	-.03	2.00	2.00	2.00	2.03
16)RVGT03W	10:05	2.05	--	2.05	2.05	2.05	2.05
17)RVGT01M	10:05	1.97	-.04	1.97	1.97	1.97	2.01
18)RVGT02M	10:05	1.95	--	1.95	1.95	1.95	1.95
19)RVGT03M	10:05	1.95	+.04	1.95	1.95	1.95	1.91
PAGE FOR MTGE REPO							

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
1464-30-0 15-Nov-01 10:35:24

Panel B: Agency Securities

Press 98<GO> to make a copy, 99<GO> to clear news alerts. M-Mkt MMR

10:36 REPO/REVERSE RP O/N & TERM Page 3 / 3
94<GO> View News.

SECURITY	TIME	LAST	CHANGE	OPEN	HIGH	LOW	CLOSE
AGENCY							
Repo							
3)RPAG01D	10:05	2.15	+.05	2.15	2.15	2.15	2.10
4)RPAG01W	n.a.	.00	n.a.	n.a.	n.a.	.00	n.a.
5)RPAG03W	10:05	2.05	+.01	2.05	2.05	2.05	2.04
6)RPAG01M	n.a.	.00	n.a.	n.a.	n.a.	.00	n.a.
7)RPAG02M	10:05	2.00	+.01	2.00	2.00	2.00	1.99
8)RPAG03M	10:05	1.85	-.09	1.85	1.85	1.85	1.94
Reverse Repo							
11)RVAG01D	10:05	2.22	+.08	2.22	2.22	2.22	2.14
12)RVAG01W	10:05	2.10	+.02	2.10	2.10	2.10	2.08
13)RVAG02W	10:05	2.09	+.01	2.09	2.09	2.09	2.08
14)RVAG03W	10:05	2.10	--	2.10	2.10	2.10	2.10
15)RVAG01M	10:05	2.05	-.01	2.05	2.05	2.05	2.06
16)RVAG02M	10:05	2.05	--	2.05	2.05	2.05	2.05
17)RVAG03M	10:05	2.00	+.01	2.00	2.00	2.00	1.99

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
1464-30-0 15-Nov-01 10:36:05

Source: Bloomberg Financial Markets

For example, suppose that a dealer enters into a term repo for one month with a money market mutual fund and a reverse repo with a corporate credit union for one month for which the collateral is identical. In this arrangement, the dealer is borrowing funds from the money market mutual fund and lending funds to the corporate credit union. From Panel A in Exhibit 8.3, we find that the repo rate for a one-month repurchase agreement is 1.90% and repo rate for a one-month reverse repurchase agreement is 1.97%. If these two positions are established simultaneously, then the dealer is borrowing at 1.90% and lending at 1.97% thereby locking in a spread of 7 basis points.

However, in practice, traders deliberately mismatch their books to take advantage of their expectations about the shape and level of the short-dated yield curve. The term matched book is therefore something of a misnomer in that most matched books are deliberately mismatched for this reason. Traders engage in positions to take advantage of (1) short-term interest rate movements and (2) anticipated demand and supply in the underlying bond.

The delivery requirement for collateral also affects the level of the repo rate. If delivery of the collateral to the lender is required, the repo rate will be lower. Conversely, if the collateral can be deposited with the bank of the borrower, a higher repo rate will be paid. For example, on November 15, 2001, Bloomberg reports that the general collateral rate (repos backed by non-specific collateral) is 2.10% if delivery of the collateral is required. For a triparty repo discussed earlier, the general collateral rate is 2.13%.

The more difficult it is to obtain the collateral, the lower the repo rate. To understand why this is so, remember that the borrower (or equivalently the seller of the collateral) has a security that lenders of cash want for whatever reason.[7] Such collateral is said to "on special." Collateral that does not share this characteristic is referred to as "general collateral." The party that needs collateral that is "on special" will be willing to lend funds at a lower repo rate in order to obtain the collateral. For example, on November 14, 2001, Bloomberg reports the on-the-run 5-year Treasury note (3.5% coupon maturing November 15, 2006) was "on special" such that the overnight repo rate was 0.65%. At the time, the general collateral rate was 2.13%.

There are several factors contributing to the demand for special collateral. They include:

- government bond auctions—the bond to be issued is shorted by dealers in anticipation of new supply and due to client demand;
- outright short selling whether a deliberate position taken based on a trader's expectations or dealers shorting bonds to satisfy client demand;

[7] Perhaps the issue is in great demand to satisfy borrowing needs.

- hedging including corporate bonds underwriters who short the relevant maturity benchmark government bond that the corporate bond is priced against;
- derivative trading such as basis trading creating a demand for a specific bond;
- buy-back or cancellation of debt at short notice.

Financial crises will also impact a particular security's "specialness." Specialness is defined the spread between the general collateral rate and the repo rate of a particular security. Michael Fleming found that the on-the-run 2-year note, 5-year note, and 30-year bond traded at an increased rate of specialness during the Asian financial crisis of 1998. In other words, the spread between the general collateral rate and the repo rates on these securities increased. Moreover, these spreads returned to more normal levels after the crisis ended.[8]

While these factors determine the repo rate on a particular transaction, the federal funds rate (discussed in Chapter 6) determines the general level of repo rates. The repo rate generally will trade lower than the federal funds rate, because a repo involves collateralized borrowing while a federal funds transaction is unsecured borrowing. Exhibit 8.4 presents a time series plot of the federal funds rate and the overnight repo rate each day from October 2, 2000 to April 6, 2001 (129 observations). The overnight repo rate is on average 8.17 basis points below the federal funds rate.[9]

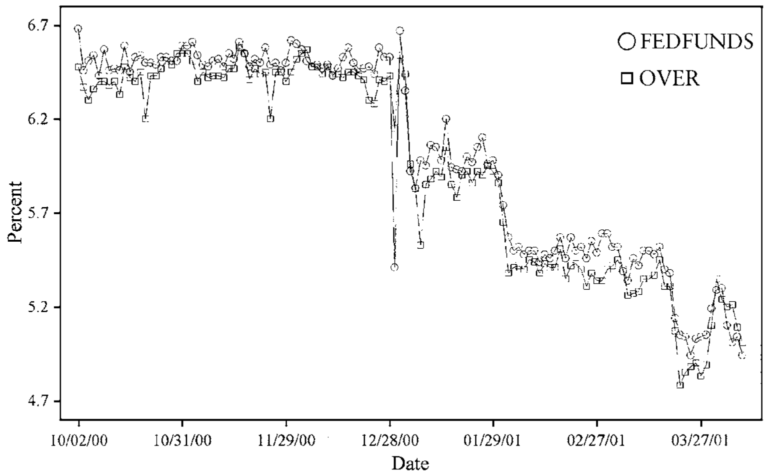
SPECIAL COLLATERAL AND ARBITRAGE

As noted earlier in the chapter, there are a number of investment strategies in which an investor borrows funds to purchase securities. The investor's expectation is that the return earned by investing in the securities purchased with the borrowed funds will exceed the borrowing cost. The use of borrowed funds to obtain greater exposure to an asset than is possible by using only cash is called *leveraging*. In certain circumstances, a borrower of funds via a repo transaction can generate an arbitrage opportunity. This occurs when it is possible to borrow funds at a lower rate than the rate that can be earned by reinvesting those funds.

[8] Michael J. Fleming, "The Benchmark U.S. Treasury Market: Recent Performance and Possible Alternatives," *FRBNY Economic Policy Review* (April 2000), pp. 129–145.

[9] Source: Bloomberg.

EXHIBIT 8.4 Time Series Plot of the Federal Funds Rate and Overnight Repo Rate



Source: Bloomberg Financial Markets

Such opportunities present themselves when a portfolio includes securities that are "on special" and the manager can reinvest at a rate higher than the repo rate. For example, suppose that a manager has securities that are "on special" in the portfolio, Bond X, that lenders of funds are willing to take as collateral for two weeks charging a repo rate of say 3%. Suppose further that the manager can invest the funds in a 2-week Treasury bill (the maturity date being the same as the term of the repo) and earn 4%. Assuming that the repo is properly structured so that there is no credit risk, then the manager has locked in a spread of 100 basis points for two weeks. This is a pure arbitrage and the manager faces no risk. Of course, the manager is exposed to the risk that Bond X may decline in value but this the manager is exposed to this risk anyway as long as the manager intends to hold the security.

The Bank of England has conducted a study examining the relationship between cash prices and repo rates for bonds that have traded special.[10] The results of the study suggest a positive correlation between changes in a bond trading expensive to the yield curve and changes in the degree to which it trades special. This result is not surprising. Traders maintain short positions in bonds which have associated funding costs only if the anticipated fall in the bond's is large enough to engender a profit. The causality could run in either direction. For example, suppose a

[10] See the markets section of the *Bank of England's Quarterly Bulletin* in the February 1997 and August 1997 issues.

bond is perceived as being expensive relative to the yield curve. This circumstance creates a greater demand for short positions and hence a greater demand for the bonds in the repo market to cover the short positions. Alternatively, suppose a bond goes on special in the repo market for whatever reason. The bond would appreciate in price in the cash market as traders close out their short positions which are now too expensive to maintain. Moreover, traders and investors would try to buy the bond outright since it now would be relatively cheap to finance in the repo market.

PARTICIPANTS IN THE MARKET

The repo market has evolved into one of the largest sectors of the money market because it is used continuously by dealer firms (investment banks and money center banks acting as dealers) to finance positions and cover short positions. Exhibit 8.5 presents the average daily amount outstanding (in billions of dollars) for reverse repurchase/repurchase agreements by U.S. government securities dealers for the period 1981-2000.[11] Financial and nonfinancial firms participate actively in the market as both sellers and buyers of collateral depending on their circumstances. Depository institutions are usually net sellers of collateral (i.e., net borrowers of funds); money market mutual funds, bank trust departments, municipalities, and corporations are usually net buyers of collateral (i.e., net lenders of funds).

Another repo market participant is the repo broker. To understand the repo broker's role, suppose that a dealer has shorted $50 million of the current 10-year Treasury note. It will then query its regular customers to determine if it can borrow, via a reverse repo, the 10-year Treasury note it shorted. Suppose that it cannot find a customer willing to do a repo transaction (repo from the customer's perspective, reverse repo from the dealer's perspective). At that point, the dealer will utilize the services of a repo broker who will find the desired collateral and arrange the transaction for a fee.

REPO MARKET STRUCTURES

Structured repo instruments have developed in recent years mainly in the U.S. market where repo is widely accepted as a money market instrument. Following the introduction of new repo types it is also possible now to transact them in other liquid markets.

[11] The collateral underlying these agreements is either U.S. Treasuries, agency debentures, or agency MBS securities.

EXHIBIT 8.5 Average Daily Amount Outstanding (in billions of dollars) for Reverse Repurchase/Repurchase Agreements

Year	Reverse Repurchase	Repurchase	Total
1981	46.7	65.4	112.1
1982	75.1	95.2	170.3
1983	81.7	102.4	184.1
1984	112.4	132.6	245.0
1985	147.9	172.9	320.8
1986	207.7	244.5	452.2
1987	275.0	292.0	567.0
1988	313.6	309.7	623.3
1989	383.2	398.2	781.4
1990	377.1	413.5	790.5
1991	417.0	496.6	913.6
1992	511.1	628.2	1139.3
1993	594.1	765.6	1359.7
1994	651.2	825.9	1477.1
1995	618.8	821.5	1440.3
1996	718.1	973.7	1691.8
1997	883.0	1159.0	2042.0
1998	1111.4	1414.0	2525.5
1999	1070.1	1361.0	2431.1
2000	1093.3	1439.6	2532.9

Source: Federal Reserve Bank of New York

Cross-Currency Repo

A cross-currency repo is an agreement in which the cash lent and securities used as collateral are denominated in different currencies say, borrow U.S. dollars with UK gilts used as collateral. Of course, fluctuating foreign exchange rates mean that it is likely that the transaction will need to be marked-to-market frequently in order to ensure that cash or securities remain fully collateralized.

Callable Repo

In a callable repo arrangement, the lender of cash in a term fixed-rate repo has the option to terminate the repo early. In other words, the repo transaction has an embedded interest rate option which benefits the lender of cash if rates rise during the repo's term. If rates rise, the lender may exercise the option to call back the cash and reinvest at a higher rate. For this reason, a callable repo will trade at a lower repo rate than an otherwise similar conventional repo.

Whole Loan Repo

A whole loan repo structure developed in the U.S. market as a response to investor demand for higher yields in a falling interest rate environment. Whole loan repo trades at a higher rate than conventional repo because a lower quality collateral is used in the transaction. There are generally two types: mortgage whole loans and consumer whole loans. Both are unsecuritized loans or interest receivables. The loans can also be credit card payments and other types of consumer loans. Lenders in a whole loan repo are not only exposed to credit risk but prepayment risk as well. This is the risk that the loan package is paid off prior to the maturity date which is often the case with consumer loans. For these reasons, the yield on a whole loan repo is higher than conventional repo collateralized by say U.S. Treasuries, trading at around 20-30 basis points over LIBOR.

Total Return Swap

A total return swap structure, also known as a "total rate of return swap," is economically identical to a repo. Swaps are discussed in Chapter 12. The main difference between a total return swap and a repo is that the former is governed by the International Swap Dealers Association (ISDA) agreement as opposed to a repo agreement. This difference is largely due to the way the transaction is reflected on the balance sheet in that a total return swap is recorded as an off-balance sheet transaction. This is one of the main motivations for entering into this type of contract. The transaction works as follows:

1. the institution sells the security at the market price
2. the institution executes a swap transaction for a fixed term, exchanging the security's total return for an agreed rate on the relevant cash amount
3. on the swap's maturity date the institution repurchases the security for the market price

In theory, each leg of the transaction can be executed separately with different counterparties; in practice, the trade is bundled together and so is economically identical to a repo.

THE UNITED KINGDOM GILT REPO MARKET

Trading in UK gilt repo market began on January 2, 1996. Prior to this, securities lending in the gilt market was available only to gilt-edged Market Makers (GEMMs), dealing through approved intermediaries, the Stock Exchange Money Brokers (SEMBs).[12] The introduction of Gilt Repo allowed all market participants to borrow and lend gilts. The market reforms also liberalized gilt securities lending by removing the restrictions on who could borrow and lend securities, thus ensuring a "level playing field" between the two types of transaction.

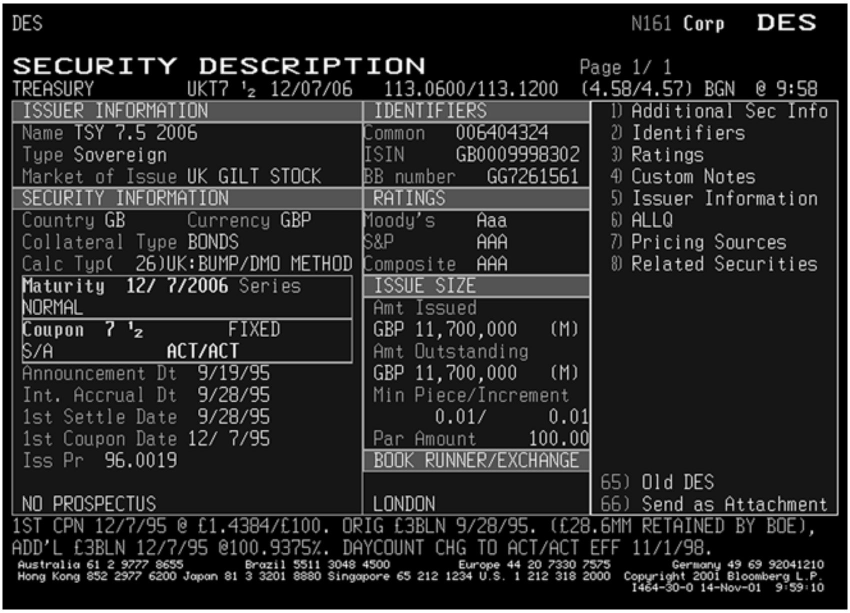
The market grew to about £50 billion of repos and securities lending outstanding in the first two months, further growth took it to nearly £95 billion by February 1997, of which £70 billion was in repos. This figure fell to about £75 billion by November 1998, compared with £100 billion for sterling certificates of deposit (CDs). Data collected on turnover in the market suggest that average daily turnover in gilt repo was around £16 billion through 1999.

Gilt repo has developed alongside growth in the existing unsecured money markets. There has been a visible shift in short-term money market trading patterns from unsecured to secured money. According to the Bank of England, market participants estimate that gilt repo now accounts for about half of all overnight transactions in the sterling money markets. The repo general collateral (GC) rate tends to trade below the interbank rate, on average about 10–15 basis points below, reflecting its status as government credit. The gap is less obvious at very short maturities, due to the lower value of such credit over the short term and also reflecting the higher demand for short-term funding through repo by securities houses that may not have access to unsecured money.

The sterling CD market has grown substantially, partly because the growth of the gilt repo and securities lending market has contributed to demand for CDs for use as collateral. One effect of gilt repo on the money market is a possible association with a reduction in the volatility of overnight unsecured rates. Fluctuations in the overnight unsecured market have been reduced since the start of an open repo market, although the evidence is not conclusive. This may be due to repo providing an alternative funding method for market participants, which may have reduced pressure on the unsecured market in overnight funds. It may also have enhanced the ability of financial intermediaries to distribute liquidity.

[12] Securities lending is defined as a temporary transfer of securities in exchange for collateral. It is not a repo in the sense there is no sale or repurchase of securities. The use of the desired asset is reflected in a fixed fee payable by the party temporarily taking the desired asset.

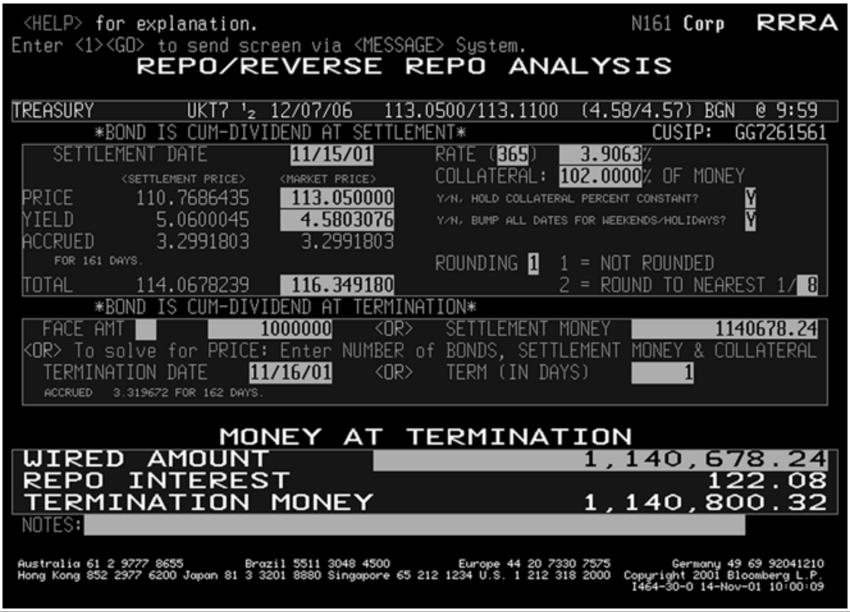
EXHIBIT 8.6 Bloomberg Security Description Screen of a UK Gilt



Source: Bloomberg Financial Markets

To illustrate a gilt repurchase agreement, let us consider a UK gilt dealer who purchases a 7.5% coupon gilt stock (in the UK bonds are referred to as stocks) and needs financing overnight. Exhibit 8.6 presents a Bloomberg Security Description screen for this security. As before, we will use Bloomberg's RRRA screen to illustrate the transaction in Exhibit 8.7. Suppose the face amount of the position is $1 million and the note's full price (i.e., flat price plus accrued interest) is £1,163,491.80. Suppose the haircut is 2%. Accordingly, the collateral is 102% of the amount being lent. This percentage appears in the box labeled "COLLATERAL" in the upper right-hand corner of the screen. Accordingly, to determine the amount being lent, we divide the note's full price of £1,163,491.80 by 1.02 to obtain £1,140,678.04 which is labeled "SETTLEMENT MONEY" located on the right-hand side of the screen. Suppose the repo rate in this transaction is 3.9063%. Then, the dealer would agree to deliver the gilt stocks for £1,140,678.24 and repurchase the same securities for £1,140,800.32 the next day. The £122.08 difference between the "WIRED AMOUNT" of £1,140,678.24 and the "TERMINATION MONEY" of £1,140,800.32 is the sterling interest on the financing. Using a repo rate of 3.9063% and a repo term of 1 day, the sterling interest is calculated as shown below:

EXHIBIT 8.7 Bloomberg Repo/Reverse Repo Analysis Screen of a UK Gilt Repo



Source: Bloomberg Financial Markets

$$£122.08 = £1,140,678.24 \times 0.039063 \times (1/365)$$

This calculation agrees with repo interest as calculated in the upper right-hand corner of Exhibit 8.7. Note that the day count convention in the UK money markets is Actual/365.

Market Structure

The UK market structure comprises both gilt repo and gilt securities lending. Some institutions will trade in one activity although of course many firms will engage in both. Although there are institutions which undertake only one type of activity, there are many institutions trading actively in both areas. For example, an institution that is short a particular gilt may cover its short position (which could result from an either an outright sale or a repo) in either the gilt repo or the securities lending market. Certain institutions prefer to use repo because they feel that the value of a special bond is more rapidly and more accurately reflected in the repo than the stock lending market.

Some firms have preferred to remain in securities lending because their existing systems and control procedures can accommodate stock lending more readily than repo. For example, a firm may have no cash reinvestment facility or experience of managing interest rate risk. Such a firm will prefer to receive collateral against a bond loan for a fee, rather than interest bearing cash in a repo. They may also feel that their business does not need or cannot justify the costs of setting up a repo trading facility.

In addition, securities lending has benefited from securities houses and banks who trade in both it and repo; for example, borrowing a bond in the lending market, repoing this and then investing the cash in say, the CD market. Other firms have embraced repo due, for instance to the perception that value from a bond on special is more readily obtained in the repo market than in the lending market.

Market Participants

Virtually from the start of the market, some firms have provided what is in effect a market making function in gilt repo. Typical of these are the former SEMBs and banks that run large matched books. According to the Bank of England, during 1999 there were approximately 20 firms, mostly banks and securities houses, which quoted two-way repo rates on request, for GC (general collateral), specifics and specials, up to three months. Longer maturities are also readily quoted. Examples of market making firms include former SEMBs such as Lazards, Cater Allen (part of the Abbey National group), and Rowe & Pitman (part of the UBS group), and banks such as RBS Financial Markets, HSBC, Deutsche Bank, and Barclays Capital. Some firms will quote only to their own clients. Many of the market making firms quote indicative repo rates on screen services such as Reuters and Bloomberg. Exhibit 8.8 presents a Bloomberg screen of repo rates in UK markets on November 13, 2001 for various maturities out to one year.

A number of sterling broking houses are active in gilt repo. Counterparties still require signed legal documentation to be in place with each other, along with credit lines, before trading can take place, which is not the case in the interbank broking market. A gilt repo agreement is not required with the broker, although firms will certainly have counterparty agreements in place with them. Typical of the firms providing broking services are Garban ICAP, Tullet & Tokyo, and King & Shaxson Bond Brokers Limited, part of Old Mutual plc. Brokers tend to specialize in different aspects of the gilt market. For example, some concentrate on GC repo, and others on specials and specifics; some on very short maturity transactions, and others on longer term trades. Brokerage is usually 1 basis point of the total nominal amount of the bond transferred for GC, and 2 basis points for specific and special repo. Brokerage is paid by both sides to a gilt repo.

EXHIBIT 8.8 Bloomberg Screen of UK Repo Rates

Source: Bloomberg Financial Markets

The range of participants has grown as the market has expanded. The overall client base now includes banks, building societies, overseas banks and securities houses, hedge funds, fund managers (such as Standard Life, Scottish Amicable, and others), insurance companies, and overseas central banks. Certain corporates have also begun to undertake gilt repo transactions. The slow start in the use of tri-party repo in the UK market has probably constrained certain corporates and smaller financial institutions from entering the market. Tri-party repo would be attractive to such institutions because of the lower administrative burden of having an external custodian. The largest users of gilt repo will remain banks and building societies, who are required to hold gilts as part of their Bank of England liquidity requirements.

Bank of England Open Market Operations

The Bank of England introduced gilt repo into its open market operations in April 1997. The Bank aims to meet the banking system's liquidity needs each day via its open market operations. Almost invariably the market's position is one of a shortage of liquidity, which the Bank generally relieves via open market operations conducted at a fixed official interest rate. The Bank's repo operation in this case is actually a reverse repo. The Bank will reverse in gilts and eligible Bills. The reason central banks choose repo as the money market instrument to relieve shortages is because it provides a combination of security (government debt as collateral) and liquidity to trade in large size.

APPENDIX: SELECTED PARAGRAPHS FROM THE BOND MARKET ASSOCIATION MASTER REPURCHASE AGREEMENT

1. Applicability

From time to time the parties hereto may enter into transactions in which one party ("Seller") agrees to transfer to the other ("Buyer") securities or other assets ("Securities") against the transfer of funds by Buyer, with a simultaneous agreement by Buyer to transfer to Seller such Securities at a date certain or on demand, against the transfer of funds by Seller. Each such transaction shall be referred to herein as a "Transaction" and, unless otherwise agreed in writing, shall be governed by this Agreement, including any supplemental terms or conditions contained in Annex I hereto and in any other annexes identified herein or therein as applicable hereunder.

2. Definitions

(a) "Act of Insolvency", with respect to any party, (i) the commencement by such party as debtor of any case or proceeding under any bankruptcy, insolvency, reorganization, liquidation, moratorium, dissolution, delinquency or similar law, or such party seeking the appointment or election of a receiver, conservator, trustee, custodian or similar official for such party or any substantial part of its property, or the convening of any meeting of creditors for purposes of commencing any such case or proceeding or seeking such an appointment or election, (ii) the commencement of any such case or proceeding against such party, or another seeking such an appointment or election, or the filing against a party of an application for a protective decree under the provisions of the Securities Investor Protection Act of 1970, which (A) is consented to or not timely contested by such party, (B) results in the entry of an order for relief, such an appointment or election, the issuance of such a protective decree or the entry of an order having a similar effect, or (C) is not dismissed within 15 days, (iii) the making by such party of a general assignment for the benefit of creditors, or (iv) the admission in writing by such party of such party's inability to pay such party's debts as they become due;

(b) "Additional Purchased Securities", Securities provided by Seller to Buyer pursuant to Paragraph 4(a) hereof;

(c) "Buyer's Margin Amount", with respect to any Transaction as of any date, the amount obtained by application of the Buyer's Margin Percentage to the Repurchase Price for such Transaction as of such date;

(d) "Buyer's Margin Percentage", with respect to any Transaction as of any date, a percentage (which may be equal to the Seller's Margin Percentage) agreed to by Buyer and Seller or, in the absence of any such agreement, the percentage obtained by dividing the Market Value of the Purchased Securities on the Purchase Date by the Purchase Price on the Purchase Date for such Transaction;

(e) "Confirmation", the meaning specified in Paragraph 3(b) hereof;

(f) "Income", with respect to any Security at any time, any principal thereof and all interest, dividends or other distributions thereon;

(g) "Margin Deficit", the meaning specified in Paragraph 4(a) hereof;

(h) "Margin Excess", the meaning specified in Paragraph 4(b) hereof;

(i) "Margin Notice Deadline", the time agreed to by the parties in the relevant Confirmation, Annex I hereto or otherwise as the deadline for giving notice requiring same-day satisfaction of margin maintenance obligations as provided in Paragraph 4 hereof (or, in the absence of any such agreement, the deadline for such purposes established in accordance with market practice);

(j) "Market Value", with respect to any Securities as of any date, the price for such Securities on such date obtained from a generally recognized source agreed to by the parties or the most recent closing bid quotation from such a source, plus accrued Income to the extent not included therein (other than any Income credited or transferred to, or applied to the obligations of, Seller pursuant to Paragraph 5 hereof) as of such date (unless contrary to market practice for such Securities);

(k) "Price Differential", with respect to any Transaction as of any date, the aggregate amount obtained by daily application of the Pricing Rate for such Transaction to the Purchase Price for such Transaction on a 360 day per year basis for the actual number of days during the period commencing on (and including) the Purchase Date for such Transaction and ending on (but excluding) the date of determination (reduced by any amount of such Price Differential previously paid by Seller to Buyer with respect to such Transaction);

(l) "Pricing Rate", the per annum percentage rate for determination of the Price Differential;

(m) "Prime Rate", the prime rate of U.S. commercial banks as published in The Wall Street Journal (or, if more than one such rate is published, the average of such rates);

(n) "Purchase Date", the date on which Purchased Securities are to be transferred by Seller to Buyer;

(o) "Purchase Price", (i) on the Purchase Date, the price at which Purchased Securities are transferred by Seller to Buyer, and (ii) thereafter, except where Buyer and Seller agree otherwise, such price increased by the amount of any cash transferred by Buyer to Seller pursuant to Paragraph 4(b) hereof and decreased by the amount of any cash transferred by Seller to Buyer pursuant to Paragraph 4(a) hereof or applied to reduce Seller's obligations under clause (ii) of Paragraph 5 hereof;

(p) "Purchased Securities", the Securities transferred by Seller to Buyer in a Transaction hereunder, and any Securities substituted therefor in accordance with Paragraph 9 hereof. The term "Purchased Securities" with respect to any Transaction at any time also shall include Additional Purchased Securities delivered pursuant to Paragraph 4(a) hereof and shall exclude Securities returned pursuant to Paragraph 4(b) hereof;

(q) "Repurchase Date", the date on which Seller is to repurchase the Purchased Securities from Buyer, including any date determined by application of the provisions of Paragraph 3(c) or 11 hereof;

(r) "Repurchase Price", the price at which Purchased Securities are to be transferred from Buyer to Seller upon termination of a Transaction, which will be determined in each case (including Transactions terminable upon demand) as the sum of the Purchase Price and the Price Differential as of the date of such determination;

(s) "Seller's Margin Amount", with respect to any Transaction as of any date, the amount obtained by application of the Seller's Margin Percentage to the Repurchase Price for such Transaction as of such date;

(t) "Seller's Margin Percentage", with respect to any Transaction as of any date, a percentage (which may be equal to the Buyer's Margin Percentage) agreed to by Buyer and Seller or, in the absence of any such agreement, the percentage obtained by dividing the Market Value of the Purchased Securities on the Purchase Date by the Purchase Price on the Purchase Date for such Transaction.

4. Margin Maintenance

(a) If at any time the aggregate Market Value of all Purchased Securities subject to all Transactions in which a particular party hereto is acting as Buyer is less than the aggregate Buyer's Margin Amount for all such Transactions (a "Margin Deficit"), then Buyer may by notice to Seller require Seller in such Transactions, at Seller's option, to transfer to Buyer cash or additional Securities reasonably acceptable to Buyer ("Additional Purchased Securities"), so that the cash and aggregate Market Value of the Purchased Securities, including any such Additional Purchased Securities, will thereupon equal or exceed such aggregate Buyer's Margin Amount (decreased by the amount of any Margin Deficit as of such date arising from any Transactions in which such Buyer is acting as Seller).

(b) If at any time the aggregate Market Value of all Purchased Securities subject to all Transactions in which a particular party hereto is acting as Seller exceeds the aggregate Seller's Margin Amount for all such Transactions at such time (a "Margin Excess"), then Seller may by notice to Buyer require Buyer in such Transactions, at Buyer's option, to transfer cash or Purchased Securities to Seller, so that the aggregate Market Value of the Purchased Securities, after deduction of any such cash or any Purchased Securities so transferred, will thereupon not exceed such aggregate Seller's Margin Amount (increased by the amount of any Margin Excess as of such date arising from any Transactions in which such Seller is acting as Buyer).

(c) If any notice is given by Buyer or Seller under subparagraph (a) or (b) of this Paragraph at or before the Margin Notice Deadline on any business day, the party receiving such notice shall transfer cash or Additional Purchased Securities as provided in such subparagraph no later than the close of business in the relevant market on such day. If any such notice is given after the Margin Notice Deadline, the party receiving such notice shall transfer such cash or Securities no later than the close of business in the relevant market on the next business day following such notice.

(d) Any cash transferred pursuant to this Paragraph shall be attributed to such Transactions as shall be agreed upon by Buyer and Seller.

(e) Seller and Buyer may agree, with respect to any or all Transactions hereunder, that the respective rights of Buyer or Seller (or both) under subparagraphs (a) and (b) of this Paragraph may be exercised only where a Margin Deficit or Margin Excess, as the case may be, exceeds a specified dollar amount or a specified percentage of the Repurchase Prices for such Transactions (which amount or percentage shall be agreed to by Buyer and Seller prior to entering into any such Transactions).

(f) Seller and Buyer may agree, with respect to any or all Transactions hereunder, that the respective rights of Buyer and Seller under subparagraphs (a) and (b) of this Paragraph to require the elimination of a Margin Deficit or a Margin Excess, as the case may be, may be exercised whenever such a Margin Deficit or Margin Excess exists with respect to any single Transaction hereunder (calculated without regard to any other Transaction outstanding under this Agreement).

8. Segregation of Purchased Securities

To the extent required by applicable law, all Purchased Securities in the possession of Seller shall be segregated from other securities in its possession and shall be identified as subject to this Agreement. Segregation may be accomplished by appropriate identification on the books and records of the holder, including a financial or securities intermediary or a clearing corporation. All of Seller's interest in the Purchased Securities shall pass to Buyer on the Purchase Date and, unless otherwise agreed by Buyer and Seller, nothing in this Agreement shall preclude Buyer from engaging in repurchase transactions with the Purchased Securities or otherwise selling, transferring, pledging or hypothecating the Purchased Securities, but no such transaction shall relieve Buyer of its obligations to transfer Purchased Securities to Seller pursuant to Paragraph 3, 4 or 11 hereof, or of Buyer's obligation to credit or pay Income to, or apply Income to the obligations of, Seller pursuant to Paragraph 5 hereof.

Required Disclosure for Transactions in Which the Seller Retains Custody of the Purchased Securities

Seller is not permitted to substitute other securities for those subject to this Agreement and therefore must keep Buyer's securities segregated at all times, unless in this Agreement Buyer grants Seller the right to substitute other securities. If Buyer grants the right to substitute, this means that Buyer's securities will likely be commingled with Seller's own securities during the trading day. Buyer is advised that, during any trading day that Buyer's securities are commingled with Seller's securities, they [will]* [may]** be subject to liens granted by Seller to [its clearing bank]* [third parties]** and may be used by Seller for deliveries on other securities transactions. Whenever the securities are commingled, Seller's ability to resegregate substitute securities for Buyer will be subject to Seller's ability to satisfy [the clearing]* [any]** lien or to obtain substitute securities.

* Language to be used under 17 C.F.R. ß403.4(e) if Seller is a government securities broker or dealer other than a financial institution.
** Language to be used under 17 C.F.R. ß403.5(d) if Seller is a financial institution.

11. Events of Default

In the event that (i) Seller fails to transfer or Buyer fails to purchase Purchased Securities upon the applicable Purchase Date, (ii) Seller fails to repurchase or Buyer fails to transfer Purchased Securities upon the applicable Repurchase Date, (iii) Seller or Buyer fails to comply with Paragraph 4 hereof, (iv) Buyer fails, after one business day's notice, to comply with Paragraph 5 hereof, (v) an Act of Insolvency occurs with respect to Seller or Buyer, (vi) any representation made by Seller or Buyer shall have been incorrect or untrue in any material respect when made or repeated or deemed to have been made or repeated, or (vii) Seller or Buyer shall admit to the other its inability to, or its intention not to, perform any of its obligations hereunder (each an "Event of Default"):

(a) The nondefaulting party may, at its option (which option shall be deemed to have been exercised immediately upon the occurrence of an Act of Insolvency), declare an Event of Default to have occurred hereunder and, upon the exercise or deemed exercise of such option, the Repurchase Date for each Transaction hereunder shall, if it has not already occurred, be deemed immediately to occur (except that, in the event that the Purchase Date for any Transaction has not yet occurred as of the date of such exercise or deemed exercise, such Transaction shall be deemed immediately canceled). The nondefaulting party shall (except upon the occurrence of an Act of Insolvency) give notice to the defaulting party of the exercise of such option as promptly as practicable.

(b) In all Transactions in which the defaulting party is acting as Seller, if the nondefaulting party exercises or is deemed to have exercised the option referred to in subparagraph (a) of this Paragraph, (i) the defaulting party's obligations in such Transactions to repurchase all Purchased Securities, at the Repurchase Price therefor on the Repurchase Date determined in accordance with subparagraph (a) of this Paragraph, shall thereupon become immediately due and payable, (ii) all Income paid after such exercise or deemed exercise shall be retained by the nondefaulting party and applied to the aggregate unpaid Repurchase Prices and any other amounts owing by the defaulting party hereunder, and (iii) the defaulting party shall immediately deliver to the nondefaulting party any Purchased Securities subject to such Transactions then in the defaulting party's possession or control.

(c) In all Transactions in which the defaulting party is acting as Buyer, upon tender by the nondefaulting party of payment of the aggregate Repurchase Prices for all such Transactions, all right, title and interest in and entitlement to all Purchased Securities subject to such Transactions shall be deemed transferred to the nondefaulting party, and the defaulting party shall deliver all such Purchased Securities to the nondefaulting party.

(d) If the nondefaulting party exercises or is deemed to have exercised the option referred to in subparagraph (a) of this Paragraph, the nondefaulting party, without prior notice to the defaulting party, may:

(i) as to Transactions in which the defaulting party is acting as Seller, (A) immediately sell, in a recognized market (or otherwise in a commercially reasonable manner) at such price or prices as the nondefaulting party may reasonably deem satisfactory, any or all Purchased Securities subject to such Transactions and apply the proceeds thereof to the aggregate unpaid Repurchase Prices and any other amounts owing by the defaulting party hereunder or (B) in its sole discretion elect, in lieu of selling all or a portion of such Purchased Securities, to give the defaulting party credit for such Purchased Securities in an amount equal to the price therefor on such date, obtained from a generally recognized source or the most recent closing bid quotation from such a source, against the aggregate unpaid Repurchase Prices and any other amounts owing by the defaulting party hereunder; and

(ii) as to Transactions in which the defaulting party is acting as Buyer, (A) immediately purchase, in a recognized market (or otherwise in a commercially reasonable manner) at such price or prices as the nondefaulting party may reasonably deem satisfactory, securities ("Replacement Securities") of the same class and amount as any Purchased Securities that are not delivered by the defaulting party to the nondefaulting party as required hereunder or (B) in its sole discretion elect, in lieu of purchasing Replacement Securities, to be deemed to have purchased Replacement Securities at the price therefor on such date, obtained from a generally recognized source or the most recent closing offer quotation from such a source.

Unless otherwise provided in Annex I, the parties acknowledge and agree that (1) the Securities subject to any Transaction hereunder are instruments traded in a recognized market, (2) in the absence of a generally recognized source for prices or bid or offer quotations for any Security, the nondefaulting party may establish the source therefor in its sole discretion and (3) all prices, bids and offers shall be determined together with accrued Income (except to the extent contrary to market practice with respect to the relevant Securities).

(e) As to Transactions in which the defaulting party is acting as Buyer, the defaulting party shall be liable to the nondefaulting party for any excess of the price paid (or deemed paid) by the nondefaulting party for Replacement Securities over the Repurchase Price for the Purchased Securities replaced thereby and for any amounts payable by the defaulting party under Paragraph 5 hereof or otherwise hereunder.

(f) For purposes of this Paragraph 11, the Repurchase Price for each Transaction hereunder in respect of which the defaulting party is acting as Buyer shall not increase above the amount of such Repurchase Price for such Transaction determined as of the date of the exercise or deemed exercise by the nondefaulting party of the option referred to in subparagraph (a) of this Paragraph.

(g) The defaulting party shall be liable to the nondefaulting party for (i) the amount of all reasonable legal or other expenses incurred by the nondefaulting party in connection with or as a result of an Event of Default, (ii) damages in an amount equal to the cost (including all fees, expenses and commissions) of entering into replacement transactions and entering into or terminating hedge transactions in connection with or as a result of an Event of Default, and (iii) any other loss, damage, cost or expense directly arising or resulting from the occurrence of an Event of Default in respect of a Transaction.

(h) To the extent permitted by applicable law, the defaulting party shall be liable to the nondefaulting party for interest on any amounts owing by the defaulting party hereunder, from the date the defaulting party becomes liable for such amounts hereunder until such amounts are (i) paid in full by the defaulting party or (ii) satisfied in full by the exercise of the nondefaulting party's rights hereunder. Interest on any sum payable by the defaulting party to the nondefaulting party under this Paragraph 11(h) shall be at a rate equal to the greater of the Pricing Rate for the relevant Transaction or the Prime Rate.

(i) The nondefaulting party shall have, in addition to its rights hereunder, any rights otherwise available to it under any other agreement or applicable law.

19. Intent

(a) The parties recognize that each Transaction is a "repurchase agreement" as that term is defined in Section 101 of Title 11 of the United States Code, as amended (except insofar as the type of Securities subject to such Transaction or the term of such Transaction would render such definition inapplicable), and a "securities contract" as that term is defined in Section 741 of Title 11 of the United States Code, as amended (except insofar as the type of assets subject to such Transaction would render such definition inapplicable).

(b) It is understood that either party's right to liquidate Securities delivered to it in connection with Transactions hereunder or to exercise any other remedies pursuant to Paragraph 11 hereof is a contractual right to liquidate such Transaction as described in Sections 555 and 559 of Title 11 of the United States Code, as amended.

(c) The parties agree and acknowledge that if a party hereto is an "insured depository institution," as such term is defined in the Federal Deposit Insurance Act, as amended ("FDIA"), then each Transaction hereunder is a "qualified financial contract," as that term is defined in FDIA and any rules, orders or policy statements thereunder (except insofar as the type of assets subject to such Transaction would render such definition inapplicable).

(d) It is understood that this Agreement constitutes a "netting contract" as defined in and subject to Title IV of the Federal Deposit Insurance Corporation Improvement Act of 1991 ("FDICIA") and each payment entitlement and payment obligation under any Transaction hereunder shall constitute a "covered contractual payment entitlement" or "covered contractual payment obligation", respectively, as defined in and subject to FDI-CIA (except insofar as one or both of the parties is not a "financial institution" as that term is defined in FDICIA).

CHAPTER 9

Short-Term Mortgage-Backed Securities

An asset-backed security (ABS) is a security supported by a pool of loans or receivables. That is, the cash flow to pay the holders of the security comes from the cash flow of the underlying loans or receivables. A mortgage-backed security (MBS) refers to an ABS created by pooling mortgage loans on real estate property. While technically the MBS market is part of the ABS market, in the United States, the two markets are viewed as being separate. There are many short-term fixed-rate products and floating-rate products in this market that fall into the money market area. In this chapter we discuss mortgage-backed securities and in the next we focus on asset-backed securities.

MORTGAGE LOANS

While any type of mortgage loans—residential or commercial—can be used as collateral for an MBS, most are backed by residential mortgages. We begin our coverage of MBS products with a description of the raw product—the mortgage loan.

Mortgage Designs

There are many types of mortgage designs. By a mortgage design we mean the specification of the interest rate (fixed or floating), the term of the mortgage, and the manner in which the principal is repaid. We summarize the major mortgage designs below.

Fixed-Rate, Level-Payment, Fully Amortized Mortgage

The basic idea behind the design of the fixed-rate, level payment, fully amortized mortgage is that the borrower pays interest and repays principal in equal installments over an agreed-upon period of time, called the maturity or term of the mortgage. The frequency of payment is typically monthly. Each monthly mortgage payment for this mortgage design is due on the first of each month and consists of:

1. interest of $\frac{1}{12}$th of the annual interest rate times the amount of the outstanding mortgage balance at the beginning of the previous month, and
2. a repayment of a portion of the outstanding mortgage balance (principal).

The difference between the monthly mortgage payment and the portion of the payment that represents interest equals the amount that is applied to reduce the outstanding mortgage balance. The portion of the monthly mortgage payment applied to interest declines each month and the portion applied to reducing the mortgage balance increases each month. The reason for this is that as the mortgage balance is reduced with each monthly mortgage payment, the interest on the mortgage balance declines. Since the monthly mortgage payment is fixed, an increasingly larger portion of the monthly payment is applied to reduce the outstanding principal in each subsequent month. The monthly mortgage payment is designed so that after the last scheduled monthly payment of the loan is made, the amount of the outstanding mortgage balance is zero (i.e., the mortgage is fully repaid or amortized).

The cash flow from this mortgage loan, as well as all mortgage designs, is not simply the interest payment and the scheduled principal repayments. There are two additional factors—servicing fees and prepayments.

Every mortgage loan must be serviced. The servicing fee is a portion of the mortgage rate. If the mortgage rate is 8.125% and the servicing fee is 50 basis points, then the investor receives interest of 7.625%. The interest rate that the investor receives is said to be the net interest or net coupon. The servicing fee is commonly called the *servicing spread*. The dollar amount of the servicing fee declines over time as the mortgage amortizes. This is true for not only the mortgage design that we have just described, but for all mortgage designs.

The second modification to the cash flow is that the borrower typically has the right to pay off any portion of the mortgage balance prior to the scheduled due date typically without a penalty. Payments made in excess of the scheduled principal repayments are called *prepayments*. When less than the entire amount of the outstanding mortgage balance is prepaid in a month, this type of prepayment is called a *curtailment* because it shortens or curtails the life of the loan. The effect of prepayments is that the amount and timing of the cash flows from a mortgage loan are not known with certainty. This risk is referred to as *prepayment risk*. This is true for all mortgage loans, not just fixed-rate, level-payment, fully amortized mortgages.

Balloon Mortgages

In a balloon mortgage, the borrower is given long-term financing by the lender but at specified future dates the mortgage rate is renegotiated. Thus, the lender is providing long-term funds for what is effectively a short-term borrowing, how short depending on the frequency of the renegotiation period. Effectively it is a short-term balloon loan in which the lender agrees to provide financing for the remainder of the term of the mortgage if certain conditions are met. The balloon payment is the original amount borrowed less the amount amortized. Thus, in a balloon mortgage, the actual maturity is shorter than the stated maturity.

Adjustable-Rate Mortgages

As the name implies, an adjustable-rate mortgage (ARM) has an adjustable or floating coupon instead of a fixed one. The coupon adjusts periodically—monthly, semiannually, or annually. Some ARMs even have coupons that adjust every three years or five years. The coupon formula for an ARM is specified in terms of a reference rate plus a quoted margin.

At origination, the mortgage usually has an initial rate for an initial period (teaser period) which is slightly below the rate specified by the coupon formula. This is called a "teaser rate" and makes it easier for first time home buyers to qualify for the loan. At the end of the teaser period, the loan rate is reset based on the coupon formula. Once the loan comes out of its teaser period and resets based on the coupon formula, it is said to be fully indexed.

To protect the homeowner from interest rate shock, there are caps imposed on the coupon adjustment level. There are periodic caps and lifetime caps. The *periodic cap* limits the amount of coupon reset upward from one reset date to another. The *lifetime cap* is the maximum absolute level for the coupon rate that the loan can reset to for the life of the mortgage.

Two categories of reference rates have been used in ARMs: (1) market determined rates and (2) calculated cost of funds for thrifts. The most common market determined rates used are the 1-year, 3-year or 5-year CMT and 3-month or 6-month London interbank offered rate (LIBOR). The most popular cost of funds for thrift index used is the Eleventh Federal Home Loan Bank Board District Cost of Funds Index (COFI).

MORTGAGE PASSTHROUGH SECURITIES

A mortgage passthrough is an MBS where the cash flows from the underlying pool of mortgage loans is distributed to the security holders on a pro rata basis. That is, if there are X certificates issued against a pool of mortgage loans, then a certificate holder is entitled to $1/X$ of the cash flow from the pool of mortgage loans. The cash flow for the certificate holder depends on the cash flow of the underlying mortgages: monthly mortgage payments representing interest, the scheduled repayment of principal, and any prepayments.

Payments are made to security holders each month. Neither the amount nor the timing, however, of the cash flows from the pool of mortgages are identical to that of the cash flows passed through to investors. The monthly cash flows for a passthrough are less than the monthly cash flows of the underlying mortgages by an amount equal to the servicing fee and other fees. The other fees are those charged by the issuer or guarantor of the passthrough for guaranteeing the issue. The coupon rate on a passthrough, called the "passthrough coupon rate," is less than the mortgage rate on the underlying pool of mortgage loans by an amount equal to the servicing fee and guarantee fee.

Not all of the mortgages that are included in a pool of mortgages that are securitized have the same mortgage rate and the same maturity. Consequently, when describing a passthrough security, a *weighted average coupon rate* and a *weighted average maturity* are determined. A weighted average coupon rate, or WAC, is found by weighting the mortgage rate of each mortgage loan in the pool by the amount of the mortgage balance outstanding. A weighted average maturity, or WAM, is found by weighting the remaining number of months to maturity for each mortgage loan in the pool by the amount of the mortgage balance outstanding.

Agency Mortgage Passthrough Securities

There are three government agencies that issue passthrough securities: Government National Mortgage Association, Federal National Mortgage Association, and Federal Home Loan Mortgage Corporation. The first is a federally related government agency. The last two are government sponsored enterprises. There are also MBS issued by nonagencies. We will postpone discussion of nonagency MBS until later in this chapter.

The Government National Mortgage Association (nicknamed "Ginnie Mae") passthroughs are guaranteed by the full faith and credit of the U.S. government. For this reason, Ginnie Mae passthroughs are viewed as risk-free in terms of default risk, just like Treasury securities. The security guaranteed by Ginnie Mae is called a *mortgage-backed* *security* (MBS). All Ginnie Mae MBS are guaranteed with respect to the timely payment of interest and principal, meaning the interest and principal will be paid when due, even if any of the borrowers fail to make their monthly mortgage payments.

Only mortgage loans insured or guaranteed by either the Federal Housing Administration, the Veterans Administration, or the Rural Housing Service can be included in a mortgage pool guaranteed by Ginnie Mae. The maximum loan size is set by Congress, based on the maximum amount that the FHA, VA, or RHS may guarantee. The maximum for a given loan varies with the region of the country and type of residential property.

The passthroughs issued by the Federal National Mortgage Association (nicknamed "Fannie Mae") are called *mortgage-backed securities* (MBSs). Although a guarantee of Fannie Mae is not a guarantee by the U.S. government, most market participants view Fannie Mae MBSs as similar, although not identical, in credit worthiness to Ginnie Mae passthroughs. All Fannie Mae MBSs carry its guarantee of timely payment of both interest and principal.

The Federal Home Loan Mortgage Corporation (nicknamed "Freddie Mac") is a government sponsored enterprise that issues a passthrough security that is called a *participation certificate* (PC). As with Fannie Mae MBS, a guarantee of Freddie Mac is not a guarantee by the U.S. government, but most market participants view Freddie Mac PCs as similar, although not identical, in credit worthiness to Ginnie Mae passthroughs. Freddie Mac has issued PCs with different types of guarantee. The old PCs issued by Freddie Mac guarantee the timely payment of interest; the scheduled principal is passed through as it is collected, with Freddie Mac only guaranteeing that the scheduled payment will be made no later than one year after it is due. Today, Freddie Mac issues PCs under its "Gold Program" in which both the timely payment of interest and principal are guaranteed.

Price Quotes and Trading Procedures

Passthroughs are quoted in the same manner as U.S. Treasury coupon securities. A quote of 94-05 means 94 and $\frac{5}{32}$nds of par value, or 94.15625% of par value. The price that the buyer pays the seller is the agreed upon sale price plus accrued interest. Given the par value, the dollar price (excluding accrued interest) is affected by the amount of the mortgage pool balance outstanding. The pool factor indicates the percentage of the initial mortgage balance still outstanding. So, a pool factor of 90 means that 90% of the original mortgage pool balance is outstanding. The pool factor is reported by the agency each month.

The dollar price paid for just the principal is found as follows given the agreed upon price, par value, and the month's pool factor provided by the agency:

$$\text{Price} = \text{Par value} \times \text{Pool factor}$$

For example, if the parties agree to a price of 92 for $1 million par value for a passthrough with a pool factor of 85, then the dollar price paid by the buyer in addition to accrued interest is:

$$0.92 \times \$1{,}000{,}000 \times 0.85 = \$782{,}000$$

Many trades occur while a pool is still unspecified, and therefore no pool information is known at the time of the trade. This kind of trade is known as a "TBA" (to be announced) trade. In a TBA trade for a fixed-rate passthrough, the two parties agree on the agency type, the agency program, the coupon rate, the face value, the price, and the settlement date. The actual pools underlying the agency passthrough are not specified in a TBA trade. However, this information is provided by the seller to the buyer before delivery. In contrast to a TBA trade, there are specified pool trades wherein the actual pool numbers to be delivered are specified.

Prepayment Conventions and Cash Flows

To value a security it is necessary to project its cash flows. The difficulty for an MBS is that the cash flows are unknown because of prepayments. The only way to project cash flows is to make some assumption about the prepayment rate over the life of the underlying mortgage pool. The prepayment rate is sometimes referred to as the *prepayment speed*, or simply *speed*. Two conventions have been used as a benchmark for prepayment rates—conditional prepayment rate and Public Securities Association prepayment benchmark.

Conditional Prepayment Rate

One convention for describing the pattern of prepayments and the cash flows of a passthrough assumes that some fraction of the remaining principal in the pool is prepaid each month for the remaining term of the mortgage. The prepayment rate assumed for a pool, called the *conditional prepayment rate* (CPR), is based on the characteristics of the pool (including its historical prepayment experience) and the current and expected future economic environment.

The CPR is an annual prepayment rate. To estimate monthly prepayments, the CPR must be converted into a monthly prepayment rate, commonly referred to as the *single-monthly mortality rate* (SMM). The following formula is used to determine the SMM for a given CPR:

$$SMM = 1 - (1 - CPR)^{1/12}$$

Suppose that the CPR used to estimate prepayments is 6%. The corresponding SMM is:

$$\begin{aligned} SMM &= 1 - (1 - 0.06)^{1/12} \\ &= 1 - (0.94)^{0.08333} = 0.005143 \end{aligned}$$

An SMM of w% means that approximately w% of the remaining mortgage balance at the beginning of the month, less the scheduled principal payment, will prepay that month. That is,

Prepayment for month t
= SMM × (Beginning mortgage balance for month t
 – Scheduled principal payment for month t)

For example, suppose that an investor owns a passthrough in which the remaining mortgage balance at the beginning of some month is $290 million. Assuming that the SMM is 0.5143% and the scheduled principal payment is $3 million, the estimated prepayment for the month is:

$$0.005143 \times (\$290{,}000{,}000 - \$3{,}000{,}000) = \$1{,}476{,}041$$

PSA Prepayment Benchmark

The Public Securities Association (PSA) prepayment benchmark is expressed as a monthly series of CPRs. The PSA benchmark assumes that prepayment rates are low for newly originated mortgages and then will speed up as the mortgages become seasoned.

The PSA prepayment benchmark assumes the following prepayment rates for 30-year mortgages: (1) a CPR of 0.2% for the first month, increased by 0.2% per year per month for the next 30 months when it reaches 6% per year, and

(2) a 6% CPR for the remaining years. This benchmark is referred to as "100% PSA" or simply "100 PSA." Slower or faster speeds are then referred to as some percentage of 100 PSA. For example, 50 PSA means one-half the CPR of the PSA benchmark prepayment rate; 150 PSA means 1.5 times the CPR of the PSA benchmark prepayment rate;

300 PSA means three times the CPR of the benchmark prepayment rate. A prepayment rate of 0 PSA means that no prepayments are assumed.

It is important to understand that the PSA benchmark is commonly referred to as a prepayment model, suggesting that it can be used to estimate prepayments. Characterization of this benchmark as a prepayment model is incorrect. It is simply a market convention describing what the PSA believes the pattern will be for prepayments.

It is worthwhile to see a monthly cash flow for a hypothetical passthrough given a PSA assumption since we can use the information in our discussion of collateralized mortgage obligations in the next section. Exhibit 9.1 shows the cash flow for selected months assuming 165 PSA for a passthrough security in which the underlying loans are assumed to be fixed-rate, level-payment, fully amortized mortgages with a WAC of 8.125%. It is assumed that the passthrough rate is 7.5% with a WAM of 357 months. The cash flow in Exhibit 9.1 is broken down into three components: (1) interest (based on the passthrough rate), (2) the regularly scheduled principal repayment, and (3) prepayments based on 165 PSA.

Since the WAM is 357 months, the underlying mortgage pool is seasoned an average of three months. Therefore, the CPR for month 27 is 1.65 times 6%.

Average Life Measure

Because an MBS is an amortizing security, market participants do not talk in terms of an issue's maturity. Instead, the average life of an MBS is computed. The average life is the average time to receipt of principal payments (scheduled principal payments and projected prepayments). Specifically, the average life is found by first calculating:

$$
\begin{array}{rl}
 & 1 \times (\text{Projected principal received in month 1}) \\
 & 2 \times (\text{Projected principal received in month 2}) \\
 & 3 \times (\text{Projected principal received in month 3}) \\
 & \ldots \\
+ & T \times (\text{Projected principal received in month } T) \\
\hline
 & \text{Weighted monthly average of principal received}
\end{array}
$$

where T is the last month that principal is expected to be received.

Then the average life is found as follows:

$$\text{Average life} = \frac{\text{Weighted monthly average of principal received}}{12(\text{Total principal to be received})}$$

EXHIBIT 9.1 Monthly Cash Flow for a $400 Million Passthrough with a 7.5% Passthrough Rate, a WAC of 8.125%, and a WAM of 357 Months Assuming 165 PSA

(1) Month	(2) Outstanding Balance	(3) SMM	(4) Mortgage Payment	(5) Net Interest	(6) Scheduled Principal	(7) Prepayment	(8) Total Principal	(9) Cash Flow
1	$400,000,000	0.00111	$2,975,868	$2,500,000	$267,535	$442,389	$709,923	$3,209,923
2	399,290,077	0.00139	2,972,575	2,495,563	269,048	552,847	821,896	3,317,459
3	398,468,181	0.00167	2,968,456	2,490,426	270,495	663,065	933,560	3,423,986
4	397,534,621	0.00195	2,963,513	2,484,591	271,873	772,949	1,044,822	3,529,413
5	396,489,799	0.00223	2,957,747	2,478,061	273,181	882,405	1,155,586	3,633,647
6	395,334,213	0.00251	2,951,160	2,470,839	274,418	991,341	1,265,759	3,736,598
7	394,068,454	0.00279	2,943,755	2,462,928	275,583	1,099,664	1,375,246	3,838,174
8	392,693,208	0.00308	2,935,534	2,454,333	276,674	1,207,280	1,483,954	3,938,287
9	391,209,254	0.00336	2,926,503	2,445,058	277,690	1,314,099	1,591,789	4,036,847
10	389,617,464	0.00365	2,916,666	2,435,109	278,631	1,420,029	1,698,659	4,133,769
11	387,918,805	0.00393	2,906,028	2,424,493	279,494	1,524,979	1,804,473	4,228,965
24	356,711,789	0.00775	2,698,575	2,229,449	283,338	2,761,139	3,044,477	5,273,926
25	353,667,312	0.00805	2,677,670	2,210,421	283,047	2,843,593	3,126,640	5,337,061
26	350,540,672	0.00835	2,656,123	2,190,879	282,671	2,923,885	3,206,556	5,397,435
27	347,334,116	0.00865	2,633,950	2,170,838	282,209	3,001,955	3,284,164	5,455,002
28	344,049,952	0.00865	2,611,167	2,150,312	281,662	2,973,553	3,255,215	5,405,527
29	340,794,737	0.00865	2,588,581	2,129,967	281,116	2,945,400	3,226,516	5,356,483
30	337,568,221	0.00865	2,566,190	2,109,801	280,572	2,917,496	3,198,067	5,307,869
100	170,142,350	0.00865	1,396,958	1,063,390	244,953	1,469,591	1,714,544	2,777,933
101	168,427,806	0.00865	1,384,875	1,052,674	244,478	1,454,765	1,699,243	2,751,916
102	166,728,563	0.00865	1,372,896	1,042,054	244,004	1,440,071	1,684,075	2,726,128
103	165,044,489	0.00865	1,361,020	1,031,528	243,531	1,425,508	1,669,039	2,700,567
200	56,746,664	0.00865	585,990	354,667	201,767	489,106	690,874	1,045,540
201	56,055,790	0.00865	580,921	350,349	201,377	483,134	684,510	1,034,859
202	55,371,280	0.00865	575,896	346,070	200,986	477,216	678,202	1,024,273
203	54,693,077	0.00865	570,915	341,832	200,597	471,353	671,950	1,013,782
300	11,758,141	0.00865	245,808	73,488	166,196	100,269	266,465	339,953
301	11,491,677	0.00865	243,682	71,823	165,874	97,967	263,841	335,664
302	11,227,836	0.00865	241,574	70,174	165,552	95,687	261,240	331,414
303	10,966,596	0.00865	239,485	68,541	165,232	93,430	258,662	327,203
353	760,027	0.00865	155,107	4,750	149,961	5,277	155,238	159,988
354	604,789	0.00865	153,765	3,780	149,670	3,937	153,607	157,387
355	451,182	0.00865	152,435	2,820	149,380	2,611	151,991	154,811
356	299,191	0.00865	151,117	1,870	149,091	1,298	150,389	152,259
357	148,802	0.00865	149,809	930	148,802	0	148,802	149,732

Note: Since the WAM is 357 months, the underlying mortgage pool is seasoned an average of three months. Therefore, the CPR for month 27 is $1.65 \times 6\%$.

The average life of a passthrough depends on the prepayment assumption. To see this, the average life is shown below for different PSA prepayment speeds for the passthrough we used to illustrate the cash flows for 165 PSA in Exhibit 9.1:

PSA speed	50	100	165	200	300	400	500	600	700
Average life	15.11	11.66	8.76	7.68	5.63	4.44	3.68	3.16	2.78

Closer Look at Prepayment Risk: Contraction Risk and Extension Risk

Just like the owner of any security that contains an embedded option, investors in passthrough securities do not know what their cash flows will be because of prepayments—the borrower's option to alter the mortgage's cash flows. As we noted earlier, this risk is called prepayment risk. To understand the significance of prepayment risk, suppose an investor buys an 8.5% coupon Ginnie Mae at a time when mortgage rates are 8.5%. Let's consider what will happen to prepayments if mortgage rates decline to, say, 6.5%. There will be two adverse consequences. First, a basic property of fixed-income securities is that the price of an option-free bond increases at an increasing rate as interest rates decline. However, for a passthrough security with an embedded prepayment option, the rise in price will not be as large as that of an option-free bond because a drop in interest rates will give the borrower an incentive to prepay the loan and refinance at a lower rate. In other words, the borrower is altering the mortgage's flows (i.e., exercising the prepayment option) when this action enhances his/her economic value. Thus, the upside price potential of a passthrough security is truncated because of prepayments in a manner similar to that of a callable bond. The second adverse consequence is that the cash flows must be reinvested at a lower rate. These two adverse consequences when mortgage rates decline are referred to as *contraction risk*. In essence, contraction risk is all the consequences resulting from borrowers prepaying at a faster rate than anticipated.

Now let's look at what happens if mortgage rates rise to 10.5%. The price of the passthrough, like the price of any bond, will decline. But again it will decline more because the higher rates will tend to slow down the rate of prepayment, in effect increasing the amount invested at the coupon rate, which is lower than the market rate. Prepayments will slow down because homeowners will not refinance or partially prepay their mortgages when mortgage rates are higher than the contract rate of 8.5%. Of course, this is just the time when investors want prepayments to speed up so that they can reinvest the prepayments at the higher market interest rate. This adverse consequence of rising mortgage rates is called *extension risk* and results from borrowers prepaying at a slower rate than anticipated.

Therefore, prepayment risk encompasses contraction risk and extension risk. Prepayment risk makes passthrough securities unattractive for certain individuals and financial institutions to hold for purposes of accomplishing their investment objectives. Some individuals and institutional investors such as cash managers and managers of short-duration portfolios are concerned with extension risk and others with contraction risk when they purchase a passthrough security. Is it possible to alter the cash flows of a mortgage passthrough security so as to reduce the contraction risk or extension risk for institutional investors? This can be done as we will see in the next section.

COLLATERALIZED MORTGAGE OBLIGATIONS

Now we will see how mortgage passthroughs securities backed by fixed-rate mortgage loans with a long WAM can be used to create a structure called a *collateralized mortgage obligation* (CMO). Two types of bond classes that can be created within the structure is a floating-rate bond class and a fixed-rate bond class with a short average life.

We will discuss CMOs issued by the three agencies that issue mortgage passthrough securities and CMOs issued by private entities. CMOs are also referred to as "paythroughs" or "multi-class passthroughs." Because they are created so as to comply with a provision in the tax law called the Real Estate Mortgage Investment Conduit, or REMIC, they are also referred to as "REMICs." Throughout this chapter we refer to these structures as simply CMOs. We will see similar paythrough or multi-class passthrough structures when we cover other asset-backed security structures in the next chapter.

Basic Principles of a CMO

By investing in a mortgage passthrough security an investor is exposed to prepayment risk. Furthermore, as explained earlier, prepayment risk can be divided into extension risk and contraction risk. Some investors are concerned with extension risk and others with contraction risk when they invest in a passthrough. An investor may be willing to accept one form of prepayment risk but seek to avoid the other. For example, a cash manager seeks a short-term security and is concerned with extension risk. A portfolio manager who seeks a long-term security, and wants to avoid reinvesting unexpected principal prepayments due to refinancing of mortgages should interest rates drop, is concerned with contraction risk.

By redirecting how the cash flows of passthrough securities are paid to different bond classes that are created, securities can be created that have different exposure to prepayment risk. When the cash flows of mortgage-related products are redistributed to different bond classes, the resulting securities are called CMOs. Simply put, CMOs set forth rules for dividing up cash flows among bond classes.

The basic principle is that redirecting cash flows (interest and principal) to different bond classes, called *tranches*, mitigates different forms of prepayment risk. It is never possible to eliminate prepayment risk. If one tranche in a CMO structure has less prepayment risk than the mortgage passthrough securities that are collateral for the structure, then another tranche in the same structure has greater prepayment risk than the collateral.

Agency Collateralized Mortgage Obligations

Issuers of CMOs are the same three entities that issue agency passthrough securities: Freddie Mac, Fannie Mae, and Ginnie Mae. However, Freddie Mac and Fannie Mae have used Ginnie Mae passthroughs as collateral for their own CMOs. CMOs issued by any of these entities are referred to as *agency CMOs*.

When an agency CMO is created it is structured so that even under the worst circumstances regarding prepayments, the interest and principal payments from the collateral will be sufficient to meet the interest obligation of each tranche and pay off the par value of each tranche. Defaults are ignored because the agency that has issued the passthroughs used as collateral is expected to make up any deficiency. Thus, the credit risk of agency CMOs is minimal. However, the guarantee of a government sponsored enterprise does not carry the full faith and credit of the U.S. government. Fannie Mae and Freddie Mac CMOs created from Ginnie Mae passthroughs effectively carry the full faith and credit of the U.S. government.

Types of Bond Classes

There have been a good number of products created in the CMO market that would be acceptable investments for short-term investors. But there are also a good number that short-term investors should avoid given the typical interest rate exposure a short-term investor seeks.

Sequential-Pay Tranches

The first CMO was structured so that each tranche would be retired sequentially. Such structures are referred to as *sequential-pay CMOs*. To illustrate a sequential-pay CMO, we will use a hypothetical deal that we will refer to as Deal 1. The collateral for Deal 1 is a hypothetical passthrough with a total par value of $400 million and the following characteristics: (1) the passthrough coupon rate is 7.5%, (2) the WAC is 8.125%, and (3) the WAM is 357 months. This is the same passthrough that we used in Exhibit 9.1 to describe the cash flows of a passthrough based on an assumed 165 PSA prepayment speed.

From this $400 million of collateral, four tranches are created. Their characteristics are summarized in Exhibit 9.2. The total par value of the four tranches is equal to the par value of the collateral (i.e., the passthrough security). In this simple structure, the coupon rate is the same for each tranche and also the same as the collateral's coupon rate. There is no reason why this must be so, and, in fact, typically the coupon rate varies by tranche. Specifically, if the yield curve is upward-sloping, the coupon rates of the tranches will usually increase with average life.

Now remember that a CMO is created by redistributing the cash flow—interest and principal—to the different tranches based on a set of payment rules. The payment rules at the bottom of Exhibit 9.2 set forth how the monthly cash flow from the passthrough (i.e., collateral) is to be distributed among the four tranches. There are separate rules for the payment of the coupon interest and the payment of principal, the principal being the total of the regularly scheduled principal payment and any prepayments.

EXHIBIT 9.2 **Deal 1: A Hypothetical Four-Tranche Sequential-Pay Structure**

Tranche	Par Amount	Coupon Rate (%)
A	$194,500,000	7.5
B	36,000,000	7.5
C	96,500,000	7.5
D	73,000,000	7.5
Total	$400,000,000	

Payment rules:
1. *For payment of periodic coupon interest:* Disburse periodic coupon interest to each tranche on the basis of the amount of principal outstanding at the beginning of the period.
2. *For disbursement of principal payments:* Disburse principal payments to tranche A until it is completely paid off. After tranche A is completely paid off, disburse principal payments to tranche B until it is completely paid off. After tranche B is completely paid off, disburse principal payments to tranche C until it is completely paid off. After tranche C is completely paid off, disburse principal payments to tranche D until it is completely paid off.

In Deal 1, each tranche receives periodic coupon interest payments based on the amount of the outstanding balance. The disbursement of the principal, however, is made in a special way. A tranche is not entitled to receive principal until the entire principal of the tranche before it has been paid off. More specifically, tranche A receives all the principal payments until the entire principal amount owed to that tranche, \$194,500,000, is paid off; then tranche B begins to receive principal and continues to do so until it is paid the entire \$36,000,000. Tranche C then receives principal, and when it is paid off, tranche D starts receiving principal payments.

While the payment rules for the disbursement of the principal payments are known, the precise amount of the principal in each period is not. This will depend on the cash flow, and therefore principal payments, of the collateral, which depends on the actual prepayment rate of the collateral. An assumed PSA speed allows the monthly cash flow to be projected. Exhibit 9.1 shows the monthly cash flow (interest, regularly scheduled principal repayment, and prepayments) assuming 165 PSA. Assuming that the collateral does prepay at 165 PSA, the cash flows available to all four tranches of Deal 1 will be precisely the cash flows shown in Exhibit 9.1.

To demonstrate how the payment rules for Deal 1 work, Exhibit 9.3 shows the cash flow for selected months assuming the collateral prepays at 165 PSA. For each tranche, the exhibit shows: (1) the balance at the end of the month, (2) the principal paid down (regularly scheduled principal repayment plus prepayments), and (3) interest. In month 1, the cash flow for the collateral consists of a principal payment of \$709,923 and interest of \$2.5 million (0.075 times \$400 million divided by 12). The interest payment is distributed to the four tranches based on the amount of the par value outstanding. So, for example, tranche A receives \$1,215,625 (0.075 times \$194,500,000 divided by 12) of the \$2.5 million. The principal, however, is all distributed to tranche A. Therefore, the cash flow for tranche A in month 1 is \$1,925,548. The principal balance at the end of month 1 for tranche A is \$193,790,076 (the original principal balance of \$194,500,000 less the principal payment of \$709,923). No principal payment is distributed to the three other tranches because there is still a principal balance outstanding for tranche A. This will be true for months 2 through 80.

After month 81, the principal balance will be zero for tranche A. For the collateral the cash flow in month 81 is \$3,318,521, consisting of a principal payment of \$2,032,196 and interest of \$1,286,325. At the beginning of month 81 (end of month 80), the principal balance for tranche A is \$311,926. Therefore, \$311,926 of the \$2,032,196 of the principal payment from the collateral will be disbursed to tranche A.

After this payment is made, no additional principal payments are made to this tranche as the principal balance is zero. The remaining principal payment from the collateral, $1,720,271, is disbursed to tranche B. According to the assumed prepayment speed of 165 PSA, tranche B then begins receiving principal payments in month 81.

EXHIBIT 9.3 Monthly Cash Flow for Selected Months for Deal 1 Assuming 165 PSA

	Tranche A			Tranche B		
Month	Balance	Principal	Interest	Balance	Principal	Interest
1	194,500,000	709,923	1,215,625	36,000,000	0	225,000
2	193,790,077	821,896	1,211,188	36,000,000	0	225,000
3	192,968,181	933,560	1,206,051	36,000,000	0	225,000
4	192,034,621	1,044,822	1,200,216	36,000,000	0	225,000
5	190,989,799	1,155,586	1,193,686	36,000,000	0	225,000
6	189,834,213	1,265,759	1,186,464	36,000,000	0	225,000
7	188,568,454	1,375,246	1,178,553	36,000,000	0	225,000
8	187,193,208	1,483,954	1,169,958	36,000,000	0	225,000
9	185,709,254	1,591,789	1,160,683	36,000,000	0	225,000
10	184,117,464	1,698,659	1,150,734	36,000,000	0	225,000
11	182,418,805	1,804,473	1,140,118	36,000,000	0	225,000
12	180,614,332	1,909,139	1,128,840	36,000,000	0	225,000
75	12,893,479	2,143,974	80,584	36,000,000	0	225,000
76	10,749,504	2,124,935	67,184	36,000,000	0	225,000
77	8,624,569	2,106,062	53,904	36,000,000	0	225,000
78	6,518,507	2,087,353	40,741	36,000,000	0	225,000
79	4,431,154	2,068,807	27,695	36,000,000	0	225,000
80	2,362,347	2,050,422	14,765	36,000,000	0	225,000
81	311,926	311,926	1,950	36,000,000	1,720,271	225,000
82	0	0	0	34,279,729	2,014,130	214,248
83	0	0	0	32,265,599	1,996,221	201,660
84	0	0	0	30,269,378	1,978,468	189,184
85	0	0	0	28,290,911	1,960,869	176,818
95	0	0	0	9,449,331	1,793,089	59,058
96	0	0	0	7,656,242	1,777,104	47,852
97	0	0	0	5,879,138	1,761,258	36,745
98	0	0	0	4,117,880	1,745,550	25,737
99	0	0	0	2,372,329	1,729,979	14,827
100	0	0	0	642,350	642,350	4,015
101	0	0	0	0	0	0
102	0	0	0	0	0	0
103	0	0	0	0	0	0
104	0	0	0	0	0	0
105	0	0	0	0	0	0

EXHIBIT 9.3 (Concluded)

	Tranche C			Tranche D		
Month	Balance	Principal	Interest	Balance	Principal	Interest
1	96,500,000	0	603,125	73,000,000	0	456,250
2	96,500,000	0	603,125	73,000,000	0	456,250
3	96,500,000	0	603,125	73,000,000	0	456,250
4	96,500,000	0	603,125	73,000,000	0	456,250
5	96,500,000	0	603,125	73,000,000	0	456,250
6	96,500,000	0	603,125	73,000,000	0	456,250
7	96,500,000	0	603,125	73,000,000	0	456,250
8	96,500,000	0	603,125	73,000,000	0	456,250
9	96,500,000	0	603,125	73,000,000	0	456,250
10	96,500,000	0	603,125	73,000,000	0	456,250
11	96,500,000	0	603,125	73,000,000	0	456,250
12	96,500,000	0	603,125	73,000,000	0	456,250
95	96,500,000	0	603,125	73,000,000	0	456,250
96	96,500,000	0	603,125	73,000,000	0	456,250
97	96,500,000	0	603,125	73,000,000	0	456,250
98	96,500,000	0	603,125	73,000,000	0	456,250
99	96,500,000	0	603,125	73,000,000	0	456,250
100	96,500,000	1,072,194	603,125	73,000,000	0	456,250
101	95,427,806	1,699,243	596,424	73,000,000	0	456,250
102	93,728,563	1,684,075	585,804	73,000,000	0	456,250
103	92,044,489	1,669,039	575,278	73,000,000	0	456,250
104	90,375,450	1,654,134	564,847	73,000,000	0	456,250
105	88,721,315	1,639,359	554,508	73,000,000	0	456,250
175	3,260,287	869,602	20,377	73,000,000	0	456,250
176	2,390,685	861,673	14,942	73,000,000	0	456,250
177	1,529,013	853,813	9,556	73,000,000	0	456,250
178	675,199	675,199	4,220	73,000,000	170,824	456,250
179	0	0	0	72,829,176	838,300	455,182
180	0	0	0	71,990,876	830,646	449,943
181	0	0	0	71,160,230	823,058	444,751
182	0	0	0	70,337,173	815,536	439,607
183	0	0	0	69,521,637	808,081	434,510
184	0	0	0	68,713,556	800,690	429,460
185	0	0	0	67,912,866	793,365	424,455
350	0	0	0	1,235,674	160,220	7,723
351	0	0	0	1,075,454	158,544	6,722
352	0	0	0	916,910	156,883	5,731
353	0	0	0	760,027	155,238	4,750
354	0	0	0	604,789	153,607	3,780
355	0	0	0	451,182	151,991	2,820
356	0	0	0	299,191	150,389	1,870
357	0	0	0	148,802	148,802	930

EXHIBIT 9.4 Average Life for the Collateral and the Four Tranches of Deal 1

Prepayment speed (PSA)	Average life for				
	Collateral	Tranche A	Tranche B	Tranche C	Tranche D
50	15.11	7.48	15.98	21.02	27.24
100	11.66	4.90	10.86	15.78	24.58
165	8.76	3.48	7.49	11.19	20.27
200	7.68	3.05	6.42	9.60	18.11
300	5.63	2.32	4.64	6.81	13.36
400	4.44	1.94	3.70	5.31	10.34
500	3.68	1.69	3.12	4.38	8.35
600	3.16	1.51	2.74	3.75	6.96
700	2.78	1.38	2.47	3.30	5.95

Exhibit 9.3 shows that tranche B is fully paid off by month 100, when tranche C begins to receive principal payments. Tranche C is not fully paid off until month 178, at which time tranche D begins receiving the remaining principal payments. The maturity (i.e., the time until the principal is fully paid off) for these four tranches assuming 165 PSA is 81 months for tranche A, 100 months for tranche B, 178 months for tranche C, and 357 months for tranche D.

The *principal pay down window* for a tranche is the time period between the beginning and the ending of the principal payments to that tranche. So, for example, for tranche A, the principal pay down window would be month 1 to month 81 assuming 165 PSA. For tranche B it is from month 81 to month 100. In confirmation of trades involving CMOs, the principal pay down window is specified in terms of the initial month that principal is expected to be received based on an assumed PSA speed to the final month that principal is expected to be received.

Let's look at what has been accomplished by creating the CMO. First, earlier we saw that the average life of the passthrough is 8.76 years, assuming a prepayment speed of 165 PSA. Exhibit 9.4 reports the average life of the collateral and the four tranches assuming different prepayment speeds. Notice that the four tranches have average lives that are both shorter and longer than the collateral, thereby attracting investors who have a preference for an average life different from that of the collateral.

There is still a major problem: there is considerable variability of the average life for the tranches. We'll see how this can be tackled later on. However, there is some protection provided for each tranche against prepayment risk. This is because prioritizing the distribution of principal (i.e., establishing the payment rules for principal) effectively protects the shorter-term tranche A in this structure against extension risk. This protection must come from somewhere—it comes from the three other tranches. Similarly, tranches C and D provide protection against extension risk for tranche B. At the same time, tranches C and D benefit because they are provided protection against contraction risk, the protection coming from tranches A and B.

Accrual Tranches

In Deal 1, the payment rules for interest provide for all tranches to be paid interest each month. In many sequential-pay CMO structures, at least one tranche does not receive current interest. Instead, the interest for that tranche would accrue and be added to the principal balance. Such a bond class is commonly referred to as an *accrual tranche* or a *Z bond* (because the bond is similar to a zero-coupon bond). The interest that would have been paid to the accrual tranche is then used to speed up pay down of the principal balance of earlier tranches.

To see this, consider Deal 2, a hypothetical CMO structure with the same collateral as Deal 1 and with four tranches, each with a coupon rate of 7.5%. The difference is in the last tranche, Z, which is an accrual tranche. The structure for Deal 2 is shown in Exhibit 9.5.

EXHIBIT 9.5 **Deal 2: A Hypothetical Four-Tranche Sequential-Pay Structure with an Accrual Bond Class**

Tranche	Par Amount	Coupon rate (%)
A	$194,500,000	7.5
B	36,000,000	7.5
C	96,500,000	7.5
Z (Accrual)	73,000,000	7.5
Total	$400,000,000	

Payment rules:
1. *For payment of periodic coupon interest:* Disburse periodic coupon interest to tranches A, B, and C on the basis of the amount of principal outstanding at the beginning of the period. For tranche Z, accrue the interest based on the principal plus accrued interest in the previous period. The interest for tranche Z is to be paid to the earlier tranches as a principal paydown.
2. *For disbursement of principal payments:* Disburse principal payments to tranche A until it is completely paid off. After tranche A is completely paid off, disburse principal payments to tranche B until it is completely paid off. After tranche B is completely paid off, disburse principal payments to tranche C until it is completely paid off. After tranche C is completely paid off, disburse principal payments to tranche Z until the original principal balance plus accrued interest is completely paid off.

It can be shown that the expected final maturity for tranches A, B, and C will shorten as a result of the inclusion of tranche Z. The final payout for tranche A is 64 months rather than 81 months; for tranche B it is 77 months rather than 100 months; and for tranche C it is 112 months rather than 178 months. The average lives for tranches A, B, and C are shorter in Deal 2 compared to Deal 1 because of the inclusion of the accrual tranche. For example, at 165 PSA, the average lives are as follows:

Structure	Tranche A	Tranche B	Tranche C
Deal 1	3.48	7.49	11.19
Deal 2	2.90	5.86	7.87

The reason for the shortening of the non-accrual tranches is that the interest that would be paid to the accrual tranche is being allocated to the other tranches. Tranche Z in Deal 2 will have a longer average life than tranche D in Deal 1. These shorter term average life tranches are more attractive to cash managers than the deal without an accrual tranche.

Floating-Rate Tranches

Now let's see how a floating-rate tranche can be created from a fixed-rate tranche. This is done by creating a floater and an inverse floater. We will illustrate the creation of a floater and an inverse floater tranche using the hypothetical CMO structure Deal 2, which is a four tranche sequential-pay structure with an accrual tranche. We can select any of the tranches from which to create a floater tranche and an inverse floater tranche. In fact, we can create these two securities for more than one of the four tranches or for only a portion of one tranche.

In this case, we created a floater and an inverse floater from tranche C. The par value for this tranche is $96.5 million, and we create two tranches that have a combined par value of $96.5 million. We refer to this CMO structure with a floater and an inverse floater as Deal 3. It has five tranches, designated A, B, FL, IFL, and Z, where FL is the floating-rate tranche and IFL is the inverse floating-rate tranche. Exhibit 9.6 describes Deal 3. Any reference rate can be used to create a floater and the corresponding inverse floater. The reference rate selected for setting the coupon rate for FL and IFL in Deal 3 is 1-month LIBOR. The principal paydown for the floater and inverse floater is proportionate to the amount of the principal paydown of tranche C.

EXHIBIT 9.6 **Deal 3: A Hypothetical Five-Tranche Sequential-Pay Structure with Floater, Inverse Floater, and Accrual Tranches**

Tranche	Par amount	Coupon rate
A	$194,500,000	7.50%
B	36,000,000	7.50%
FL	72,375,000	1-mo. LIBOR + 0.50
IFL	24,125,000	28.50 – 3 × (1-mo. LIBOR)
Z (Accrual)	73,000,000	7.50%
Total	$400,000,000	

Payment rules:
1. *For payment of periodic coupon interest:* Disburse periodic coupon interest to tranches A, B, FL, and IFL on the basis of the amount of principal outstanding at the beginning of the period. For tranche Z, accrue the interest based on the principal plus accrued interest in the previous period. The interest for tranche Z is to be paid to the earlier tranches as a principal paydown. The maximum coupon rate for FL is 10%; the minimum coupon rate for IFL is 0%.
2. *For disbursement of principal payments:* Disburse principal payments to tranche A until it is completely paid off. After tranche A is completely paid off, disburse principal payments to tranche B until it is completely paid off. After tranche B is completely paid off, disburse principal payments to tranches FL and IFL until they are completely paid off. The principal payments between tranches FL and IFL should be made in the following way: 75% to tranche FL and 25% to tranche IFL. After tranches FL and IFL are completely paid off, disburse principal payments to tranche Z until the original principal balance plus accrued interest is completely paid off.

The amount of the par value of the floater tranche will be some portion of the $96.5 million. There are an infinite number of ways to cut up the $96.5 million between the floater and inverse floater, and final partitioning will be driven by the demands of investors. In Deal 3, we made the floater from $72,375,000 or 75% of the $96.5 million. Therefore, for every $100 of principal received in a month, the floater receives $75 and the inverse floater receives $25. The coupon rate on the floater is set at 1-month LIBOR plus 50 basis points. So, for example, if LIBOR is 3.75% at the coupon reset date, the coupon rate on the floater is 3.75% + 0.5%, or 4.25%. There is a cap on the coupon rate for the floater (discussed later).

Unlike the floaters discussed in Chapter 7 whose principal is unchanged over the life of the instrument, the floater's principal balance declines over time as principal repayments are made. The principal payments to the floater are determined by the principal payments from the tranche from which the floater is created. In Deal 3, this is tranche C.

Since the floater's par value is $72,375,000 of the $96.5 million, the balance is the inverse floater. Assuming that 1-month LIBOR is the reference rate, the coupon reset formula for an inverse floater takes the following form:

$$K - L \times (\text{1-month LIBOR})$$

In Deal 3, K is set at 28.50% and L at 3. Thus, if 1-month LIBOR is 3.75%, the coupon rate for the month is:

$$28.50\% - 3 \times (3.75\%) = 17.25\%$$

K is the cap or maximum coupon rate for the inverse floater. In Deal 3, the cap for the inverse floater is 28.50%.

The L or multiple in the coupon reset formula for the inverse floater is called the "coupon leverage." The higher the coupon leverage, the more the inverse floater's coupon rate changes for a given change in 1-month LIBOR. For example, a coupon leverage of 3 means that a 1-basis point change in 1-month LIBOR will change the coupon rate on the inverse floater by 3 basis points.

Because 1-month LIBOR is always positive, the coupon rate paid to the floating-rate tranche cannot be negative. If there are no restrictions placed on the coupon rate for the inverse floater, however, it is possible for the coupon rate for that tranche to be negative. To prevent this, a floor, or minimum, is placed on the coupon rate. In many structures, the floor is set at zero. Once a floor is set for the inverse floater, a cap is imposed on the floater. In Deal 3, a floor of zero is set for the inverse floater. The floor results in a cap for the floater of 10%.

As noted in Chapter 7, inverse floaters have substantial price volatility, a point that was unfortunately not recognized by some cash or short-duration managers who purchased them in anticipation of a decline in interest rates.

Planned Amortization Class Tranches

A *planned amortization class* (PAC) bond is one in which a schedule of principal payments is set forth in the prospectus. The PAC bondholders have priority over all other bond classes in the structure with respect to the receipt of the scheduled principal payments. While there is no assurance that the principal payments will be actually realized so as to satisfy the schedule, a PAC bond is structured so that if prepayment speeds are within a certain range of prepayment speeds, the collateral will generate sufficient principal to meet the schedule of principal payments.[1]

[1] For an explanation of how a PAC schedule is created, see Chapter 6 in Frank J. Fabozzi and Chuck Ramsey, *Collateralized Mortgage Obligations: Structures and Analysis* (New Hope, PA: Frank J. Fabozzi Associates, 1999).

EXHIBIT 9.7 Deal 4: Structure with One PAC Bond and One Support Bond

Tranche	Par amount	Coupon rate (%)
P (PAC)	$243,800,000	7.5
S (Support)	156,200,000	7.5
Total	$400,000,000	

Payment rules:
1. *For payment of periodic coupon interest:* Disburse periodic coupon interest to each tranche on the basis of the amount of principal outstanding at the beginning of the period.
2. *For disbursement of principal payments:* Disburse principal payments to tranche P based on its schedule of principal repayments. Tranche P has priority with respect to current and future principal payments to satisfy the schedule. Any excess principal payments in a month over the amount necessary to satisfy the schedule for tranche P are paid to tranche S. When tranche S is completely paid off, all principal payments are to be made to tranche P regardless of the schedule.

The greater certainty of the cash flow for the PAC bonds comes at the expense of the non-PAC classes, called the *support* or *companion tranches*. It is these tranches that absorb the prepayment risk. Because PAC bonds have protection against both extension risk and contraction risk, they are said to provide "two-sided" prepayment protection.

Exhibit 9.7 shows a CMO structure, Deal 4, created from the $400 million 7.5% coupon passthrough with a WAC of 8.125% and a WAM of 357 months. There are just two tranches in this structure: a 7.5% coupon PAC bond created assuming 90 to 300 PSA with a par value of $243.8 million, and a support bond with a par value of $156.2 million. The two speeds used to create a PAC bond are called the *initial PAC collars* (or *initial PAC bands*). For Deal 4, 90 PSA is the lower collar and 300 PSA the upper collar.

Exhibit 9.8 reports the average life for the PAC bond and the support bond in Deal 4 assuming various actual prepayment speeds. Notice that between 90 PSA and 300 PSA, the average life for the PAC bond is stable at 7.26 years. However, at slower or faster PSA speeds the schedule is broken and the average life changes, lengthening when the prepayment speed is less than 90 PSA and shortening when it is greater than 300 PSA. Even so, there is much greater variability for the average life of the support bond.

Most CMO PAC structures have more than one class of PAC bonds. Exhibit 9.9 shows six PAC bonds created from the single PAC bond in Deal 4. We will refer to this CMO structure as Deal 5. Information about this CMO structure is provided in Exhibit 9.9. The total par value of the six PAC bonds is equal to $243.8 million, which is the amount of the single PAC bond in Deal 4.

EXHIBIT 9.8 **Average Life for PAC Bond and Support Bond in Deal 4 Assuming Various Prepayment Speeds**

Prepayment rate (PSA)	PAC Bond (P)	Support Bond (S)
0	15.97	27.26
50	9.44	24.00
90	7.26	18.56
100	7.26	18.56
150	7.26	12.57
165	7.26	11.16
200	7.26	8.38
250	7.26	5.37
300	7.26	3.13
350	6.56	2.51
400	5.92	2.17
450	5.38	1.94
500	4.93	1.77
700	3.70	1.37

EXHIBIT 9.9 **Deal 5: Structure with Six PAC Bonds and One Support Bond**

Tranche	Par amount	Coupon rate (%)
P-A	$85,000,000	7.5
P-B	8,000,000	7.5
P-C	35,000,000	7.5
P-D	45,000,000	7.5
P-E	40,000,000	7.5
P-F	30,800,000	7.5
S	156,200,000	7.5
Total	$400,000,000	

Payment rules:
1. *For payment of periodic coupon interest:* Disburse periodic coupon interest to each tranche on the basis of the amount of principal outstanding at the beginning of the period.
2. *For disbursement of principal payments:* Disburse principal payments to tranches P-A to P-F based on their respective schedules of principal repayments. Tranche P-A has priority with respect to current and future principal payments to satisfy the schedule. Any excess principal payments in a month over the amount necessary to satisfy the schedule for tranche P-A are paid to tranche S. Once tranche P-A is completely paid off, tranche P-B has priority, then tranche P-C, etc. When tranche S is completely paid off, all principal payments are to be made to the remaining PAC tranches in order of priority regardless of the schedule.

EXHIBIT 9.10 Average Life for PAC Bond and Support Bond in Deal 5 Assuming Various Prepayment Speeds

Prepayment rate (PSA)	PAC Bonds					
	P-A	P-B	P-C	P-D	P-E	P-F
0	8.46	14.61	16.49	19.41	21.91	23.76
50	3.58	6.82	8.36	11.30	14.50	18.20
90	2.58	4.72	5.78	7.89	10.83	16.92
100	2.58	4.72	5.78	7.89	10.83	16.92
150	2.58	4.72	5.78	7.89	10.83	16.92
165	2.58	4.72	5.78	7.89	10.83	16.92
200	2.58	4.72	5.78	7.89	10.83	16.92
250	2.58	4.72	5.78	7.89	10.83	16.92
300	2.58	4.72	5.78	7.89	10.83	16.92
350	2.58	4.72	5.94	6.95	9.24	14.91
400	2.57	4.37	4.91	6.17	8.33	13.21
450	2.50	3.97	4.44	5.56	7.45	11.81
500	2.40	3.65	4.07	5.06	6.74	10.65
700	2.06	2.82	3.10	3.75	4.88	7.51

Exhibit 9.10 shows the average life for the six PAC bonds and the support bond in Deal 5 at various prepayment speeds. From a PAC bond in Deal 4 with an average life of 7.26, we have created six PAC bonds with an average life as short as 2.58 years (P-A) and as long as 16.92 years (P-F) if prepayments stay within 90 PSA and 300 PSA.

As expected, the average lives are stable if the prepayment speed is between 90 PSA and 300 PSA. Notice that even outside this range the average life is stable for several of the shorter PAC bonds. For example, PAC P-A is stable even if prepayment speeds are as high as 400 PSA. For the PAC P-B, the average life does not vary when prepayments are between 90 PSA and 350 PSA. Why is it that the shorter the PAC, the more protection it has against faster prepayments?

To understand why this is so, remember that there are $156.2 million in support bonds that are protecting the $85 million of PAC P-A. Thus, even if prepayments are faster than the initial upper collar, there may be sufficient support bonds to assure the satisfaction of the schedule. In fact, as can been from Exhibit 9.10, even if prepayments are 400 PSA over the life of the collateral, the average life is unchanged.

Now consider PAC P-B. The support bonds are providing protection for both the $85 million of PAC P-A and $93 million of PAC P-B. As can be seen from Exhibit 9.10, prepayments could be 350 PSA and the average life is still unchanged. From Exhibit 9.10 it can be seen that the degree of protection against extension risk increases the shorter the PAC. Thus, while the initial collar may be 90 to 300 PSA, the effective collar is wider for the shorter PAC tranches.

PAC Floaters Given a series of PAC bonds, any of the tranches can be carved up to make a floater and an inverse floater. The advantage of the PAC floater compared to a sequential-pay floater is that there is two-sided prepayment protection and therefore the uncertainty of the average life is less. The trade-off is that this greater prepayment protection is not free. All other factors constant, the margin over the same reference rate offered on a PAC floater will be less than that on a sequential-pay floater and/or the cap will be the lower.

Effective Collars and Actual Prepayments As we have emphasized, the creation of an MBS cannot make prepayment risk disappear. This is true for both a passthrough and a CMO. Thus, the reduction in prepayment risk (both extension risk and contraction risk) that a PAC bond offers must come from somewhere.

The prepayment protection comes from the support bonds. It is the support bonds that have principal payments deferred if the collateral prepayments are slow; support bonds do not receive any principal until the PAC bonds receive the scheduled principal repayment. This reduces the risk that the PAC bonds will extend. Similarly, it is the support bonds that absorb any principal payments in excess of the scheduled principal payments that are made. This reduces the contraction risk of the PAC bonds. Thus, the key to the prepayment protection offered by a PAC bond is the amount of support bonds outstanding. If the support bonds are paid off quickly because of faster-than-expected prepayments, then there is no longer any protection for the PAC bonds. In fact, in Deal 5, if the support bond is paid off, the structure is effectively reduced to a sequential-pay CMO. In such cases, the schedule is unlikely to be maintained, and the structure is referred to as a *busted PAC*.

The support bonds can be thought of as bodyguards for the PAC bondholders. When the bullets fly—i.e., prepayments occur—it is the bodyguards that get killed first. The bodyguards are there to absorb the bullets. Once all the bodyguards are killed off (i.e., the support bonds paid off with faster-than-expected prepayments), the PAC bonds must fend for themselves: they are exposed to all the bullets.

With the bodyguard metaphor for the support bonds in mind, let's consider two questions asked by buyers of PAC bonds:

1. Will the schedule of principal repayments be satisfied if prepayments are faster than the initial upper collar?
2. Will the schedule of principal repayments be satisfied as long as prepayments stay within the initial collar?

Let's address the first question. The initial upper collar for Deal 4 is 300 PSA. Suppose that actual prepayments are 500 PSA for seven consecutive months. Will this disrupt the schedule of principal repayments? The answer is: it depends!

There are two pieces of information we will need to answer this question. First, when does the 500 PSA occur? Second, what has been the actual prepayment experience up to the time that prepayments are 500 PSA? For example, suppose six years from now is when the prepayments reach 500 PSA, and also suppose that for the past six years the actual prepayment speed has been 90 PSA every month. What this means is that there are more bodyguards (i.e., support bonds) around than was expected when the PAC was structured at the initial collar. In establishing the schedule of principal repayments, it is assumed that the bodyguards would be killed off at 300 PSA. But the actual prepayment experience results in them being killed off at only 90 PSA. Thus, six years from now when the 500 PSA is assumed to occur, there are more bodyguards than expected. Thus, a 500 PSA for seven consecutive months may have no effect on the ability of the schedule of principal repayments to be met.

In contrast, suppose that the actual prepayment experience for the first six years is 300 PSA (the upper collar of the initial PAC collar). In this case, there are no extra bodyguards around. As a result, any prepayment speeds faster than 300 PSA, such as 500 PSA in our example, jeopardize satisfaction of the principal repayment schedule and increase contraction risk. What this means is that the prepayment protection is reduced.

It should be clear from these observations that the initial collars are not particularly useful in assessing the prepayment protection for a seasoned PAC bond. This is most important to understand, as it is common for CMO buyers to compare prepayment protection of PACs in different CMO structures, and conclude that the greater protection is offered by the one with the wider initial collars. This approach is inadequate because it is actual prepayment experience that determines the degree of prepayment protection going forward, as well as the expected future prepayment behavior of the collateral.

The way to determine this protection is to calculate the *effective collar* for a PAC bond. An effective collar for a PAC is the lower and the upper PSA that can occur in the future and still allow maintenance of the schedule of principal repayments.

The effective collar changes every month. An extended period over which actual prepayments are below the upper range of the initial PAC collar will result in an increase in the upper range of the effective collar. This is because there will be more bodyguards around than anticipated. An extended period of prepayments slower than the lower range of the initial PAC collar will raise the lower range of the effective collar. This is because it will take faster prepayments to make up the shortfall of the scheduled principal payments not made plus the scheduled future principal payments.

It is important to understand that the PAC schedule may not be satisfied even if the actual prepayments never fall outside of the initial collar. This may seem surprising since our previous analysis indicated that the average life would not change if prepayments are at either extreme of the initial collar. However, recall that all of our previous analysis has been based on a single PSA speed for the life of the structure. If we vary the PSA speed over time rather than keep it constant over the life of the CMO, we can see what happens to the effective collar if the prepayments are at the initial upper collar for a certain number of months. For example, if one computed the average life two years from now for the PAC bond in Deal 4 assuming that prepayments are 300 PSA for the first 24 months, one would find that the average life is stable at six years if the prepayments for the following months are between 115 PSA and 300 PSA. That is, the effective PAC collar is no longer the initial collar. Instead, the lower collar has shifted upward. This means that the protection from year 2 on is for 115 PSA to 300 PSA, a narrower band than initially, even though the earlier prepayments did not exceed the initial upper collar.

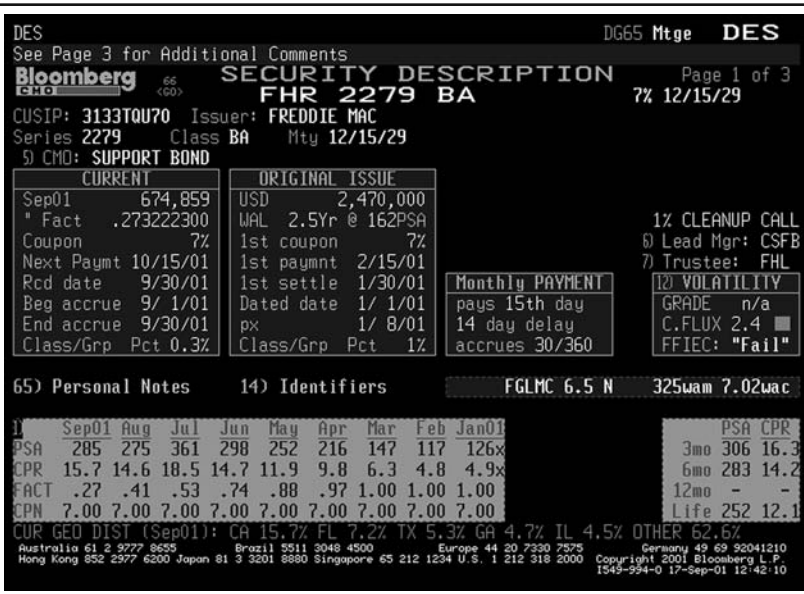
Support Bonds

The support bonds are the bonds that provide prepayment protection for the PAC tranches. Consequently, support tranches expose investors to the greatest level of prepayment risk. Because of this, investors must be particularly careful in assessing the cash flow characteristics of support bonds to reduce the likelihood of adverse portfolio consequences due to prepayments.

To see this, consider a short-term, 7% coupon support bond issued by Freddie Mac (Class BA, Series 2279) in January 2001. Exhibit 9.11 presents a Bloomberg Security Description screen for this security. This support bond makes coupon payments monthly on the fifteenth day of each month. Let's analyze this support bond's exposure to prepayment risk using Bloomberg's PT (Price Table) function in Exhibit 9.12. Suppose at current interest rates, the underlying mortgage collateral prepays at 210 PSA and the security's current price is 100-07. Note at the bottom of the screen, given a prepayment speed of 210 PSA, the average life is 0.22 years. If we shock the current U.S. Treasury yield curve by ±100, 200, 300 basis points, respectively, and feed those shocks into a prepayment model, what will happen to the prepayment speed of the collateral and the average life of this support bond? As can be seen from the Price Table, if interest rates rise, prepayment speeds will decrease and the security's average life will extend from 0.22 years to 7.17 years for a 100 basis point upward parallel shift in the yield curve. Of course, this is a concern to an investor who thought that they were purchasing a money market-type instrument. Correspondingly, if interest rate decline, prepayment speeds will increase such that the security's average life will shorten.

The support bond typically is divided into different tranches. All the tranches we have discussed earlier are available, including sequential-pay support tranches and floater and inverse floater support tranches. The support bond can even be partitioned so as to create support tranches with a schedule of principal payments. That is, support tranches that are PAC bonds can be created. In a structure with a PAC bond and a support bond with a PAC schedule of principal payments, the former is called a *PAC I bond* or *Level I PAC bond* and the latter a *PAC II bond* or *Level II PAC bond* or *scheduled bond*. While PAC II bonds have greater prepayment protection than the support tranches without a schedule of principal repayments, the prepayment protection is less than that provided PAC I bonds.

EXHIBIT 9.11 **Bloomberg Security Description Screen for a Freddie Mac Support Bond**



Source: Bloomberg Financial Markets

EXHIBIT 9.12 Bloomberg Price Table Screen

Source: Bloomberg Financial Markets

There is more that can be done with the PAC II bond. A series of PAC IIs can be created just as we did with the PACs in Deal 5. PAC IIs can also be used to create any other type of bond class, such as a PAC II floater and inverse floater, for example. The support bond without a principal repayment schedule can be used to create any type of bond class. In fact, a portion of the non-PAC II support bond can be given a schedule of principal repayments. This bond class would be called a *PAC III bond* or a *Level III PAC bond*. While it provides protection against prepayments for the PAC I and PAC II bonds and is therefore subject to considerable prepayment risk, such a bond class has greater protection than the support bond class without a schedule of principal repayments.

NONAGENCY CMOS

There are short-term fixed-rate bonds and floaters created in CMO deals in which the issuer is a private entity rather than Ginnie Mae, Fannie Mae, or Freddie Mac. These securities are called *nonagency mortgage-backed securities* (referred to as *nonagency securities* hereafter). Other mortgage-backed products that are separately classified in the industry as asset-backed securities are home equity loan-backed securities and manufactured housing-backed securities. These products are discussed in the next chapter. Since all of these mortgage-related securities expose an investor to credit risk, these securities are sometimes referred to as *credit-sensitive mortgage-backed securities*.

For agency CMOs, the concern is with the redistribution or "tranching" of prepayment risk. For nonagency CMOs, the bonds issued are not guaranteed by a federally related agency or a government sponsored enterprise. Consequently, there is concern with credit risk. As a result, nonagency CMOs expose the investor to both prepayment risk and credit risk. The same types of tranches are created in nonagency CMO structures as described earlier for agency CMO structures. What is unique is the mechanisms for enhancing the credit of a nonagency CMO so that an issuer can obtain any credit rating desired for a tranche in a deal. The same credit enhancement mechanisms are used for ABS structures discussed in the next chapter.

Agency CMOs are created from pools of passthrough securities. In the nonagency market, a CMO can be created from either a pool of passthroughs or unsecuritized mortgage loans. It is uncommon for nonconforming mortgage loans to be securitized as passthroughs and then the passthroughs carved up to create a CMO. Instead, in the nonagency market a CMO is carved out of mortgage loans that have not been securitized as passthroughs. Since a mortgage loan is commonly referred to as a whole loan, nonagency CMOs are also referred to as *whole-loan CMOs*.

The underlying loans for agency securities are those that conform to the underwriting standards of the agency issuing or guaranteeing the issue. That is, only conforming loans are included in pools that are collateral for an agency mortgage-backed security. The three main underwriting standards deal with (1) the maximum loan-to-value ratio, (2) the maximum payment-to-income ratio, and (3) the maximum loan amount. A nonconforming mortgage loan is one that does not conform to the underwriting standards established by any of the agencies.

Credit Enhancement Mechanisms

Typically a double A or triple A rating is sought for the most senior tranche in a nonagency CMO. The amount of credit enhancement necessary depends on rating agency requirements. There are two general types of credit enhancement mechanisms: external and internal. We describe each type below.

External Credit Enhancements

External credit enhancements come in the form of third-party guarantees that provide for first protection against losses up to a specified level, for example, 10%. The most common forms of external credit enhancement are (1) a corporate guarantee, (2) a letter of credit, (3) pool insurance, and (4) bond insurance.

Pool insurance policies cover losses resulting from defaults and foreclosures. Policies are typically written for a dollar amount of coverage that continues in force throughout the life of the pool. However, some policies are written so that the dollar amount of coverage declines as the pool seasons as long as two conditions are met: (1) the credit performance is better than expected and (2) the rating agencies that rated the issue approve. Since only defaults and foreclosures are covered, additional insurance must be obtained to cover losses resulting from bankruptcy (i.e., court mandated modification of mortgage debt—"cramdown"), fraud arising in the origination process, and special hazards (i.e., losses resulting from events not covered by a standard homeowner's insurance policy).

Bond insurance provides the same function as in municipal bond structures. The major insurers are AMBAC, MBIA, FSA, and FGIC.

A nonagency CMO with external credit support is subject to the credit risk of the third-party guarantor. Should the third-party guarantor be downgraded, the issue itself could be subject to downgrade even if the structure is performing as expected. This is based on the "weak link" test followed by rating agencies. According to this test, when evaluating a proposed structure, the credit quality of the issue is only as good as the weakest link in credit enhancement regardless of the quality of the underlying loans. This is the chief disadvantage of third-party guarantees, sometimes referred to as "event risk." Therefore, it is imperative that investors monitor the third-party guarantor as well as the collateral.

External credit enhancements do not materially alter the cash flow characteristics of a CMO structure except in the form of prepayments. In case of a default resulting in net losses within the guarantee level, investors will receive the principal amount as if a prepayment has occurred. If the net losses exceed the guarantee level, investors will realize a shortfall in the cash flows.

Internal Credit Enhancements

Internal credit enhancements come in more complicated forms than external credit enhancements and may alter the cash flow characteristics of the loans even in the absence of default. The most common forms of internal credit enhancements are reserve funds and senior/subordinated structures.

Reserve funds come in two forms, cash reserve funds and excess servicing spread. Cash reserve funds are straight deposits of cash generated from issuance proceeds. In this case, part of the underwriting profits from the deal are deposited into a fund which typically invests in money market instruments. *Cash reserve funds* are typically used in conjunction with letters of credit or other kinds of external credit enhancements.

Excess servicing spread accounts involve the allocation of excess spread or cash into a separate reserve account after paying out the net coupon, servicing fee, and all other expenses on a monthly basis. For example, suppose that the gross WAC is 7.75%, the servicing and other fees are 0.25%, and the net WAC is 7.25%. This means that there is excess servicing of 0.25%. The amount in the reserve account will gradually increase and can be used to pay for possible future losses. This form of credit enhancement relies on the assumption that defaults occur infrequently in the very early life of the loans but gradually increase in the following two to five years.

The most widely used internal credit enhancement structure is the *senior/subordinated structure*. Today a typical structure will have a senior tranche and several junior tranches. The junior tranches represent the subordinated tranches of the structure. The issuer will seek a triple A or double A rating for the senior tranche. The junior tranches will have lower ratings—investment grade and non-investment grade. Typically, the most junior tranche—called the *first loss piece*—will not be rated.

Exhibit 9.13 shows a hypothetical $200 million structure with a senior tranche representing 92.25% of the deal and five junior tranches representing 7.75% of the deal. Note that all that has been done in this structure is "credit tranching." The senior or any of the junior tranches can then be carved up to create other CMO tranches such as sequential pays.

The first loss piece in this hypothetical deal is tranche X5. The subordination level in this hypothetical structure is 7.75%. The junior classes will absorb all losses up to $15.5 million and the senior tranche will start to experience losses thereafter. So, if there is a $10 million loss, no loss will be realized by the senior tranche. If, instead, there is a $20 million loss, the senior tranche will experience a loss of $4.5 million ($20 million minus $15.5 million) or a 2.4% loss ($4.5/$184.5).

EXHIBIT 9.13 **Hypothetical $200 Million Senior/Subordinated Structure**

Bond	Rating	Amount ($ in millions)	Percent of deal(%)
Senior	AAA	$184.50	92.25
Junior			
X1	AA	4.00	2.00
X2	A	2.00	1.00
X3	BBB	3.00	1.50
X4	BB	4.00	2.00
X5[a]	Not rated	2.50	1.25

[a] First loss piece.

In the case where the loss is $10 million, the first loss piece (tranche X5), tranche X4, and tranche X3 absorb $9.5 million. These tranches will realize a loss experience of 100%. Tranche X2 will realize a loss of $0.5 million, thereby having a loss experience of 25% ($0.5/$2.0). Tranche X1 will not realize any loss. If the loss is $20 million, all junior bonds will have a loss experience of 100%.

The junior tranches obviously would require a yield premium to take on the greater credit risk exposure relative to the senior tranche. This setup is a form of self-insurance wherein investors in the senior tranche are giving up yield spread to the investors in the junior tranches. This form of credit enhancement still does not affect the cash flow characteristics of the senior tranche except in the form of prepayments. To the extent that losses are within the subordination level, investors in the senior tranche will receive principal as if a prepayment has occurred.

The basic concern is that while the subordinate tranche provides a certain level of credit protection for the senior tranche at the closing of the deal, the level of protection changes over time due to prepayments and certain liquidation proceeds. The objective is to distribute these payments of principal such that the credit protection for the senior tranche does not deteriorate over time.

To accomplish this, almost all existing senior/subordinated structures incorporate a *shifting interest structure*. A shifting interest structure redirects prepayments disproportionally from the subordinated classes to the senior class according to a specified schedule. An example of such a schedule would be as follows:

Months	Percentage of prepayments directed to senior class
1-60	100%
61-72	70%
73-84	60%
85-96	40%
97-108	20%
109+	pro rata

The rationale for the shifting interest structure is to have enough insurance outstanding to cover future losses. Because of the shifting interest structure, the subordination amount may actually grow in time especially in a low default and fast prepayment environment. Using the same example of our previous $200 million deal with 7.75% initial subordination and assuming a cumulative paydown (prepayments at 165 PSA and regularly scheduled repayments) of $40 million by year 3, the subordination will actually increase to 10.7% [$15.5/($184.50 – $40)] without any net losses. Even if the subordinated classes have experienced some losses, say, $1 million, the subordination will still increase to 9.3% [($15.5 – $1)/($184.50 – $40)].

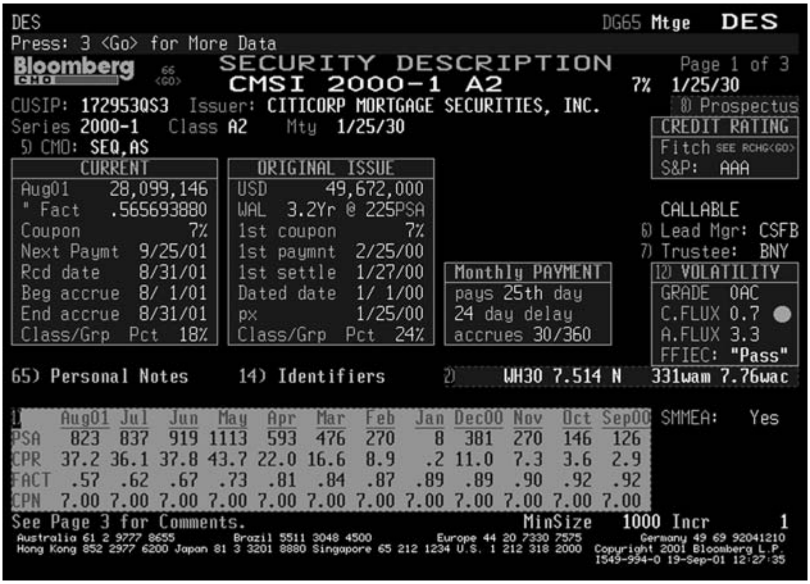
While the shifting interest structure is beneficial to the senior tranche from a credit standpoint, it does alter the cash flow characteristics of the senior tranche even in the absence of defaults.

As an illustration, consider a short-term, nonagency CMO with a 7% coupon issued by Citigroup Mortgage Securities, Inc. (Class A2, Series CMSI 2000-1) issued in January 2000. Exhibit 9.14 presents the Bloomberg Security Description screen for this security. As can be seen from the screen, this senior security is designated as an accelerated security (AS) which means it receives principal payments at a faster rate than the underlying collateral. This is an example of the shifting interest structure. Note also this security is rated AAA by Standard & Poor's which is indicated in the upper right-hand corner of the screen.

Once again, let's analyze this security's exposure to prepayment risk using Bloomberg's PT (Price Table) function in Exhibit 9.15. We consider interest rate shocks of ±100, 200, and 300 basis points. The "BWP" beside each interest rate shock is a Bloomberg-defined prepayment rate notation. For example, –100 BWP generates a prepayment vector using the Bear Stearns Whole Loan Prepayment Vectors model given a parallel interest rate shift of minus 100 basis points. The other interest rate shocks are interpreted similarly. So, as before, the interest rate shock is fed into a prepayment model that tells us how prepayments change when interest rates change. At current interest rates and prepayment speed represented by +0 BWP, the security's average life is 0.47 years. For shocks of +100, +200, and +300, prepayment speeds decrease and the average life increases. However, note the average life does not extend as much as the agency support bond analyzed earlier. The reason is that even though slowing prepayments extend tranche A2's average life, this security still receives prepayments at a faster rate than the underlying collateral. Thus, accelerated securities have greater protection from extension risk even when prepayments slow. For shocks of –100, –200, and –300, prepayments increase and the average life shortens.

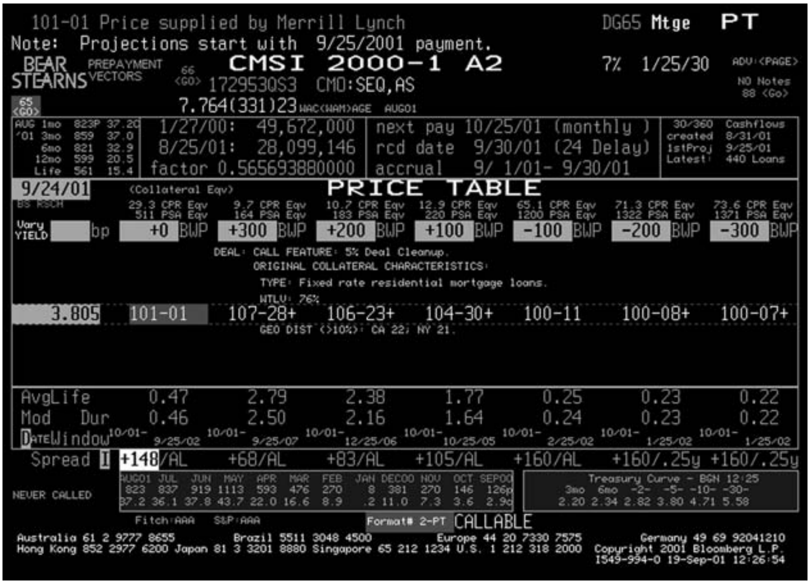
Panels A and B of Exhibit 9.16 present a Bloomberg screen of this tranche's paydown history from issuance in January 2000 through August 2001. In particular, this screen indicates the original principal balance is $49,672,000 and details how the principal balance has changed each month as the principal pays down. Note the principal payments vary considerably due to prepayments but the monthly interest payments decline each month as expected.

EXHIBIT 9.14 Bloomberg Security Description Screen for a Nonagency CMO



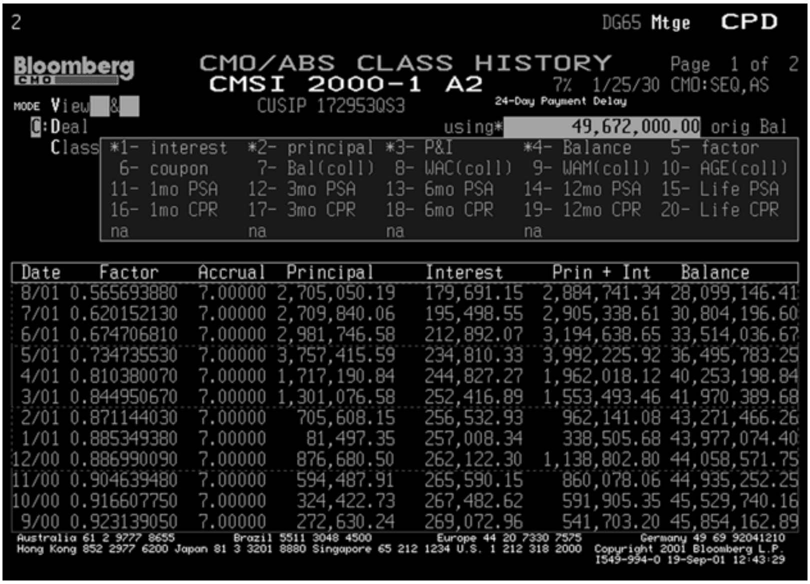
Source: Bloomberg Financial Markets

EXHIBIT 9.15 Bloomberg Price Table Screen



Source: Bloomberg Financial Markets

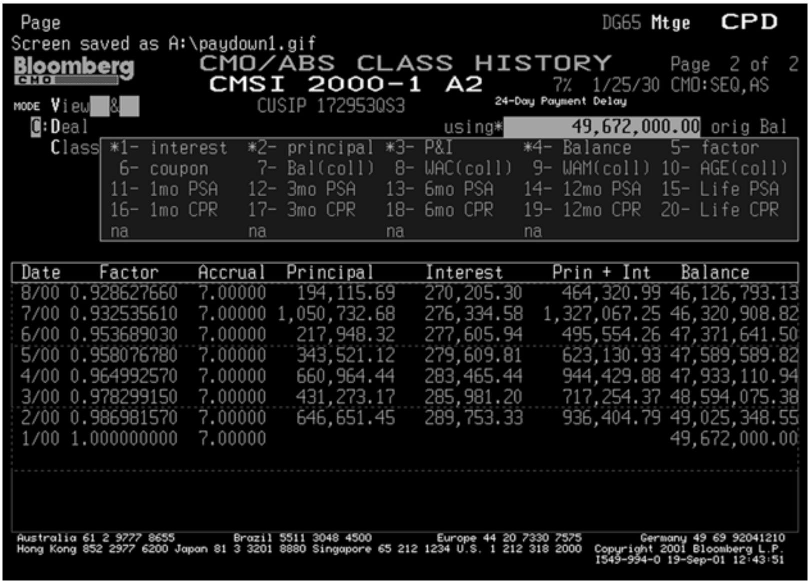
EXHIBIT 9.16 Bloomberg CMO/ABS Class History Screen
Panel A


2
DG65 Mtge CPD
Bloomberg CMO
CMO/ABS CLASS HISTORY Page 1 of 2
CMSI 2000-1 A2 7% 1/25/30 CMO:SEQ,AS
CUSIP 172953QS3 24-Day Payment Delay
MODE View &
C:Deal using* 49,672,000.00 orig Bal
Class *1- interest *2- principal *3- P&I *4- Balance 5- factor
6- coupon 7- Bal(coll) 8- WAC(coll) 9- WAM(coll) 10- AGE(coll)
11- 1mo PSA 12- 3mo PSA 13- 6mo PSA 14- 12mo PSA 15- Life PSA
16- 1mo CPR 17- 3mo CPR 18- 6mo CPR 19- 12mo CPR 20- Life CPR
na na na na

Date	Factor	Accrual	Principal	Interest	Prin + Int	Balance
8/01	0.565693880	7.00000	2,705,050.19	179,691.15	2,884,741.34	28,099,146.41
7/01	0.620152130	7.00000	2,709,840.06	195,498.55	2,905,338.61	30,804,196.60
6/01	0.674706810	7.00000	2,981,746.58	212,892.07	3,194,638.65	33,514,036.67
5/01	0.734735530	7.00000	3,757,415.59	234,810.33	3,992,225.92	36,495,783.25
4/01	0.810380070	7.00000	1,717,190.84	244,827.27	1,962,018.12	40,253,198.84
3/01	0.844950670	7.00000	1,301,076.58	252,416.89	1,553,493.46	41,970,389.68
2/01	0.871144030	7.00000	705,608.15	256,532.93	962,141.08	43,271,466.26
1/01	0.885349380	7.00000	81,497.35	257,008.34	338,505.68	43,977,074.40
12/00	0.886990090	7.00000	876,680.50	262,122.30	1,138,802.80	44,058,571.75
11/00	0.904639480	7.00000	594,487.91	265,590.15	860,078.06	44,935,252.25
10/00	0.916607750	7.00000	324,422.73	267,482.62	591,905.35	45,529,740.16
9/00	0.923139050	7.00000	272,630.24	269,072.96	541,703.20	45,854,162.89

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
I549-994-0 19-Sep-01 12:43:29

Panel B


Page
DG65 Mtge CPD
Screen saved as A:\paydown1.gif
Bloomberg CMO
CMO/ABS CLASS HISTORY Page 2 of 2
CMSI 2000-1 A2 7% 1/25/30 CMO:SEQ,AS
CUSIP 172953QS3 24-Day Payment Delay
MODE View &
C:Deal using* 49,672,000.00 orig Bal
Class *1- interest *2- principal *3- P&I *4- Balance 5- factor
6- coupon 7- Bal(coll) 8- WAC(coll) 9- WAM(coll) 10- AGE(coll)
11- 1mo PSA 12- 3mo PSA 13- 6mo PSA 14- 12mo PSA 15- Life PSA
16- 1mo CPR 17- 3mo CPR 18- 6mo CPR 19- 12mo CPR 20- Life CPR
na na na na

Date	Factor	Accrual	Principal	Interest	Prin + Int	Balance
8/00	0.928627660	7.00000	194,115.69	270,205.30	464,320.99	46,126,793.13
7/00	0.932535610	7.00000	1,050,732.68	276,334.58	1,327,067.25	46,320,908.82
6/00	0.953689030	7.00000	217,948.32	277,605.94	495,554.26	47,371,641.50
5/00	0.958076780	7.00000	343,521.12	279,609.81	623,130.93	47,589,589.82
4/00	0.964992570	7.00000	660,964.44	283,465.44	944,429.88	47,933,110.94
3/00	0.978299150	7.00000	431,273.17	285,981.20	717,254.37	48,594,075.38
2/00	0.986981570	7.00000	646,651.45	289,753.33	936,404.79	49,025,348.55
1/00	1.000000000	7.00000				49,672,000.00

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
I549-994-0 19-Sep-01 12:43:51

Source: Bloomberg Financial Markets

CHAPTER 10

Short-Term Asset-Backed Securities

While residential mortgage loans are by far the most commonly securitized asset type, securities backed by other assets (consumer and business loans and receivables) have also been securitized. In this chapter we discuss the various asset-backed securities products.

Just as with collateralized mortgage obligations (CMOs), structures with multiple tranches can be created from a pool of loans or receivables to create short-term average life tranches. Floating-rate asset-backed securities are typically created where the underlying pool of loans or receivables pay a floating rate. The most common are securities backed by credit card receivables, home equity line of credit receivables, closed-end home equity loans with an adjustable rate, student loans, Small Business Administration loans, and trade receivables. As demonstrated in the previous chapter, fixed-rate loans also can be used to create a structure that has one or more floating-rate tranches. For example, there are closed-end home equity loans with a fixed rate that can be pooled to create a structure with one or more floating-rate tranches.

CREDIT RISK

Asset-backed securities (ABS) expose investors to credit risk. The three nationally recognized statistical rating organizations rate asset-backed securities. In analyzing credit risk, all three rating companies focus on similar areas of analysis: (1) credit quality of the collateral, (2) the quality of the seller/servicer, (3) cash flow stress and payment structure, and (4) legal structure.

The credit enhancements—internal and external—that were described in the previous chapter for nonagency CMOs are also used for all ABS products. The amount of enhancement necessary to obtain a specific rating for each tranche in an ABS deal is determined by a rating agency after analysis of the collateral and the structure.

BASIS RISK AND FLOATING-RATE ABS

A floating-rate ABS is often exposed to *basis risk*. This risk is defined as any mismatch between adjustments to the coupon rate paid to bondholders and the interest rate paid on the floating-rate collateral. Two common sources of basis risk are index risk and reset risk.

Index risk is a type of yield curve risk that arises because the ABS floater's coupon rate and the interest rate of the underlying collateral are usually determined at different ends of the yield curve. Specifically, the floater's coupon rate is typically spread off the short-term sector of the yield curve (e.g., U.S. Treasury) while the collateral's interest rate is spread off a longer maturity sector of the same yield curve or in some cases a different yield curve (e.g., LIBOR). This mismatch is a source of risk. For example, for home equity loan-backed securities in which the collateral is adjustable-rate loans, the reference rate for the loans may be 6-month LIBOR while the reference rate for the bonds is usually 1-month LIBOR. Both the collateral and the bonds are indexed off LIBOR, but different sectors of the Eurodollar yield curve. The reference rate for some home equity loans is a constant maturity Treasury. Thus, the collateral is based on a spread off the 1-month sector of the Eurodollar yield curve while the bonds are spread off a longer maturity sector of the Treasury yield curve. As another example, for credit card-backed ABS the interest rate paid is usually a spread over the prime rate (a spread over the Treasury yield curve) while the coupon rate for the bonds is usually a spread over 1-month LIBOR (a spread over the Eurodollar yield curve).

Reset risk is the risk associated with the mismatch between the frequency of the resetting of the interest rate on the floating-rate collateral and the frequency of reset of the coupon rate on the bonds. This risk is common for ABS. For home equity loan-backed securities, for example, the underlying collateral for the adjustable-rate loans is either reset semiannually or annually. However, the coupon rate on the bonds is reset every month. For credit card-backed securities, the coupon rate for the bonds is set monthly, while the finance charges on the outstanding credit card balances are computed daily at a fixed spread over the prime rate.

Basis risk has an impact on the cap of an ABS floater. For a non-ABS floater, the coupon rate has a fixed cap (typically, for the life of the floater). In contrast, the cap for an ABS floater depends on the performance of the underlying collateral. For ABS floaters, basis risk affects the excess spread available to pay the coupon rate for the bondholders. In the case of home equity loan-backed ABS and student loan ABS, the cap on the bondholder's coupon is called the *available funds cap*. Typically, the large spread on the collateral loans compared to the spread offered on the bonds provides protection for ABS investors against basis risk.

Where there is an available funds cap, typically there is a provision for carrying any interest shortfall resulting from the cap forward to future months. So, for example, suppose that in one month the full coupon rate would be 6.5% but the available fund cap restricts the coupon rate for that month to 6.2%. The 30 basis point difference between the full coupon rate and the rate due to the available funds cap is capitalized and paid in a subsequent month (or months) when the funds are available to pay the bondholder. As a result, the presence of an available funds cap does not have the same impact on cash flow as a typical cap which does not have a catch-up provision.

CASH FLOW OF ASSET-BACKED SECURITIES

The collateral for an ABS can be classified as either amortizing or non-amortizing assets. Amortizing assets are loans in which the borrower's periodic payment consists of scheduled principal and interest payments over the life of the loan. The schedule for the repayment of the principal is called the amortization schedule. The standard residential mortgage loan falls into this category. Auto loans and certain types of home equity loans (specifically, closed-end home equity loans discussed later in this chapter) are amortizing assets. Any excess payment over the scheduled principal payment is called a prepayment. Prepayments can be made to pay off the entire balance or a partial prepayment, called a curtailment.

In contrast to amortizing assets, non-amortizing assets do not have a schedule for the periodic payments that the borrower must make. Instead, a non-amortizing asset is one in which the borrower must make a minimum periodic payment. If that payment is less than the interest on the outstanding loan balance, the shortfall is added to the outstanding loan balance. If the periodic payment is greater than the interest on the outstanding loan balance, then the difference is applied to the reduction of the outstanding loan balance. There is no schedule of principal payments (i.e., no amortization schedule) for a non-amortizing asset.

Consequently, the concept of a prepayment does not apply. Credit card receivables and certain types of home equity loans described later in this chapter are examples of non-amortizing assets.

For an amortizing asset, projection of the cash flows requires projecting prepayments. One factor that may affect prepayments is the prevailing level of interest rates relative to the interest rate on the loan. In projecting prepayments it is critical to estimate the extent to which borrowers are expected to take advantage of a possible decline in interest rates below the loan rate by refinancing the loan.

Modeling defaults for the collateral is critical in estimating the cash flow of an ABS. Proceeds that are recovered in the event of a default of a loan prior to the scheduled principal repayment date of an amortizing asset represent a prepayment. Projecting prepayments for amortizing assets requires an assumption of the default rate and the recovery rate. For a non-amortizing asset, while the concept of a prepayment does not exist, a projection of defaults is still necessary to project how much will be recovered and when.

MAJOR ABS SECTORS

Below we review major sectors of the asset-backed securities market. Exhibit 10.1 presents a Bloomberg screen that summarizes ABS issuance for the period January 1, 1999 through August 22, 2001. The box labeled "Collateral" indicates the dollar amount (billions of dollars) of ABS by type of underlying collateral, which includes credit card receivables (CARD), auto loans (AUTO), home equity loans (HOMEQ), manufactured housing loans (MANUF), and student loans (STDLN). Second, the box labeled "Deal Structure" indicates the dollar amount of ABS by the payment structure and includes sequential (SEQ), controlled amortization structure (CAM), hard bullet and soft bullet (HB/SB), subordinated (SUB), and all others. These different types of payment structures will be discussed later in the chapter. The next box is labeled "Interest Method" and indicates the dollar amount of floating-rate ABS issued versus all other types (e.g., fixed-rate). The final box labeled "Class Rating" shows dollar amount of ABS issuance by credit rating.

Auto Loan-Backed Securities

Auto loan-backed securities are issued by (1) the financial subsidiaries of auto manufacturers (domestic and foreign), (2) commercial banks, and (3) independent finance companies and small financial institutions specializing in auto loans.

EXHIBIT 10.1 Bloomberg Screen of ABS Issuance

Page N159 Mtge IABS

Bloomberg ABS

ABS ISSUANCE
$ Billion 1999-2001

Page 2 of 7

	Aug01	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec	Nov	Oct	Sep	YTD '01	'00	'99
TOTAL	20.3	21.5	35.2	31.5	16.1	47.3	18.9	24.0	27.7	38.7	22.3	33.7	215	293	280
Collateral															
CARD	6.9	2.6	11.7	7.6	2.9	6.1	8.4	5.5	2.7	10.0	4.9	7.3	52	56	44
AUTO	9.4	6.7	6.6	10.8	4.6	11.6	6.1	9.4	7.7	13.9	9.3	7.7	65	87	62
HOMEQ	1.5	8.2	8.2	7.0	3.0	12.5	1.3	5.0	7.0	3.7	2.0	6.8	47	49	61
MANUF	-	-	.5	.2	-	1.3	.4	.3	1.1	.3	.7	.9	3	11	16
STDLN	2.4	.3	1.5	.5	.5	1.8	.1	.0	.2	-	1.0	2.7	7	18	10
OTHER	.1	3.7	6.7	5.4	5.1	14.0	2.7	3.9	9.0	10.7	4.2	8.3	42	74	87
Deal Structure															
SEQ	5.3	6.5	5.6	10.0	4.4	14.8	6.6	9.6	9.5	15.2	6.2	12.1	63	100	103
CAM	-	-	-	-	.5	1.1	-	-	-	-	-	-	2	3	5
HB/SB	8.4	2.2	10.8	7.9	2.6	8.4	6.4	5.0	2.7	9.0	6.7	5.8	52	58	52
"SUB"	1.5	1.5	3.6	2.7	2.1	4.4	1.5	2.7	3.2	4.4	2.7	2.7	20	30	26
Other	5.1	11.3	15.2	10.9	6.5	18.6	4.5	6.7	12.3	10.0	7.4	13.1	79	103	93
Interest Method															
FLT	13.4	12.9	23.3	17.3	9.7	28.5	12.3	14.1	15.2	19.7	15.4	14.9	131	159	131
Other	6.9	8.6	11.8	14.2	6.4	18.8	6.8	9.9	12.6	18.9	7.7	18.8	83	135	149
Class Ratings															
AAA	17.8	13.5	28.9	24.0	11.1	35.3	15.5	18.6	22.4	30.9	17.8	25.5	165	224	210
Other	2.5	8.0	6.2	7.5	5.0	12.0	3.6	5.4	5.3	7.8	5.3	8.2	50	70	70

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Source: Bloomberg Financial Markets

Cash Flow and Prepayments

The cash flow for auto loan-backed securities consists of regularly scheduled monthly loan payments (interest and scheduled principal repayments) and any prepayments. For securities backed by auto loans, prepayments result from (1) sales and tradeins requiring full payoff of the loan, (2) repossession and subsequent resale of the automobile, (3) loss or destruction of the vehicle, (4) payoff of the loan with cash to save on the interest cost, and (5) refinancing of the loan at a lower interest cost.

Prepayments due to repossessions and subsequent resale are sensitive to the economic cycle. In recessionary economic periods, prepayments due to this factor increase. While refinancings may be a major reason for prepayments of mortgage loans, they are of minor importance for automobile loans. Moreover, the interest rates for the automobile loans underlying several issues are substantially below market rates if they are offered by manufacturers as part of a sales promotion.

Prepayments for auto loan-backed securities are measured in terms of the *absolute prepayment speed* (ABS). The ABS is the monthly prepayment expressed as a percentage of the original collateral amount. Recall that the SMM (monthly CPR) expresses prepayments based on the prior month's balance. There is a mathematical relationship between the SMM and the ABS measures.[1]

Payment Structure

There are auto loan-backed deals that are passthrough structures and paythrough structures. A typical passthrough structure for an auto loan-backed deal is as follows:[2]

Tranche	Amount ($)	Average Life (Years)	Coupon Rate
A	$187,050,000	1.87	Fixed
B	18,499,000	1.87	Fixed
IO	6,000,000	1.46	Fixed

In this typical passthrough structure there is a senior tranche (A) and a subordinated tranche (B). There is also an interest-only class. While more deals are structured as passthroughs, this structure is typically used for smaller deals.

Larger deals usually have a paythrough structure. As an illustration, consider auto-loan backed securities issued from the Chase Manhattan Auto Owner Trust 2001-A displayed in the Bloomberg screen in Exhibit 10.2. Note in this typical paythrough structure, the senior pieces are tranched to create a range of average lives. The subordinated piece typically is not tranched.

Credit Card Receivable ABS

Credit cards are originated by banks (e.g., Visa and MasterCard), retailers (e.g., JCPenney and Sears), and travel and entertainment companies (e.g., American Express). Deals are structured as a master trust. With a master trust the issuer can sell several series from the same trust. Each series issued by the master trust shares the cash flow and therefore the credit risk of one pool of credit card receivables of the issuer.

---

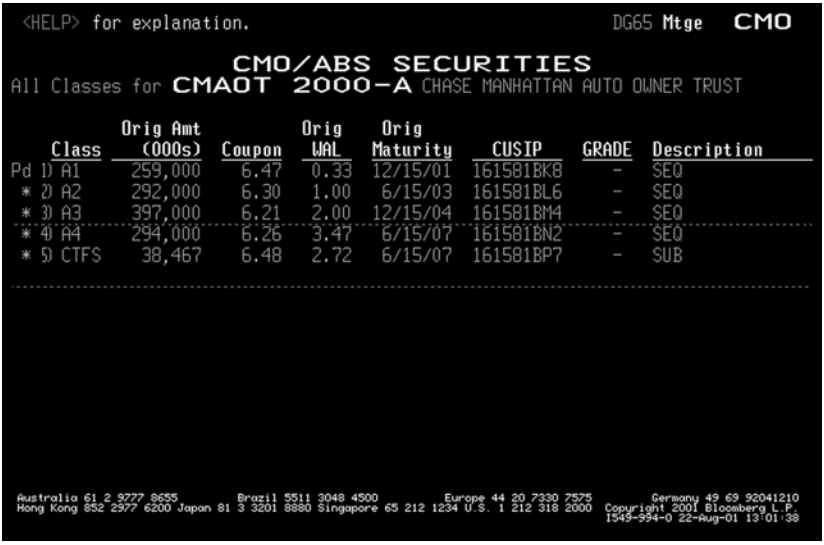
[1] Letting M denote the number of months after loan origination, the SMM rate can be calculated from the ABS rate using the following formula:

$$\text{SMM} = \frac{\text{ABS}}{1 - \text{ABS} \times (M - 1)}$$

where the ABS and SMM rates are expressed in decimal form.

[2] Thomas Zimmerman and Leo Burrell, "Auto Loan-Backed Securities," Chapter 4 in Anand K. Bhattacharya and Frank J. Fabozzi (eds.) *Asset-Backed Securities* (New Hope, PA: Frank J. Fabozzi Associates, 1996).

EXHIBIT 10.2 Bloomberg Screen of Auto Loan-Backed Paythrough Structure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CMO/ABS SECURITIES

All Classes for CMAOT 2000-A CHASE MANHATTAN AUTO OWNER TRUST

	Class	Orig Amt (000s)	Coupon	Orig WAL	Orig Maturity	CUSIP	GRADE	Description
Pd	1) A1	259,000	6.47	0.33	12/15/01	161581BK8	-	SEQ
*	2) A2	292,000	6.30	1.00	6/15/03	161581BL6	-	SEQ
*	3) A3	397,000	6.21	2.00	12/15/04	161581BM4	-	SEQ
*	4) A4	294,000	6.26	3.47	6/15/07	161581BN2	-	SEQ
*	5) CTFS	38,467	6.48	2.72	6/15/07	161581BP7	-	SUB

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Source: Bloomberg Financial Markets

For a pool of credit card receivables, the cash flow consists of finance charges collected, fees, interchange, and principal. Finance charges collected represent the periodic interest the credit card borrower is charged based on the unpaid balance after the grace period. Fees include late payment fees and any annual membership fees. For Visa and MasterCard, a payment is made to originators. This payment is called interchange and is made to the originator for providing funding and accepting risk during the grace period. The principal is the amount of the borrowed funds repaid. Interest to security holders is paid periodically (e.g, monthly, quarterly, or semiannually). The interest rate may be fixed or floating.

A credit card receivable-backed security is a non-amortizing security. For a specified period of time, referred to as the *lockout period* or *revolving period*, the principal payments made by credit card borrowers comprising the pool are retained by the trustee and reinvested in additional receivables. The lockout period can vary from 18 months to 10 years. So, during the lockout period, the cash flow that is paid out is based on finance charges collected and fees. After the lockout period, the principal is no longer reinvested but paid to investors. This period is referred to as the *principal-amortization period.*

There are three different amortization structures that have been used in credit-card receivable-backed security structures: (1) passthrough structure, (2) controlled-amortization structure, and (3) bullet-payment structure.

In a passthrough structure, the principal cash flows from the credit card accounts are paid to the security holders on a pro rata basis. In a *controlled-amortization structure*, a scheduled principal amount is established. The scheduled principal amount is sufficiently low so that the obligation can be satisfied even under certain stress scenarios. The investor is paid the lesser of the scheduled principal amount and the pro rata amount. In a *bullet-payment structure*, the investor receives the entire amount in one distribution. Since there is no assurance that the entire amount can be paid in one lump sum, the procedure is for the trustee to place principal monthly into an account that generates sufficient interest to make periodic interest payments and to accumulate the principal to be repaid. The time period over which the principal is accumulated is called the *accumulation period*. There are two basic types of bullet payments (i.e., soft versus hard) that differ according to steps taken by the issuer to insure investors will receive full payment of principal on the maturity date.[3] With a soft bullet payment, investors rely exclusively on the underlying portfolio's payment speed for full payment of the principal at maturity. So, while the principal funding account is structured to have sufficient funds to pay the entire principal on the bond's expected maturity date, there is no guarantee. Conversely, with a hard bullet payment, the issuer purchases a maturity guarantee to ensure there will be sufficient funds to pay the entire principal on the expected maturity date.

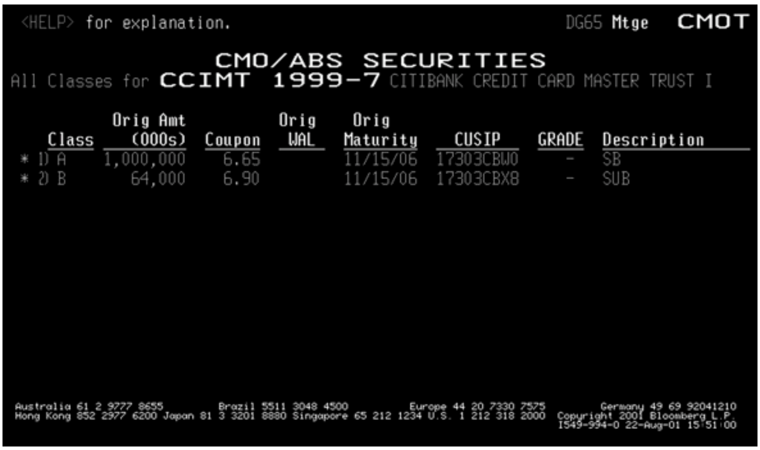
There are provisions in credit card receivable-backed securities that require early amortization of the principal if certain events occur. Such provisions, which are referred to as *early amortization* or *rapid amortization provisions*, are included to safeguard the credit quality of the issue. The only way that the cash flows can be altered is by the triggering of the early amortization provision. When early amortization occurs, the credit card tranches are retired sequentially (i.e., first the AAA bond, then the AA rated bond, and so on).

Exhibit 10.3 presents a Bloomberg screen displaying a credit card receivable structure. The deal consists of two securities (A and B) issued from the Citibank Credit Card Master Trust I, Series 1999-7. Exhibit 10.4 presents a Bloomberg Security Description screen for the senior tranche A. This tranche is rated Aaa and carries a 6.65% coupon rate paid semiannually. Note also that next to WAL (weighted average life) in the center of the screen is an "n.a." or not applicable. This is so because credit card receivables are non-amortizing assets so the concept of a prepayment does not apply. Hence, WAL does not apply. The amortization structure used is

[3] Robert Karr, Greg Richter, R. J. Shook, and Lireen Tsai, "Credit-Card Receivables" Chapter 3 in Anand K. Bhattacharya and Frank J. Fabozzi (eds.), *Asset-Backed Securities* (New Hope, PA: Frank J. Fabozzi Associates, 1996).

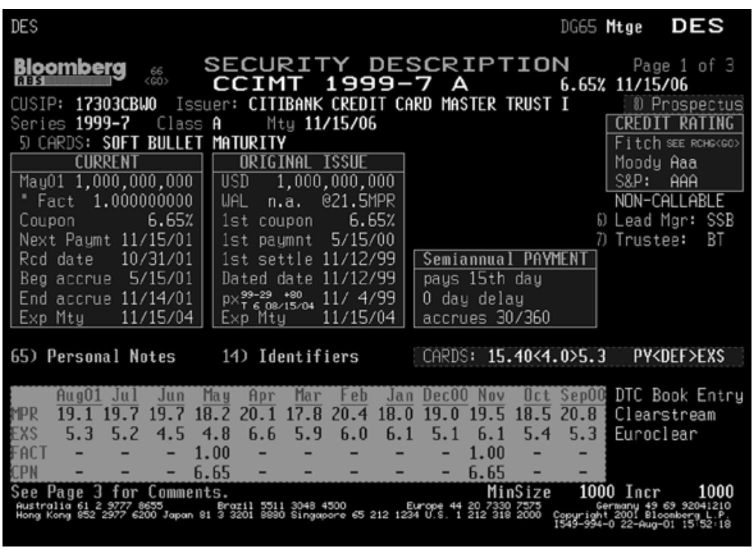
a soft bullet with the principal expected to be paid in a single payment on November 15, 2004. Exhibit 10.5 presents a Bloomberg Security Description screen for the subordinated tranche B. Note that B is rated A2 by Moody's and carries a higher coupon rate of 6.9%.

EXHIBIT 10.3 **Bloomberg Screen of a Credit Card Receivable Deal**



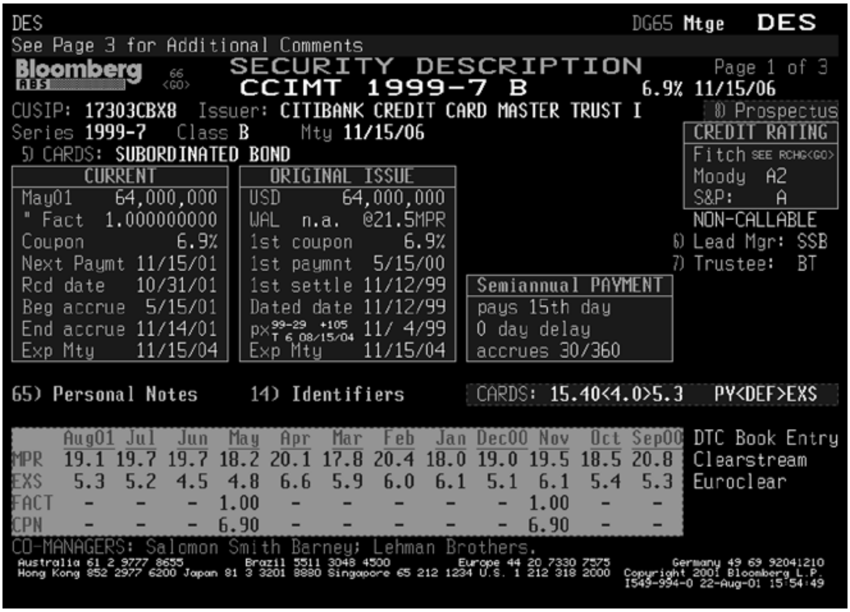
Source: Bloomberg Financial Markets

EXHIBIT 10.4 **Bloomberg Security Description Screen of Credit Card Receivable ABS, Senior Tranche A**



Source: Bloomberg Financial Markets

EXHIBIT 10.5 **Bloomberg Security Description Screen of Credit Card Receivable ABS, Subordinated Tranche B**



Source: Bloomberg Financial Markets

There are several concepts that must be understood in order to assess the performance of the portfolio of receivables and the ability of the issuer to meet its interest obligation and repay principal as scheduled.

We begin with the concept of *gross portfolio yield*. This yield includes finance charges collected and fees. Some issuers include interchange in the computation of portfolio yield. *Charge-offs* represent the accounts charged off as uncollectible. *Net portfolio yield* is equal to gross portfolio yield minus charge-offs. *Delinquencies* are the percentage of receivable that are past due a specified number of months.

The *monthly payment rate* (MPR) expresses the monthly payment (which includes finance charges, fees, and any principal repayment) of a credit card receivable portfolio as a percentage of debt outstanding in the previous month. For example, suppose a $500 million credit card receivable portfolio in January realized $50 million of payments in February. The MPR would then be 10% ($50 million divided by $500 million).

The MPR is an important statistic that is presented to investors in monthly credit card portfolio performance reports. An example is presented in Exhibit 10.6 for four series (1999-A, 1999-B, 1999-C, and 2001-A) from the BA Master Credit Card Trust for July 2001 using Bloomberg's

CCR function. Bloomberg displays monthly credit card portfolio performance reports for the leading credit card ABS issuers. Investors use the data to make assessments about how the underlying collateral is performing and to determine the likelihood that early amortization will be triggered.

MPR is an important indicator for two reasons. With a low level of MPR, extension risk with respect to the principal payments may increase. Also a low MPR, indicating low cash flows to satisfy principal payments, may trigger early amortization of the principal.

Closed-End Home Equity Loan-Backed Securities

A home equity loan (HEL) is a loan backed by residential property. At one time, the loan was typically a second lien on property that has already been pledged to secure a first lien. In some cases, the lien may be a third lien. In recent years, the character of a home equity loan has changed. Today, a home equity loan is often a first lien on property where the borrower has an impaired credit history so that the loan cannot qualify as a conforming loan for Ginnie Mae, Fannie Mae, or Freddie Mac. Typically, the borrower uses a home equity loan to consolidate consumer debt using the current home as collateral rather than to obtain funds to purchase a new home. Borrowers are segmented into four general credit quality groups, A, B, C, and D. There is no standard industrywide criteria for classifying a borrower.

EXHIBIT 10.6 Bloomberg Screen of Monthly Credit Card Portfolio Performance Report

<HELP> for explanation. N159n Mtge CCR

BANK OF AMERICA NA (USA)
BA Master Credit Card Trust - July 2001
Page 2 of 3

Series	1999-A	1999-B	1999-C	2001-A
Investor Interest (MM)	$500	$1000	$500	$800
Securities	Float Rate	Float Rate	Float Rate	Float Rate
Expected Maturity	May, 2004	July, 2002	July, 2006	May, 2006
Excess Spread:				
Gross Portfolio Yield	18.92%	18.92%	18.92%	17.98%
LESS: Base Rate	5.88%	5.88%	5.99%	6.49%
Default Rate	7.37%	7.37%	7.37%	7.45%
Excess Spread: Jul-2001	5.68%	5.67%	5.57%	4.04%
Jun-2001	4.28%	4.27%	4.16%	N/A
May-2001	5.93%	5.93%	5.82%	N/A
3-Mo Average	5.30%	4.29%	5.18%	4.04%
Investor Rate (Average)	4.05%	4.05%	4.16%	4.68%
Servicing Fees	2.00%	2.00%	2.00%	2.00%
30+ Days Delinquency Rate	4.50%	4.50%	4.50%	4.50%
Monthly Payment Rate	15.23%	15.23%	15.23%	15.23%
Seller's Interest	14.36%	14.36%	14.36%	14.36%
Special Notes	Revolving	Revolving	Revolving	Revolving

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Source: Bloomberg Financial Markets

Home equity loans can be either open end or closed end. An open-end home equity loan is discussed in the next section. A closed-end HEL is structured the same way as a fully amortizing residential mortgage loan. That is, it has a fixed maturity and the payments are structured to fully amortize the loan by the maturity date. There are both fixed-rate and variable-rate closed-end HELs. Typically, variable-rate loans have a reference rate of 6-month LIBOR and have periodic caps and lifetime caps, just as the adjustable-rate mortgages discussed in the previous chapter. The cash flow of a pool of closed-end HELs is comprised of interest, regularly scheduled principal repayments, and prepayments, just as with mortgage-backed securities. Thus, it is necessary to have a prepayment model and a default model to forecast cash flows. The prepayment speed is measured in terms of a conditional prepayment rate (CPR).

Cash Flow

The monthly cash flow for a security backed by closed-end HELs is the same as for mortgage-backed securities. That is, the cash flow consists of (1) net interest, (2) regularly scheduled principal payments, and (3) prepayments. The uncertainty about the cash flow arises from prepayments.

Borrower characteristics must be kept in mind when trying to assess prepayments for a particular deal. In the prospectus of an offering, a base case prepayment assumption is made—the initial speed and the amount of time until the collateral is expected to season. Thus, the prepayment benchmark is issue specific and is called the *prospectus prepayment curve* or PPC.

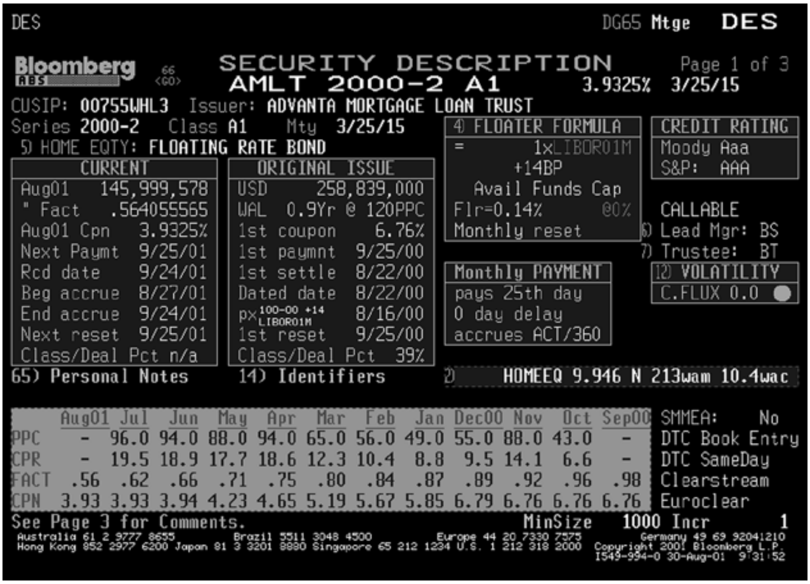
Payment Structure

There are passthrough and paythrough home equity loan-backed structures. Typically, home equity loan-backed securities are securitized by both closed-end fixed-rate and adjustable-rate (or variable-rate) HELs. The securities backed by the latter are called *HEL floaters*. The reference rate of the underlying loans is typically 6-month LIBOR. The cash flow of these loans is affected by periodic and lifetime caps on the loan rate.

To increase the attractiveness of home equity loan-backed securities to short-term investors, the securities typically have been created in which the reference rate is 1-month LIBOR. Because of (1) the mismatch between the reference rate on the underlying loans and that of the HEL floater and (2) the periodic and lifetime caps of the underlying loans, there is an available funds cap on the coupon rate for the HEL floater.

Exhibit 10.7 presents a Bloomberg Security Description screen HEL floater issued from the Advanta Mortgage Loan Trust, Series 2000-2. This floating-rate tranche has a coupon formula of 1-month LIBOR plus 14 basis points with a floor of 14 basis points. This floater also has an available funds cap.

EXHIBIT 10.7 Bloomberg Security Description Screen of a HEL Floater



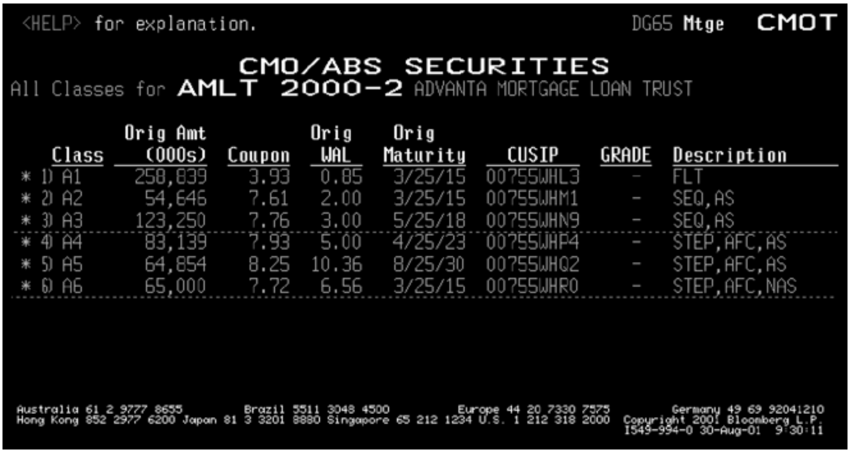
Source: Bloomberg Financial Markets

Tranches have been structured in HEL deals so as to give some senior tranches greater prepayment protection than other senior tranches. The two types of structures that do this are the *planned amortization class* (PAC) *tranche* and *non-accelerating senior* (NAS) *tranche*. In our discussion of CMOs issued by the agencies in the previous chapter we explained how a planned amortization class tranche can be created. These tranches are also created in HEL structures.

A NAS tranche receives principal payments according to a schedule. The schedule is not a dollar amount. Rather, it is a principal schedule that shows for a given month the share of pro rata principal that must be distributed to the NAS tranche. A typical principal schedule for a NAS tranche is as follows:

Months	Share of pro rata principal
1 through 36	0%
37 through 60	45%
61 through 72	80%
73 through 84	100%
After month 84	300%

EXHIBIT 10.8 Bloomberg Screen of a HEL-Backed Deal



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CMO/ABS SECURITIES

All Classes for AMLT 2000-2 ADVANTA MORTGAGE LOAN TRUST

Class	Orig Amt (000s)	Coupon	Orig WAL	Orig Maturity	CUSIP	GRADE	Description
* 1) A1	258,839	3.93	0.85	3/25/15	00755WHL3	-	FLT
* 2) A2	54,646	7.61	2.00	3/25/15	00755WHM1	-	SEQ,AS
* 3) A3	123,250	7.76	3.00	5/25/18	00755WHN9	-	SEQ,AS
* 4) A4	83,139	7.93	5.00	4/25/23	00755WHP4	-	STEP,AFC,AS
* 5) A5	64,854	8.25	10.36	8/25/30	00755WHQ2	-	STEP,AFC,AS
* 6) A6	65,000	7.72	6.56	3/25/15	00755WHR0	-	STEP,AFC,NAS

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Source: Bloomberg Financial Markets

The average life for the NAS tranche is stable for a large range of prepayments because for the first three years all prepayments are made to the other senior tranches. This reduces the risk of the NAS tranche contracting (i.e., shortening) due to fast prepayments. After month 84, 300% of its pro rata share is paid to the NAS tranche thereby reducing its extension risk.

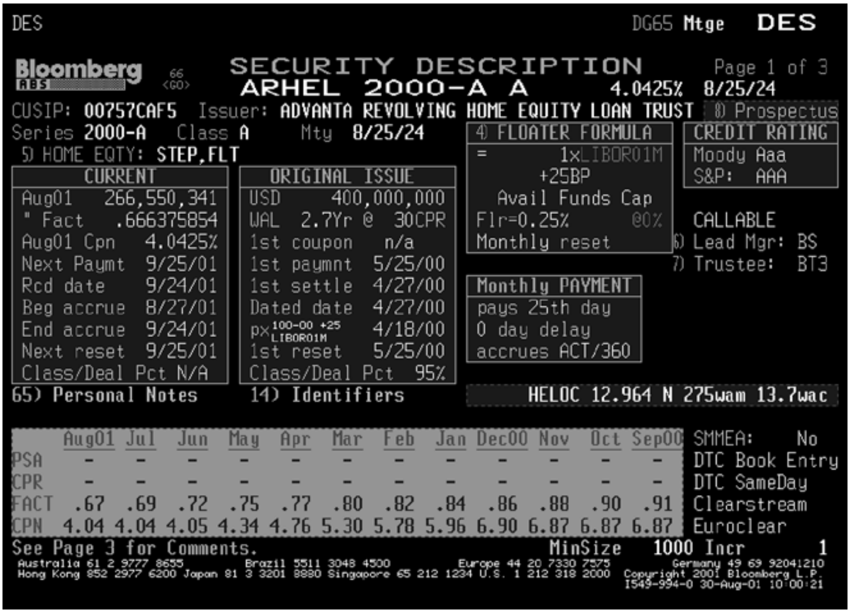
As an illustration, Exhibit 10.8 presents a Bloomberg screen that presents a HEL-backed deal issued by the Advanta Mortgage Loan Trust, Series 2000-2. Note that tranche A6 is the NAS tranche. Moreover, tranches A2 through A5 are accelerated securities (AS) which means simply these tranches receive principal payments faster than the underlying collateral.

Open-End Home Equity Loan-Backed Securities

With an open-end home equity loan (HELOC) the homeowner is given a credit line and can write checks or use a credit card for up to the amount of the credit line. The amount of the credit line depends on the amount of the equity the borrower has in the property.

The revolving period for a HELOC is the period during which the borrower can take down all or part of the line of credit. The revolving period can run from 10 to 15 years. At the end of the revolving period, the HELOC can specify either a balloon payment or an amortization schedule (of up to 10 years). Almost all HELOCs are floating-rate loans. The interest rate paid by HELOC borrowers is typically reset monthly to the prime rate as reported in *The Wall Street Journal* plus a spread.

EXHIBIT 10.9 Bloomberg Security Description Screen of a HELOC Floater



Source: Bloomberg Financial Markets

The securities created in HELOC deals are floating-rate tranches. While the underlying loans are priced based on a spread over the prime rate, the securities created are based on a spread over 1-month LIBOR.

Exhibit 10.9 presents a Bloomberg Security Description screen of a HELOC floating-rate tranche issued from the Advanta Revolving Home Equity Loan Trust, Series 2000-A. This floater has a coupon formula of 1-month LIBOR plus 25 basis points with a floor of 25 basis points. The coupon payments are delivered and reset monthly.

Because HELOCs are for revolving lines, the deal structures are quite different for HELOCs and closed-end HELs. As with other ABS involving revolving credit lines such as credit card deals, there is a revolving period, an amortization period, and a rapid amortization period.

Manufactured Housing-Backed Securities

Manufactured housing-backed securities are backed by loans for manufactured homes. In contrast to site-built homes, manufactured homes are built at a factory and then transported to a manufactured home community or private land. The loan may be either a mortgage loan (for both the land and the home) or a consumer retail installment loan.

Manufactured housing-backed securities are issued by Ginnie Mae and private entities. The former securities are guaranteed by the full faith and credit of the U.S. government. Loans not backed by the FHA or VA are called conventional loans. Manufactured housing-backed securities that are backed by such loans are called conventional manufactured housing-backed securities.

The typical loan for a manufactured home is 15 to 20 years. The loan repayment is structured to fully amortize the amount borrowed. Therefore, as with residential mortgage loans and HELs, the cash flow consists of net interest, regularly scheduled principal, and prepayments. However, prepayments are more stable for manufactured housing-backed securities because they are not sensitive to refinancing.

There are several reasons for this. First, the loan balances are typically small so that there is no significant dollar savings from refinancing. Second, the rate of depreciation of manufactured homes may be such that in the earlier years depreciation is greater than the amount of the loan paid off. This makes it difficult to refinance the loan. Finally, typically borrowers are of lower credit quality and therefore find it difficult to obtain funds to refinance. As with residential mortgage loans and HELs, prepayments on manufactured housing-backed securities are measured in terms of CPR.

The payment structure is the same as with nonagency mortgage-backed securities and home equity loan-backed securities.

As an illustration, Exhibit 10.10 presents a Bloomberg screen of manufactured housing-backed securities issued by Green Tree Financial Corporation, Series 1999-5. In the last column labeled "Description", there may be some abbreviations that require explanation. SEQ means the security is a sequential-pay tranche. AFC means that tranche has an available funds cap, as discussed earlier in the chapter. MEZ stands for a mezzanine bond that provides credit support for the senior tranches but has a higher credit rating than the subordinated (SUB) bonds. Finally, EXE stands for Excess bond, this type of bond receives any cash flows in excess of the amount of principal and interest obligated to all other securities in the structure. Exhibit 10.11 presents a Bloomberg Security Description screen of shortest maturity security (A1). A1 carries a coupon rate of 6.27% and makes payments monthly. Note this security carries a AAA credit rating from Standard & Poor's.

Student Loan-Backed Securities

Student loans are made to cover college costs (undergraduate, graduate, and professional programs such as medical school and law school) and tuition for a wide range of vocational and trade schools. Securities backed by student loans, popularly referred to as SLABS (student loan asset-backed securities), have similar structural features as the other ABS products we discussed.

EXHIBIT 10.10 Bloomberg Screen of Manufactured Housing-Backed Deal

<HELP> for explanation. DG65 Mtge CMOT

CMO/ABS SECURITIES

All Classes for GT 1999-5 GREEN TREE FINANCIAL CORPORATION

	Class	Orig Amt (000s)	Coupon	Orig WAL	Orig Maturity	x = Non-CUSIP	GRADE	Description
* 1)	A1	150,000	6.27	0.90	4/ 1/31	3935053K6	-	SEQ
* 2)	A2	70,000	6.77	2.20	4/ 1/31	3935053L4	-	SEQ
* 3)	A3	110,000	6.97	3.20	4/ 1/31	3935053M2	-	SEQ
* 4)	A4	125,000	7.33	5.00	4/ 1/31	3935053N0	-	SEQ
* 5)	A5	295,000	7.86	11.80	4/ 1/31	3935053P5	-	AFC,SEQ
* 6)	A6	850,000	7.50	6.40	4/ 1/31	393505303	-	AFC,SEQ
* 7)	M1	120,000	8.05	10.00	4/ 1/31	3935053R1	-	MEZ,AFC
* 8)	M2	70,000	8.67	10.00	4/ 1/31	3935053S9	-	MEZ,AFC
* 9)	B1	70,000	9.20	5.40	4/ 1/31	3935053T7	-	SUB,AFC
* 10)	B2	140,000	9.20	12.30	4/ 1/31	3935053U4	-	SUB,AFC
11)	B3I	0	0.00		4/ 1/31	xBCC034EG8	-	SUB,EXE
12)	C	0	0.00		4/ 1/31	xBCC034EI4	-	SUB

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I549-994-0 28-Aug-01 9:51:07

Source: Bloomberg Financial Markets

EXHIBIT 10.11 Bloomberg Security Description Screen Manufactured Housing-Backed Security, Tranche A1

DES DG65 Mtge DES

Bloomberg ABS 66 <GO> SECURITY DESCRIPTION Page 1 of 3

GT 1999-5 A1 6.27% 4/ 1/31

CUSIP: 3935053K6 Issuer: GREEN TREE FINANCIAL CORPORATION

Series 1999-5 Class A1 Mty 4/ 1/31

5) MANUFCT HM: SEQUENTIAL PAYER

CURRENT		ORIGINAL ISSUE	
Aug01	17,716,845	USD	150,000,000
" Fact	.118112301	WAL	0.9Yr @ 175MHP
Coupon	6.27%	1st coupon	6.27%
Next Paymt	9/ 1/01	1st paymnt	10/ 1/99
Rcd date	8/31/01	1st settle	9/15/99
Beg accrue	8/ 1/01	Dated date	9/15/99
End accrue	8/31/01	px 100-00 +40 INTRP EDSF	8/24/99
Class/Deal Pct n/a		Class/Deal Pct 7.5%	

CREDIT RATING
Fitch SEE RCHG<GO>
S&P: AAA

CALLABLE
6) Lead Mgr: LB
7) Trustee: UBN

Monthly PAYMENT
pays 1st day
0 day delay
accrues 30/360

12) VOLATILITY
C.FLUX 0.0

65) Personal Notes 14) Identifiers 2) MANUF 9.724 N 295wam 10.2wac

	Aug01	Jul	Jun	May	Apr	Mar	Feb	Jan	Dec00	Nov	Oct	Sep00
MHP	-	172	165	187	165	133	149	108	117	130	128	118
CPR	-	10.9	10.3	11.8	10.2	7.8	8.7	6.2	6.6	7.2	6.8	6.2
FACT	.12	.17	.22	.28	.33	.37	.42	.45	.49	.53	.57	.60
CPN	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27	6.27

SMMEA: Yes
DTC Book Entry

See Page 3 for Comments. MinSize 1000 Incr 1000

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Source: Bloomberg Financial Markets

The student loans that have been most commonly securitized are those that are made under the Federal Family Education Loan Program (FFELP). Under this program, the government makes loans to students via private lenders. The decision by private lenders to extend a loan to a student is not based on the applicant's ability to repay the loan. If a default of a loan occurs and the loan has been properly serviced, then the government will guarantee up to 98% of the principal plus accrued interest. The federal government has a direct lending program—the Federal Direct Student Loan Program (FDSLP)—in which the Department of Education (DOE) makes loans directly to students; however, these loans are retained by the DOE and not securitized. Loans that are *not* part of a government guarantee program are called *alternative loans*. These loans are basically consumer loans and the lender's decision to extend an alternative loan will be based on the ability of the applicant to repay the loan. Alternative loans have been securitized.

As Congress did with the creation of Fannie Mae and Freddie Mac to provide liquidity in the mortgage market by allowing these entities to buy mortgage loans in the secondary market, it created the Student Loan Marketing Association ("Sallie Mae") as a government-sponsored enterprise to purchase student loans in the secondary market and to securitize pools of student loans. Its first issuance was in 1995. Sallie Mae is now the major issuer of SLABS and its issues are viewed as the benchmark issues. Other entities that issue SLABS are traditional corporate entities (e.g., PNC Bank) and non-profit organizations (Michigan Higher Education Loan Authority and the California Educational Facilities Authority). The SLABS of the latter are typically issued as tax-exempt securities and therefore trade in the municipal market.

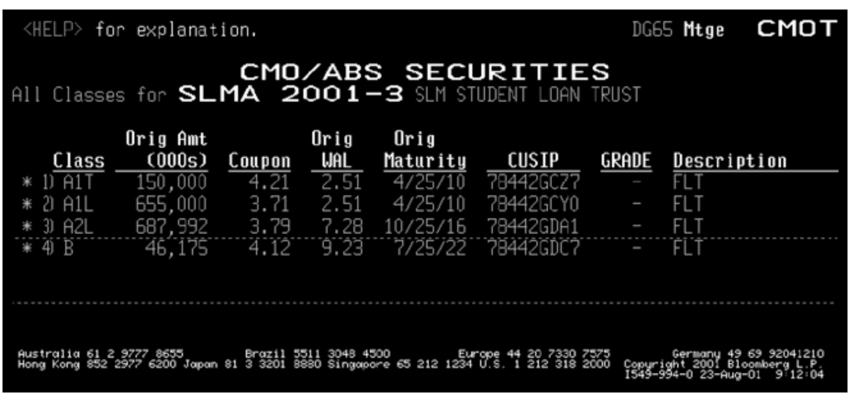
Let's first look at the cash flow for the student loans themselves. There are different types of student loans under the FFELP, including subsidized and unsubsidized Stafford loans, Parental Loans for Undergraduate Students (PLUS), and Supplemental Loans to Students (SLS). These loans involve three periods with respect to the borrower's payments—deferment period, grace period, and loan repayment period. Typically, student loans work as follows. While in school, no payments are made by the student on the loan. This is the deferment period. Upon leaving school, the student is extended a grace period of usually six months when no payments on the loan need to be made. After this period, payments are made on the loan by the borrower.

Prior to July 1, 1998, the reference rate for student loans originated under the FFELP program was the 3-month Treasury bill rate plus a margin of either 250 basis points (during the deferment and grace periods) or 310 basis points (during the repayment period). Since July 1, 1998, the Higher Education Act changed the reference rate to the 10-year Treasury note. The interest rate is the 10-year Treasury note plus 100 basis points. The spread over the reference rate varies with the cycle period for the loan.

As with other ABS, the reference rate need not be the same as that of the underlying loans. For investors in non-Sallie Mae issues, there is exposure to collateral performance due to basis risk discussed earlier in this chapter. Typically, non-Sallie Mae issues have been LIBOR-based floaters. For Sallie Mae issues, there is an indirect government guarantee. Sallie Mae has typically issued SLABS indexed to the 3-month Treasury bill rate. However, late in the second quarter of 1999, Sallie Mae issued bonds in which the buyer of the 2-year tranche had the choice of receiving either LIBOR plus 8 basis points or the 3-month Treasury bill rate plus 87 basis points. There are available funds caps in ABS deals because of the different reference rates.

Exhibit 10.12 presents a Bloomberg screen for SLABS issued by Sallie Mae from the SLM Student Loan Trust 2001-3. As can be seen from the screen, all four tranches are floaters. However, investors have a choice of reference rates in the floater's coupon formula. Specifically, the first tranche A1 is divided into two securities A1T and A1L. Panels A and B of Exhibit 10.13 presents the Bloomberg Security Description screens for these two securities. From the "Floater Formula" box in Panel A, we see that A1T's coupon formula is the 3-month Treasury bill rate plus 65 basis points with a floor of 65 basis points. The coupon is paid quarterly and reset weekly. Conversely from Panel B, we see that A1L's coupon formula is 3-month LIBOR plus 4 basis points with a floor of 4 basis points. The coupon is paid and reset quarterly. The remaining two securities in the deal—A2L and B—both have coupon formulas tied to 3-month LIBOR.

EXHIBIT 10.12 **Bloomberg Screen of a SLABS Deal**


<HELP> for explanation. DG65 Mtge CMOT

CMO/ABS SECURITIES

All Classes for SLMA 2001-3 SLM STUDENT LOAN TRUST

	Class	Orig Amt (000s)	Coupon	Orig WAL	Orig Maturity	CUSIP	GRADE	Description
* 1)	A1T	150,000	4.21	2.51	4/25/10	78442GCZ7	-	FLT
* 2)	A1L	655,000	3.71	2.51	4/25/10	78442GCY0	-	FLT
* 3)	A2L	687,992	3.79	7.28	10/25/16	78442GDA1	-	FLT
* 4)	B	46,175	4.12	9.23	7/25/22	78442GDC7	-	FLT

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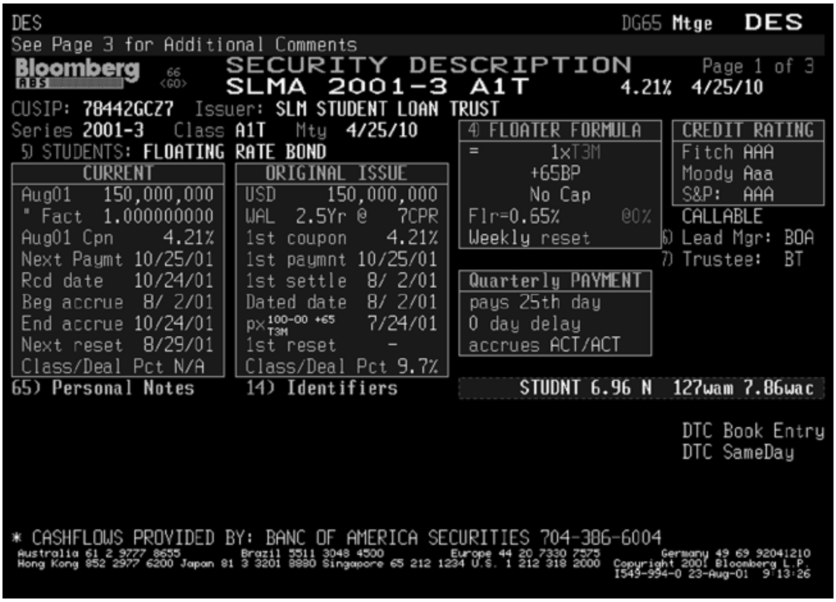
1549-994-0 23-Aug-01 9:12:04

Source: Bloomberg Financial Markets

EXHIBIT 10.13 Bloomberg Security Description Screen of a Sallie Mae SLABS
Panel A: Tranche A1T



DES DG65 Mtge DES
See Page 3 for Additional Comments
Bloomberg ABS 66 <GO> SECURITY DESCRIPTION Page 1 of 3
SLMA 2001-3 A1T 4.21% 4/25/10
CUSIP: 78442GCZ7 Issuer: SLM STUDENT LOAN TRUST
Series 2001-3 Class A1T Mty 4/25/10
5) STUDENTS: FLOATING RATE BOND

CURRENT		ORIGINAL ISSUE	
Aug01	150,000,000	USD	150,000,000
" Fact	1.000000000	WAL	2.5Yr @ 7CPR
Aug01 Cpn	4.21%	1st coupon	4.21%
Next Paymt	10/25/01	1st paymnt	10/25/01
Rcd date	10/24/01	1st settle	8/ 2/01
Beg accrue	8/ 2/01	Dated date	8/ 2/01
End accrue	10/24/01	px 100-00 +65 T3M	7/24/01
Next reset	8/29/01	1st reset	-
Class/Deal Pct	N/A	Class/Deal Pct	9.7%

65) Personal Notes 14) Identifiers

4) FLOATER FORMULA
= 1xT3M
+65BP
No Cap
Flr=0.65% @0%
Weekly reset

CREDIT RATING
Fitch AAA
Moody Aaa
S&P: AAA
CALLABLE
6) Lead Mgr: BOA
7) Trustee: BT

Quarterly PAYMENT
pays 25th day
0 day delay
accrues ACT/ACT

STUDNT 6.96 N 127wam 7.86wac

DTC Book Entry
DTC SameDay

* CASHFLOWS PROVIDED BY: BANC OF AMERICA SECURITIES 704-386-6004
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Panel B: Tranche A1L

DES DG65 Mtge DES
Bloomberg ABS 66 <GO> SECURITY DESCRIPTION Page 1 of 3
SLMA 2001-3 A1L 3.71% 4/25/10
CUSIP: 78442GCY0 Issuer: SLM STUDENT LOAN TRUST
Series 2001-3 Class A1L Mty 4/25/10
5) STUDENTS: FLOATING RATE BOND

CURRENT		ORIGINAL ISSUE	
Aug01	655,000,000	USD	655,000,000
" Fact	1.000000000	WAL	2.5Yr @ 7CPR
Aug01 Cpn	3.71%	1st coupon	3.71%
Next Paymt	10/25/01	1st paymnt	10/25/01
Rcd date	10/24/01	1st settle	8/ 2/01
Beg accrue	8/ 2/01	Dated date	8/ 2/01
End accrue	10/24/01	px 100-00 +4 LIBOR03M	7/24/01
Next reset	10/25/01	1st reset	10/25/01
Class/Deal Pct	N/A	Class/Deal Pct	43%

65) Personal Notes 14) Identifiers

4) FLOATER FORMULA
= 1xLIBOR03M
+4BP
No Cap
Flr=0.04% @0%
Quarterly reset

CREDIT RATING
Fitch AAA
Moody Aaa
S&P: AAA
CALLABLE
6) Lead Mgr: BOA
7) Trustee: BT

Quarterly PAYMENT
pays 25th day
0 day delay
accrues ACT/360

STUDNT 6.96 N 127wam 7.86wac

DTC Book Entry
DTC SameDay

See Page 3 for Comments. MinSize 1000 Incr 1000
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Source: Bloomberg Financial Markets

Prepayments typically occur due to defaults or loan consolidation. Even if there is no loss of principal faced by the investor when defaults occur, the investor is still exposed to contraction risk. This is the risk that the investor must reinvest the proceeds at a lower spread and in the case of a bond purchased at a premium, the premium will be lost. Studies have shown student loan prepayments are insensitive to the level of interest rates. Consolidations of loans occur when the students who have loans over several years combine them into a single loan. The proceeds from the consolidation are distributed to the original lender and, in turn, distributed to the bondholders.

SBA Loan-Backed Securities

The Small Business Administration (SBA) is an agency of the federal government empowered to guarantee loans made by approved SBA lenders to qualified borrowers. The loans are backed by the full faith and credit of the U.S. government. Most SBA loans are variable-rate loans where the reference rate is the prime rate. The rate on the loan is either reset monthly on the first of the month or quarterly on the first of January, April, July, and October. SBA regulations specify the maximum coupon allowable in the secondary market. As of this writing, the maximum coupon rate is equal to the prime rate plus 1.625%. SBA loans typically do not have caps. Newly originated loans have maturities between 5 and 25 years.

The Small Business Secondary Market Improvement Act passed in 1984 permitted the pooling of SBA loans. When pooled, the underlying loans must have similar terms and features. The maturities typically used for pooling loans are 7, 10, 15, 20, and 25 years. Loans without caps are not pooled with loans that have caps.

Most variable-rate SBA loans make monthly payments consisting of interest and principal repayment. The amount of the monthly payment for an individual loan is determined as follows. Given the coupon formula of the prime rate plus the loan's quoted margin, the interest rate is determined. Given the interest rate, a level payment amortization schedule is determined. It is this level payment that is paid for the months until the coupon rate is reset. When variable-rate SBA loans are pooled, the amortization schedule is based on the net pool rate and the rate is recomputed either every month or every quarter.

Prepayments for SBA-backed securities are measured in terms of CPR. Voluntary prepayments can be made by the borrower without any penalty. Exhibit 10.14 presents a Bloomberg screen of the historical CPR for SBA pools (all variable rate pools) for the period January 1991 until August 2001. Even a cursory glance suggests that prepayments vary considerably over time and across pools established in different years. There are several factors contributing to the prepayment speed of a pool of SBA loans. A factor affecting prepayments is the maturity date of the loan. It has been found that the fastest speeds on SBA loans and pools occur for shorter maturities. The purpose of the loan also affects prepayments. There are loans for working capital purposes and loans to finance real estate construction or acquisition. It has been observed that SBA pools with maturities of 10 years or less made for working capital purposes tend to prepay at the fastest speed. In contrast, loans backed by real estate that have long maturities tend to prepay at a slow speed. All other factors constant, pools that have capped loans tend to prepay more slowly than pools of uncapped loans.

EXHIBIT 10.14 Bloomberg Screen of Historical CPR for SBA Pools

Backpage N159 Mtge PSBA

Bloomberg MBS

SBA Pools

Page 2 of 19

Latest Factor: Aug 2001

ALL Variable Rate Pools

Iss.	Num	$Mil			YTD	Calendar Year Historical CPR									
Date	Pool	Cur	Orig	Life	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991
2001	273	1675	1706	3.9	3.9										
2000	426	2677	3099	11.0	13.2	5.8									
1999	443	1961	2723	12.5	17.2	10.7	6.2								
1998	353	1331	2382	15.1	18.9	16.6	12.7	5.8							
1997	427	1079	2580	16.8	20.1	17.5	20.3	12.2	4.9						
1996	392	607	1927	18.0	18.8	17.0	24.8	18.7	10.5	4.8					
1995	349	429	1727	17.9	17.0	17.4	25.6	22.0	14.3	9.9	4.1				
1994	340	399	1943	17.2	18.3	17.1	25.5	22.2	16.1	12.8	7.4	3.2			
1993	379	322	2004	17.4	15.7	17.2	25.8	26.4	15.7	16.2	10.7	5.5	2.8		
1992	389	294	1864	15.2	15.1	16.2	22.5	23.4	15.4	15.1	10.3	9.0	5.1	2.0	
1991	322	199	1395	13.7	16.5	13.9	23.3	18.9	12.6	12.7	10.9	10.5	8.8	7.3	3.2
TOT	4093	****	23349	16.0	16.0	14.2	19.3	17.9	12.9	12.5	9.1	7.3	5.8	5.6	3.2

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I549-994-0 28-Aug-01 10:09:56

Source: Bloomberg Financial Markets

CHAPTER 11

Futures and Forward Rate Agreements

This chapter is the first of two devoted to derivative instruments used by money market participants. The focus of this chapter is on interest rate futures and forward rate agreements while in the next we discuss swaps and caps/floors. In essence, a *derivative instrument* is one that derives its value from some underlying variable or variables. The underlying variables could be the price of a financial asset, an interest rate, the spread between two interest rates, or the amount of snowfall in Aspen, Colorado. Indeed, the possibilities of variables underlying a derivative contract are limitless. We will discuss the forward contracts first and then proceed quickly to a discussion of interest rate futures. In the last section of the chapter, we discuss forward rate agreements.

FORWARD CONTRACTS

A *forward contract* is an over-the-counter agreement between two parties for the future delivery of the underlying at a specified price at the end of a designated time period. The party that assumes the long (short) position is obligated to buy (sell) the underlying at the specified price. The terms of the contract are the product of negotiation between the two parties. As such, a forward contract is specific to the two parties. Although we commonly refer to taking a long position as "buying a forward contract" and conversely taking a short position as "selling a forward contract," this is a misnomer. No money changes hands between the parties at the time the forward contract is established. Both sides are making a promise to engage in a transaction in the future according to terms negotiated upfront.

At expiration, the party with the long position pays the specified price called the *forward price* in exchange for delivery of the underlying from the party with the short position. The payoff of the forward contract for the long position on the expiration date is simply the difference between the price of the underlying minus the forward price. Conversely, the payoff of the forward contract for the short position on the expiration date is the difference between the forward price minus the price of the underlying. Clearly, a forward contract is a zero-sum game. Now that we have introduced forward contracts, it is a short walk to futures contracts.

FUTURES CONTRACTS

A *futures contract* is a legal agreement between a buyer (seller) and an established exchange or its clearinghouse in which the buyer (seller) agrees to take (make) delivery of something at a specified price at the end of designated period. The price at which the parties agree to transact in the future is called the *futures price*. The designated date at which the parties must transact is called the *settlement* or *delivery date*. When a market participant takes a position by buying a futures contract, the individual is said to be in a *long futures position* or to be *long futures*. If, instead, the market participant's opening position is the sale of a futures contract, the investor is said to be in a *short position* or *short futures*.

As can be seen from the description, a futures contract is quite similar to a forward contract. They differ on four dimensions. First, futures contracts are standardized agreements as to the delivery date (or month) and quality of the deliverable. Moreover, because these contracts are standardized, they are traded on organized exchanges. In contrast, forward contracts are usually negotiated individually between buyer and seller and the secondary markets are often nonexistent or extremely thin. Second, an intermediary called a clearinghouse (whose function is discussed shortly) stands between the two counterparties to a futures contract and guarantees their performance. Both parties to a forward contract are subject to *counterparty risk*. Counterparty risk is the risk that the other party to the contract will fail to perform. Third, a futures contract is *marked-to-market* (discussed shortly) while a forward contract may or may not be marked-to-market. Last, although both a futures and forward contract set forth terms of delivery, futures contracts are not intended to be settled by delivery. In fact, generally less than 2% of outstanding contracts are settled by delivery. Forward contracts, on the other hand, are intended for delivery.

Role of the Clearinghouse

Associated with every futures exchange is a *clearinghouse*, which performs several functions. One of these functions is guaranteeing that the two parties to the transaction will perform. When a market participant takes a position in the futures market, the clearinghouse takes the opposite position and agrees to satisfy the terms set forth in the contract. Because of the clearinghouse, the user need not worry about the financial strength and integrity of the counterparty to the contract. After the initial execution of an order, the relationship between the two parties ends. The clearinghouse interposes itself as the buyer for every sale and the seller for every purchase. Thus, users are free to liquidate their positions without involving the other party in the original contract and without concern that the other party may default. This is the reason why we define a futures contract as an agreement between a party and a clearinghouse associated with an exchange. In addition to its guarantee function, the clearinghouse makes it simple for parties to a futures contract to unwind their positions prior to the settlement date.

Margin Requirements

When a position is established in a futures contract, each party must deposit a minimum dollar amount per contract as specified by the exchange in the terms of the contract. This amount, which is called the *initial margin*, is required as deposit by the exchange.[1]

The initial margin may be in the form of an interest-bearing security such as a Treasury bill. In some futures exchanges around the world, other forms of margin are accepted such as common stock, corporate bonds or even letters of credit. As the price of the futures contract fluctuates, the value of the user's equity in the position changes. At the end of each trading day, the exchange determines the *settlement price* of the futures contract which is an average of the prices of the last few trades of the day. This price is used to mark-to-market the user's position, so that any gain or loss from the position is reflected in the investor's margin account.

Maintenance margin is the minimum level (specified by the exchange) to which a user's margin account may fall as a result of an unfavorable price change before the user is required to deposit additional margin. The additional margin deposited is called *variation margin* and it is an amount necessary to bring the margin in the account balance back to its initial margin level. Unlike initial margin, variation margin must be in cash, not interest-bearing instruments. If a party to a

[1] Individual brokerage firms are free to set margin requirements above the minimum established by the exchange.

futures contract receives a margin call and is required to deposit variation margin fails to do so within 24 hours, the futures position is closed out. Conversely, any excess margin may be withdrawn by the user.

Although there are initial and maintenance margin requirements for buying securities on margin, the concept of margin differs for securities and futures. When securities are acquired on margin, the difference between the security's price and the initial margin is borrowed from the broker. The security purchased serves as collateral for the loan and the investor pays interest. For futures contracts, the initial margin, in effect, serves as a performance bond, an indication that the user will be able to satisfy the obligation of the contract. Normally, no money is borrowed.

SHORT-TERM INTEREST RATE FUTURES CONTRACTS

The more actively traded short-term interest futures contracts in the United States and the United Kingdom are described below.

U.S. Treasury Bill Futures

The Treasury bill futures market, which is traded on the International Monetary Market (IMM) of the Chicago Mercantile Exchange, is based on a 13-week (3-month) Treasury bill with a face value of $1 million. More specifically, the seller of a Treasury bill futures contract agrees to deliver to the buyer on the settlement date a Treasury bill with 13 weeks remaining to maturity and a face value of $1 million. The Treasury bill delivered can be newly issued or seasoned. The futures price is the price at which the Treasury bill will be sold by the short and purchased by the long. For example, a Treasury bill futures contract that settles in 3 months requires that 3 months from now the short deliver to the long $1 million face value of a Treasury bill with 13 weeks remaining to maturity. The Treasury bill delivered could be a newly issued 13-week Treasury bill or a seasoned 26-week Treasury bill that has only 13 weeks remaining until maturity.

As explained in Chapter 3, the convention for quoting bids and offers in the secondary market is different for Treasury bills and Treasury coupon securities. Bids/offers on bills are quoted in a special way. Unlike bonds that pay coupon interest, Treasury bill values are quoted on a *bank discount basis*, not on a price basis. The yield on a bank discount basis is computed as follows:

$$Y_d = \frac{D}{F} \times \frac{360}{t}$$

where:

Y_d = annualized yield on a bank discount basis (expressed as a decimal)
D = dollar discount, which is equal to the difference between the face value and the price
F = face value
t = number of days remaining to maturity

Given the yield on a bank discount basis, the price of a Treasury bill is found by first solving the formula for the dollar discount (D), as follows:

$$D = Y_d \times F \times (t/360)$$

The price is then

$$\text{price} = F - D$$

In contrast, the Treasury bill futures contract is quoted not directly in terms of yield, but instead on an index basis that is related to the yield on a bank discount basis as follows:

$$\text{Index price} = 100 - (Y_d \times 100)$$

For example, if Y_d is 1.77%, the index price is

$$100 - (0.0177 \times 100) = 98.23$$

Given the index price of the futures contract, the yield on a bank discount basis for the futures contract is determined as follows:

$$Y_d = \frac{100 - \text{Index price}}{100}$$

To illustrate how this works, let's use Bloomberg's Futures Contract Description screen presented in Exhibit 11.1. This 3-month U.S. Treasury bill futures contract began trading on June 19, 2001 and expires on March 18, 2002. On December 19, 2001, the index price was 98.230, which is labeled as "Contract Price" and is located on the left-hand side of the screen. The yield on a bank discount basis for this Treasury bill futures contract is:

$$Y_d = \frac{100 - 98.230}{100} = 0.0177 \text{ or } 1.77\%$$

The invoice price that the buyer of \$1 million face value of 13-week Treasury bills must pay at settlement is found by first computing the dollar discount, as follows:

$$D = Y_d \times \$1{,}000{,}000 \times t\,/360$$

where t is either 90 or 91 days.

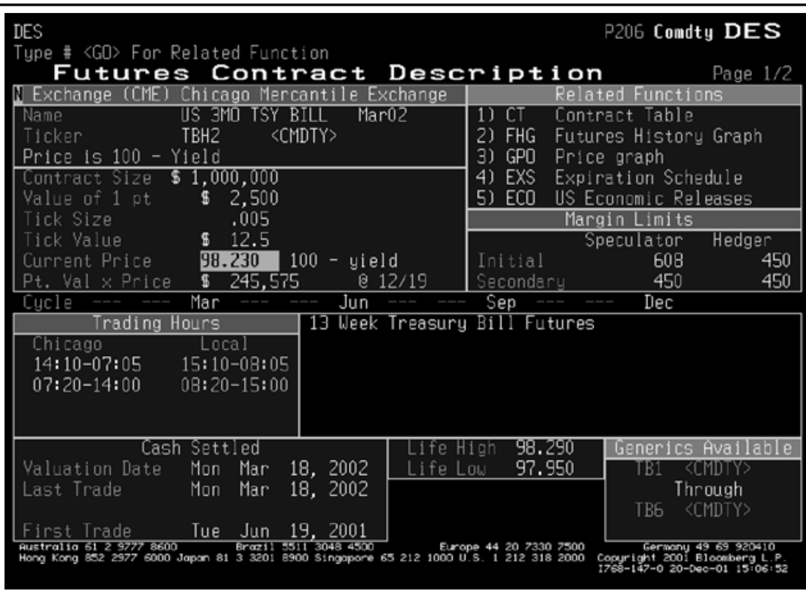
Typically, the number of days to maturity of a 13-week Treasury bill is 91 days. The invoice price is then:

$$\text{Invoice price} = \$1{,}000{,}000 - D$$

For example, if the index price is 98.230 (and a yield on a bank discount basis of 1.77%), the dollar discount for the 13-week Treasury bill to be delivered with 91 days to maturity is:

$$D = 0.0177 \times \$1{,}000{,}000 \times 91/360 = \$4{,}474.167$$

EXHIBIT 11.1 **Bloomberg Futures Contract Description Screen for a U.S. Treasury Bill Futures Contract**



Source: Bloomberg Financial Markets

The invoice price is:

$$\text{Invoice price} = \$1,000,000 - \$4,474.167 = \$995,525.833$$

The minimum index price fluctuation or "tick" for this futures contract is 0.005. A change of 0.005 for the minimum index price translates into a change in the yield on a bank discount basis of one-half of a basis point (0.00005). A one-half basis point change results in a change in the invoice price as follows:

$$0.00005 \times \$1,000,000 \times t/360$$

For a 13-week Treasury bill with 91 days to maturity, the change in the dollar discount is:

$$0.00005 \times \$1,000,000 \times 91/360 = \$12.639$$

For a 13-week Treasury bill with 90 days to maturity, the change in the dollar discount would be \$12.50. Despite the fact that a 13-week Treasury bill usually has 91 days to maturity, market participants commonly refer to the value of a tick for this futures contract as \$12.50. As evidence of this, on the left side of Exhibit 11.1, the "Tick Value" is \$12.50.

Eurodollar CD Futures

As discussed in Chapter 6, Eurodollar certificates of deposit (CDs) are denominated in dollars but represent the liabilities of banks outside the United States. The contracts are traded on the International Monetary Market of the Chicago Mercantile Exchange and the London International Financial Futures Exchange (LIFFE). As noted several times in the book, the rate paid on Eurodollar CDs is the London interbank offered rate (LIBOR).

The 3-month (90 day) Eurodollar CD is the underlying instrument for the Eurodollar CD futures contract. Exhibit 11.2 presents the Bloomberg Futures Contract Description screen for the April 2002 contract. As with the Treasury bill futures contract, this contract is for \$1 million of face value and is traded on an index price basis. The index price basis in which the contract is quoted is equal to 100 minus the annualized futures LIBOR. For example, a Eurodollar CD futures price of 98.00 means a futures 3-month LIBOR of 2%.

The minimum price fluctuation (tick) for this contract is 0.005 or ½ basis point. This means that the tick value for this contract is \$12.50, which is determined as follows:

$$\text{tick value} = \$1{,}000{,}000 \times (0.005 \times 90/360)$$

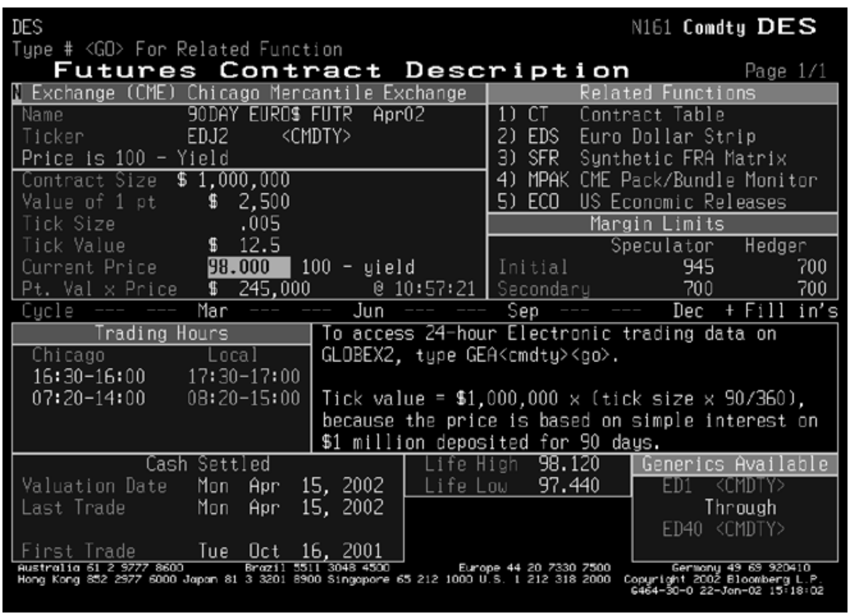
$$\text{tick value} = \$12.50$$

This expression appears in the lower right-hand corner of Exhibit 11.2.

The Eurodollar CD futures contract is a cash settlement contract. Specifically, the parties settle in cash for the value of a Eurodollar CD based on LIBOR at the settlement date. The Eurodollar CD futures contract is one of the most heavily traded futures contracts in the world. Exhibit 11.3 presents Bloomberg's Contract Table screen for the active 90-day Eurodollar CD futures contracts on January 22, 2002. Note the very large open interest for March, June, September, and December 2002 contracts.[2]

The Eurodollar CD futures contract is used frequently to trade the short end of the yield curve and many hedgers believe this contract to be the best hedging vehicle for a wide range of hedging situations.

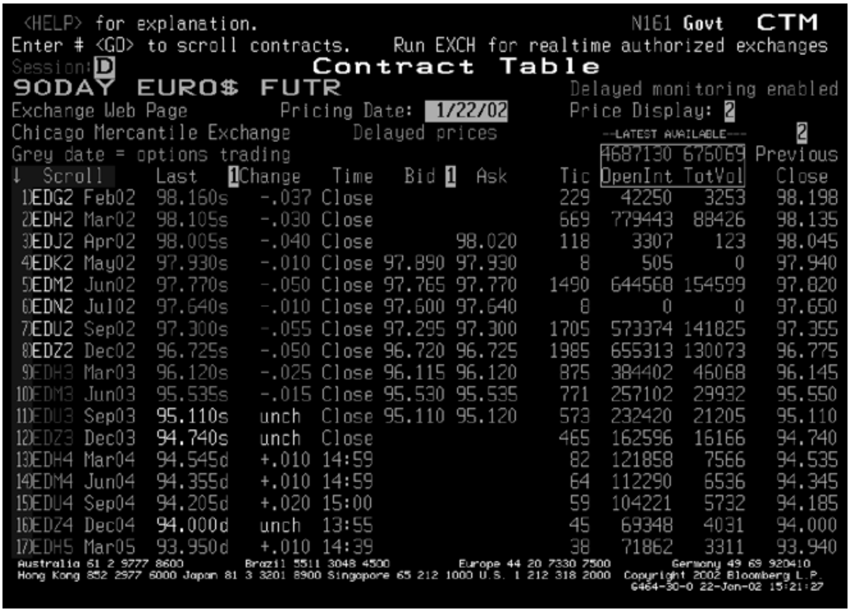
EXHIBIT 11.2 **Bloomberg Futures Contract Description Screen for a Eurodollar CD Futures Contract**



Source: Bloomberg Financial Markets

[2] Open interest is the number of futures contracts established that have yet to be offset.

EXHIBIT 11.3 Bloomberg Contract Table for a Eurodollar CD Futures Contract



<HELP> for explanation. N161 Govt CTM
Enter # <GO> to scroll contracts. Run EXCH for realtime authorized exchanges
Session: D **Contract Table**
90DAY EURO$ FUTR Delayed monitoring enabled
Exchange Web Page Pricing Date: 1/22/02 Price Display: 2
Chicago Mercantile Exchange Delayed prices --LATEST AVAILABLE--- 2
Grey date = options trading 4687130 676069

↓ Scroll		Last	1 Change	Time	Bid 1	Ask	Tic	OpenInt	TotVol	Previous Close
1) EDG2	Feb02	98.160s	-.037	Close			229	42250	3253	98.198
2) EDH2	Mar02	98.105s	-.030	Close			669	779443	88426	98.135
3) EDJ2	Apr02	98.005s	-.040	Close		98.020	118	3307	123	98.045
4) EDK2	May02	97.930s	-.010	Close	97.890	97.930	8	505	0	97.940
5) EDM2	Jun02	97.770s	-.050	Close	97.765	97.770	1490	644568	154599	97.820
6) EDN2	Jul02	97.640s	-.010	Close	97.600	97.640	8	0	0	97.650
7) EDU2	Sep02	97.300s	-.055	Close	97.295	97.300	1705	573374	141825	97.355
8) EDZ2	Dec02	96.725s	-.050	Close	96.720	96.725	1985	655313	130073	96.775
9) EDH3	Mar03	96.120s	-.025	Close	96.115	96.120	875	384402	46068	96.145
10) EDM3	Jun03	95.535s	-.015	Close	95.530	95.535	771	257102	29932	95.550
11) EDU3	Sep03	95.110s	unch	Close	95.110	95.120	573	232420	21205	95.110
12) EDZ3	Dec03	94.740s	unch	Close			465	162596	16166	94.740
13) EDH4	Mar04	94.545d	+.010	14:59			82	121858	7566	94.535
14) EDM4	Jun04	94.355d	+.010	14:59			64	112290	6536	94.345
15) EDU4	Sep04	94.205d	+.020	15:00			59	104221	5732	94.185
16) EDZ4	Dec04	94.000d	unch	13:55			45	69348	4031	94.000
17) EDH5	Mar05	93.950d	+.010	14:39			38	71862	3311	93.940

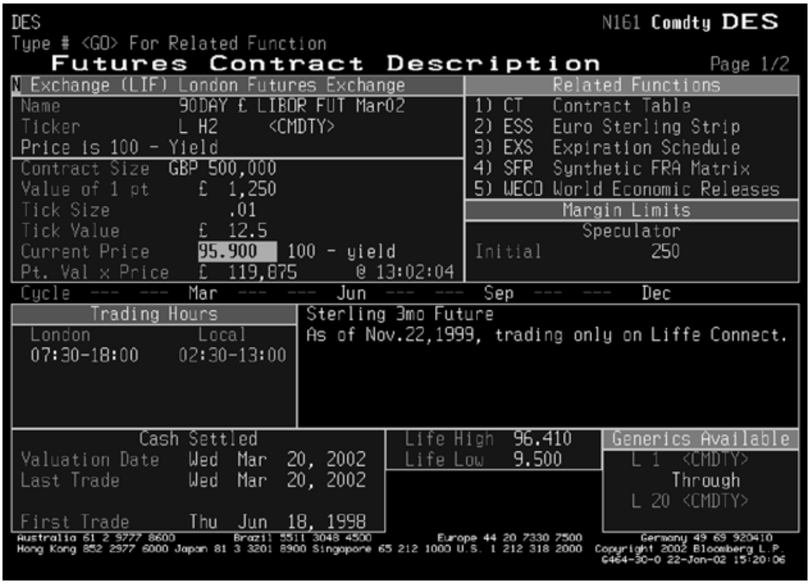
Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 212 1000 U.S. 1 212 318 2000 Copyright 2002 Bloomberg L.P.
6464-30-0 22-Jan-02 15:21:27

Source: Bloomberg Financial Markets

The 90-day sterling Libor interest rate futures contract trades on the main London futures exchange, LIFFE. The contract is structured similarly to the Eurodollar futures contract described above. The Bloomberg Futures Contract Description screen for the March 2002 contract is presented in Exhibit 11.4. Prices are quoted as 100 minus the interest rate and the delivery months are March, June, September, and December. The contract size is £500,000. A tick is 0.01 or one basis point and the tick value is £12.5. Exhibit 11.5 presents a Bloomberg screen with settlement prices of the near-term 90-day sterling LIBOR contract on January 22, 2002.

The LIFFE exchange also trades short-term interest rate futures for other major currencies including euros, yen, and Swiss franc. For example, Exhibit 11.6 presents a Bloomberg Futures Contract Description screen for the June 2002 90-day Euro Euribor contract. Short-term interest rate contracts in other currencies are similar to the 90-day sterling Libor contract and trade on exchanges such as Deutsche Terminbourse in Frankfort and MATIF in Paris.

EXHIBIT 11.4 Bloomberg Futures Contract Description Screen for a 90-Day Sterling Libor Contract



DES N161 Comdty DES
Type # <GO> For Related Function
Futures Contract Description Page 1/2

N Exchange (LIF) London Futures Exchange
Name 90DAY £ LIBOR FUT Mar02
Ticker L H2 <CMDTY>
Price is 100 - Yield
Contract Size GBP 500,000
Value of 1 pt £ 1,250
Tick Size .01
Tick Value £ 12.5
Current Price 95.900 100 - yield
Pt. Val x Price £ 119,875 @ 13:02:04

Related Functions
1) CT Contract Table
2) ESS Euro Sterling Strip
3) EXS Expiration Schedule
4) SFR Synthetic FRA Matrix
5) WECO World Economic Releases

Margin Limits
Speculator
Initial 250

Cycle --- --- Mar --- --- Jun --- --- Sep --- --- Dec

Trading Hours
London Local
07:30-18:00 02:30-13:00

Sterling 3mo Future
As of Nov.22,1999, trading only on Liffe Connect.

Cash Settled
Valuation Date Wed Mar 20, 2002
Last Trade Wed Mar 20, 2002
First Trade Thu Jun 18, 1998

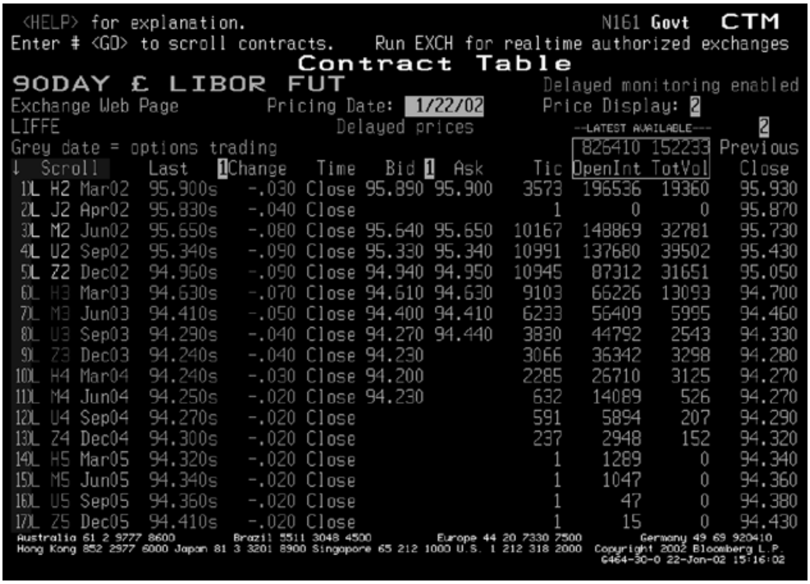
Life High 96.410
Life Low 9.500

Generics Available
L 1 <CMDTY>
Through
L 20 <CMDTY>

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 212 1000 U.S. 1 212 318 2000 Copyright 2002 Bloomberg L.P.
G464-30-0 22-Jan-02 15:20:06

Source: Bloomberg Financial Markets

EXHIBIT 11.5 Bloomberg Contract Table for the 90-Day Sterling Libor Contracts



<HELP> for explanation. N161 Govt CTM
Enter # <GO> to scroll contracts. Run EXCH for realtime authorized exchanges
Contract Table
90DAY £ LIBOR FUT Delayed monitoring enabled
Exchange Web Page Pricing Date: 1/22/02 Price Display: 2
LIFFE Delayed prices --LATEST AVAILABLE--- 2
Grey date = options trading 826410 152233 Previous

↓ Scroll	Last	1 Change	Time	Bid 1	Ask	Tic	OpenInt	TotVol	Close
1) L H2 Mar02	95.900s	-.030	Close	95.890	95.900	3573	196536	19360	95.930
2) L J2 Apr02	95.830s	-.040	Close			1	0	0	95.870
3) L M2 Jun02	95.650s	-.080	Close	95.640	95.650	10167	148869	32781	95.730
4) L U2 Sep02	95.340s	-.090	Close	95.330	95.340	10991	137680	39502	95.430
5) L Z2 Dec02	94.960s	-.090	Close	94.940	94.950	10945	87312	31651	95.050
6) L H3 Mar03	94.630s	-.070	Close	94.610	94.630	9103	66226	13093	94.700
7) L M3 Jun03	94.410s	-.050	Close	94.400	94.410	6233	56409	5995	94.460
8) L U3 Sep03	94.290s	-.040	Close	94.270	94.440	3830	44792	2543	94.330
9) L Z3 Dec03	94.240s	-.040	Close	94.230		3066	36342	3298	94.280
10) L H4 Mar04	94.240s	-.030	Close	94.200		2285	26710	3125	94.270
11) L M4 Jun04	94.250s	-.020	Close	94.230		632	14089	526	94.270
12) L U4 Sep04	94.270s	-.020	Close			591	5894	207	94.290
13) L Z4 Dec04	94.300s	-.020	Close			237	2948	152	94.320
14) L H5 Mar05	94.320s	-.020	Close			1	1289	0	94.340
15) L M5 Jun05	94.340s	-.020	Close			1	1047	0	94.360
16) L U5 Sep05	94.360s	-.020	Close			1	47	0	94.380
17) L Z5 Dec05	94.410s	-.020	Close			1	15	0	94.430

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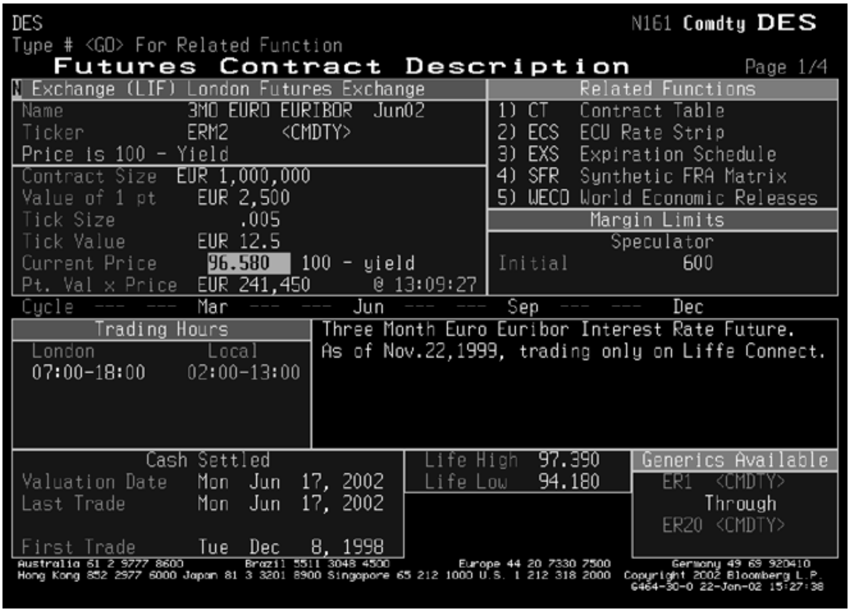
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 212 1000 U.S. 1 212 318 2000 Copyright 2002 Bloomberg L.P.
G464-30-0 22-Jan-02 15:16:02

Source: Bloomberg Financial Markets

EXHIBIT 11.6 Bloomberg Futures Contract Description Screen for the 90-Day Euro Euribor Contract



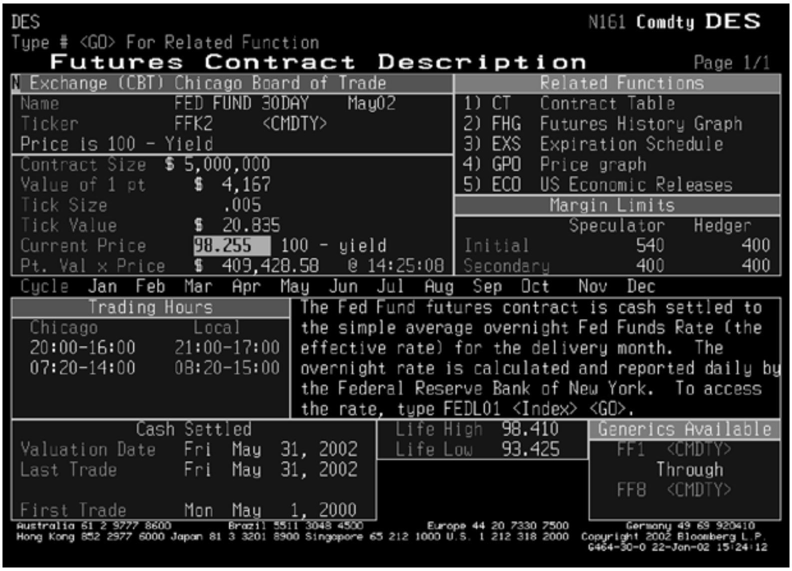
Source: Bloomberg Financial Markets

Fed Funds Futures Contract

When the Federal Reserve formulates and executes monetary policy, the federal funds rate is frequently a significant operating target. Accordingly, the federal funds rate is a key short-term interest rate. The fed funds futures contract is designed for hedgers who have exposure to this rate or speculators who want to make a bet on the direction of U.S. monetary policy. Underlying this contract is the simple average overnight federal funds rate (i.e., the effective rate) for the delivery month. As such, this contract is settled in cash.

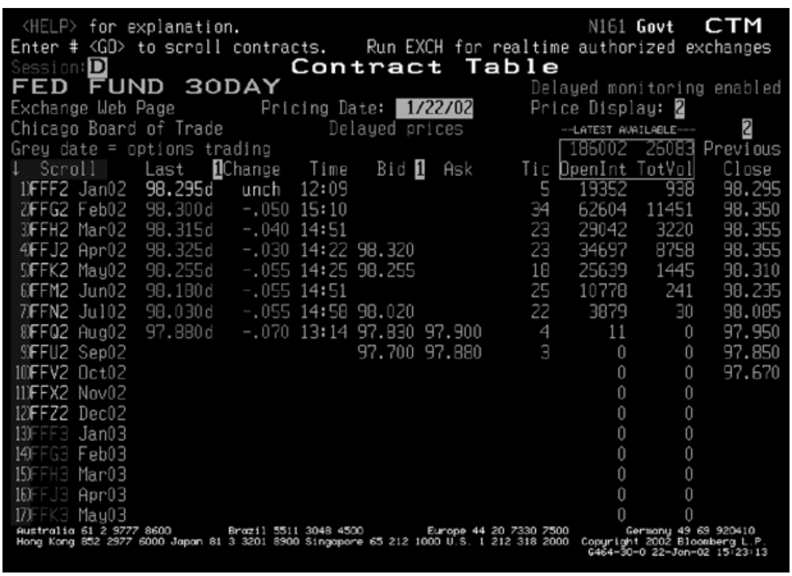
Exhibit 11.7 presents the Bloomberg Futures Contract Description screen for the May 2002 fed funds futures contract. The contract size is $5,000,000 and the tick size is 0.005 or ½ basis point. Accordingly, the tick value is 20.835. Just as the other short-term interest futures contracts discussed above, prices are quoted as 100—the interest rate. Exhibit 11.8 presents the Bloomberg Contract Table screen for the active fed funds futures contracts on January 22, 2002.

EXHIBIT 11.7 Bloomberg Futures Contract Description Screen for the Federal Funds Futures Contract



Source: Bloomberg Financial Markets

EXHIBIT 11.8 Bloomberg Contract Table for the Federal Funds Futures Contract



Source: Bloomberg Financial Markets

FORWARD RATE AGREEMENTS

A *forward rate agreement* (FRA) is an over-the-counter derivative instrument that trades as part of the money markets. In essence, an FRA is a forward-starting loan, but with no exchange of principal, so the cash exchanged between the counterparties depend only on the difference in interest rates. While the FRA market is truly global, much business is transacted in London. Trading in FRAs began in the early 1980s and the market now is large and liquid. According to the British Bankers Association, turnover in London exceeds $5 billion each day.

In effect an FRA is a forward dated loan, transacted at a fixed rate, but with no exchange of principal—only the interest applicable on the notional amount between the rate agreed to when the contract is established and the actual rate prevailing at the time of settlement changes hands. For this reason, FRAs are off-balance sheet instruments. By trading today at an interest rate that is effective at some point in the future, FRAs enable banks and corporations to hedge forward interest rate exposure. Naturally, they are also used to speculate on the level of future interest rates.

FRA Basics

An FRA is an agreement to borrow or lend a notional cash sum for a period of time lasting up to 12 months, starting at any point over the next 12 months, at an agreed rate of interest (the FRA rate). The "buyer" of a FRA is borrowing a notional sum of money while the "seller" is lending this cash sum. Note how this differs from all other money market instruments. In the cash market, the party buying a CD, Treasury bill, or bidding for bond in the repo market, is the lender of funds. In the FRA market, to "buy" is to "borrow." Of course, we use the term "notional" because with an FRA no borrowing or lending of cash actually takes place. The notional sum is simply the amount on which interest payment is calculated (i.e., a scale factor).

Accordingly, when a FRA is traded, the buyer is borrowing (and the seller is lending) a specified notional sum at a fixed rate of interest for a specified period, the "loan" to commence at an agreed date in the future. The buyer is the notional borrower, and so if there is a rise in interest rates between the date that the FRA is traded and the date that the FRA comes into effect, she will be protected. If there is a fall in interest rates, the buyer must pay the difference between the rate at which the FRA was traded and the actual rate, as a percentage of the notional sum. The buyer may be using the FRA to hedge an actual exposure, that is an actual borrowing of money, or simply speculating on a rise in interest rates. The counterparty to the transaction, the seller of the FRA, is the notional lender of funds, and has fixed the rate for lending funds. If there is a fall in interest rates, the seller will gain, and if there is a rise in rates, the seller will pay. Again, the seller may have an actual loan of cash to hedge or is acting as a speculator.

In FRA trading, only the payment that arises because of the difference in interest rates changes hands. There is no exchange of cash at the time of the trade. The cash payment that does arise is the difference in interest rates between that at which the FRA was traded and the actual rate prevailing when the FRA matures, as a percentage of the notional amount. FRAs are traded by both banks and corporations. The FRA market is liquid in all major currencies and rates are readily quoted on screens by both banks and brokers. Dealing is over the telephone or over a dealing system such as Reuters.

The terminology quoting FRAs refers to the borrowing time period and the time at which the FRA comes into effect (or matures). Hence if a buyer of a FRA wished to hedge against a rise in rates to cover a 3-month loan starting in three months' time, she would transact a "3-against-6 month" FRA, or more usually denoted as a 3×6 or 3v6 FRA. This is referred to in the market as a "threes-sixes" FRA, and means a 3-month loan beginning in three months' time. So correspondingly, a "ones-fours" FRA (1v4) is a 3-month loan in one month's time, and a "three-nines" FRA (3v9) is a 6-month loan in three months' time.

As an illustration, suppose a corporation anticipates it will need to borrow in six months time for a 6-month period. It can borrow today at 6-month LIBOR plus 50 basis points. Assume that 6-month LIBOR rates are 4.0425% but the corporation's treasurer expects rates to go up to about 4.50% over the next several weeks. If the treasurer's suspicion is correct, the corporation will be forced to borrow at higher rates unless some sort of hedge is put in place to protect the borrowing requirement. The treasurer elects to buy a 6v12 FRA to cover the 6-month period beginning six months from now. A bank quotes 4.3105% for the FRA, which the corporation buys for a £1,000,000 notional principal. Suppose that six months from now, 6-month LIBOR has indeed backed-up to 4.50%, so the treasurer must borrow funds at 5% (LIBOR plus the 50 basis point spread). However, offsetting this rise in rates, the corporation will receive a settlement amount which will be the difference between the rate at which the FRA was bought (4.3105%) and today's 6-month LIBOR rate (4.50%) as a percentage of the notional principal of £1,000,000. This payment will compensate for some of the increased borrowing costs.

FRA Mechanics

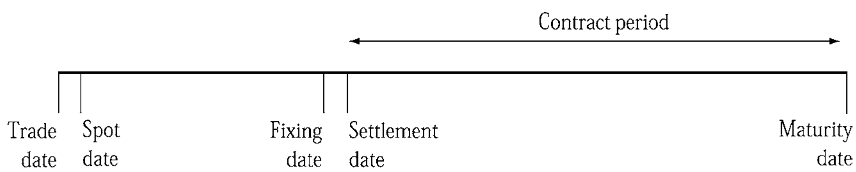
In virtually every market, FRAs trade under a set of terms and conventions that are identical. The British Bankers Association (BBA) has compiled standard legal documentation to cover FRA trading. The following standard terms are used in the market.

- *Notional sum:* The amount for which the FRA is traded.
- *Trade date:* The date on which the FRA is transacted.
- *Settlement date:* The date on which the notional loan or deposit of funds becomes effective, that is, is said to begin. This date is used, in conjunction with the notional sum, for calculation purposes only as no actual loan or deposit takes place.
- *Fixing date:* This is the date on which the reference rate is determined, that is, the rate to which the FRA rate is compared.
- *Maturity date:* The date on which the notional loan or deposit expires.
- *Contract period:* The time between the settlement date and maturity date.
- *FRA rate:* The interest rate at which the FRA is traded.
- *Reference rate:* This is the rate used as part of the calculation of the settlement amount, usually the Libor rate on the fixing date for the contract period in question.
- *Settlement sum:* The amount calculated as the difference between the FRA rate and the reference rate as a percentage of the notional sum, paid by one party to the other on the settlement date.

These key dates are illustrated in Exhibit 11.9.

The spot date is usually two business days after the trade date, however it can by agreement be sooner or later than this. The settlement date will be the time period after the spot date referred to by the FRA terms: for example a 1×4 FRA will have a settlement date one calendar month after the spot date. The fixing date is usually two business days before the settlement date. The settlement sum is paid on the settlement date, and as it refers to an amount over a period of time that is paid up front (i.e., at the start of the contract period), the calculated sum is a discounted present value. This is because a normal payment of interest on a loan/deposit is paid at the end of the time period to which it relates; because an FRA makes this payment at the start of the relevant period, the settlement amount is a discounted present value sum. With most FRA trades, the reference rate is the LIBOR setting on the fixing date.

EXHIBIT 11.9 Key Dates in a FRA Trade



The settlement sum is calculated after the fixing date, for payment on the settlement date. We can illustrate this with a hypothetical example. Consider a case where a corporation has bought £1 million notional of a 1×4 FRA, and transacted at 5.75%, and that the market rate is 6.50% on the fixing date. The contract period is 90 days. In the cash market the extra interest charge that the corporate would pay is a simple interest calculation, and is:

$$\text{extra interest charge} = \frac{6.50 - 5.75}{100} \times £1{,}000{,}000 \times (91/365) = £1{,}869.86$$

Note that in the U.S. money market, a 360 day year is assumed rather than the 365 day year used in the UK money market.

This extra interest that the corporation is facing would be payable with the interest payment for the loan, which (as it is a money market loan) is paid when the loan matures. Under a FRA then, the settlement sum payable should, if it was paid on the same day as the cash market interest charge, be exactly equal to this. This would make it a perfect hedge. As we noted above though, FRA settlement value is paid at the start of the contract period, that is, the beginning of the underlying loan and not the end. Therefore, the settlement sum has to be adjusted to account for this, and the amount of the adjustment is the value of the interest that would be earned if the unadjusted cash value were invested for the contract period in the money market. The settlement value is given by the following expression:

$$\text{settlement value} = \frac{(r_{\text{ref}} - r_{\text{FRA}}) \times M \times (n/B)}{1 + [r_{\text{ref}} \times (n/B)]}$$

where

r_{ref} = the reference interest fixing rate
r_{FRA} = the FRA rate or contract rate
M = the notional value
n = the number of days in the contract period
B = the day-count basis (360 or 365).

The expression for the settlement value above simply calculates the extra interest payable in the cash market, resulting from the difference between the two interest rates, and then discounts the amount because it is payable at the start of the period and not, as would happen in the cash market, at the end of the period.

In our hypothetical illustration, as the fixing rate is higher than the contract rate, the buyer of the FRA receives the settlement sum from the seller. This payment compensates the buyer for the higher borrowing costs that they would have to pay in the cash market. If the fixing rate had been lower than 5.75%, the buyer would pay the difference to the seller, because the cash market rates will mean that they are subject to a lower interest rate in the cash market. What the FRA has done is hedge the interest rate exposure, so that whatever happens in the market, the buyer will pay 5.75% on its borrowing.

A market maker in FRAs is trading short-term interest rates. The settlement sum is the value of the FRA. The concept is exactly as with trading short-term interest-rate futures; a trader who buys a FRA is running a long position, so that if on the fixing date the reference rate is greater than the contract rate then the settlement sum is positive and the trader realizes a profit. What has happened is that the trader, by buying the FRA, "borrowed" money at the FRA rate, which subsequently rose. This is a gain, exactly like a short position in an interest rate futures contract, where if the price goes down (that is, interest rates go up), the trader realizes a gain. Conversely, a "short" position in a FRA which is accomplished by selling a FRA realizes a gain if on the fixing date the reference rate is less than the FRA rate.

FRA Pricing

FRAs are forward rate instruments and are priced using standard forward rate principles.[3] Consider an investor who has two alternatives, either a 6-month investment at 5% or a 1-year investment at 6%. If the investor wishes to invest for six months and then rollover the investment for a further six months, what rate is required for the rollover period such that the final return equals the 6% available from the 1-year investment? If we view a FRA rate as the break-even forward rate between the two periods, we simply solve for this forward rate and that is our approximate FRA rate.

In practice, FRAs are priced off the exchange-traded short-term interest rate futures for that currency. For this reason, the contract rates (FRA rates) for FRAs are possibly the most liquid and transparent of any non-exchange-traded derivative instrument. To illustrate the pricing of FRAs, we will assume that

[3] For a discussion of these principles, see Frank J. Fabozzi and Steven V. Mann, *Introduction to Fixed-Income Analytics* (New Hope, PA: Frank J. Fabozzi Associates, 2001)

- the FRAs start today, January 1 of year 1 (FRA settlement date)
- the reference rate is LIBOR
- today 3-month LIBOR is 4.05%

Exhibit 11.10 presents the information that we will utilize in the FRA pricing. We will in an analogous manner as when we determined the future floating-rate payments in a swap contract in the next chapter. Shown in Column (1) is when the quarter begins and in Column (2) when the quarter ends in year 1. Column (3) lists the number of days in each quarter. Column (4) shows the current value of 3-month LIBOR. Column (5) contains the prices of 3-month Eurodollar CD futures contracts used to determine the implied 3-LIBOR forward rates in Column (6). Lastly, Column (7) contains the forward rate for the period that we will refer to as the *period forward rate*. The period forward rate is computed using the following formula:

$$\text{period forward rate} = \text{annual forward rate} \times (\text{days in period}/360)$$

For example, the annual forward rate for the second quarter is 4.15%. The period forward rate for quarter 2 is:

$$\text{period forward rate} = 4.15\% \times (91/360) = 1.0490\%$$

Using the information presented above, let's illustrate the pricing of a 3v9 FRA. Simply put, using the forward rates implied by the Eurodollar CD futures contracts, we are asking what is the annualized implied 6-month LIBOR forward rate three months hence. Accordingly, the 3v9 FRA price is calculated as follows:

$$[(1.010490)(1.011628) - 1](360/183) = 0.043751 = 4.3751\%$$

EXHIBIT 11.10 **Calculating the Implied Forward Rates**

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Quarter starts	Quarter ends	Number of days in quarter	Current 3-month LIBOR	Eurodollar CD futures price	Forward rate	Period forward rate
Jan 1 year 1	Mar 1 year 1	90	4.05%		—	1.0125%
Apr 1 year 1	June 30 year1	91		95.85	4.15%	1.0490%
July 1 year 1	Sept 30 year 1	92		95.45	4.55%	1.1628%
Oct 1 year 1	Dec 31 year 1	92		95.28	4.72%	1.2062%

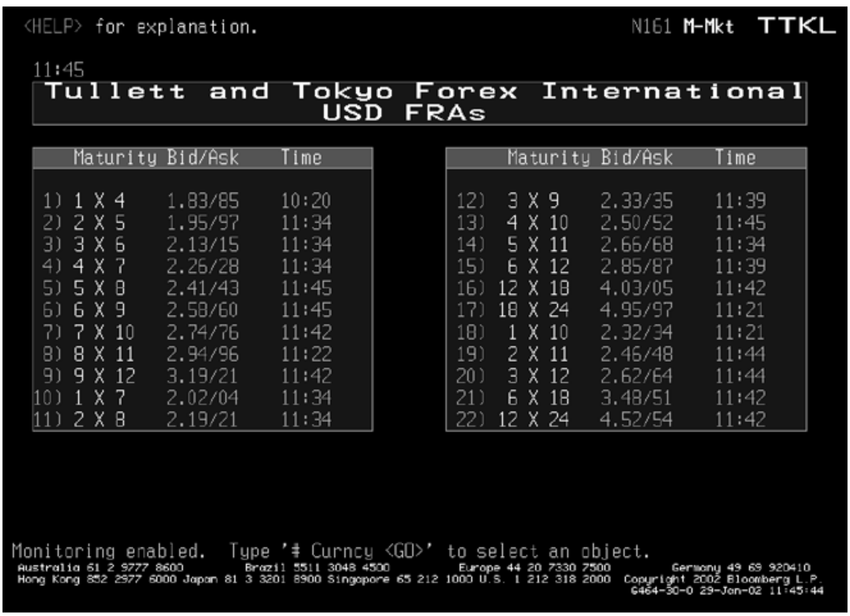
A couple of points should be noted here. First, in the U.S. money markets an Actual/360, day count convention is used but in the UK the day count convention is Actual/365. Second, in the calculation, the 183 days is the length of the 6-month period beginning three months from now.

By the same reasoning, we can price a 3v12 FRA. In this illustration, we are calculating the implied 9-month forward rate (annualized) three months hence. The price of a 3v12 is calculate as follows:

$$[(1.010490)(1.011628)(1.012062) - 1](360/275)$$
$$= 0.045256 = 4.5256\%$$

Exhibit 11.11, Panels A, B, and C present three Bloomberg screens of bid/ask rates for FRAs for various maturities and currencies. These data are supplied to Bloomberg by Tullett and Tokyo Forex International. The currencies are U.S. dollars, sterling, and euros, respectively.

EXHIBIT 11.11 **FRA Rates for Various Maturities and Currencies**
Panel A: U.S. Dollar FRAs


<HELP> for explanation. N161 M-Mkt TTKL

11:45

Tullett and Tokyo Forex International
USD FRAs

	Maturity	Bid/Ask	Time
1)	1 X 4	1.83/85	10:20
2)	2 X 5	1.95/97	11:34
3)	3 X 6	2.13/15	11:34
4)	4 X 7	2.26/28	11:34
5)	5 X 8	2.41/43	11:45
6)	6 X 9	2.58/60	11:45
7)	7 X 10	2.74/76	11:42
8)	8 X 11	2.94/96	11:22
9)	9 X 12	3.19/21	11:42
10)	1 X 7	2.02/04	11:34
11)	2 X 8	2.19/21	11:34

	Maturity	Bid/Ask	Time
12)	3 X 9	2.33/35	11:39
13)	4 X 10	2.50/52	11:45
14)	5 X 11	2.66/68	11:34
15)	6 X 12	2.85/87	11:39
16)	12 X 18	4.03/05	11:42
17)	18 X 24	4.95/97	11:21
18)	1 X 10	2.32/34	11:21
19)	2 X 11	2.46/48	11:44
20)	3 X 12	2.62/64	11:44
21)	6 X 18	3.48/51	11:42
22)	12 X 24	4.52/54	11:42

Monitoring enabled. Type '# Curncy <GO>' to select an object.
Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 212 1000 U.S. 1 212 318 2000 Copyright 2002 Bloomberg L.P.
6464-30-0 29-Jan-02 11:45:44

EXHIBIT 11.11 (Continued)
Panel B: Sterling FRAs

<HELP> for explanation. N161 M-Mkt TTKL

11:46
Tullett and Tokyo Forex International
GBP FRAs

Maturity	Bid/Ask	Time	Maturity	Bid/Ask	Time
1) 1 X 4	4.05/08	11:39	12) 3 X 9	4.45/48	11:39
2) 2 X 5	4.12/15	11:39	13) 4 X 10	4.57/60	11:39
3) 3 X 6	4.24/27	11:42	14) 5 X 11	4.70/73	11:39
4) 4 X 7	4.34/37	11:39	15) 6 X 12	4.83/86	11:40
5) 5 X 8	4.48/51	11:39	16) 12 X 18		
6) 6 X 9	4.59/62	11:39	17) 18 X 24		
7) 7 X 10	4.74/77	11:40	18) 1 X 10	4.78/83	10:38
8) 8 X 11	4.87/90	11:39	19) 2 X 11	4.53/58	11:02
9) 9 X 12	4.99/02	11:39	20) 3 X 12	4.66/71	11:42
10) 1 X 7	4.25/28	11:42	21) 6 X 18	5.22/27	11:42
11) 2 X 8	4.33/36	11:39	22) 12 X 24	5.72/75	11:46

Monitoring enabled. Type '# Curncy <GO>' to select an object.
Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 212 1000 U.S. 1 212 318 2000 Copyright 2002 Bloomberg L.P.
G464-30-0 29-Jan-02 11:46:38

Panel C: Euro FRAs

<HELP> for explanation. N161 M-Mkt TTKL

11:47
Tullett and Tokyo Forex International
EUR FRAs

Maturity	Bid/Ask	Time	Maturity	Bid/Ask	Time
1) 1 X 4	3.38/39	1 /25	12) 3 X 9	3.54/56	1 /25
2) 2 X 5	3.39/40	1 /25	13) 4 X 10	3.61/62	1 /25
3) 3 X 6	3.43/44	1 /25	14) 5 X 11	3.69/71	1 /25
4) 4 X 7	3.47/49	1 /25	15) 6 X 12	3.81/82	1 /25
5) 5 X 8	3.54/55	1 /25	16) 12 X 18	4.36/37	1 /25
6) 6 X 9	3.62/63	1 /25	17) 18 X 24	4.70/72	1 /25
7) 7 X 10	3.71/72	1 /25	18) 1 X 10	3.55/56	1 /25
8) 8 X 11	3.82/83	1 /25	19) 2 X 11	3.61/63	1 /25
9) 9 X 12	3.96/97	1 /25	20) 3 X 12	3.70/72	1 /25
10) 1 X 7	3.43/45	1 /25	21) 6 X 18	4.12/13	1 /25
11) 2 X 8	3.48/50	1 /25	22) 12 X 24	4.57/59	1 /25

Monitoring enabled. Type '# Curncy <GO>' to select an object.
Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 920410
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 212 1000 U.S. 1 212 318 2000 Copyright 2002 Bloomberg L.P.
G464-30-0 29-Jan-02 11:47:25

Source: Bloomberg Financial Markets

CHAPTER 12
Swaps and Caps/Floors

In addition to interest rate futures and FRAs, there are two additional derivative instruments used by money market participants to control their exposure to interest rate risk—swaps and caps/floors. These instruments have an important feature in common. Namely, both swaps and caps/floors are combinations of more basic derivative instruments. A swap is a portfolio of forward contracts; caps/floors are portfolios of options on interest rates.

The most prevalent swap contract is an *interest rate swap*. An interest rate swap contract provides a vehicle for market participants to transform the nature of cash flows and the interest rate exposure of a portfolio or balance sheet. In this chapter, we explain how to analyze interest rate swaps. We will describe a generic interest rate swap, the parties to a swap, the risk and return of a swap, and the economic interpretation of a swap. Then we look at how to compute the floating-rate payments and calculate the present value of these payments. Next we will see how to calculate the fixed-rate payments given the swap rate. Before we look at how to calculate the value of a swap, we will see how to calculate the swap rate. Given the swap rate, we will then see how the value of a swap is determined after the inception of a swap. We will also discuss other types of swaps, options on swaps called swaptions, and swap futures contracts. The final section of the chapter introduces caps and floors.

DESCRIPTION OF AN INTEREST RATE SWAP

In an *interest rate swap*, 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 amount*. The dollar amount each counterparty pays to the other is the agreed-upon periodic interest rate times the notional amount. The only dollars that are exchanged between the parties are the interest payments, not the notional amount. Accordingly, the notional principal serves only as a scale factor to translate an interest rate into a cash flow. 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, who agrees to make interest rate payments that float with some reference rate, is referred to as the *floating-rate payer.*

The reference rates that have been used for the floating rate in an interest rate swap are various money market rates: Treasury bill rate, the London interbank offered rate, commercial paper rate, bankers acceptances rate, certificates of deposit rate, the federal funds rate, and the prime rate. The most common is the London interbank offered rate (LIBOR). LIBOR is the rate at which prime banks offer to pay on Eurodollar deposits available to other prime banks for a given maturity. There is not just one rate but a rate for different maturities. For example, there is a 1-month LIBOR, 3-month LIBOR, and 6-month LIBOR.

To illustrate an interest rate swap, 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 6-month LIBOR (the reference 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 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 6-month LIBOR times $50 million divided by 2. If 6-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.

Interest rate swaps are over-the-counter instruments. This means that they are not traded on an exchange. An institutional investor wishing to enter into a swap transaction can do so through either a securities firm or a commercial bank that transacts in swaps.[1] These entities can do one of the following. First, they can arrange or broker a swap between two par-

[1] Do not get confused here about the role of commercial banks. A bank can use a swap in its asset/liability management. Or, a bank can transact (buy and sell) swaps to clients to generate fee income. It is in the latter sense that we are discussing the role of a commercial bank in the swap market here.

ties that want to enter into an interest rate swap. In this case, the securities firm or commercial bank is acting in a brokerage capacity.

The second way in which a securities firm or commercial bank can get an institutional investor into a swap position is by taking the other side of the swap. This means that the securities firm or the commercial bank is a dealer rather than a broker in the transaction. Acting as a dealer, the securities firm or the commercial bank must hedge its swap position in the same way that it hedges its position in other securities. Also it means that the swap dealer is the counterparty to the transaction.

The risks that the two parties take on when they enter into a swap is that the other party will fail to fulfill its obligations as set forth in the swap agreement. That is, each party faces default risk. The default risk in a swap agreement is called *counterparty risk*. In any agreement between two parties that must perform according to the terms of a contract, counterparty risk is the risk that the other party will default. With futures and exchange-traded options the counterparty risk is the risk that the clearinghouse will default. Market participants view this risk as small. In contrast, counterparty risk in a swap can be significant.

Because of counterparty risk, not all securities firms and commercial banks can be swap dealers. Several securities firms have established subsidiaries that are separately capitalized so that they have a high credit rating which permit them to enter into swap transactions as a dealer.

Thus, it is imperative to keep in mind that any party who enters into a swap is subject to counterparty risk.

INTERPRETING A SWAP POSITION

There are two ways that a swap position can be interpreted: (1) a package of forward/futures contracts and (2) a package of cash flows from buying and selling cash market instruments.

Package of Forward Contracts

Consider the hypothetical interest rate swap used earlier to illustrate a swap. Let's look at party X's position. Party X has agreed to pay 10% and receive 6-month LIBOR. More specifically, assuming a \$50 million notional amount, X has agreed to buy a commodity called "6-month LIBOR" for \$2.5 million. This is effectively a 6-month forward contract where X agrees to pay \$2.5 million in exchange for delivery of 6-month LIBOR. The fixed-rate payer is effectively long a 6-month forward contract on 6-month LIBOR. The floating-rate payer is effectively short a 6-

month forward contract on 6-month LIBOR. There is therefore an implicit forward contract corresponding to each exchange date.

Consequently, interest rate swaps can be viewed as a package of more basic interest rate derivative instruments—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 in which the underlying for the forward contract is the same reference rate.

While an interest rate swap may be nothing more than a package of forward contracts, it is not a redundant contract for several reasons. First, maturities for forward or futures contracts do not extend out as far as those of an interest rate swap; 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 an entity can effectively establish a payoff equivalent to a package of forward contracts. The forward contracts would each have to be negotiated separately. Third, the interest rate swap market has grown in liquidity since its establishment in 1981; interest rate swaps now provide more liquidity than forward contracts, particularly long-dated (i.e., long-term) forward contracts.

Package of Cash Market Instruments

To understand why a swap can also be interpreted as a package of cash market instruments, consider an investor who enters into the transaction below:

- buy \$50 million par value of a 5-year floating-rate bond that pays 6-month LIBOR every six months
- finance the purchase by borrowing \$50 million for five years at a 10% annual interest rate paid every six months.

The cash flows for this transaction are set forth in Exhibit 12.1. The second column of the exhibit shows the cash flows from purchasing the 5-year floating-rate bond. There is a \$50 million cash outlay and then ten cash inflows. The amount of the cash inflows is uncertain because they depend on future levels of 6-month LIBOR. The next column shows the cash flows from borrowing \$50 million on a fixed-rate basis. The last column shows the net cash flows from the entire transaction. As the last column indicates, there is no initial cash flow (the cash inflow and cash outlay offset each other). In all ten 6-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.

EXHIBIT 12.1 **Cash Flows for the Purchase of a 5-Year Floating-Rate Bond Financed by Borrowing on a Fixed-Rate Basis**

Transaction:

- Purchase for \$50 million a 5-year floating-rate bond:
  floating rate = LIBOR, semiannual pay
- Borrow \$50 million for five years:
  fixed rate = 10%, semiannual payments

Six Month	Cash Flow (In Millions of Dollars) From:		
Period	Floating-rate Bond [a]	Borrowing Cost	Net
0	–\$50	+\$50.0	\$0
1	+ $(\text{LIBOR}_1/2) \times 50$	–2.5	+ $(\text{LIBOR}_1/2) \times 50 - 2.5$
2	+ $(\text{LIBOR}_2/2) \times 50$	–2.5	+ $(\text{LIBOR}_2/2) \times 50 - 2.5$
3	+ $(\text{LIBOR}_3/2) \times 50$	–2.5	+ $(\text{LIBOR}_3/2) \times 50 - 2.5$
4	+ $(\text{LIBOR}_4/2) \times 50$	–2.5	+ $(\text{LIBOR}_4/2) \times 50 - 2.5$
5	+ $(\text{LIBOR}_5/2) \times 50$	–2.5	+ $(\text{LIBOR}_5/2) \times 50 - 2.5$
6	+ $(\text{LIBOR}_6/2) \times 50$	–2.5	+ $(\text{LIBOR}_6/2) \times 50 - 2.5$
7	+ $(\text{LIBOR}_7/2) \times 50$	–2.5	+ $(\text{LIBOR}_7/2) \times 50 - 2.5$
8	+ $(\text{LIBOR}_8/2) \times 50$	–2.5	+ $(\text{LIBOR}_8/2) \times 50 - 2.5$
9	+ $(\text{LIBOR}_9/2) \times 50$	–2.5	+ $(\text{LIBOR}_9/2) \times 50 - 2.5$
10	+ $(\text{LIBOR}_{10}/2) \times 50 + 50$	–52.5	+ $(\text{LIBOR}_{10}/2) \times 50 - 2.5$

[a] The subscript for LIBOR indicates the 6-month LIBOR as per the terms of the floating-rate bond at time *t*.

It can be seen from the net cash flow in Exhibit 12.1 that a fixed-rate payer has a cash market position that is equivalent to a long position in a floating-rate bond and a short position in a fixed-rate bond—the short position being the equivalent of borrowing by issuing a fixed-rate bond.

What about the position of a floating-rate payer? It can be easily 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, where the floating rate is the reference 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.

TERMINOLOGY, CONVENTIONS, AND MARKET QUOTES

Here we review some of the terminology used in the swaps market and explain how swaps are quoted. The *trade date* for a swap is not surprisingly, the date on which the swap is transacted. The terms of the trade include the fixed interest rate, the maturity, the notional amount of the swap, and the payment bases of both legs of the swap. The date from which floating interest payments are determined is the *reset* or *setting date*, which may also be the trade date. In the same way as for FRAs (discussed in the previous chapter), the rate is fixed two business days before the interest period begins. The second (and subsequent) reset date will be two business days before the beginning of the second (and subsequent) swap periods. The *effective date* is the date from which interest on the swap is calculated, and this is typically two business days after the trade date. In a *forward-start swap* the effective date will be at some point in the future, specified in the swap terms. The floating-interest rate for each period is fixed at the start of the period, so that the interest payment amount is known in advance by both parties (the fixed rate is known of course, throughout the swap by both parties).

While our illustrations assume that the timing of the cash flows for both the fixed-rate payer and floating-rate payer will be the same, this is rarely the case in a swap. An agreement may call for the fixed-rate payer to make payments annually but the floating-rate payer to make payments more frequently (semiannually or quarterly). Also, the way in which interest accrues on each leg of the transaction differs. Normally, the fixed interest payments are paid on the basis of a 30/360 day count which is described in Chapter 2. Floating-rate payments for dollar and euro-denominated swaps use an Actual/360 day count similar to other money market instruments in those currencies. Sterling-denominated swaps use an Actual/365 day count.

Accordingly, the fixed interest payments will differ slightly owing to the differences in the lengths of successive coupon periods. The floating payments will differ owing to day counts as well as movements in the reference rate.

The terminology used to describe the position of a party in the swap markets combines cash market jargon and futures market jargon, given that a swap position can be interpreted either as a position in a package of cash market instruments or a package of futures/forward positions. As we have said, the counterparty to an interest rate swap is either a fixed-rate payer or floating-rate payer.

The fixed-rate payer receives floating-rate interest and is said to be "long" or to have "bought" the swap. The long side has conceptually purchased a floating-rate note (because it receives floating-rate interest) and issued a fixed coupon bond (because it pays out fixed interest at periodic intervals). In essence, the fixed-rate payer is borrowing at fixed-rate and investing in a floating-rate asset. 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 it receives fixed-rate interest) and issued a floating-rate note (because it pays floating-rate interest). A floating-rate payer is borrowing at floating rate and investing in a fixed rate asset.

The convention that has evolved for quoting swaps levels is that a swap dealer sets the floating rate equal to the reference rate and then quotes the fixed rate that will apply. To illustrate this convention, consider the following 10-year swap terms available from a dealer:

- *Floating-rate payer:*
  Pay floating rate of 3-month LIBOR quarterly.
  Receive fixed rate of 8.75% semiannually.
- *Fixed-rate payer:*
  Pay fixed rate of 8.85% semiannually
  Receive floating rate of 3-month LIBOR quarterly.

The offer price that the dealer would quote the fixed-rate payer would be to pay 8.85% and receive LIBOR "flat." (The word flat means with no spread.) The bid price that the dealer would quote the floating-rate payer would be to pay LIBOR flat and receive 8.75%. The bid-offer spread is 10 basis points.

In order to solidify our intuition, it is useful to think of the swap market as a market where two counterparties trade the floating reference rate in a series of exchanges for a fixed price. In effect, the swap market is a market to buy and sell LIBOR. So, buying a swap (pay fixed/receive floating) can be thought of as buying LIBOR on each reset date for the fixed rate agreed to on the trade date. Conversely, selling a swap (receive fixed/pay floating) is effectively selling LIBOR on each reset date for a fixed rate agreed to on the trade date. In this framework, a dealer's bid-offer spread can be easily interpreted. Using the numbers presented above, the bid price of 8.75% is the price the dealer will pay to the counterparty to receive 3-month LIBOR. In other words, buy LIBOR at the bid. Similarly, the offer price of 8.85% is the price the dealer receives from the counterparty in exchange for 3-month LIBOR. In other words, sell LIBOR at the offer.

The fixed rate is some spread above the Treasury yield curve with the same term to maturity as the swap. In our illustration, suppose that the 10-year Treasury yield is 8.35%. Then 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. The dealer would quote such a swap as 40-50, meaning that the dealer is willing to enter into a swap to receive LIBOR and pay a fixed rate equal to the 10-year Treasury rate plus 40 basis points; and he or she would be willing to enter into a swap to pay LIBOR and receive a fixed rate equal to the 10-year Treasury rate plus 50 basis points. The difference between the Treasury rate paid and received is the bid-offer spread.[2]

VALUING INTEREST RATE SWAPS

In an interest rate swap, the counterparties agree to exchange periodic interest payments. The dollar amount of the interest payments exchanged is based on the notional principal. In the most common type of swap, there is a fixed-rate payer and a fixed-rate receiver. The convention for quoting swap rates is that a swap dealer sets the floating rate equal to the reference rate and then quotes the fixed rate that will apply.

Computing the Payments for a Swap

In the previous section we described in general terms the payments by the fixed-rate payer and fixed-rate receiver but we did not give any details. That is, we explained that if the swap rate is 6% and the notional amount is $100 million, then the fixed-rate payment will be $6 million for the year and the payment is then adjusted based on the frequency of settlement. So, if settlement is semiannual, the payment is $3 million. If it is quarterly, it is $1.5 million. Similarly, the floating-rate payment would be found by multiplying the reference rate by the notional amount and then scaling based on the frequency of settlement.

It was useful to illustrate the basic features of an interest rate swap with simple calculations for the payments such as described above and then explain how the parties to a swap either benefit or hurt when interest rates change. However, we will show how to value a swap in this section. To value a swap, it is necessary to determine both the present value of the fixed-rate payments and the present value of the floating-rate payments. The difference between these two present values is the value of a swap. As will be explained below, whether the value is positive (i.e., an asset) or negative (i.e., a liability) will depend on the party.

At the inception of the swap, the terms of the swap will be such that the present value of the floating-rate payments is equal to the present value of the fixed-rate payments. That is, the value of the swap is equal to zero at its inception. This is the fundamental principle in determining the swap rate (i.e., the fixed rate that the fixed-rate payer will make).

[2] A question that commonly arises is why is the fixed rate of a swap is quoted as a fixed spread above a Treasury rate when Treasury rates are not used directly in swap valuation? Because of the timing difference between the quote and settlement, quoting the fixed-rate side as a spread above a Treasury rate allows the swap dealer to hedge against changing interest rates.

Here is a roadmap of the presentation. First we will look at how to compute the floating-rate payments. We will see how the future values of the reference rate are determined to obtain the floating rate for the period. From the future values of the reference rate we will then see how to compute the floating-rate payments taking into account the number of days in the payment period. Next we will see how to calculate the fixed-rate payments given the swap rate. Before we look at how to calculate the value of a swap, we will see how to calculate the swap rate. This will require an explanation of how the present value of any cash flow in an interest rate swap is computed. Given the floating-rate payments and the present value of the floating-rate payments, the swap rate can be determined by using the principle that the swap rate is the fixed rate that will make the present value of the fixed-rate payments equal to the present value of the floating-rate payments. Finally, we will see how the value of swap is determined after the inception of a swap.

Calculating the Floating-Rate Payments

For the first floating-rate payment, the amount is known. For all subsequent payments, the floating-rate payment depends on the value of the reference rate when the floating rate is determined. To illustrate the issues associated with calculating the floating-rate payment, we will assume that

- a swap starts today, January 1 of year 1(swap settlement date)
- the floating-rate payments are made quarterly based on "actual/360"
- the reference rate is 3-month LIBOR
- the notional amount of the swap is $100 million
- the term of the swap is three years

The quarterly floating-rate payments are based on an "actual/360" day count convention. Recall that this convention means that 360 days are assumed in a year and that in computing the interest for the quarter, the actual number of days in the quarter is used. The floating-rate payment is set at the beginning of the quarter but paid at the end of the quarter—that is, the floating-rate payments are made in arrears.

Suppose that today 3-month LIBOR is 4.05%. Let's look at what the fixed-rate payer will receive on March 31 of year 1—the date when the first quarterly swap payment is made. There is no uncertainty about what the floating-rate payment will be. In general, the floating-rate payment is determined as follows:

$$\text{notional amount} \times (\text{3-month LIBOR}) \times \frac{\text{no. of days in period}}{360}$$

In our illustration, assuming a non-leap year, the number of days from January 1 of year 1 to March 31 of year 1 (the first quarter) is 90. If 3-month LIBOR is 4.05%, then the fixed-rate payer will receive a floating-rate payment on March 31 of year 1 equal to:

$$\$100{,}000{,}000 \times 0.0405 \times \frac{90}{360} = \$1{,}012{,}500$$

Now the difficulty is in determining the floating-rate payment after the first quarterly payment. That is, for the 3-year swap there will be 12 quarterly floating-rate payments. So, while the first quarterly payment is known, the next 11 are not. However, there is a way to hedge the next 11 floating-rate payments by using a futures contract. Specifically, the futures contract used to hedge the future floating-rate payments in a swap whose reference rate is 3-month LIBOR is the Eurodollar CD futures contract.

Determining Future Floating-Rate Payments

Now let's determine the future floating-rate payments. These payments can be locked in over the life of the swap using the Eurodollar CD futures contract. We will show how these floating-rate payments are computed using this contract.

We will begin with the next quarterly payment—from April 1 of year 1 to June 30 of year 1. This quarter has 91 days. The floating-rate payment will be determined by 3-month LIBOR on April 1 of year 1 and paid on June 30 of year 1. Where might the fixed-rate payer look to today (January 1 of year 1) to project what 3-month LIBOR will be on April 1 of year 1? One possibility is the Eurodollar CD futures market. There is a 3-month Eurodollar CD futures contract for settlement on June 30 of year 1. That futures contract will express the market's expectation of 3-month LIBOR on April 1 of year 1. For example, if the futures price for the 3-month Eurodollar CD futures contract that settles on June 30 of year 1 is 95.85, then as explained above, the 3-month Eurodollar futures rate is 4.15%. We will refer to that rate for 3-month LIBOR as the "forward rate." Therefore, if the fixed-rate payer bought 100 of these 3-month Eurodollar CD futures contracts on January 1 of year 1 (the inception of the swap) that settle on June 30 of year 1, then the payment that will be locked in for the quarter (April 1 to June 30 of year 1) is

$$\$100{,}000{,}000 \times 0.0415 \times \frac{91}{360} = \$1{,}049{,}028$$

EXHIBIT 12.2 **Floating-Rate Payments Based on Initial LIBOR and Eurodollar CD Futures**

(1) Quarter starts	(2) Quarter ends	(3) Number of days in quarter	(4) Current 3-month LIBOR	(5) Eurodollar CD futures price	(6) Forward rate	(7) Period = End of quarter	(8) Floating-rate payment at end of quarter
Jan 1 year 1	Mar 31 year 1	90	4.05%		—	1	1,012,500
Apr 1 year 1	June 30 year 1	91		95.85	4.15%	2	1,049,028
July 1 year 1	Sept 30 year 1	92		95.45	4.55%	3	1,162,778
Oct 1 year 1	Dec 31 year 1	92		95.28	4.72%	4	1,206,222
Jan 1 year 2	Mar 31 year 2	90		95.10	4.90%	5	1,225,000
Apr 1 year 2	June 30 year 2	91		94.97	5.03%	6	1,271,472
July 1 year 2	Sept 30 year 2	92		94.85	5.15%	7	1,316,111
Oct 1 year 2	Dec 31 year 2	92		94.75	5.25%	8	1,341,667
Jan 1 year 3	Mar 31 year 3	90		94.60	5.40%	9	1,350,000
Apr 1 year 3	June 30 year 3	91		94.50	5.50%	10	1,390,278
July 1 year 3	Sept 30 year 3	92		94.35	5.65%	11	1,443,889
Oct 1 year 3	Dec 31 year 3	92		94.24	5.76%	12	1,472,000

(Note that each futures contract is for \$1 million and hence 100 contracts have a notional amount of \$100 million.) Similarly, the Eurodollar CD futures contract can be used to lock in a floating-rate payment for each of the next 10 quarters.[3] Once again, it is important to emphasize that the reference rate at the beginning of period t determines the floating-rate that will be paid for the period. However, the floating-rate payment is not made until the end of period t.

Exhibit 12.2 shows this for the 3-year swap. Shown in Column (1) is when the quarter begins and in Column (2) when the quarter ends. The payment will be received at the end of the first quarter (March 31 of year 1) and is \$1,012,500. That is the known floating-rate payment as explained earlier. It is the only payment that is known. The information used to compute the first payment is in Column (4) which shows the current 3-month LIBOR (4.05%). The payment is shown in the last column, Column (8).

Notice that Column (7) numbers the quarters from 1 through 12. Look at the heading for Column (7). It identifies each quarter in terms of the end of the quarter. This is important because we will eventually be

[3] The Chicago Mercantile Exchange offers pre-packaged series of Eurodollar CD futures contracts that expire on consecutive dates called *bundles*. Specifically, a bundle is the simultaneous sale or purchase of one of each of a consecutive series of Eurodollar CD futures contracts. So, rather than construct the same positions with individual contracts, a series of contracts can be sold or purchased in a single transaction.

discounting the payments (cash flows). We must take care to understand when each payment is to be exchanged in order to properly discount. So, for the first payment of $1,012,500 it is going to be received at the end of quarter 1. When we refer to the time period for any payment, the reference is to the end of quarter. So, the fifth payment of $1,225,000 would be identified as the payment for period 5, where period 5 means that it will be exchanged at the end of the fifth quarter.

Calculating the Fixed-Rate Payments

The swap will specify the frequency of settlement for the fixed-rate payments. The frequency need not be the same as the floating-rate payments. For example, in the 3-year swap we have been using to illustrate the calculation of the floating-rate payments, the frequency is quarterly. The frequency of the fixed-rate payments could be semiannual rather than quarterly.

In our illustration we will assume that the frequency of settlement is quarterly for the fixed-rate payments, the same as with the floating-rate payments. The day count convention is the same as for the floating-rate payment, "actual/360". The equation for determining the dollar amount of the fixed-rate payment for the period is:

$$\text{notional amount} \times (\text{swap rate}) \times \frac{\text{no. of days in period}}{360}$$

It is the same equation as for determining the floating-rate payment except that the swap rate is used instead of the reference rate (3-month LIBOR in our illustration).

For example, suppose that the swap rate is 4.98% and the quarter has 90 days. Then the fixed-rate payment for the quarter is:

$$\$100{,}000{,}000 \times 0.0498 \times \frac{90}{360} = \$1{,}245{,}000$$

If there are 92 days in a quarter, the fixed-rate payment for the quarter is:

$$\$100{,}000{,}000 \times 0.0498 \times \frac{92}{360} = \$1{,}272{,}667$$

Note that the rate is fixed for each quarter but the dollar amount of the payment depends on the number of days in the period.

Exhibit 12.3 shows the fixed-rate payments based on different assumed values for the swap rate. The first three columns of the exhibit show the same information as in Exhibit 12.2—the beginning and end of the quarter and the number of days in the quarter. Column (4) simply uses the notation for the period. That is, period 1 means the end of the first quarter, period 2 means the end of the second quarter, and so on. The other columns of the exhibit show the payments for each assumed swap rate.

Calculation of the Swap Rate

Now that we know how to calculate the payments for the fixed-rate and floating-rate sides of a swap where the reference rate is 3-month LIBOR given (1) the current value for 3-month LIBOR, (2) the expected 3-month LIBOR from the Eurodollar CD futures contract, and (3) the assumed swap rate, we can demonstrate how to compute the swap rate.

At the initiation of an interest rate swap, the counterparties are agreeing to exchange future payments and no upfront payments are made by either party. This means that the swap terms must be such that the present value of the payments to be made by the counterparties must be at least equal to the present value of the payments that will be received. In fact, to eliminate arbitrage opportunities, the present value of the payments made by a party will be equal to the present value of the payments received by that same party. *The equivalence (or no arbitrage) of the present value of the payments is the key principle in calculating the swap rate.*

Since we will have to calculate the present value of the payments, let's show how this is done.

Calculating the Present Value of the Floating-Rate Payments

As explained earlier, we must be careful about how we compute the present value of payments. In particular, we must carefully specify (1) the timing of the payment and (2) the interest rates that should be used to discount the payments. We have already addressed the first issue. In constructing the exhibit for the payments, we indicated that the payments are at the end of the quarter. So, we denoted the time periods with respect to the end of the quarter.

Now let's turn to the interest rates that should be used for discounting. First, every cash flow should be discounted at its own discount rate using a spot rate. So, if we discounted a cash flow of \$1 using the spot rate for period t, the present value would be:

$$\text{present value of \$1 to be received in period } t = \frac{\$1}{(1 + \text{spot rate for period } t)^t}$$

EXHIBIT 12.3 Fixed-Rate Payments for Several Assumed Swap Rates

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Quarter starts	Quarter ends	Number of days in quarter	Period = End of quarter	Fixed-rate payment if swap rate is assumed to be				
				4.9800%	4.9873%	4.9874%	4.9875%	4.9880%
Jan 1 year 1	Mar 31 year 1	90	1	1,245,000	1,246,825	1,246,850	1,246,875	1,247,000
Apr 1 year 1	June 30 year 1	91	2	1,258,833	1,260,679	1,260,704	1,260,729	1,260,856
July 1 year 1	Sept 30 year 1	92	3	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711
Oct 1 year 1	Dec 31 year 1	92	4	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711
Jan 1 year 2	Mar 31 year 2	90	5	1,245,000	1,246,825	1,246,850	1,246,875	1,247,000
Apr 1 year 2	June 30 year 2	91	6	1,258,833	1,260,679	1,260,704	1,260,729	1,260,856
July 1 year 2	Sept 30 year 2	92	7	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711
Oct 1 year 2	Dec 31 year 2	92	8	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711
Jan 1 year 3	Mar 31 year 3	90	9	1,245,000	1,246,825	1,246,850	1,246,875	1,247,000
Apr 1 year 3	June 30 year 3	91	10	1,258,833	1,260,679	1,260,704	1,260,729	1,260,856
July 1 year 3	Sept 30 year 3	92	11	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711
Oct 1 year 3	Dec 31 year 3	92	12	1,272,667	1,274,532	1,274,558	1,274,583	1,274,711

EXHIBIT 12.4 **Calculating the Forward Discount Factor**

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Quarter starts	Quarter ends	Number of days in quarter	Period = End of quarter	Forward rate	Period forward rate	Forward discount factor
Jan 1 year 1	Mar 31 year 1	90	1	4.05%	1.0125%	0.98997649
Apr 1 year 1	June 30 year 1	91	2	4.15%	1.0490%	0.97969917
July 1 year 1	Sept 30 year 1	92	3	4.55%	1.1628%	0.96843839
Oct 1 year 1	Dec 31 year 1	92	4	4.72%	1.2062%	0.95689609
Jan 1 year 2	Mar 31 year 2	90	5	4.90%	1.2250%	0.94531597
Apr 1 year 2	June 30 year 2	91	6	5.03%	1.2715%	0.93344745
July 1 year 2	Sept 30 year 2	92	7	5.15%	1.3161%	0.92132183
Oct 1 year 2	Dec 31 year 2	92	8	5.25%	1.3417%	0.90912441
Jan 1 year 3	Mar 31 year 3	90	9	5.40%	1.3500%	0.89701471
Apr 1 year 3	June 30 year 3	91	10	5.50%	1.3903%	0.88471472
July 1 year 3	Sept 30 year 3	92	11	5.65%	1.4439%	0.87212224
Oct 1 year 3	Dec 31 year 3	92	12	5.76%	1.4720%	0.85947083

Second, forward rates are derived from spot rates so that if we discounted a cash flow using forward rates rather than spot rates, we would come up with the same value. That is, the present value of \$1 to be received in period t can be rewritten as:

$$\text{present value of \$1 to be received in period } t$$
$$= \frac{\$1}{(1+\text{forward rate for period 1})(1+\text{forward rate for period 2})\cdots(1+\text{forward rate for period } t)}$$

We will refer to the present value of \$1 to be received in period t as the *forward discount factor*. In our calculations involving swaps, we will compute the forward discount factor for a period using the forward rates. These are the same forward rates that are used to compute the floating-rate payments—those obtained from the Eurodollar CD futures contract. We must make just one more adjustment. We must adjust the forward rates used in the formula for the number of days in the period (i.e., the quarter in our illustrations) in the same way that we made this adjustment to obtain the payments. Specifically, the forward rate for a period, which we will refer to as the period forward rate, is computed using the following equation:

$$\text{period forward rate} = \text{annual forward rate} \times \left(\frac{\text{days in period}}{360}\right)$$

For example, look at Exhibit 12.2. The annual forward rate for period 4 is 4.72%. The period forward rate for period 4 is:

$$\text{period forward rate} = 4.72\% \times \left(\frac{92}{360}\right) = 1.2062\%$$

Column (5) in Exhibit 12.4 shows the annual forward rate for all 12 periods (reproduced from Exhibit 12.3) and Column (6) shows the period forward rate for all 12 periods. Note that the period forward rate for period 1 is 4.05%, the known rate for 3-month LIBOR.

Also shown in Exhibit 12.4 is the forward discount factor for all 12 periods. These values are shown in the last column. Let's show how the forward discount factor is computed for periods 1, 2, and 3. For period 1, the forward discount factor is:

$$\text{forward discount factor} = \frac{\$1}{(1.010125)} = 0.98997649$$

For period 2,

$$\text{forward discount factor} = \frac{\$1}{(1.010125)(1.010490)} = 0.97969917$$

For period 3,

$$\begin{aligned}\text{forward discount factor} &= \frac{\$1}{(1.010125)(1.010490)(1.011628)}\\ &= 0.96843839\end{aligned}$$

Given the floating-rate payment for a period and the forward discount factor for the period, the present value of the payment can be computed. For example, from Exhibit 12.2 we see that the floating-rate payment for period 4 is $1,206,222. From Exhibit 12.4, the forward discount factor for period 4 is 0.95689609. Therefore, the present value of the payment is:

$$\begin{aligned}\text{present value of period 4 payment} &= \$1{,}206{,}222 \times 0.95689609\\ &= \$1{,}154{,}229\end{aligned}$$

Exhibit 12.5 shows the present value for each payment. The total present value of the 12 floating-rate payments is $14,052,917. Thus, the present value of the payments that the fixed-rate payer will receive is \$14,052,917 and the present value of the payments that the fixed-rate receiver will make is \$14,052,917.

Determination of the Swap Rate

The fixed-rate payer will require that the present value of the fixed-rate payments that must be made based on the swap rate not exceed the \$14,052,917 payments to be received from the floating-rate payments. The fixed-rate receiver will require that the present value of the fixed-rate payments to be received is at least as great as the \$14,052,917 that must be paid. This means that both parties will require a present value for the fixed-rate payments to be \$14,052,917. If that is the case, the present value of the fixed-rate payments is equal to the present value of the floating-rate payments and therefore the value of the swap is zero for both parties at the inception of the swap. The interest rates that should be used to compute the present value of the fixed-rate payments are the same interest rates as those used to discount the floating-rate payments.

To show how to compute the swap rate, we begin with the basic relationship for no arbitrage to exist:

$$\text{PV of floating-rate payments} = \text{PV of fixed-rate payments}$$

We know the value for the left-hand side of the equation.

EXHIBIT 12.5 **Present Value of the Floating-Rate Payments**

(1)	(2)	(3)	(4)	(5)	(6)
Quarter starts	Quarter ends	Period = End of quarter	Forward discount factor	Floating-rate payment at end of quarter	PV of floating-rate payment
Jan 1 year 1	Mar 31 year 1	1	0.98997649	1,012,500	1,002,351
Apr 1 year 1	June 30 year 1	2	0.97969917	1,049,028	1,027,732
July 1 year 1	Sept 30 year 1	3	0.96843839	1,162,778	1,126,079
Oct 1 year 1	Dec 31 year 1	4	0.95689609	1,206,222	1,154,229
Jan 1 year 2	Mar 31 year 2	5	0.94531597	1,225,000	1,158,012
Apr 1 year 2	June 30 year 2	6	0.93344745	1,271,472	1,186,852
July 1 year 2	Sept 30 year 2	7	0.92132183	1,316,111	1,212,562
Oct 1 year 2	Dec 31 year 2	8	0.90912441	1,341,667	1,219,742
Jan 1 year 3	Mar 31 year 3	9	0.89701471	1,350,000	1,210,970
Apr 1 year 3	June 30 year 3	10	0.88471472	1,390,278	1,229,999
July 1 year 3	Sept 30 year 3	11	0.87212224	1,443,889	1,259,248
Oct 1 year 3	Dec 31 year 3	12	0.85947083	1,472,000	1,265,141
				Total	14,052,917

If we let

$$SR = \text{swap rate}$$

and

$$\text{Days}_t = \text{number of days in the payment period } t$$

then the fixed-rate payment for period t is equal to:

$$\text{notional amount} \times SR \times \frac{\text{Days}_t}{360}$$

The present value of the fixed-rate payment for period t is found by multiplying the previous expression by the forward discount factor. If we let FDF_t denote the forward discount factor for period t, then the present value of the fixed-rate payment for period t is equal to:

$$\text{notional amount} \times SR \times \frac{\text{Days}_t}{360} \times \text{FDF}_t$$

We can now sum up the present value of the fixed-rate payment for each period to get the present value of the floating-rate payments. Using the Greek symbol sigma, Σ, to denote summation and letting N be the number of periods in the swap, then the present value of the fixed-rate payments can be expressed as:

$$\sum_{t=1}^{N} \text{notional amount} \times SR \times \frac{\text{Days}_t}{360} \times \text{FDF}_t$$

This can also be expressed as

$$SR \sum_{t=1}^{N} \text{notional amount} \times \frac{\text{Days}_t}{360} \times \text{FDF}_t$$

The condition for no arbitrage is that the present value of the fixed-rate payments as given by the expression above is equal to the present value of the floating-rate payments. That is,

$$SR \sum_{t=1}^{N} \text{notional amount} \times \frac{\text{Days}_t}{360} \times \text{FDF}_t = PV \text{ of floating-rate payments}$$

Solving for the swap rate

$$SR = \frac{PV \text{ of floating-rate payments}}{\sum_{t=1}^{N} \text{notional amount} \times \frac{\text{Days}_t}{360} \times \text{FDF}_t}$$

All of the values to compute the swap rate are known.

Let's apply the formula to determine the swap rate for our 3-year swap. Exhibit 12.6 shows the calculation of the denominator of the formula. The forward discount factor for each period shown in Column (5) is obtained from Column (4) of Exhibit 12.5. The sum of the last column in Exhibit 12.6 shows that the denominator of the swap rate formula is \$281,764,282. We know from Exhibit 12.5 that the present value of the floating-rate payments is \$14,052,917. Therefore, the swap rate is

$$SR = \frac{\$14{,}052{,}917}{\$281{,}764{,}282} = 0.049875 = 4.9875\%$$

Given the swap rate, the *swap spread* can be determined. For example, since this is a 3-year swap, the convention is to use the 3-year on-the-run Treasury rate as the benchmark. If the yield on that issue is 4.5875%, the swap spread is 40 basis points (4.9875% – 4.5875%).

The calculation of the swap rate for all swaps follows the same principle: equating the present value of the fixed-rate payments to that of the floating-rate payments.

Valuing a Swap

Once the swap transaction is completed, changes in market interest rates will change the payments of the floating-rate side of the swap. The value of an interest rate swap is the difference between the present value of the payments of the two sides of the swap. The 3-month LIBOR forward rates from the current Eurodollar CD futures contracts are used to (1) calculate the floating-rate payments and (2) determine the discount factors at which to calculate the present value of the payments.

EXHIBIT 12.6 Calculating the Denominator for the Swap Rate Formula

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Quarter starts	Quarter ends	Number of days in quarter	Period = End of quarter	Forward discount factor	Days/360	Forward discount factor × Days/360 × notional
Jan 1 year 1	Mar 31 year 1	90	1	0.98997649	0.25000000	24,749,412
Apr 1 year 1	June 30 year 1	91	2	0.97969917	0.25277778	24,764,618
July 1 year 1	Sept 30 year 1	92	3	0.96843839	0.25555556	24,748,981
Oct 1 year 1	Dec 31 year 1	92	4	0.95689609	0.25555556	24,454,011
Jan 1 year 2	Mar 31 year 2	90	5	0.94531597	0.25000000	23,632,899
Apr 1 year 2	June 30 year 2	91	6	0.93344745	0.25277778	23,595,477
July 1 year 2	Sept 30 year 2	92	7	0.92132183	0.25555556	23,544,891
Oct 1 year 2	Dec 31 year 2	92	8	0.90912441	0.25555556	23,233,179
Jan 1 year 3	Mar 31 year 3	90	9	0.89701471	0.25000000	22,425,368
Apr 1 year 3	June 30 year 3	91	10	0.88471472	0.25277778	22,363,622
July 1 year 3	Sept 30 year 3	92	11	0.87212224	0.25555556	22,287,568
Oct 1 year 3	Dec 31 year 3	92	12	0.85947083	0.25555556	21,964,255
					Total	281,764,282

To illustrate this, consider the 3-year swap used to demonstrate how to calculate the swap rate. Suppose that one year later, interest rates change as shown in Columns (4) and (6) in Exhibit 12.7. In Column (4) shows the current 3-month LIBOR. In Column (5) are the Eurodollar CD futures price for each period. These rates are used to compute the forward rates in Column (6). Note that the interest rates have increased one year later since the rates in Exhibit 12.7 are greater than those in Exhibit 12.2. As in Exhibit 12.2, the current 3-month LIBOR and the forward rates are used to compute the floating-rate payments. These payments are shown in Column (8) of Exhibit 12.7.

In Exhibit 12.8, the forward discount factor is computed for each period. The calculation is the same as in Exhibit 12.4 to obtain the forward discount factor for each period. The forward discount factor for each period is shown in the last column of Exhibit 12.8.

In Exhibit 12.9 the forward discount factor (from Exhibit 12.8) and the floating-rate payments (from Exhibit 12.7) are shown. The fixed-rate payments need not be recomputed. They are the payments shown in Column (8) of Exhibit 12.3. These are fixed-rate payments for the swap rate of 4.9875% and are reproduced in Exhibit 12.9. Now the two payment streams must be discounted using the new forward discount factors. As shown at the bottom of Exhibit 12.9, the two present values are as follows:

Present value of floating-rate payments	$11,459,495
Present value of fixed-rate payments	$9,473,390

The two present values are not equal and therefore for one party the value of the swap increased and for the other party the value of the swap decreased. Let's look at which party gained and which party lost.

The fixed-rate payer will receive the floating-rate payments. And these payments have a present value of $11,459,495. The present value of the payments that must be made by the fixed-rate payer is $9,473,390. Thus, the swap has a positive value for the fixed-rate payer equal to the difference in the two present values of $1,986,105. This is the value of the swap to the fixed-rate payer. Notice, consistent with what we said in the previous chapter, when interest rates increase (as they did in our illustration), the fixed-rate payer benefits because the value of the swap increases.

In contrast, the fixed-rate receiver must make payments with a present value of $11,459,495 but will only receive fixed-rate payments with a present value equal to $9,473,390. Thus, the value of the swap for the fixed-rate receiver is −$1,986,105. Again, as explained earlier, the fixed-rate receiver is adversely affected by a rise in interest rates because it results in a decline in the value of a swap.

EXHIBIT 12.7 Rates and Floating-Rate Payments One Year Later if Rates Increase

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Quarter starts	Quarter ends	Number of days in quarter	Current 3-month LIBOR	Eurodollar futures price	Forward rate	Period = End of quarter	Floating-rate payments at end of quarter
Jan 1 year 2	Mar 31 year 2	90	5.25%			1	1,312,500
Apr 1 year 2	June 30 year 2	91		94.27	5.73%	2	1,448,417
July 1 year 2	Sept 30 year 2	92		94.22	5.78%	3	1,477,111
Oct 1 year 2	Dec 31 year 2	92		94.00	6.00%	4	1,533,333
Jan 1 year 3	Mar 31 year 3	90		93.85	6.15%	5	1,537,500
Apr 1 year 3	June 30 year 3	91		93.75	6.25%	6	1,579,861
July 1 year 3	Sept 30 year 3	92		93.54	6.46%	7	1,650,889
Oct 1 year 3	Dec 31 year 3	92		93.25	6.75%	8	1,725,000

EXHIBIT 12.8 Period Forward Rates and Forward Discount Factors One Year Later if Rates Increase

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Quarter starts	Quarter ends	Number of days in quarter	Period = End of quarter	Forward rate	Period forward rate	Forward discount factor
Jan 1 year 2	Mar 31 year 2	90	1	5.25%	1.3125%	0.98704503
Apr 1 year 2	June 30 year 2	91	2	5.73%	1.4484%	0.97295263
July 1 year 2	Sept 30 year 2	92	3	5.78%	1.4771%	0.95879023
Oct 1 year 2	Dec 31 year 2	92	4	6.00%	1.5333%	0.94431080
Jan 1 year 3	Mar 31 year 3	90	5	6.15%	1.5375%	0.93001186
Apr 1 year 3	June 30 year 3	91	6	6.25%	1.5799%	0.91554749
July 1 year 3	Sept 30 year 3	92	7	6.46%	1.6509%	0.90067829
Oct 1 year 3	Dec 31 year 3	92	8	6.75%	1.7250%	0.88540505

EXHIBIT 12.9 Valuing the Swap One Year Later if Rates Increase

(1) Quarter starts	(2) Quarter ends	(3) Forward discount factor	(4) Floating cash flow at end of quarter	(5) PV of floating cash flow	(6) Fixed cash flow at end of quarter	(7) PV of fixed cash flow
Jan 1 year 2	Mar 31 year 2	0.98704503	1,312,500	1,295,497	1,246,875	1,230,722
Apr 1 year 2	June 30 year 2	0.97295263	1,448,417	1,409,241	1,260,729	1,226,630
July 1 year 2	Sept 30 year 2	0.95879023	1,477,111	1,416,240	1,274,583	1,222,058
Oct 1 year 2	Dec 31 year 2	0.94431080	1,533,333	1,447,943	1,274,583	1,203,603
Jan 1 year 3	Mar 31 year 3	0.93001186	1,537,500	1,429,893	1,246,875	1,159,609
Apr 1 year 3	June 30 year 3	0.91554749	1,579,861	1,446,438	1,260,729	1,154,257
July 1 year 3	Sept 30 year 3	0.90067829	1,650,889	1,486,920	1,274,583	1,147,990
Oct 1 year 3	Dec 31 year 3	0.88540505	1,725,000	1,527,324	1,274,583	1,128,523
			Total	11,459,495		9,473,390

Summary	Fixed-rate payer	Fixed-rate receiver
PV of payments received	11,459,495	9,473,390
PV of payments made	9,473,390	11,459,495
Value of swap	1,986,105	–1,986,105

EXHIBIT 12.10 Swap Rates and Spreads for Various Maturities

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94<GO> View News.

SECURITY	Bid	Ask	CHANGE	SECURITY	Bid	Ask	CHANGE
US Semi 30/360				US Spreads 30/360			
3) 2 YR	3.6500	3.6700	-.0100	23) 2YR	47.00	49.00	-2.00
4) 3 YR	4.4000	4.4200	+.0760	24) 3YR	78.00	80.00	+.50
5) 4 YR	4.8600	4.8800	+.1000	25) 4YR	80.50	82.50	+.50
6) 5 YR	5.1900	5.2050	+.1275	26) 5YR	70.00	72.00	--
7) 6 YR	5.3660	5.4060	+.1050	27) 6YR	77.00	79.00	--
8) 7 YR	5.5600	5.5800	+.1355	28) 7YR	80.50	82.50	+.50
9) 8 YR	5.6750	5.7150	+.1320	29) 8YR	79.50	81.50	+1.00
10) 9 YR	5.7720	5.8120	+.1370	30) 9YR	76.00	78.00	+.50
11) 10 YR	5.8700	5.8900	+.1600	31) 10YR	71.00	73.00	+.50
12) 15 YR	6.1800	6.1980	+.1545	32) 15YR	90.50	92.50	+.25
13) 20 YR	6.2730	6.3130	+.1340	33) 20YR	90.75	92.75	-.25
14) 30 YR	6.2790	6.3190	+.1330	34) 30YR	68.50	70.50	--
Change on Day				Change on Day			
IYC4 I52<GO>				IYC4 I48<GO>			
Change on Month				Change on Month			
IYC6 I52<GO>				IYC6 I48<GO>			

Page for ANN Rates

Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 92041210
Hong Kong 852 2977 6000 Japan 81 3 3201 8900 Singapore 65 212 1000 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
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Source: Bloomberg Financial Markets

The same valuation principle applies to more complicated swaps. For example, there are swaps whose notional amount changes in a predetermined way over the life of the swap. These include amortizing swaps, accreting swaps, and roller coaster swaps. Once the payments are specified, the present value is calculated as described above by simply adjusting the payment amounts by the changing notional amounts—the methodology does *not* change.

PRIMARY DETERMINANTS OF SWAP SPREADS

As we have seen, interest rate swaps are valued using no-arbitrage relationships relative to instruments (funding or investment vehicles) that produce the same cash flows under the same circumstances. 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 tenor.

Exhibit 12.10 displays a Bloomberg screen with interest rate swap rates (in percent) and swap spreads (in basis points) for various maturities out to 30 on December 7, 2001. Recall, the bid price is the fixed rate that the broker/dealer is willing to pay in order to receive a floating rate. Conversely, the ask price is the fixed rate the broker/dealer wants to receive in order to pay a floating rate. Current swap rates and spreads for a number of countries can be obtained on Bloomberg with the function IRSB. Exhibit 12.11 presents a Bloomberg screen of interest rate swap rates for eight different currencies. Bloomberg collects the spread information throughout the trading day and an average is calculated using the spreads from three market makers. The actual swap rates can be obtained simply by adding the swap spreads to the on-the-run U.S. Treasury yield curve. Exhibit 12.12 is a time series plot obtained from Bloomberg for daily values of the 5-year swap spread (in basis points) for the period December 7, 2000 to December 7, 2001. This plot can be obtained using the function USSP5 Index GP.

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 tenors (i.e., maturities) of five years or less is the cost of hedging in the Eurodollar CD futures market.[4] Although listed contracts exist with delivery dates out to 10 years, the liquidity of the Eurodollar CD futures market diminishes considerably after about five years. For longer tenor swaps, the swap spread is largely driven by credit spreads in the corporate bond market.[5] 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 CD futures prices. As noted, there is a liquid market for Eurodollar CD futures contracts with maturities every three months for approximately five years. A market participant can create a synthetic fixed-rate security or a fixed-rate funding vehicle by taking a position in a bundle of Eurodollar CD futures contracts (i.e., a position in every 3-month Eurodollar CD futures contract up to the desired maturity date).

[4] Naturally, this presupposes the reference rate used for the floating-rate cash flows is LIBOR. Furthermore, part of swap spread is attributable simply to the fact that LIBOR for a given maturity is higher than the rate on a comparable-maturity U.S. Treasury.

[5] The default risk component of a swap spread will be smaller than for a comparable bond credit spread. The reasons are straightforward. 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, Third Edition* (Upper Saddle River, NJ: Prentice Hall, 1998).

EXHIBIT 12.11 Swap Rates for Various Currencies

Source: Bloomberg Financial Markets

EXHIBIT 12.12 Time Series of the 5-Year Swap Spread

Source: Bloomberg Financial Markets

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 3-month LIBOR. This financial institution can hedge this mismatched asset/liability position by buying a 3-year bundle of Eurodollar CD futures contracts. By doing so, the financial institution is receiving LIBOR over the 3-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 CD 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 3-year swap in which it pays fixed and receives 3-month LIBOR. Other things 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 3-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 tenors greater than five years, we cannot rely on the Eurodollar CD futures due to diminishing liquidity of such contracts. Instead, longer-dated swaps are priced using rates available for 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 primary determinant of the swap spread. Empirically, the swap curve lies above the U.S. Treasury yield curve and below the on-the-run yield curve for AA-rated banks.[6] Swap fixed rates are lower than AA-rated bond yields because their lower credit due to netting and offsetting of swap positions.

In addition, there are a number of other technical factors that influence the level of swap spreads.[7] While the impact of some 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 technical factors that affect swap dealers; and (4) the level of asset-based swap activity.

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

[7] See Ellen L. Evans and Gioia Parente Bales, "What Drives Interest Rate Swap Spreads," Chapter 13 in Carl R. Beidleman (ed.), *Interest Rate Swaps* (Burr Ridge, IL: Irwin Professional Publishing, 1991).

The level, slope, and curvature of the U.S. Treasury yield is an important influence on swap spreads at various maturities. The reason is that embedded in the yield curve are the market's expectations of the direction of future interest rates. While these expectations are sometimes challenging to extract, the decision to borrow at a fixed-rate or a floating-rate will be based, in part, on these expectations. The relative supply of fixed- and floating-rate payers in the interest rate swap market should also be influenced by these expectations. For example, many corporate issuers—financial institutions and federal agencies in particular—swap their newly issued fixed-rate debt into floating using the swap market. Consequently, swap spreads will be affected by the corporate debt issuance calendar. In addition, swap spreads, like credit spreads, also tend to increase with the swap's tenor or maturity.

Swap spreads are also affected by the hedging costs faced by swap dealers. Dealers hedge the interest rate risk of long (short) swap positions by taking a long (short) position in a Treasury security with the same maturity as the swap's tenor and borrowing funds (lending funds) in the repo market. As a result, the spread between LIBOR and the appropriate repo rate will be a critical determinant of the hedging costs. For example, with the burgeoning U.S. government budget surpluses starting in the late 1990s, the supply of Treasury securities has diminished. One impact of the decreased supply is an increase in the spread between the yields of on-the-run and off-the-run Treasuries. As this spread widens, investors must pay up for the relatively more liquid on-the-run issues. This chain reaction continues and results in on-the-run Treasuries going "on special" in repo markets. When on-the-run Treasuries go "on special," it is correspondingly more expensive to use these Treasuries as a hedge. This increase in hedging costs results in wider swap spreads.[8]

Another influence on the level of swap spreads is the volume of asset-based swap transactions. An asset-based swap transaction involves the creation of a synthetic security via the purchase of an existing security and the simultaneous execution of a swap. For example, after the Russian debt default and ruble devaluation in August 1998, risk-averse investors sold corporate bonds and fled to the relative safety of U.S. Treasuries. Credit spreads widened considerably and liquidity diminished. A contrary-minded floating-rate investor (like a financial institution) could have taken advantage of these circumstances by buying newly issued invest-

[8] Traders often use the repo market to obtain specific securities to cover short positions. If a security is in short supply relative to demand, the repo rate on a specific security used as collateral in repo transaction will be below the general (i.e., generic) collateral repo rate. When a particular security's repo rate falls markedly, that security is said to be "on special." Investors who own these securities are able to lend them out as collateral and borrow at bargain basement rates.

ment grade corporate bonds with relatively attractive coupon rates and simultaneously taking a long position in an interest rate swap (pay fixed/ receive floating). Because of the higher credit spreads, the coupon rate that the financial institution receives is higher than the fixed-rate paid in the swap. Accordingly, the financial institution ends up with a synthetic floating-rate asset with a sizeable spread above LIBOR.

By similar reasoning, investors can use swaps to create a synthetic fixed-rate security. For example, during the mid-1980s, many banks issued perpetual floating-rate notes in the Eurobond market. A perpetual floating-rate note is a security that delivers floating-rate cash flows forever. The coupon is reset and paid usually every three months with a coupon formula equal to the reference rate (e.g., 3-month LIBOR) plus a spread. When the perpetual floating-rate note market collapsed in late 1986, the contagion spread into other sectors of the floaters market.[9] Many floaters cheapened considerably. As before, contrary-minded fixed-rate investors could exploit this situation through the purchase of a relatively cheap (from the investor's perspective) floater while simultaneously taking a short position in an interest rate swap (pay floating/receive fixed) thereby creating a synthetic fixed-rate investment. The investor makes floating-rate payments (say based on LIBOR) to their counterparty and receives fixed-rate payments equal to the Treasury yield plus the swap spread. Accordingly, the fixed rate on this synthetic security is equal to the sum of the following: (1) the Treasury bond yield that matches the swap's tenor; (2) the swap spread; and (3) the floater's index spread.

NON-VANILLA INTEREST-RATE SWAPS

The swap market is very flexible and instruments can be tailor-made to fit the requirements of individual customers. A wide variety of swap contracts are traded in the market. Although the most common reference rate for the floating-leg of a swap is six-month Libor for a semiannual paying floating leg, other reference rates that have been used include three-month Libor, the prime rate (for dollar swaps), the one-month commercial paper rate, and the Treasury bill rate, and the municipal bond rate.

The term of a swap need not be fixed; swaps may be *extendible* or *putable*. In an extendible swap, one of the parties has the right but not the obligation to extend the life of the swap beyond the fixed maturity date, while in a putable swap one party has the right to terminate the swap prior to the specified maturity date.

[9] Suresh E. Krishman, "Asset-Based Interest Rate Swaps," Chapter 8 in *Interest Rate Swaps*.

It is also possible to transact options on swaps, known as *swaptions*. A swaption is the right to enter into a swap agreement at some point in the future, during the life of the option. Essentially a swaption is an option to exchange a fixed-rate bond cash flow for a floating-rate bond cash flow structure. As a floating-rate bond is valued on its principal value at the start of a swap, a swaption may be viewed as the value on a fixed-rate bond, with a strike price that is equal to the face value of the floating-rate bond. Swaptions will be described in more detail later.

Other swaps are described below.

Constant Maturity Swap

In a constant maturity swap, the parties exchange a Libor rate for a fixed swap rate. For example, the terms of the swap might state that six-month Libor is exchanged for the five-year swap rate on a semiannual basis for the next five years, or for the five-year government bond rate. In the U.S. market, the second type of constant maturity swap is known as a *constant maturity Treasury swap*.

Accreting and Amortizing Swaps

In a plain vanilla swap, the notional principal remains unchanged during the life of the swap. However it is possible to trade a swap where the notional principal varies during its life. An accreting (or step-up) swap is one in which the principal starts off at one level and then increases in amount over time. The opposite, an amortizing swap, is one in which the notional reduces in size over time. An accreting swap would be useful where for instance, a funding liability that is being hedged increases over time. The amortizing swap might be employed by a borrower hedging a bond issue that featured sinking fund payments, where a part of the notional amount outstanding is paid off at set points during the life of the bond. If the principal fluctuates in amount, for example increasing in one year and then reducing in another, the swap is known as a *roller-coaster swap*. Another application of an amortizing swap is as a hedge for a loan that is itself an amortizing one. Frequently this is combined with a forward-starting swap, to tie in with the cash flows payable on the loan. The pricing and valuation of an amortizing swap is no different in principle to a vanilla interest-rate swap; a single swap rate is calculated using the relevant discount factors, and at this rate the net present value of the swap cash flows will equal zero at the start of the swap.

Zero-Coupon Swap

A zero-coupon swap replaces the stream of fixed-rate payments with a single payment at the end of the swap's life, or less common, at the beginning. The floating-rate payments are made in the normal way. Such a swap exposes the floating-rate payer to some credit risk because it makes regular payments but does not receive any payment until the termination date of the swap.

Libor-in-Arrears Swap

In a Libor-in-arrears swap (also known as a *back-set swap*), the reset date is just before the end of the accrual period for the floating-rate rather than just before the start. Such a swap would be attractive to a counterparty who had a different view on interest rates compared to the market consensus. For instance in a rising yield curve environment, forward rates will be higher than current market rates, and this will be reflected in the pricing of a swap. A Libor-in-arrears swap would be priced higher than a conventional swap. If the floating-rate payer believed that interest rates would in fact rise more slowly than forward rates (and the market) were suggesting, he or she may wish to enter into an arrears swap as opposed to a conventional swap.

Basis Swap

In a conventional swap one leg comprises fixed-rate payments and the other floating-rate payments. In a *basis swap* both legs are floating-rate, but linked to different money market indices. One leg is normally linked to Libor, while the other might be linked to the CD rate or the commercial paper rate. This type of swap would be used by a bank in the United States that had made loans that paid at the prime rate and funded its loans at Libor. A basis swap would eliminate the basis risk between the bank's income and interest expense. Other basis swaps are traded in which both legs are linked to Libor, but at different maturities; for instance one leg might be at three-month Libor and the other at six-month Libor. In such a swap, the basis is different as is the payment frequency: one leg pays out semiannually while the other would be paying on a quarterly basis.

Margin Swap

It is common to encounter swaps where there is a margin above or below Libor on the floating leg, as opposed to a floating leg of Libor flat. Such swaps are called *margin swaps*. If a bank's borrowing is financed at Libor+25bps, it may wish to receive Libor+25bps in the swap so that its cash flows match exactly. The fixed-rate quote for a swap must be adjusted correspondingly to allow for the margin on the floating side. So in our example if the fixed-rate quote is say, 6.00%, it would be adjusted to around 6.25%; differences in the margin quoted on the fixed leg might arise if the day-count convention or payment frequency were to differ between fixed and floating legs. Another reason why there may be a margin is if the credit quality of the counterparty demanded it, so that highly rated counterparties may pay slightly below Libor, for instance.

Off-Market Swap

When a swap is transacted, its fixed rate is quoted at the current market rate for that maturity. When the fixed rate is different from the market rate, this type of swap is an *off-market swap*, and a compensating payment is made by one party to the other. An off-market rate may be used for particular hedging requirements for example, or when a bond issuer wishes to use the swap to hedge the bond as well as to cover the bond's issue costs.

Differential Swap

A differential swap is a basis swap but with one of the legs calculated in a different currency. Typically one leg is floating-rate, while the other is floating-rate but with the reference rate stated in another currency but denominated in the domestic currency. For example, a differential swap may have one party paying six-month sterling Libor, in sterling, on a notional principal of £10 million, and receiving euro-Libor minus a margin, payable in sterling and on the same notional principal. Differential swaps are not very common and are the most difficult for a bank to hedge. The hedging is usually carried out using what is known as a *quanto option*.

Forward-Start Swap

A *forward-start swap* is one where the effective date is not the usual one or two days after the trade date but a considerable time afterwards, for instance say six months after trade date. Such a swap might be entered into where one counterparty wanted to fix a hedge or cost of borrowing now, but for a point some time in the future. Typically this would be because the party considered that interest rates would rise or the cost of hedging would rise. The swap rate for a forward-starting swap is calculated in the same way as that for a vanilla swap.

CANCELLING A SWAP

When financial institutions enter into a swap contract in order to hedge interest-rate liabilities, the swap will be kept in place until its expiration. However, circumstances may change or a financial institution may alter its view on interest rates, and so circumstances may arise such that it may be necessary to terminate the swap. The most straightforward option is for the corporation to take out a second contract that negates the first. This allows the first swap to remain in place, but there may be residual cash flows unless the two swaps cancel each other out precisely. The terms for the second swap, being non-standard (and unlikely to be a exactly whole years to maturity, unless traded on the anniversary of the first), may also result in it being more expensive than a vanilla swap. As it is unlikely that the second swap will have the same rate, the two fixed legs will not net to zero. And if the second swap is not traded on an anniversary, payment dates will not match.

For these reasons, an entity may wish to cancel the swap entirely. To do this it will ask a swap market maker for a quotation on a *cancellation fee*. The bank will determine the cancellation fee by calculating the net present value of the remaining cash flows in the swap, using the relevant discount factor for each future cash flow. In practice just the fixed leg will be present valued, and then netted with Libor. The net present value of all the cash flows is the fair price for canceling the swap. The valuation principles we established earlier will apply; that is, if the fixed rate payer is asking to cancel the swap when interest rates have fallen, he will pay the cancellation fee, and vice-versa if rates have risen.

CREDIT RISK

The rate quoted for swaps in the interbank market assumes that the counterparty to the transaction has a lending line with the swap bank, so the swap rate therefore reflects the credit risk associated with interbank quality counterparty. This credit risk is reflected in the spread between the swap rate and the equivalent-maturity government bond, although, as noted, the spread also reflects other considerations such as liquidity and supply and demand. The credit risk of a swap is separate from its interest-rate risk or market risk, and arises from the possibility of the counterparty to the swap defaulting on its obligations. If the present value of the swap at the time of default is net positive, then a bank is at risk of loss of this amount. While market risk can be hedged, it is more problematic to hedge credit risk. The common measures taken include limits on lending lines, collateral, and diversification across counterparty sectors, as well as a form of credit value-at-risk to monitor credit exposures.

A bank therefore is at risk of loss due to counterparty default for all its swap transactions. If at the time of default, the net present value of the swap is positive, this amount is potentially at risk and will probably be written off. If the value of the swap is negative at the time of default, in theory this amount is a potential gain to the bank, although in practice the counterparty's administrators will try to recover the value for their client. In this case then, there is no net gain or loss to the swap bank. The credit risk management department of a bank will therefore often assess the ongoing credit quality of counterparties with whom the swap transactions are currently positive in value.

CROSS-CURRENCY SWAPS

So far we have discussed swap contracts where the interest payments are both in the same currency. A *cross-currency swap* is similar to an interest-rate swap, except that the currencies of the two legs are different. Like interest-rate swaps, the legs are usually fixed- and floating-rate, although again it is common to come across both fixed-rate or both floating-rate legs in a currency swap. On maturity of the swap, there is an exchange of principals, and usually (but not always) there is an exchange of principals at the start of the swap. Where currencies are exchanged at the start of the swap, at the prevailing spot exchange rate for the two currencies, the exact amounts are exchanged back on maturity.

During the time of the swap, the parties make interest payments in the currency that they have *received* when principals are exchanged. It may seem that exchanging the same amount at maturity gives rise to some sort of currency risk, in fact it is this feature that removes any element of currency risk from the swap transaction.

Currency swaps are widely used in association with bond issues by borrowers who seek to tap opportunities in different markets but have no requirement for that market's currency. By means of a currency swap, a corporation can raise funds in virtually any market and swap the proceeds into the currency that it requires. Often the underwriting bank that is responsible for the bond issue will also arrange for the currency swap transaction. In a currency swap, therefore, the exchange of principal means that the value of the principal amounts must be accounted for, and is dependent on the prevailing spot exchange rate between the two currencies.

The same principles we established earlier in the chapter for the pricing and valuation of interest rate swaps may also be applied to currency swaps. A generic currency swap with fixed-rate payment legs would be valued at the fair value swap rate for each currency, which would give a net present value of zero. A floating-floating currency swap may be valued in the same way, and for valuation purposes the floating-leg payments are replaced with an exchange of principals, as we observed for the floating leg of an interest rate swap. A fixed-floating currency swap is therefore valued at the fixed-rate swap rate for that currency for the fixed leg, and at Libor or the relevant reference rate for the floating leg.

SWAPTIONS

A bank or corporation may enter into an option on a swap, which is called a swaption. The buyer of a swaption has the right but not the obligation to enter into an interest rate swap at any time during the option's life. The terms of the swaption will specify whether the buyer is the fixed- or floating-rate payer; the seller of the option (the *writer*) becomes the counterparty to the swap if the option is exercised. In the market, the convention is that if the buyer has the right to exercise the option as the fixed-rate payer, the buyer has purchased a *call swaption*, while if by exercising the buyer of the swaption becomes the floating-rate payer he has bought a *put swaption*. The writer of the swaption is the party that has an obligation to establish the other leg.

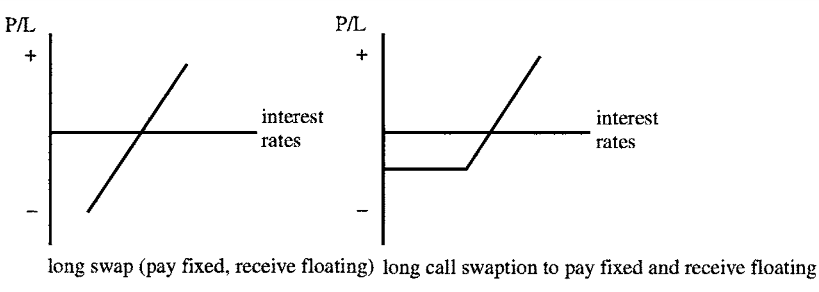
Swaptions are up to a point similar to forward start swaps, but the buyer has the option of whether or not to commence payments on the effective date. A bank may purchase a call swaption if it expects interest rates to rise, and will exercise the option if indeed rates do rise as the bank has expected. This is shown in the profit/loss diagrams in Exhibit 12.13. The profit/loss (P/L) diagram on the left is for a long swap position while the one on the right is for a long swaption.

A corporation will use swaptions as part of an interest-rate hedge for an anticipated future exposure. For example, assume that a corporation will be entering into a five-year bank loan in three months' time. Interest on the loan is charged on a floating-rate basis, but the corporation intends to swap this to a fixed-rate liability after it has entered into the loan. As an added hedge, the corporation may choose to purchase a swaption that gives it the right to receive Libor and pay a fixed rate, say 6%, for a five-year period beginning in three months' time. When the time comes for the corporation to engage in a swap contract and exchange its interest-rate liability in three months' time (having entered into the loan), if the five-year swap rate is below 6%, the corporation will transact the swap in the normal way and the swaption will expire worthless. However, if the five-year swap rate is above 6%, the corporation will instead exercise the swaption, giving it the right to enter into a five-year swap and paying a fixed rate of 6%. Essentially the corporation has taken out "insurance" that it does not have to pay a fixed rate of more than 6%. Hence swaptions can be used to guarantee a maximum swap rate liability. They are similar to forward-starting swaps, but differ because they represent an option (as opposed to an obligation) to enter into a swap on fixed terms. The swaption enables a corporation to hedge against unfavorable movements in interest rates but also to gain from favorable movements, although there is of course a cost associated with this, which is the premium paid for the swaption.

SWAPNOTE®—AN EXCHANGE-TRADED INTEREST-RATE SWAP CONTRACT

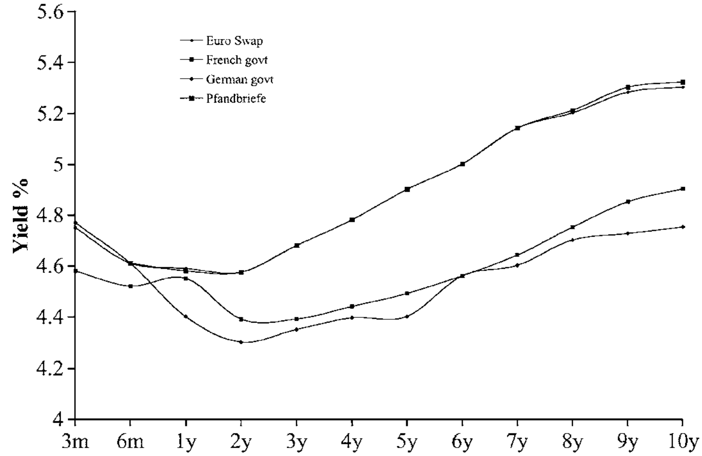
In both the U.S. dollar and euro markets, the position of the government bond yield curve as the benchmark instrument for pricing, valuation, and hedging purposes is eroding. In the U.S. dollar market this has been the result of the decreasing supply of U.S. Treasury securities, due to continuing federal government budget surpluses, leading to illiquidity particularly at the long end of the curve.[10] In Europe, the introduction of the euro in 1999 resulted in a homogeneous euro swap curve replacing individual government bond yield curves as the benchmark. The nominal volumes of swap contacts far outstrip that of government bonds in both currency areas. For instance in June 2000 there was $22.9 trillion of swap contracts outstanding, which was over five times the combined size of the German, French, and Italian government bond markets.[11] The falling issuance of government bonds has placed pressure on government bonds as benchmark instruments, which has resulted in greater basis risk for market participants using exchange-traded government bond futures contracts as hedging tools.

EXHIBIT 12.13 Profit/Loss Diagrams for an Interest Rate Swap and a Swaption



[10] On October 31, 2001, the U.S. Treasury announced it would no longer issue 30-year bonds.
[11] The source is the LIFFE. The authors would like to thank Nimmish Thakker at LIFFE for assistance with statistics and information on the Swapnote contract.

EXHIBIT 12.14 Yield Curves for French and German Government Bonds, Pfandbriefe Securities and Euro Interest-Rate Swaps, February 2001



The increasing importance of interest rate swaps as hedging and even benchmark instruments was a primary motivation behind the development of an exchange-traded contract referenced against the swap curve. The swap curve is the inter-bank curve, derived from inter-bank deposits, short-term interest rate futures and interest-rate swaps. Swapnote®, introduced by LIFFE in 2001, is a standardized contract that allows market participants to put on an exposure to the interest-rate swap curve, but with the ease of access of an exchange-traded future. It is the first such contract in the world. It may be that the euro swap curve becomes the reference not only for valuing non-government securities, but also for European government bonds. In that case, the euro swap curve will transform into the cornerstone for the entire euro-area debt capital market, which will deteriorate further the relationship between government bonds and non-government bonds. An indication of this is given in Exhibit 12.14 which shows the yield curves for the swap curve as well as two government curves and a AAA-rated security. The non-government security mirrors the swap curve much more closely than the government bonds.

Swapnote may be thought of as combining the features of an exchange-traded futures contract and an OTC FRA contract. Alternatively, it may be viewed as a cash-settled bond futures contract in which the delivery basket consists of a single bond. It is referenced to the euro interest-rate swap curve, and contracts are provided for two-, five-, and ten-year maturities. The contract can be used for speculative purposes, or for hedging purposes of credit exposures such as corporate bonds or an interest-rate swap book. In theory, it provides a closer correlation between the hedging instrument and the exposure, thus reducing basis risk. By using an exchange-traded contract rather than swaps themselves, users also gain from the advantages associated with exchange-based trading and central clearing. This includes lower regulatory capital requirements, removal of counterparty risk, and elimination of administration requirements of actual swap contracts, which can stretch out to many years. Market participants will compare this to hedging using conventional interest-rate swaps, which involve credit line issues, documentation issues, and bid-offer spreads which can make the swap market difficult and/or expensive to access.

Market participants can gain exposure to the yield curve out to ten years; beyond that, government bonds must continue to be used.

Contract Specification

The Swapnote contract specification provides for a standardized exchange-traded futures contract referenced to the swap curve. It is a price-based contract, similar in concept to a forward-starting swap, and is cash settled against the swap curve. The contract consists of a series of notional cash flows representing the cash flows of a bond, with a fixed-rate cash flow and a principal repayment. The fixed-rate cash flow is set at 6%, and the price quotation is per 100 euro just like a bond future. When the contract expires its price reflects the market price at the time, reflecting supply and demand, and other economic and market fundamentals. The settlement price is calculated using the standard exchange delivery settlement price methodology (EDSP). For Swapnote the EDSP is given by

$$EDSP = 100\left[d_m + C\sum_{i=1}^{m} A_i d_i\right] \tag{1}$$

where

- C = the notional coupon for the contract, which is fixed at 6%
- m = he maturity of the contract in years, either 2, 5 or 10
- A_i = the notional accrued interest between coupon dates, given as the number of days between the i-1 and i notional cash flows and divided by 360. Day counts use the 30/360 basis.
- d_i = is the zero-coupon discount factor, calculated from the swap rate is fixed for each period from the delivery date to the ith notional cash flow.

The zero-coupon yield curve is constructed by LIFFE from ISDA benchmark swap fixes as at the expiry date of the contract. The first discount factor d_1 is given by

$$d_1 = \frac{1}{1 + A_1 rs_1} \tag{2}$$

where rs is the swap rate and rs_1 is the one-year swap rate. The full set of discount factors is then calculated using the bootstrapping technique, and is given by

$$d_i = \frac{1 - rs_i \sum_{j=1}^{i-1} A_j d_j}{1 + A_1 rs_i} \tag{3}$$

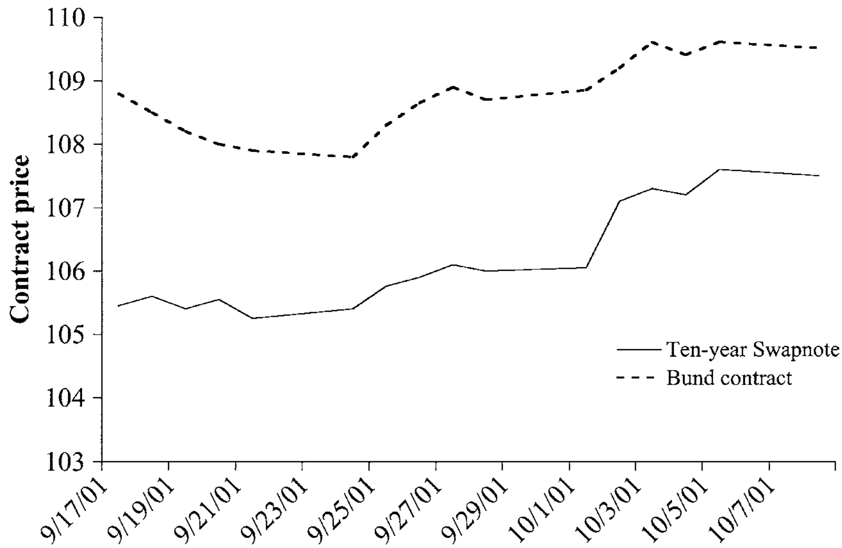
Equation (1) states that the EDSP is the sum of the discounted notional cash flows, with the present value of each notional cash flow calculated using zero-coupon discount factors that have been derived from the ISDA benchmark swap curve as at the expiration date. The fair price of the contract is the sum of the present values of the notional cash flows, valued to the trade date and then forward valued to the contract delivery date. Forward valuing to the delivery date can be regarded as funding the position (were it a coupon bond) from trade date to delivery date. Exhibit 12.15 presents a summary of the ten-year Swapnote contract specifications.

EXHIBIT 12.15 **Ten-Year Euro Swapnote Contract Specification**

Unit of trading	100,000 notional principal amount
Notional fixed rate	6.0%
Maturity	Notional principal amount due ten years from delivery day
Delivery months	March, June, September, December
Delivery day	Third Wednesday of delivery month
Last trading day	10:00 London time Two business days prior to the delivery day
Price quote	Per 100 nominal value
Minimum price movement	0.01
Tick size and value	10
Trading hours (LIFFE Connect)	07:00–18:00

Notes
The contract is cash settled, therefore "principal" and "coupon" payments are notional and do not actually occur.
The maturity of a Swapnote contract is defined as the time from the delivery month to the maturity of the last notional cash flow.
Source: LIFFE

EXHIBIT 12.16 Price Trading History, Ten-Year Swapnote (LIFFE) and Ten-Year Bund (Eurex), September-October 2001



Trade Spread History

To illustrate the similarity in market price movements, Exhibit 12.16 shows the price trading history of the ten-year Swapnote contract against the ten-year Bund contract as traded on Eurex during September and October 2001. The exhibit indicates that the Swapnote is behaving as a benchmark to the market, similar to the Bund contract, with a narrowing spread between the contracts over time.

CBOT SWAP FUTURES CONTRACT

The Chicago Board of Trade (CBOT) introduced a swap futures contract in late October 2001. The underlying instrument is the notional price of the fixed-rate side of a 10-year interest rate swap that has a notional principal equal to $100,000 and that exchanges semi-annual interest payments at a fixed annual rate of 6% for floating interest rate payments based on 3-month LIBOR. This swap futures contract is cash-settled with a settlement price determined by the ISDA benchmark 10-year swap rate on the last day of trading before the contract expires. This benchmark rate is published with a one day lag in the Federal Reserve Board's statistical release H.15. Contracts expire the third month of each quarter

(March, June, September and December) just like the other CBOT interest rate futures contracts. The last trading day is the second London business day preceding the third Wednesday of the expiration month.

The swap futures contract will be priced just as a forward-start swap discussed earlier in this chapter. For example, the December 2001 swap futures contract will be for a new 10-year interest rate swap beginning on December 17, 2001. It is anticipated that this contract will be a valuable tool to hedge spread product.

CAPS AND FLOORS

An important option combination in debt markets is the *cap* and *floor*, which are used to control interest-rate risk exposure. Caps and floors are combinations of the same types of options (calls or puts) with identical strike prices but arranged to run over a range of time periods. In the last chapter, we reviewed the main instruments used to control interest-rate risk, including short-dated interest-rate futures and FRAs. For example, a corporation that desires to protect against a rise in future borrowing costs could buy FRAs or sell futures. These instruments allow the user to lock in the forward interest rate available today. However, such positions do not allow the hedger to gain if market rates actually move as feared/anticipated. Hedging with FRAs or futures can prevent loss but at the expense of any extra gain. To overcome this, the hedger might choose to construct the hedge using options. For interest rate hedges, primary instruments are the cap and floor.[12]

Caps and floors are agreements between two parties whereby one party for an upfront fee agrees to compensate the other if a designated interest rate (called the *reference rate*) is different from a predetermined level. The party that benefits if the reference rate differs from a perdetermined level is called the buyer and the party that must potentially make payments is called the seller. The predetermined interest rate level is called the *strike rate*. An interest rate cap specifies that the seller agrees to pay the buyer if the reference rate exceeds the strike rate. An interest rate floor specifies that the seller agrees to pay the buyer if the reference rate is below the strike rate.

The terms of an interest rate agreement include: (1) the reference rate; (2) the strike rate that sets the cap or floor; (3) the length of the agreement; (4) the frequency of reset; and (5) the notional amount (which determines the size of the payments). If a cap or a floor are in-the-money on the reset date, the payment by the seller is typically made in arrears.

[12] The term cap and floor is not to be confused with floating-rate note products that have caps and/or floors which restrict how much a floater's coupon rate can float.

Some commercial banks and investment banks now write options on interest rate caps and floors for customers. Options on caps are called *captions*. Options on floors are called *flotions*.

Caps

A cap is essentially a strip of options. A borrower with an existing interest-rate liability can protect against a rise in interest rates by purchasing a cap. If rates rise above the cap, the borrower will be compensated by the cap payout. Conversely, if rates fall the borrower gains from lower funding costs and the only expense is the upfront premium paid to purchase the cap. The payoff for the cap buyer at a reset date if the value of the reference rate exceeds the cap rate on that date is as follows:

Notional amount × (Value of the reference rate – Cap rate)
× (Number of days in settlement period/Number of days in year)

Naturally, if the reference rate is below the cap rate, the payoff is zero.

A cap is composed of a series of individual options or caplets. The price of a cap is obtained by pricing each of the caplets individually. Each caplet has a strike interest-rate that is the rate of the cap. For example, a borrower might purchase a 3% cap (Libor reference rate), which means that if rates rise above 3% the cap will pay out the difference between the cap rate and the actual Libor rate. A one-year cap might be composed of a strip of three individual caplets, each providing protection for successive three-month periods. The first three-month period in the one-year term is usually not covered, because the interest rate for that period, as it begins immediately, will be known already. A caplet runs over two periods, the exposure period and the protection period. The exposure period runs from the date the cap is purchased to the interest reset date for the next borrowing period. At this point, the protection period begins and runs to the expiration of the caplet. The protection period is usually three months, six months or one year, and will be set to the interest rate reset liability that the borrower wishes to hedge. Therefore, the protection period is usually identical for all the caplets in a cap.

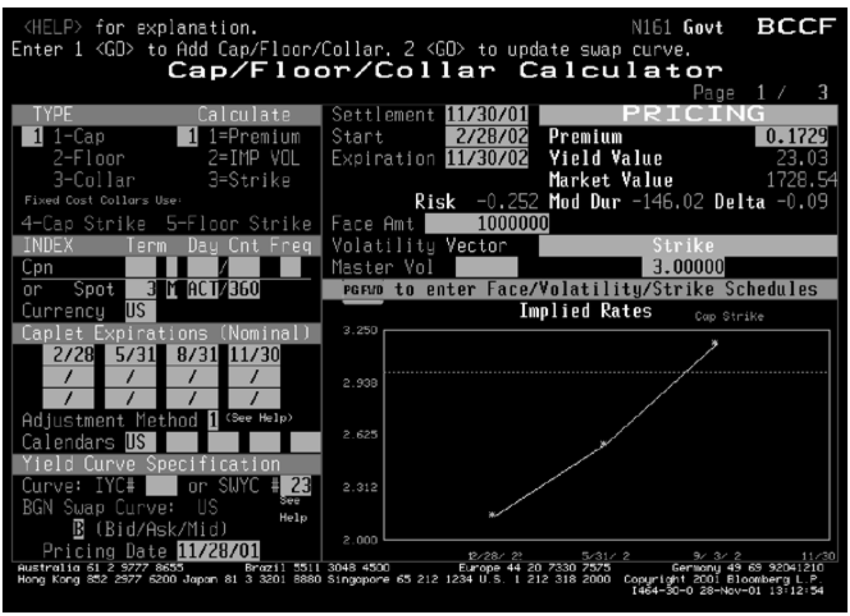
As an illustration, let's utilize Bloomberg's Cap, Floor, Collar Calculator presented in Exhibit 12.17. Consider a hypothetical one-year cap on three-month LIBOR with a strike rate of 3%. The settlement date for the agreement is November 30, 2001 and the expiration date is November 30, 2002. The first reset date is February 28, 2002, which is labelled "Start" in the top center of the screen. If three-month LIBOR is above the strike rate on this date, say, 3.5%, the payoff of the cap assuming the notional principal is $1,000,000 is computed as follows:

$$\$1{,}000{,}000 \times (3.5\% - 3.0\%) \times 92/360 = \$1{,}277.78$$

This payment is made on May 31, 2002. Note that the day count convention is Actual/360 in the US markets and Actual/365 in the UK. The second reset date is May 31, 2002 for which payment is made, if necessary, on August 31, 2002. Finally, the third reset date is August 31, 2002 for which payment is made, if necessary, on November 30, 2002.

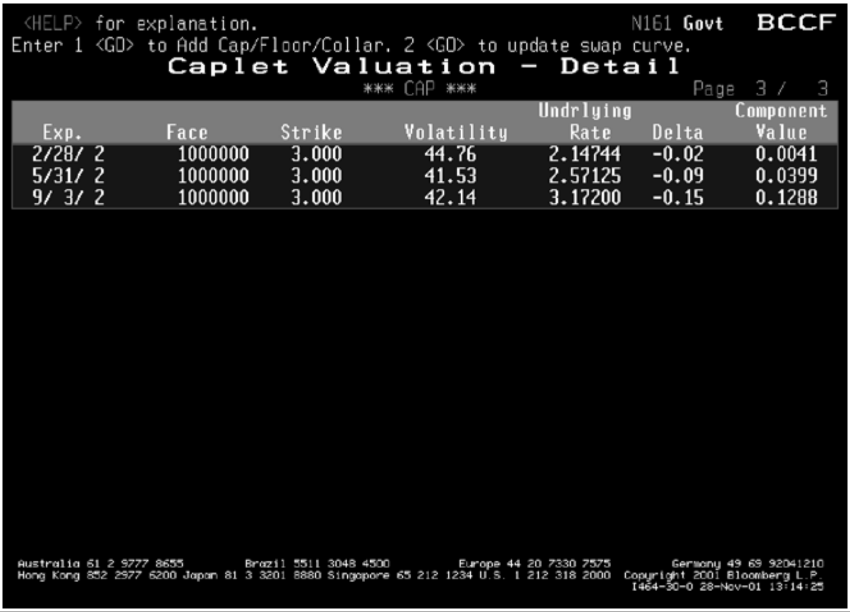
As noted above, each cap can be thought of a series of call options or caplets on the underlying reference rate in this case, three-month LIBOR. The first caplet expires on the next reset date, February 28, 2002; the second caplet expires on May 31, 2002, and so forth. Accordingly, the value of the cap is the sum of the values of all the caplets. In the "PRICING" box, the "Premium" represents the value of our hypothetical cap as a percentage of the notional amount. For our hypothetical cap, the premium is 0.1729% or approximately \$1,729. Exhibit 12.18 presents Bloomberg's Caplet Valuation screen that shows the value of caplet in the column labelled "Component Value." Bloomberg uses a modified Black-Scholes model to value each caplet and users can choose whether to use the same volatility estimate for each caplet or allow the volatility for each caplet to differ. Binomial lattice models are also extensively in practice to value caps.

EXHIBIT 12.17 **Bloomberg's Cap/Floor/Collar Calculator**



Source: Bloomberg Financial Markets

EXHIBIT 12.18 Bloomberg Screen with the Valuation of a Hypothetical Cap


<HELP> for explanation. N161 Govt BCCF
Enter 1 <GO> to Add Cap/Floor/Collar. 2 <GO> to update swap curve.
Caplet Valuation – Detail
*** CAP *** Page 3 / 3

Exp.	Face	Strike	Volatility	Undrlying Rate	Delta	Component Value
2/28/ 2	1000000	3.000	44.76	2.14744	-0.02	0.0041
5/31/ 2	1000000	3.000	41.53	2.57125	-0.09	0.0399
9/ 3/ 2	1000000	3.000	42.14	3.17200	-0.15	0.1288

Australia 61 2 9777 8655 Brazil 5511 3048 4500 Europe 44 20 7330 7575 Germany 49 69 92041210
Hong Kong 852 2977 6200 Japan 81 3 3201 8880 Singapore 65 212 1234 U.S. 1 212 318 2000 Copyright 2001 Bloomberg L.P.
I464-30-0 28-Nov-01 13:14:25

Source: Bloomberg Financial Markets

Floors

It is possible to protect against a drop in interest rates by purchasing a floor. This is exactly opposite of a cap in that a floor pay outs when the reference rate falls below the stike rate. This would be used by an institution that wished to protect against a fall in income caused by a fall in interest rate—for example, a commercial bank with a large proportion of floating-rate assets. For the floor buyer, the payoff at a reset date is as follows if the value of the reference rate at the reset date is less than the floor rate:

$$\text{Notional amount} \times (\text{Floor rate} - \text{Value of the reference rate})$$
$$\times (\text{Number of days in settlement period/Number of days in a year})$$

The floor's payoff is zero if the reference rate is higher than the floor rate.

To illustrate, let's once again utilize Bloomberg's Cap, Floor, Collar Calculator presented in Exhibit 12.19. Consider a hypothetical one-year floor on three-month LIBOR with a strike rate of 2.5%. The settlement date for the agreement is November 30, 2001 and the expiration date is November 30, 2002. If three-month LIBOR is below the strike rate on this date, say, 2%, the payoff of the floor assuming the notional amount is $1,000,000 is computed as follows:

$$\$1{,}000{,}000 \times (2.5\% - 2.0\%) \times 92/360 = \$1{,}277.78$$

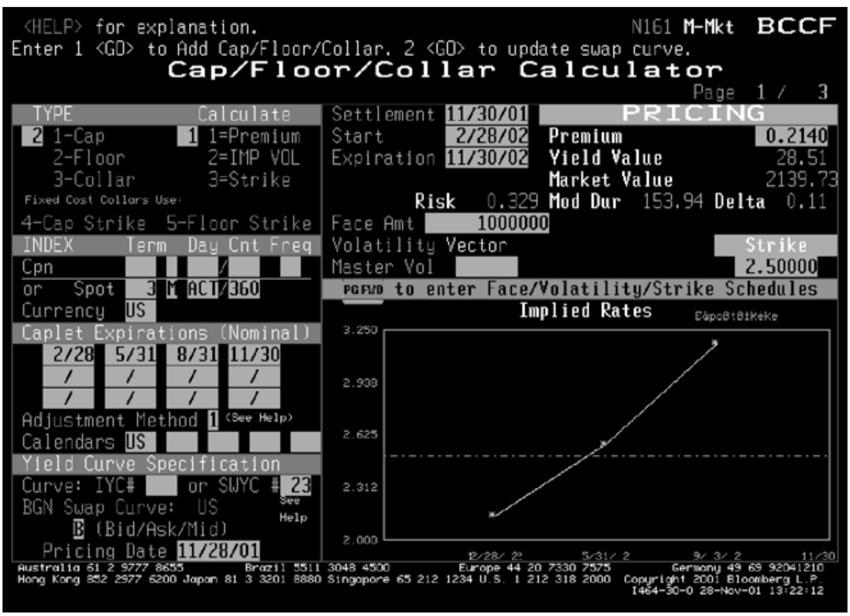
This payment is made on May 31, 2002. Note that the day count convention is Actual/360 one again.

A floor can be thought of as a series of put options on the underlying reference rate in this case, three-month LIBOR. The value of the floor is the sum of the values of all the individual put options. In the "PRICING" box, the "Premium" for our hypothetical cap, the premium is 0.2140% or approximately $2,140.

Collars

The combination of a cap and a floor creates a collar, which is a corridor that fixes interest payment or receipt levels. A collar is sometimes advantageous for borrowers because it is a lower cost than a straight cap. A collar protects against a rise in rates, and provides some gain if there is a fall down to the floor rate. The cheapest structure is a collar with a narrow spread between cap and floor rates.

EXHIBIT 12.19 **Bloomberg's Cap/Floor/Collar Calculator**



Source: Bloomberg Financial Markets

CHAPTER 13

Asset and Liability Management

The activity of commercial and investment banks in the money market centers around what is termed *asset and liability management* of the main banking book. This book (also known as the *liquidity book*) is comprised of the net position of the bank's deposits and loans as well as other short-term, high-quality debt instruments (e.g., certificates of deposit, Treasury bills, etc.). The major players in the money markets must manage their exposure to the risk of adverse movements in interest rates as part of their daily operations in these markets. Accordingly, an understanding of asset and liability management, as a branch of banking risk management, is essential for a full understanding of the money markets as a whole.

In this chapter we present an introduction to asset and liability management. Asset and liability management (ALM) is the term covering tools and techniques used by a bank to minimize exposure to market risk and *liquidity risk* while achieving its profit objectives, through holding the optimum combination of assets and liabilities. In the context of a banking book, in theory pure ALM would attempt to match precisely the timing and value of cash inflows of assets with the cash outflows of liabilities. Given the nature of a bank's activities, however, this would be difficult, if not impossible, to structure. Moreover, it would be expensive in terms of capital and opportunities foregone. For this reason a number of other approaches are followed to manage the risks of the banking book in a way that maximizes potential revenue. ALM also covers banking procedures dealing with balance sheet structure, funding policy, regulatory and capital issues, and profit target; we do not discuss these facets of ALM here. The aspect of ALM we are interested in is that dealing with policy on liquidity and interest-rate risk, and how these are hedged. In essence the ALM policy of a commercial bank will be to keep this risk at an acceptable level, given the institution's appetite for risk and expectations of future interest rate levels. Liquidity and interest-rate risk are interdependent issues, although the risks they represent are distinct.

FOUNDATIONS OF ALM

One of the major areas of decision-making in a bank involves the maturity of assets and liabilities. Typically longer-term interest rates are higher than shorter-term rates; that is, it is common for the yield curve in the short-term (say 0–3 year range) to be positively sloping. To take advantage of this, banks usually raise a large proportion of their funds from the short-dated end of the yield curve and lend out these funds for longer maturities at higher rates. The spread between the borrowing and lending rates is in principle the bank's profit. The obvious risk from such a strategy is that the level of short-term rates rises during the term of the loan, so that when the loan is refinanced the bank makes a lower profit or a net loss. Managing this risk exposure is the key function of an ALM desk. As well as managing the interest rate risk itself, banks also match assets with liabilities—thus locking in a profit—and diversify their loan book to reduce exposure to one sector of the economy.

Another risk factor is liquidity. From a banking and Treasury point of view the term *liquidity* means funding liquidity, or the "nearness" of money. The most liquid asset is cash. Banks bear several interrelated liquidity risks, including the risk of being unable to pay depositors on demand, an inability to raise funds in the market at reasonable rates, and an insufficient level of funds available with which to make loans. Banks keep only a small portion of their assets in the form of cash because cash earns no return for them. In fact, once they have met the minimum cash level requirement, which is something set down by international regulation, they will hold assets in the form of other instruments. Therefore, the ability to meet deposit withdrawals depends on a bank's ability to raise funds in the market. The market and the public's perception of a bank's financial position heavily influences liquidity. If this view is very negative, the bank may be unable to raise funds and consequently be unable to meet withdrawals or loan demand. Thus, liquidity management is running a bank in a way that maintains confidence in its financial position. The assets of the banks that are held in near-cash instruments, such as Treasury bills and clearing bank CDs, must be managed with liquidity considerations in mind. The asset book on which these instruments are held is sometimes called the *liquidity book*.

The general term *asset and liability management* entered common usage from the mid-1970s onwards. In the changing interest rate environment, it became imperative for banks to manage both assets and liabilities simultaneously, in order to minimize interest rate and liquidity risk and maximize interest income. ALM is a key component of any financial institution's overall operating strategy.

In the era of stable interest rates that preceded the breakdown of the Bretton-Woods agreement, ALM was a more straightforward process, constricted by regulatory restrictions and the saving and borrowing pattern of bank customers.[1] The introduction of the negotiable Certificate of Deposit by Citibank in the 1960s enabled banks to diversify both their investment and funding sources. With this innovation there developed the concept of the *interest margin*, which is the spread between the interest earned on assets and interest paid on liabilities. This led to the concept of the *interest gap* and the management of the gap, which is the cornerstone of modern-day ALM. The increasing volatility of interest rates, and the rise in absolute levels of rates themselves, made gap management a vital part of running the banking book. This development meant that banks could no longer rely on permanently on the traditional approach of borrowing short (funding short) to lend long, as a rise in the level of short-term rates would result in funding losses. The introduction of derivative instruments such as FRAs and swaps in the early 1980s removed the previous uncertainty and allowed banks to continue the traditional approach while hedging against medium-term uncertainty.

ALM Concept

ALM is based on four well-known concepts. The first is *liquidity*, which in an ALM context does *not* refer to the ease with which an asset can be bought or sold in the secondary market, but the ease with which assets can be converted into cash.[2] A banking book is required by the regulatory authorities to hold a specified minimum share of its assets in the form of

[1] For instance in the U.S. banking sector the terms on deposit accounts were fixed by regulation, and there were restrictions on the geographic base of customers and the interest rates that could be offered. Interest-rate volatility was also low. In this environment, ALM consisted primarily of asset management, in which the bank would use depositors' funds to arrange the asset portfolio that was most appropriate for the liability portfolio. This involved little more than setting aside some of the assets in non-interest reserves at the central bank authority and investing the balance in short-term securities, while any surplus outside of this would be lent out at very short-term maturities.

[2] The marketability definition of liquidity is also important in ALM. Less liquid financial instruments must offer a yield premium compared to liquid instruments.

very liquid instruments. Liquidity is very important to any institution that accepts deposits because of the need to meet customer demand for instant access funds. In terms of a banking book, the most liquid assets are overnight funds, while the least liquid are medium-term bonds. Short-term assets such as Treasury bills and CDs are also considered very liquid.

The second key concept is the money market *term structure* of interest rates. The shape of the yield curve at any one time, and expectations as to its shape in the short- and medium-term, impact to a significant extent on the ALM strategy employed by a bank. Market risk in the form of *interest-rate sensitivity* is significant, in the form of present-value sensitivity of specific instruments to changes in the level of interest rates, as well as the sensitivity of floating-rate assets and liabilities to changes in rates.

The *maturity profile* of the book is the third key concept. The maturities of assets and liabilities can be matched or unmatched; although the latter is more common the former is also used routinely depending on the specific strategies that are being employed. Matched assets and liabilities lock in return in the form of the spread between the funding rate and the return on assets. The maturity profile, the absence of a locked-in spread and the yield curve combine to determine the total interest-rate risk of the banking book.

The fourth key concept is *default risk*—the risk exposure that borrowers will default on interest or principal payments that are due to the banking institution.

To illustrate the basic ALM dilemma, let us consider a simple hypothetical situation. Suppose a bank may access the markets for 3-month and 6-month funding and investments. The rates available for these maturities are presented in Exhibit 13.1. The ALM manager also expects that 3-month LIBOR in three months hence to be 5.10%.[3] The bank can typically fund its portfolio at LIBOR while it is able to lend at LIBOR plus 100 basis points.

EXHIBIT 13.1 **Hypothetical Money Market Rates**

Term	LIBOR	Bank Rate
3-month	5.50%	6.50%
6-month	5.75%	6.75%
Expected 3-month rate 3-months hence	5.10%	6.10%
3×6 Forward Rate Agreement	6.60%	

[3] This forward rate could be obtained by observing the price of a Eurodollar CD futures contract or simply the ALM manager's best guess based on his/her intuition and experience.

The bank could adopt any of the following strategies, or a combination of them.

- Borrow 3-month funds at 5.50% and lend this out for three months at 6.50%. This locks-in a return of 1% for a 3-month period.
- Borrow 6-month funds at 5.75% and lend for six months at 6.75%; again this earns a locked-in spread of 1%.
- Borrow 3-month funds at 5.50% and lend for six months at 6.75%. This approach would require the bank to refund the loan in 3-month's time, which it expects to be able to do at 5.10%. This approach locks in a return of 1.25% in the first 3-month period, and an expected return of 1.65% in the second 3-month period. The risk of this tactic is that the 3-month rate in three months time does not fall as expected by the ALM manager, reducing profits and possibly leading to loss.
- Borrow in the 6-month at 5.75% and lend for a 3-month period at 6.50%. After this period, lend the funds for either three or six months. This strategy is inconsistent with the ALM manager's view however, who expects a fall in rates and so should not wish to be long funds in three months time.
- Borrow 3-month funds at 5.50% and again, lend six months at 6.75%. To hedge the gap risk, the ALM manager simultaneously buys a 3×6 FRA to lock in the 3-month rate in three months time. The first period spread of 1.25% is guaranteed, but the FRA guarantees only a spread of 15 basis points in the second period. This is the cost of the hedge (and also suggests that the market does not agree with the ALM manager's assessment of where rates will be three months from now!), the price the bank must pay for reducing uncertainty, which is the lower spread return. Alternatively, the bank could lend in the 6-month period, funding initially for three months, and buying an interest-rate cap with a ceiling rate of 6.60% and pegged to Libor, the rate at which the bank can actually fund its book.

Although simplistic, these scenarios serve to illustrate what is possible, and indeed there are many other strategies that could be adopted. The approaches described in the last option show how derivative instruments can be actively used to manage the banking book, and the cost that is associated with employing them.

The Balance Sheet

ALM and transactions required in managing the bank's traditional activity may first be viewed in the context of the balance sheet. A banking balance sheet essentially is a grouping of the following activities:

- treasury and banking transactions
- collection of deposits and disbursing loans
- financial assets
- long-dated assets, and capital (equity and long-term debt)

A simplified balance sheet is shown in Exhibit 13.2.

The Financial Accounting Standards Board has defined assets as "probable future economic benefits obtained or controlled" by the bank that have arisen as a result of transactions entered into by the bank. Liabilities are defined as "probable future sacrifices of economic benefits arising from present obligations" of the bank to transfer assets to other bodies as a result of transactions it has entered into. Assets are further sub-divided into *current assets* which are cash or can be converted into cash within one year, and *long-term assets* which are expected to provide benefits over periods longer than one year. A similar classification is applied to *current liabilities* and *long-term liabilities*.

The relative shares of each constituent in a bank balance sheet will depend on the type of activity carried out by the bank. Commercial banks have a higher share of deposit-taking and loan activity, which are held in the banking book. Integrated banking groups combining commercial activity and investment activity, and investment banks, will have a greater proportion of market transactions in the capital markets, such as bond trading, equity trading, foreign-exchange, and derivatives market making. These activities will be placed in the trading book. Risk management in a bank is concerned (among other things) with the funding and hedging of the balance sheet. In terms of the activities undertaken, there is therefore an obvious distinction between each of the four types of transaction listed above.

EXHIBIT 13.2 **Banking Balance Sheet**

Assets	Liabilities
Cash	Short-term debt
Loans	Deposits
Financial assets	Financial assets
Fixed assets	Long-term debt
	Equity capital
Off-balance sheet (contingencies received)	Off-balance sheet (contingencies paid)

The Banking Book

Traditionally ALM has been concerned with the banking book. The conventional techniques of ALM were developed for application to a bank's banking book—that is, the lending and deposit-taking transactions. The core banking activity will generate either an excess of funds, when the receipt of deposits outweighs the volume of lending the bank has undertaken, or a shortage of funds, when the reverse occurs. This mismatch is balanced via financial transactions in the wholesale market. The banking book generates both interest-rate and liquidity risks, which are then monitored and managed by the ALM desk. Interest-rate risk is the risk that the bank suffers losses due to adverse movements in market interest rates. Liquidity risk is the risk that the bank cannot generate sufficient funds when required; the most extreme version of this is when there is a "run" on the bank, and the bank cannot raise the funds required when depositors withdraw their cash.

Note that the asset side of the banking book, which is the loan portfolio, also generates credit risk.

The ALM desk will be concerned with risk management that focuses on the quantitative management of the liquidity and interest-rate risks inherent in a banking book. The major areas of ALM include:

- *measurement and monitoring of liquidity and interest-rate risk*. This includes setting up targets for earnings and volume of transactions, and setting up and monitoring interest-rate risk limits;
- *funding and control of any constraints on the balance sheet*. This includes liquidity constraints, debt policy and capital adequacy ratio and solvency;
- *hedging of liquidity and interest-rate risk*. This involves taking positions whose value will offset an exposure to these two sources of risk.

THE ALM DESK

The ALM desk or unit of a bank is a specialized business unit that fulfills a range of functions. Its precise set of duties will be driven by the type of activities in which the financial institution is engaged. Let us consider the main types of activities that are carried out.

If an ALM unit has a profit target of zero, it will act as a cost center with a responsibility to minimize operating costs. This would be consistent with a strategy that emphasizes commercial banking as the core business of the firm, and where ALM policy is concerned purely with hedging interest-rate and liquidity risk.

The next level is where the ALM unit is responsible for minimizing the cost of funding. That would allow the unit to maintain an element of exposure to interest-rate risk, depending on the view that was held as to the future level of interest rates. As we noted above, the core banking activity generates either an excess or shortage of funds. To hedge away all of the excess or shortage, while removing interest-rate exposure, has an opportunity cost associated with it since it eliminates any potential gain that might arise from movements in market rates. Of course, without a complete hedge, there is an exposure to interest-rate risk. The ALM desk is responsible for monitoring and managing this risk, and of course is credited with any cost savings in the cost of funds that arise from the exposure. The saving may be measured as the difference between the funding costs of a full hedging policy and the actual policy that the ALM desk adopts. Under this policy, interest-rate risk limits are set which the ALM desk ensures the bank's operations do not breach.

The final stage of development is to turn the ALM unit into a profit center, with responsibility for optimizing the funding policy within specified limits. The limits may be set as *gap* limits, *value-at-risk* limits or by another measure, such as level of earnings volatility. Under this scenario, the ALM desk is responsible for managing all financial risk.

This ultimate development of the ALM function has resulted in it taking on a more active role. The previous paragraphs described the three stages of development that ALM has undergone, although all three versions are part of the "traditional" approach. Practitioners are now beginning to think of ALM as extending beyond the risk management field, and being responsible for adding value to the net worth of the bank, through proactive positioning of the book and hence, the balance sheet. That is, in addition to the traditional function of managing liquidity risk and interest-rate risk, ALM should be concerned additionally with managing the regulatory capital of the bank and with actively positioning the balance sheet to maximize profit. The latest developments indicate that there are now financial institutions that run a much more sophisticated ALM operation than that associated with a traditional banking book.

Let us review the traditional and developed elements of an ALM function.

Traditional ALM

We have noted that the simplest approach to ALM is to match assets with liabilities. For a number of reasons, which include the need to meet client demand and to maximize return on capital, this is not practical and banks must adopt more active ALM strategies. One of the most important of these is the role of the "gap" and "gap management." This term describes the practice of varying the asset and liability gap in response to expectations about the future course of interest rates and the shape of the yield curve. The gap here is the difference between floating-rate assets and liabilities, but gap management must also be pursued when one of these elements is fixed rate. Simply put, this means increasing the gap when interest rates are expected to rise, and decreasing it when rates are expected to decline.

Such an approach is not without hazards. Gap management assumes that the ALM manager is correct in his/her prediction of the future direction of interest rates and the yield curve. Expectations that turn out to be incorrect can lead to unexpected widening or narrowing of the gap spread and losses. The ALM manager must choose the level of trade-off between risk and expected return.

Gap management also assumes that the profile of the banking book can be altered with relative ease. This was not always the case, and even today may still present problems, although the availability of a liquid market in off-balance sheet interest-rate derivatives has eased this problem somewhat. However, historically it has always been difficult to change the structure of the book, as many loans cannot be liquidated instantly and fixed-rate assets and liabilities cannot be changed to floating-rate ones. Client relationships must also be observed and maintained, a key banking issue. For this reason, it is much more common for ALM managers to use off-balance sheet products when dynamically managing the book. For example, FRAs can be used to hedge gap exposure, while interest-rate swaps are used to alter an interest-basis from fixed to floating, or vice-versa. The widespread use of derivatives has enhanced the opportunities available to ALM managers, as well as the flexibility with which the banking book can be managed, but it has also contributed to the increase in competition and the reduction in margins and bid-offer spreads.

Basic Concepts in ALM

Generally a bank's ALM function has in the past been concerned with managing the risk associated with the banking book. In recent years, additional functions have been added to the ALM role. There are a large number of financial institutions that adopt the traditional approach, indeed the nature of their operations would not lend themselves to anything more. We can summarize the role of the traditional ALM desk as follows:

- *Interest-rate risk management.* This is the interest-rate risk arising from the operation of the banking book. It includes net interest income sensitivity analysis, typified by maturity gap and duration gap analysis, and the sensitivity of the book to parallel changes in the yield curve.

The ALM desk will monitor the exposure and position the book in accordance with the limits as well as its market view. Smaller banks, or subsidiaries of banks that are based overseas, often run no interest-rate risk, that is there is no short gap in their book. Otherwise the ALM desk is responsible for hedging the interest-rate risk or positioning the book in accordance with its view.

- *Liquidity and funding management*. There are regulatory requirements that dictate the proportion of banking assets that must be held as short-term instruments. The liquidity book in a bank is responsible for running the portfolio of short-term instruments. The exact make-up of the book is however the responsibility of the ALM desk, and will be a function of the desk's view of market interest rates, as well as its opinion on the relative value of one asset over another. For example, it may decide to move some assets into short-dated government bonds, above what it normally holds, at the expense of other money market instruments, or vice-versa.
- Reporting on hedging of risks. The ALM desk provides senior management with information by regularly reporting on the bank's risk exposure.
- Setting up risk limits. The ALM unit will set limits, implement them and enforce them, although it is common for an independent "middle office" risk function to monitor compliance with limits.
- *Capital requirement reporting*. This function involves the compilation of reports on capital usage and position limits as a percentage of capital allowed, and reporting to regulatory authorities.

All financial institutions will carry out the activities described above.

Developments in ALM

A greater number of financial institutions are enhancing their risk management function by adding to the responsibilities of the ALM function. These have included enhancing the role of the head of Treasury and the *asset and liability committee* (ALCO), using other risk exposure measures such as option-adjusted spread and value-at-risk (VaR), and integrating the traditional interest-rate risk management with credit risk and operational risk. The increasing use of credit derivatives has facilitated this integrated approach to risk management.

The additional roles of the ALM desk may include:

- using the VaR tool to assess risk exposure;
- integrating market risk and credit risk;
- using new *risk-adjusted* measures of return;

- optimizing portfolio return;
- proactively managing the balance sheet; this includes giving direction on securitization of assets (removing them from the balance sheet), hedging credit exposure using credit derivatives, and actively enhancing returns from the liquidity book, such as entering into security lending and repo.

An expanded ALM function will by definition expand the role of the Treasury function and the ALCO. Specifically, this may result in the Treasury function becoming active "portfolio managers" of the bank's book. The ALCO, traditionally composed of risk managers from across the bank as well as the senior member of the ALM desk or liquidity desk, is responsible for assisting the head of Treasury and the Chief Financial Officer in the risk management process. In order to fulfill the new enhanced function, the Treasurer will require a more strategic approach to his or her function, as many of the decisions with running the bank's entire portfolio will be closely connected with the overall direction that the bank wishes to take. These are board-level decisions.

LIQUIDITY AND INTEREST-RATE RISK

Liquidity risk arises because a bank's portfolio will consist of assets and liabilities with different sizes and maturities. When assets are greater than resources from operations, a funding gap will exist which needs to be sourced in the wholesale market. When the opposite occurs, the excess resources must be invested in the market. The differences between the assets and liabilities is called the *liquidity gap*. For example if a bank has long-term commitments that have arisen from its dealings and its resources are exceeded by these commitments, and have a shorter maturity, there is both an immediate and a future deficit. The liquidity risk for the bank is that, at any time, there are not enough resources (or funds) available in the market to balance the assets.

Liquidity management has several objectives; possibly the most important is to ensure that deficits can be funded under all foreseen circumstances without incurring prohibitive costs. In addition, there are regulatory requirements that force a bank to operate within certain limits, and state that short-term assets be in excess of short-run liabilities, in order to provide a safety net of highly liquid assets. Liquidity management is also concerned with funding deficits and investing surpluses, with managing and growing the balance sheet, and with ensuring that the bank operates within regulatory and in-house limits. In this section we review the main issues concerned with liquidity and interest-rate risk.

The liquidity gap is the difference, at all future dates, between assets and liabilities of the banking portfolio. Gaps generate liquidity risk. When liabilities exceed assets, there is an excess of funds. An excess does not of course generate liquidity risk, but it does generate interest-rate risk because the present value of the book is sensitive to changes in market rates. When assets exceed liabilities, there is a funding deficit and the bank has long-term commitments that are not currently funded by existing operations. The liquidity risk is that the bank requires funds at a future date to match the assets. The bank is able to remove any liquidity risk by locking in maturities, but of course there is a cost involved as it will be dealing at longer maturities.[4]

Gap Risk and Limits

Liquidity gaps are measured by taking the difference between outstanding balances of assets and liabilities over time. At any point a positive gap between assets and liabilities is equivalent to a deficit, and this is measured as a cash amount. The *marginal gap* is the difference between the changes of assets and liabilities over a given period. A positive marginal gap means that the variation of the value of assets exceeds the variation of value of the liabilities. As new assets and liabilities are added over time, as part of the ordinary course of business, the gap profile changes.

The gap profile is tabulated or charted (or both) during and at the end of each day as a primary measure of risk. For illustration, a tabulated gap report is shown in Exhibit 13.3 and is an actual example from a UK banking institution. It shows the assets and liabilities grouped into maturity *buckets* and the net position for each bucket. It is a snapshot today of the exposure, and hence funding requirement, of the bank for future maturity periods.

Exhibit 13.3 is very much a summary presentation, because the maturity gaps are very wide. For risk management purposes, the buckets would be much narrower; for instance, the period between zero and 12 months might be split into 12 different maturity buckets. An example of a more detailed gap report is shown in Exhibit 13.4, which is from another UK banking institution. Note that the overall net position is zero, because this is a balance sheet and therefore, not surprisingly, it balances. However along the maturity buckets or grid points there are net positions which are the gaps that need to be managed.

[4] This assumes a conventional upward-sloping yield curve.

EXHIBIT 13.3 Example Gap Profile

	Total		Time periods 0–6 months		6-12 months		1-3 years		3-7 years		7+ years	
Assets	40,533	6.17%	28,636	6.08%	3,801	6.12%	4,563	6.75%	2,879	6.58%	654	4.47%
Liabilities	40,533	4.31%	30,733	4.04%	3,234	4.61%	3,005	6.29%	2,048	6.54%	1,513	2.21%
Net Cumulative Positions	0	1.86%	(2,097)		567		1,558		831		(859)	
Margin on total assets:			2.58%									
Average margin on total assets:			2.53%									

EXHIBIT 13.4 Detailed Gap Report

ASSETS	Total £m	Up To 1 Month	1–3 Months	3–6 Months	6 Months To 1 Year	1–2 Years	2–3 Years	3–4 Years	4–5 Years	5–6 Years	6–7 Years	7–8 Years	8–9 Years	9–10 Years	10 Years Plus
Cash & Interbank Loans	2,156.82	1,484.73	219.36	448.90	3.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Certificates of Deposit purchased	1,271.49	58.77	132.99	210.26	776.50	92.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Floating Rate Notes purchased	936.03	245.62	586.60	12.68	26.13	45.48	0.00	0.00	19.52	0.00	0.00	0.00	0.00	0.00	0.00
Bank Bills	314.35	104.09	178.36	31.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Loans	13.00	0.00	1.00	0.00	0.00	7.00	0.00	1.00	0.00	0.00	2.00	2.00	0.00	0.00	0.00
Debt Securities/Gilts	859.45	0.00	25.98	7.58	60.05	439.06	199.48	26.81	100.50	0.00	0.00	0.00	0.00	0.00	0.00
Fixed rate Mortgages	4,180.89	97.72	177.37	143.13	964.98	1,452.91	181.86	661.36	450.42	22.78	4.30	3.65	3.10	2.63	14.67

EXHIBIT 13.4 (Continued)

ASSETS	Total £m	Up To 1 Month	1–3 Months	3–6 Months	6 Months To 1 Year	1–2 Years	2–3 Years	3–4 Years	4–5 Years	5–6 Years	6–7 Years	7–8 Years	8–9 Years	9–10 Years	10 Years Plus
Variable & Capped Rate Mortgages	14,850.49	14,850.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial Loans	271.77	96.62	96.22	56.52	0.86	2.16	1.12	3.64	8.85	1.06	0.16	0.17	0.16	4.23	0.00
Unsecured Lending and Leasing	3,720.13	272.13	1,105.20	360.03	507.69	694.86	400.84	195.19	79.98	25.45	14.06	10.03	10.44	10.82	33.42
Other Assets	665.53	357.72	0.00	18.77	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	284.03
TOTAL CASH ASSETS	29,239.95	17,567.91	2,523.06	1,289.77	2,345.05	2,734.43	783.31	888.00	659.26	49.28	20.53	15.85	13.71	17.68	332.12
Swaps	9,993.28	3,707.34	1,462.32	1,735.59	1,060.61	344.00	146.50	537.60	649.00	70.00	5.32	200.00	75.00	0.00	0.00
Forward Rate Agreements	425.00	0.00	50.00	0.00	220.00	5.00	150.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Futures	875.00	0.00	300.00	0.00	175.00	400.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	40,533.24	21,275.24	4,335.38	3,025.36	3,800.66	3,483.43	1,079.81	1,425.60	1,308.26	119.28	25.84	215.85	88.71	17.68	332.12
LIABILITIES	£m														
Bank Deposits	3,993.45	2,553.85	850.45	233.03	329.06	21.07	1.00	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Certificates of Deposit issued	1,431.42	375.96	506.76	154.70	309.50	60.00	20.00	3.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial Paper – CP & Euro	508.46	271.82	128.42	108.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subordinated Debt	275.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	200.00	75.00	0.00	0.00
Eurobonds + Other	2,582.24	768.75	1,231.29	121.94	53.86	9.77	13.16	150.43	150.53	0.00	7.51	0.00	0.00	0.00	75.00
Customer Deposits	17,267.55	15,493.65	953.60	311.70	340.50	129.10	6.60	24.90	0.00	7.50	0.00	0.00	0.00	0.00	0.00
Other Liabilities(incl capital/reserves)	3,181.83	1,336.83	0.00	0.00	741.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,103.28
TOTAL CASH LIABILITIES	29,239.96	20,800.86	3,670.52	929.58	1,774.64	219.93	40.76	178.83	156.53	7.50	7.51	200.00	75.00	0.00	1,178.28
Swaps	9,993.28	1,754.70	1,657.59	1,399.75	1,254.24	1,887.97	281.44	905.06	770.52	15.76	6.48	7.27	8.13	13.06	31.30
FRA's	425.00	0.00	150.00	70.00	55.00	150.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Futures	875.00	0.00	0.00	300.00	150.00	425.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	40,533.24	22,555.56	5,478.11	2,699.33	3,233.89	2,682.90	322.20	1,083.90	927.05	23.26	13.99	207.27	83.13	13.06	1,209.58
Net Positions	0.00	–1,351.09	–1,234.54	265.58	583.48	929.10	803.46	341.70	404.88	104.28	11.85	8.58	5.57	4.62	–877.45

EXHIBIT 13.5 Gap Maturity Profile in Graphical Form

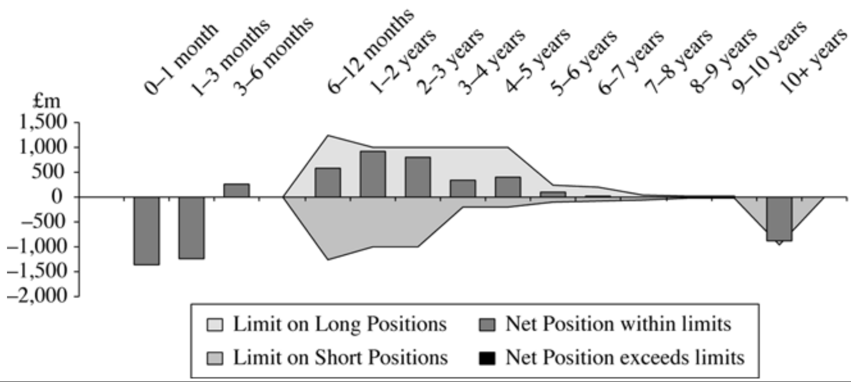
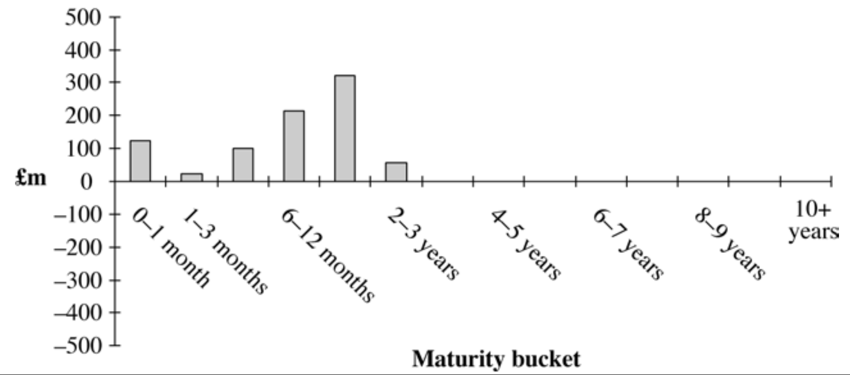
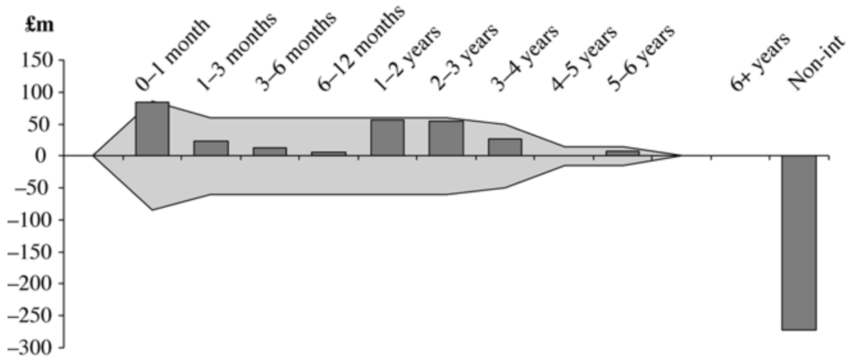


EXHIBIT 13.6 Gap Maturity Profile, Bank with No Short Funding Allowed



The maturity gap can be charted to provide an illustration of net exposure, and an example is shown in Exhibit 13.5, from yet another UK banking institution. Some reports present both the assets and the liabilities are shown for each maturity point, but in our example only the net position is shown. This net position is the gap exposure for that maturity point. A second example, used by the overseas subsidiary of a middle eastern commercial bank, which has no funding lines in the interbank market and so does not run short positions, is shown in Exhibit 13.6, while the gap report for a UK high-street bank is shown in Exhibit 13.7. Note the large short gap under the maturity labelled “non-int”; this stands for *non-interest bearing liabilities* and represents the balance of current accounts (cheque or “checking” accounts) which are funds that attract no interest and are in theory very short-dated (because they are demand deposits, so may be called at instant notice).

EXHIBIT 13.7 Gap Maturity Profile, UK High-Street Bank



Gaps represent cumulative funding required at all dates. The cumulative funding is not necessarily identical to the new funding required at each period, because the debt issued in previous periods is not necessarily amortized at subsequent periods. For example, the new funding between months 3 and 4 is not the accumulated deficit between months 2 and 4 because the debt contracted at month 3 is not necessarily amortized at month 4. Marginal gaps may be identified as the new funding required or the new excess funds of the period that should be invested in the market. Note that all the reports are snapshots at a fixed point in time and the picture is of course a continuously moving one. In practice the liquidity position of a bank cannot be characterized by one gap at any given date, and the entire gap profile must be used to gauge the extent of the book's profile.

The liquidity book manager may decide to match its assets with its liabilities. This is known as *cash matching* and occurs when the time profiles of both assets and liabilities are identical. By following such a course the bank can lock in the spread between its funding rate and the rate at which it lends cash, and generate a guaranteed profit. Under cash matching, the liquidity gaps will be zero. Matching the profile of both legs of the book is done at the overall level; that is, cash matching does not mean that deposits should always match loans. This would be difficult as both result from customer demand, although an individual purchase of say, a CD, can be matched with an identical loan. Nevertheless, the bank can elect to match assets and liabilities once the net position is known, and keep the book matched at all times. However, it is highly unusual for a bank to adopt a cash matching strategy.

Liquidity Management

The continuous process of raising new funds or investing surplus funds is known as *liquidity management*. If we consider that a gap today is funded, by balancing assets and liabilities and thus squaring-off the book, the next day a new deficit or surplus is generated which also has to be funded. The liquidity management decision must cover the amount required to bridge the gap that exists the following day, as well as position the book across future dates in line with the bank's view on interest rates.

Usually in order to define the maturity structure of debt a target profile of resources is defined. This may be done in several ways. If the objective of ALM is to replicate the asset profile with resources, the new funding should contribute to bringing the resources profile closer to that of the assets, that is, more of a matched book looking forward. This is the lowest-risk option. Another target profile may be imposed on the bank by liquidity constraints. This circumstance may arise if for example the bank has a limit on borrowing lines in the market so that it could not raise a certain amount each week or month. For instance, if the maximum that could be raised in one week by a bank is $10 million, the maximum period liquidity gap is constrained by that limit. The ALM desk will manage the book in line with the target profile that has been adopted, which requires it to try to reach the required profile over a given time horizon.

Managing the banking book's liquidity is a dynamic process, as loans and deposits are known at any given point, but new business will be taking place continuously and the profile of the book looking forward must be continuously rebalanced to keep it within the target profile. There are several factors that influence this dynamic process, the most important of which are reviewed below.

Demand Deposits

Deposits placed on demand at the bank, such as current accounts (cheque or checking), have no stated maturity and are available on demand at the bank. Technically they are referred to as "non-interest bearing liabilities" because the bank pays no or very low rates of interest on them, so they are effectively free funds. The balance of these funds can increase or decrease throughout the day without any warning, although in practice the balance is quite stable.

There are a number of ways that a bank can choose to deal with these balances, which are:

- to group all outstanding balances into one maturity bucket at a future date that is the preferred time horizon of the bank, or a date beyond this. This would then exclude them from the gap profile. Although this is considered unrealistic because it excludes the current account balances from the gap profile, it is nevertheless a fairly common approach;
- to rely on an assumed rate of amortization for the balances, say 5% or 10% each year;

- to divide deposits into stable and unstable balances, of which the core deposits are set as a permanent balance. The amount of the core balance is set by the bank based on a study of the total balance volatility pattern over time. The excess over the core balance is then viewed as very short-term debt. This method is reasonably close to reality as it is based on historical observations;
- to make projections based on observable variables that are correlated with the outstanding balances of deposits. For instance, such variables could be based on the level of economic growth plus an error factor based on the short-term fluctuations in the growth pattern.

Pre-Set Contingencies

A bank will have committed lines of credit, the utilization of which depends on customer demand. Contingencies generate outflows of funds that are by definition uncertain, as they are contingent upon some event, for example the willingness of the borrower to use a committed line of credit. The usual way for a bank to deal with these unforeseen fluctuations is to use statistical data based on past observation to project a future level of activity.

Prepayment Options of Existing Assets

Where the maturity schedule is stated in the terms of a loan, it may still be subject to uncertainty because of prepayment options. This is similar to the prepayment risk associated with a mortgage-backed security. An element of prepayment risk renders the actual maturity profile of a loan book to be uncertain; banks often calculate an "effective maturity schedule" based on prepayment statistics instead of the theoretical schedule. There are also a range of prepayment models that may be used, the simplest of which use constant prepayment ratios to assess the average life of the portfolio. The more sophisticated models incorporate more parameters, such as one that bases the prepayment rate on the interest rate differential between the loan rate and the current market rate, or the time elapsed since the loan was taken out.

Interest Cash Flows

Assets and liabilities generate interest cash inflows and outflows, as well as the amortization of principal. The interest payments must be included in the gap profile as well.

Interest-Rate Gap

The interest-rate gap is the standard measure of the exposure of the banking book to interest-rate risk. The interest-rate gap for a given period is defined as the difference between fixed-rate assets and fixed-rate liabilities. It can also be calculated as the difference between interest-rate sensitive assets and interest-rate sensitive liabilities. Both differences are identical in value when total assets are equal to total liabilities, but will differ when the balance sheet is not balanced. This only occurs intra-day, when, for example, a short position has not been funded yet. The general market practice is to calculate the interest-rate gap as the difference between assets and liabilities. The gap is defined in terms of the maturity period that has been specified for it.

The convention for calculating gaps is important for interpretation. The "fixed-rate" gap is the opposite of the "variable-rate" gap when assets and liabilities are equal. They differ when assets and liabilities do not match and there are many reference rates. When there is a deficit, the "fixed-rate gap" is consistent with the assumption that the gap will be funded through liabilities for which the rate is unknown. This funding is then a variable-rate liability and is the bank's risk, unless the rate has been locked-in beforehand. The same assumption applies when the banks run a cash surplus position, and the interest rate for any period in the future is unknown. The gap position at a given time bucket is sensitive to the interest rate that applies to that period.

The gap is calculated for each discrete time bucket, so there is a net exposure for say, 0–1 month, 1–3 months, and so on. Loans and deposits do not, except at the time of being undertaken, have precise maturities like that, so they are "mapped" to a time bucket in terms of their relative weighting. For example, a \$100 million deposit that matures in 20 days' time will have most of its balance mapped to the 3-week time bucket, but a smaller amount will also be allocated to the 2-week bucket. Interest-rate risk is measured as the change in present value of the deposit, at each grid point, given a 1 basis point change in the interest rate. So a \$10 million 1-month CD that was bought at 6.50% will have its present value move upwards if on the next day the 1-month rate moves down by a basis point.

The net change in present value for a 1 basis point move is the key measure of interest-rate risk for a banking book and this is what is usually referred to as a "gap report," although strictly speaking it is not. The correct term for such a report is a "PVBP" or "DV01" report, which stand for "present value of a basis point" and "dollar value of an 01 [1 basis point]", respectively. The calculation of interest-rate sensitivity assumes a *parallel shift* in the yield curve; that is, it assumes that every maturity point along the term structure moves by the same amount (here one basis point) and in the same direction. An example of a PVBP report is given in Exhibit 13.8, split by different currency books, but with all values converted to British pounds sterling.

EXHIBIT 13.8 Banking Book PVBP Grid Report

	1 day	1 week	1 month	2 months	3 months	6 months	12 months	2 years
GBP	8,395	6,431	9,927	8,856	(20,897)	(115,303)	(11,500)	(237,658)
USD	1,796	(903)	10,502	12,941	16,784	17,308	(13,998)	(18,768)
Euro	1,026	1,450	5,105	2,877	(24,433)	(24,864)	(17,980)	(9,675)
Total	11,217	6,978	25,534	24,674	(28,546)	(122,859)	(43,478)	(266,101)

	3 years	4 years	5 years	7 years	10 years	15 years	20 years	30 years
GBP	(349,876)	(349,654)	5,398	(5,015)	(25,334)	(1,765)	(31,243)	(50,980)
USD	(66,543)	(9,876)	(1,966)	237	2,320	(5,676)	(1,121)	0
Euro	(11,208)	(3,076)	1,365	1,122	3,354	(545)	(440)	(52)
Total	(427,627)	(362,606)	4,797	(3,656)	(19,660)	(7,986)	(32,804)	(51,032)

GBP total: (1,160,218); USD total: (56,963); Euro total: (75,974); Grand total: (1,293,155)
All figures £

The basic concept in the gap report is the net present value (NPV) of the banking book. The PVBP report measures the difference between the market values of assets and liabilities in the banking book. To calculate NPV we require a discount rate, and it represents a *mark-to-market* of the book. The rates used are always the zero-coupon rates derived from the benchmark government bond yield curve, although some adjustment should be made to this to allow for individual instruments.

Gaps may be calculated as differences between outstanding balances at one given date, or as differences of variations of those balances over a time period. A gap number calculated from variations is known as a *margin gap*. The cumulative margin gaps over a period of time plus the initial difference in assets and liabilities at the beginning of the period are identical to the gaps between assets and liabilities at the end of the period.

The interest-rate gap differs from the liquidity gap in a number of detail ways, which include:

- whereas for liquidity gap all assets and liabilities must be accounted for, only those that have a fixed rate are used for the interest-rate gap;
- the interest-rate gap cannot be calculated unless a period has been defined because of the fixed-rate/variable-rate distinction. The interest-rate gap is dependent on a maturity period and an original date.

The primary purpose in compiling the gap report is to determine the sensitivity of the interest margin to changes in interest rates. As we noted earlier, the measurement of the gap is always "behind the curve" as it is an historical snapshot; the actual gap is a dynamic value as the banking book continually changes.

CRITIQUE OF THE TRADITIONAL APPROACH

Traditionally, the main approach of ALM concentrated on interest sensitivity and net present value sensitivity of a bank's loan/deposit book. The usual interest sensitivity report is the maturity gap report, which we reviewed briefly earlier. The maturity gap report is not perfect however, and can be said to have the following drawbacks:

- the re-pricing intervals chosen for gap analysis are ultimately arbitrary, and there may be significant mismatches within a re-pricing interval. For instance, a common re-pricing interval chosen is the 1-year gap and the 1–3 year gap; there are (albeit extreme) circumstances when mismatches would go undetected by the model. Consider a banking book that is composed solely of liabilities that reprice in one month's time, and an equal cash value of assets that reprice in 11 months' time. The 1-year gap of the book (assuming no other positions) would be zero, implying no risk to net interest income. In fact, under our scenario the net interest income is significantly at risk from a rise in interest rates;

- maturity gap models assume that interest rates change by a uniform magnitude and direction. For any given change in the general level of interest rates however, it is more realistic for different maturity interest rates to change by different amounts, what is known as a non-parallel shift;
- maturity gap models assume that principal cash flows do not change when interest rates change. Therefore it is not possible to effectively incorporate the impact of options embedded in certain financial instruments. Instruments such as mortgage-backed bonds and convertibles do not fall accurately into a gap analysis, as only their first-order risk exposure is captured.

Not withstanding these drawbacks, the gap model is widely used as it is easily understood in the commercial banking and mortgage industry, and its application does not require a knowledge of sophisticated financial modelling techniques.

CHAPTER 14

Bank Regulatory Capital

The primary players in the global money markets are banking and financial institutions which include investment banks, commercial banks, thrifts and other deposit and loan institutions. Banking activity and the return it generates reflects the bank's asset allocation policies. Asset allocation decisions are largely influenced by the capital considerations that such an allocation implies and the capital costs incurred. The cost of capital must, in turn, take into account the *regulatory capital* implications of the positions taken by a trading desk. Therefore, money market participants must understand regulatory capital issues regardless of the products they trade or they will not fully understand the cost of their own capital or the return on its use.

The rules defining what constitutes capital and how much of it to allocate are laid out in the Bank for International Settlements (BIS) guidelines, known as the *Basel rules*. Although the BIS is not a regulatory body per se and its pronouncements carry no legislative weight, to maintain investors and public confidence national authorities endeavor to demonstrate that they follow the Basel rules at a minimum. The purpose of this chapter is to outline the main elements of the Basel rules, which are in the process of being updated and modernized as Basel II.

Money market participants are cognizant of the basic tenets of the rules, so as to optimize their asset allocation as well as their hedging policy. Derivatives for instance require a significantly lower level of capital allocation than cash products, which (along with their liquidity) is a primary reason for their use as hedging instruments. In addition, the credit quality of a bank's counterparty also affects significantly the level of capital charge, and regulatory rules influence a bank's lending policy and counterparty limit settings. All banks have internal rules dictating the extent of lending, across all money market products, to their counterparties. Capital allocation, targeted rates of return (which are a function of capital costs), and extent of counterparty risk aversion all dictate the extent to which funds may be lent to counterparties of various credit ratings.

This chapter reviews the main aspects of the capital rules and also introduces the Basel II proposals, and how credit risk exposure determines the extent of capital allocation. It also indicates the interplay between the money market desk and longer-term traders whose capital allocation requirements are greater. This will enable the money market participant to place his/her operations in the context of banking specifically and capital markets business generally.

BANKING REGULATORY CAPITAL REQUIREMENTS

Banks and financial institutions are subject to a range of regulations and controls, a primary one of which is concerned with the level of capital that a bank holds, and that this level is sufficient to provide a cushion for the activities that the bank enters into. Typically an institution is subject to regulatory requirements of its domestic regulator, but may also be subject to cross-border requirements such as the European Union's Capital Adequacy Directive.[1] A capital requirements scheme proposed by a committee of central banks acting under the auspices of the Bank for International Settlements (BIS) in 1988 has been adopted universally by banks around the world. These are known as the *BIS regulatory requirements* or the *Basel capital ratios*, from the town in Switzerland where the BIS is based.[2] Under the Basel requirements all cash and off-balance sheet instruments in a bank's portfolio are assigned a risk weighting, based on their perceived credit risk, that determines the minimum level of capital that must be set against them.

A bank's *capital* is, in its simplest form, the difference between assets and liabilities on its balance sheet, and is the property of the bank's owners. It may be used to meet any operating losses incurred by the bank, and if such losses exceeded the amount of available capital then the bank

[1] In the United States banking supervision is conducted by the Federal Reserve; it is common for the central bank to be a country's domestic banking regulator. In the United Kingdom banking regulation is now the responsibility of the Financial Services Authority, which took over responsibility for this area from the Bank of England in 1998.

[2] Bank for International Settlements, Basel Committee on Banking Regulations and Supervisory Practice, *International Convergence of Capital Measurement and Capital Standards*, July 1988.

would have difficulty in repaying liabilities, which may lead to bankruptcy. However for regulatory purposes capital is defined differently; again in its simplest form regulatory capital is comprised of those elements in a bank's balance sheet that are eligible for inclusion in the calculation of capital ratios. The ratio required by a regulator will be that level deemed sufficient to protect the bank's depositors. Regulatory capital includes equity, preference shares, and subordinated debt, as well as the general reserves. The common element of these items is that they are all *loss-absorbing*, whether this is on an ongoing basis or in the event of liquidation. This is crucial to regulators, who are concerned that depositors and senior creditors are repaid in full in the event of bankruptcy.

The Basel rules on regulatory capital originated in the 1980s, when there were widespread concerns that a number of large banks with cross-border business were operating with insufficient capital. The regulatory authorities of the G-10 group of countries established the Basel Committee on Banking Supervision. The Basel Committee on Banking Supervision's 1988 paper, *International Convergence of Capital Measurement and Capital Standards*, set proposals that were adopted by regulators around the world as the Basel rules. The Basel Accord was a methodology for calculating risk, weighting assets according to the type of borrower and its domicile. The Basel ratio[3] set a minimum capital requirement of 8% of risk-weighted assets.

The Basel rules came into effect in 1992. The BIS is currently inviting comment on proposals for a new system of capital adequacy to replace the current rules. The deadline for comment on its proposals is June 2002, with the BIS hoping to implement the agreed upon requirements during 2005.

Capital Adequacy Requirements

The origin of the current capital adequacy rules was a desire by banking regulators to strengthen the stability of the global banking system as well as harmonize international regulations. The 1988 Basel accord was a significant advancement in banking regulation, setting a formal standard for capitalization worldwide. It was subsequently adopted by the national regulators in over 100 countries. The Basel rules have no regulatory force as such; rather, individual country regulatory regimes adopt them as a minimum required standard. This means that there are slight variations on the basic Basel requirements around the world, of which the European Union's Capital Adequacy Directives are the best example.

[3] Also known as the "Cooke ratio" after the Chairman of the Basel Committee at the time, Peter Cooke.

The Basel I Rules

The BIS rules set a minimum ratio of capital to assets of 8% of the value of the assets. Assets are defined in terms of their risk, and it is the *weighted risk assets* that are multiplied by the 8% figure. Each asset is assigned a risk weighting, which is 0% for risk-free assets such as certain country government bonds, up to 100% for the highest-risk assets such as certain corporate loans. So while a loan in the interbank market would be assigned a 20% weighting, a loan of exactly the same size to a corporation would receive the highest weighting of 100%.

Formally, the BIS requirements are set in terms of the type of capital that is being set aside against assets. International regulation defines the following types of capital for a bank:

- *Tier 1:* perpetual capital, capable of absorbing loss through the non-payment of a dividend. This is shareholders' equity and also non-cumulative preference shares;
- *Upper Tier 2:* this is also perpetual capital, subordinated in repayment to other creditors; this may include for example irredeemable subordinated debt;
- *Lower Tier 2:* this is capital that is subordinated in repayment to other creditors, such as long-dated subordinated bonds.

The level of capital requirement is as follows:

$$\begin{aligned} \frac{\text{Tier 1 capital}}{\text{Risk-adjusted exposure}} &> 4\% \\ \frac{\text{Tier 1 + Tier 2 capital}}{\text{Risk-adjusted exposure}} &> 8\% \end{aligned} \tag{1}$$

These ratios therefore set minimum levels. A bank's *risk-adjusted exposure* is the cash risk-adjusted exposure together with the total risk-adjusted off-balance sheet exposure. For cash products on the banking book, the capital charge calculations (risk-adjusted exposure) is given by:

$$\text{principal value} \times \text{risk weighting} \times \text{capital charge [8\%]}$$

calculated for each instrument.

The sum of the exposures is taken. Firms may use netting or portfolio modelling to reduce the total principal value.

The capital requirements for off-balance sheet instruments are lower because for these instruments the *principal* is rarely at risk. Interest-rate derivatives such as forward rate agreements (FRAs) of less than one year's maturity have no capital requirement at all, while a long-term currency swap requires capital of between 0.08% and 0.2% of the nominal principal.[4]

The BIS makes a distinction between *banking book* transactions as carried out by retail and commercial banks (primarily deposits and lending) and *trading book* transactions as carried out by investment banks and securities houses. Capital treatment sometimes differs between banking and trading books. A repo transaction attracts a charge on the *trading book*. The formula for calculating the capital allocation (*CA*) is:

$$CA = \max\{[(C_{mv} - S_{mv}) \times 8\% \times RW], 0\} \tag{2}$$

where

C_{mv} = the value of cash proceeds
S_{mv} = the market value of securities
RW = the counterparty risk weighting (as percentage)

As an illustration, the capital allocation for an unsecured loan of $50 million to an OECD (Organization for Economic Cooperation and Development) bank that has a counterparty risk weighting of 20% is determined as follows:

$$\begin{aligned} CA &= \max\{[(\$50{,}000{,}000 - 0) \times 0.20 \times 0.08], 0\} \\ &= \$800{,}000 \end{aligned}$$

Conversely, a repo transaction of the same size with the same counterparty fully collateralized with U.S. Treasuries would have a capital allocation determined as follows:

$$\begin{aligned} CA &= \max\{[(\$50{,}000{,}000 - \$50{,}000{,}000) \times 0.20 \times 0.08], 0\} \\ &= \$0 \end{aligned}$$

The detailed risk weights for market instruments are given in Exhibit 14.1.

Under the original Basel rules, assets are defined as belonging to a bank's *banking book* or its *trading book*. The banking book essentially comprises the traditional activities of deposit taking and lending, with assets booked at cost and not revalued. Trading book assets (which include derivatives) are marked-to-market on a daily basis, with a daily unrealized profit or loss recorded. Such assets are risk-weighted on a different basis to that shown in Exhibit 14.1, on a scale made up of market risk and credit risk. Market risk is estimated using techniques such as

[4] FRAs and swaps are discussed in Chapter 11.

value-at-risk, while credit risk is a function of the type of asset. The calculation of capital requirements for trading book assets is more complex than that for banking book assets.

The process of determining the capital requirement of a banking institution involves calculating the quantitative risk exposure of its existing operations and comparing this amount to the level of regulatory capital of the bank. The different asset classes are assigned into the risk buckets of 0%, 20%, 50%, and 100%. Not surprisingly, this somewhat rigid classification has led to distortions in the pricing of assets, as any movement between the risk buckets has a significant impact on the capital required and the return on capital calculation. Over time the impact of the Basel rules has led to the modified rules now proposed as Basel II, the final form of which is expected to come into force in 2005.

EXHIBIT 14.1 Risk Weightings of Typical Banking Book Assets, Basel I

Weighting	Asset Type	Remarks
0%	• Cash • Claims on own sovereign and Zone A sovereigns and central banks • Claims on Zone B sovereign issuers denominated in that country's domestic currency	Zone A countries are members of the OECD and countries that have concluded special lending arrangements with the IMF. Zone B consists of all other countries. Under certain regulatory regimes, holdings of other Zone A government bonds are given 10% or 20% weightings, and Zone B government bonds must be funded in that country's currency to qualify for 0% weighting, otherwise 100% weighting applies.
20%	• Claims on multilateral development banks • Claims on regional governments or local authorities in own or Zone A countries • Senior claims on own country or guaranteed by Zone A banking institutions • Senior claims on Zone B banking institutions with an original maturity of under one year	Under certain regulatory regimes, claims on Zone B banking institutions with residual maturity of less than one year also qualify for 20% weighting.
50%	• Claims secured on residential property • Mortgage-backed securities	
100%	• All other claims	

Source: BIS

Exhibit 14.2 summarizes the elements that comprise the different types of capital that make up regulatory capital as set out in the EU's Capital Adequacy Directive. Tier 1 capital supplementary capital is usually issued in the form of non-cumulative preference shares, known in the U.S. as preferred stock. Banks generally build Tier 1 reserves as a means of boosting capital ratios, as well as to support a reduced pure equity ratio. Tier 1 capital now includes certain securities that have similar characteristics to debt, as they are structured to allow interest payments to be made on a pre-tax basis rather than after tax basis; this means they behave like preference shares or equity, and improves the financial efficiency of the bank's regulatory capital. Such securities along with those classified as Upper Tier 2 capital, contain interest deferral clauses so that they may be classified similar to preference shares or equity.

ACTION IN THE EVENT OF FAILURE

The existence of a regulatory capital system is designed to protect the financial system, and therefore by definition the free market economy, by attempting to ensure that credit institutions carry adequate reserves to allow for counterparty risk. However domestic regulators are also faced with a dilemma should a banking institution find itself in an insolvency situation, namely, to what extent should the bank be "rescued" by the authorities. If the bank is sufficiently large, its failure could have a significant negative impact on the national and global economy, as other banks, businesses and ultimately individuals also suffered losses. The large "money center" banks[5] are obvious examples of the type of firm that is considered too important to be allowed to fail. It is not desirable though for regulators or national governments to present explicit guarantees against failure however, since this introduces the risk of moral hazard as risk of loss is reduced.[6] There would also be an element of subsidy as a bank that was perceived as benefiting from an explicit or implicit guarantee would be able to raise finance at below-market cost. This introduces an anti-competitive element in one of the most important sectors of the economy.

[5] Known as "high street" banks in the United Kingdom.

[6] This is the risk that, given that a guarantee against loss is available, a firm ceases to act prudently and enters into high-risk transactions, in the expectation that it can always call on the authorities should its risk strategy land it in financial trouble.

EXHIBIT 14.2 European Union Regulatory Capital Rules

	Limits	Capital type	Deductions
Tier 1	• No limit to Tier 1 • "Esoteric" instruments such as trust-preferred securities are restricted to 15% of total Tier 1	• Equity share capital, including share premium account • Retained profits • Non-cumulative preference shares and other hybrid capital securities	• Bank holding's of its own Tier 1 instruments • Goodwill and other intangible assets • Current year unpublished losses
Tier 2	• Total Tier 2 may not exceed 100% of Tier 1		
Upper Tier 2		• Perpetual subordinated, loss-absorbing debt • Cumulative preference shares • General reserves • Revaluation reserves	• Holdings of other banks' own fund instruments in excess of 10% of the value of own capital • Holding of more than 10% of another credit institution's own funds • Specified investments in non-consolidated subsidiaries • Qualified investments, defined as a holding of more 10% of a company
Lower Tier 2	• Cannot exceed 50% of Tier 1 • Amount qualifying as capital amortizes on a straight-line basis in the last five years	• Fixed maturity subordinated debt • Perpetual subordinated non-loss absorbing debt	
Tier 3	• Minimum 28.5% of capital covering market risk must be Tier 1 • Tier 3 capital can only cover market risk on trading books. All credit risk must be covered by Tier 1 and Tier 2 capital	• Trading book profits • Short-term subordinated debt with a minimum maturity of two years, plus a feature enabling regulator to block payment of interest or principal in the event of financial weakness	• Trading book losses
Other	• Capital to only include fully paid-up amounts • Issues of capital cannot include cross-default or negative pledge clauses • Default of Lower Tier 2 capital is defined as non-payment of interest or a winding-up of the bank • No rights of set-off to be included in capital issues documentation • Early repayment of debt must be approved by the bank's regulator • Interim profits must be audited accounts, and net of expected losses, tax and dividends		

Source: Bank of England

EXHIBIT 14.3 **Add-On Risk Adjustment for Interest-Rate Swaps, Percentage of Nominal Value**

Maturity	Plain vanilla	Floating/Floating swaps	Currency swaps
Up to 1 year	0.0	0.0	1.0
Over 1 year	0.5	0.0	5.0

Observation would appear to indicate that domestic regulators do not treat all banks as equal however, notwithstanding the reluctance of regulators to provide even implicit guarantees. The desire to avoid contagion effects and safeguard the financial system means that large banks may be rescued while smaller banks are allowed to fail. This has the effect of maintaining an orderly market but also emphasizing the need for discipline and effective risk management. For example, in the United Kingdom both BCCI and Barings were allowed to fail, as their operations were deemed to affect relatively few depositors and their failure did not threaten the banking system. In the United States, Continental Illinois was saved, as was Den Norske Bank in Norway, while two smaller banks in that country were allowed to fail, these being Norian Bank and Oslobanken. In Japan many small banks have been allowed to fail, as was Yamaichi Securities, while Long Term Credit Bank and Nippon Credit Bank both were rescued.

There is, of course, a cost associated with maintaining capital levels, which is one of the main reasons for the growth in the use of derivative (off-balance sheet) instruments, as well as the rise in securitization. Derivative instruments attract a lower capital charge than cash instruments, because the principal in a derivative instrument does not change hands and so is not at risk, while the process of securitization removes assets from a bank's balance sheet, thereby reducing its capital requirements.

The capital rules for off-balance sheet instruments are slightly more involved. Certain instruments such as FRAs and swaps with a maturity of less than one year have no capital requirement at all, while longer-dated interest-rate swaps and currency swaps are assigned a risk weighting of between 0.08% and 0.20% of the nominal value. This is a significantly lower level than for cash instruments. For example, a \$50 million 10-year interest-rate swap conducted between two banking counterparties would attract a capital charge of only \$40,000, compared to the \$800,000 capital an interbank loan of this value would require; a corporate loan of this value would require a higher capital level still, of \$4 million.

The capital calculations for derivatives have detail differences between them, depending on the instrument that is being traded. For example for interest-rate swaps the exposure includes an "add-on factor" to what is termed the instrument's "current exposure." This add-on factor is a percentage of the nominal value, and is shown in Exhibit 14.3.

THE PROPOSED BASEL II ACCORD

The perceived shortcomings of the 1988 Basel capital accord attracted much comment from academics and practitioners alike, almost as soon as they were adopted. The main criticism was that the requirements made no allowance for the credit risk ratings of different corporate borrowers, and was too rigid in its application of the risk weightings. That these were valid issues was recognized when, on June 3, 1999 the BIS published proposals to update the capital requirements rules. The new guidelines are designed "to promote safety and soundness in the financial system, to provide a more comprehensive approach for addressing risks, and to enhance competitive equality." The proposals also are intended to apply to all banks worldwide, and not simply those that are active across international borders.

The 1988 accord was based on very broad counterparty credit requirements, and despite an amendment introduced in 1996 to cover trading book requirements, remained open to the criticism of inflexibility. The proposed new Basel II rules have three pillars, and are designed to be more closely related to the risk levels of particular credit exposures. These are:

- *Pillar 1:* A new capital requirement for credit risk, as well as a charge for the new category of *operational risk*.
- *Pillar 2:* The requirement for supervisors to take action if a bank's risk profile is high compared to the level of capital held.
- *Pillar 3:* The requirement for greater disclosure from banks than before to enhance market discipline.

The markets have developed to a much greater level of sophistication since the original rules were drafted, and the Committee has considered a wide range of issues related to the determinants of credit risk.

ELEMENTS OF THE PROPOSED NEW BASEL II RULES

In this section we consider the main points of the Basel II proposal and also assess market reaction to it at the time of writing. As just noted, as they currently stand the new Basel accord is split into three approaches or Pillars, which we consider in more detail in this section.

Pillar 1—The Minimum Capital Requirements

The capital requirements are stated under two approaches—the standardized approach and the internal ratings based approach (IRB). Within

IRB there is a foundation approach and an advanced approach, the latter of which gives banks more scope to set elements of the capital charges themselves.

Standardized Approach

In the standardized approach banks will risk-weight assets in accordance with a set matrix, which splits assets according to their formal credit ratings. The matrix is detailed in Exhibit 14.4, which shows the new proposed risk weights as percentages of the standard 8% ratio.

The greatest change is to the four risk weight buckets of the current regime. The revised ruling would redistribute the capital required for different types of lending and also add an additional category for very low-rated assets. For sovereign lending there is a smooth scale from 0% to 8%, while the scale is more staggered for corporates. An unusual feature is that low-rated companies attract a higher charge than non-rated borrowers. For lending to other banks there are two options. In the first, the sovereign risk of the home country of the bank is used, and the bank placed in the next lower category. In the second option, the credit rating of a bank itself is used. Whatever option is selected, the main effect will be that the capital charge for interbank lending will increase significantly, virtually doubling the current level.

National regulators will select which of the two approaches to use for interbank exposures. Under option 1, loans will be categorized in accordance with the rating of their sovereign domicile, while under option 2 loans would be slotted according to the bank's own rating. If using the latter approach, assets of shorter than three months will receive preferential treatment.

EXHIBIT 14.4 **Basel Capital Requirement Proposals, Percentage Weightings**

	Credit Rating						
Asset	AAA to AA	A+ to A–	BBB+ to BBB–	BB+ to BB–	B+ to B–	Below B–	Unrated
Sovereign	0%	20%	50%	100%	100%	150%	100%
Banks–option 1[a]	0%	20%	50%	100%	100%	150%	100%
Banks–option 2[b] < 3 month	20%	20%	20%	50%	50%	150%	20%
Banks–option 2[b] > 3 month	20%	50%	50%	100%	100%	150%	50%
Corporates	20%	100%	100%	100%	100%	150%	100%

[a] Based on the risk weighting of the sovereign in which the bank is incorporated.
[b] Based on the assessment of the individual bank.
Source: BIS

Loans made to unrated borrowers will be placed in a separate band that carries the full risk weighting of 100%, although the BIS has stated that regulators should review the historical default experience of the relevant market and assess whether this weighting is sufficient. Short-term credit facilities with corporates that remain undrawn, which under Basel I attract a zero weighting, would be weighted at 20% under Basel II.

Compared to Basel I, under Basel II there is a greater allowance for credit risk reduction, principally in the form of recognition of securities as collateral. The following assets would be recognized as collateral:

- cash and government securities (as currently recognized under Basel I)
- securities rated BB- and above issued by a sovereign or public sector entity
- securities rated BBB- and above
- equities that are constituents of a main index, or listed on a recognized investment exchange
- gold

Securities placed as collateral will be given a "haircut" to their market value to reflect their price volatility.

Internal Ratings Based Approach

In the IRB approach banks' assets are categorized in accordance with their own internal risk assessment. To undertake this approach a bank must have its internal systems recognized by its relevant supervisory body, and systems and procedures must have been in place for at least three years previously. This includes a system that enables the bank to assess the default probability of borrowers. If using an IRB approach a bank will use its own internal ratings to categorize loans in *probability-to-default* or PD bands. The number of PD bands set up is at the discretion of the bank. The BIS has compiled a formula that enables the bank to calculate the capital allocation requirement in accordance with its PD bands. Exhibit 14.5 sets out the capital requirements under Basel I and both the standard and IRB approaches under Basel II.

If using the advanced approach, banks may recognize any form of collateral and set their own parameters when using the BIS formula for calculating capital, following approval from their banking supervisory body. For the first two years after such approval, the credit risk element of capital allocation cannot be lower than 90% of the allocation calculated under the foundation approach; after two years the BIS propose to review the advanced approach and comment.

EXHIBIT 14.5 Capital Requirements under Specified PD Bands

Credit Rating	PD Band	Basel I	Standard Approach	IRB Foundation Approach
AAA	0.03	8.0	1.6	1.13
AA	0.03	8.0	1.6	1.13
A	0.03	8.0	4.0	1.13
BBB	0.20	8.0	8.0	3.61
BB	1.40	8.0	8.0	12.35
B	6.60	8.0	12.0	30.96
CCC	15.00	8.0	12.0	47.04

Source: BoE

Operational Risk

One of the most controversial elements of the Basel II is the new capital charge to cover banks' operational risk. The Committee has proposed three different approaches for calculating the operational risk capital charge. These are:

- the basic indicator approach, under which a 20% of total capital would be allocated;
- a standardized approach, under which different risk indicators will be allocated to different lines of business within a bank; this would be the level of average assets for a retail bank and assets under management for a fund manager. The Committee would set the capital charge level for each business line in accordance with its perceived level of risk in each national jurisdiction, and the total operational risk would be the sum of the exposures of all business lines;
- an internal estimation by a bank of the expected losses due to operational risk for each business lines. Operational risk here would be risk of loss as a result of fraud, IT failures, legal risk, and so on.

Total Minimum Capital

The sum of the capital calculation for credit risk exposure, operational risk and the bank's trading book will be the total minimum capital requirement. This capital requirement will be expressed as a 8% risk-asset ratio, identical to the rules under Basel I.

Pillar 2—Supervisory Approach

A new element of the Basel II accord is the requirement for a supervision approach to capital allocation. This is based on three principles. First, banks must have a procedure for calculating their capital requirements in accordance with their individual risk profile. This means they are required to look beyond the minimum capital requirement as provided for under Pillar 1, and assess specific risk areas that reflect their own business activities. This method would consider for instance, interest rate risk exposure within the banking book, or prepayment risk as part of mortgage business. These procedures will be reviewed constantly by banking supervisory authorities. Secondly, the risk-weighted capital requirement calculated under Pillar 1 is viewed as a minimum only, and banks are expected to set aside capital above this minimum level to provide an element of reserve. Supervisors will be empowered to require a bank to raise its capital level above the stipulated minimum. Finally, supervisors are instructed to constantly review the capital levels of banks under their authority, and act accordingly in good time so that such levels do not fall below a level deemed sufficient to support an individual bank's business activity.

Pillar 3—Disclosure

The Basel II accord sets out rules on core disclosure that banks are required to meet, and which supervisors must enforce. In addition there are supplementary disclosure rules; these differ from core rules in that banks have more flexibility on reporting them if they are deemed not relevant to their specific operating activities, or of they are deemed non-material. The disclosures include:

capital: the elements that make up the bank's capital, such as the types of instruments that make up the Tier 1 and Tier 2 capital;

capital adequacy: this covers the amount of capital required against credit, market and operational risk, as well as capital requirements as a percentage of the total capital of the bank;

risk exposure: the overall risk exposure of a bank, as measured by credit risk, market risk, operational risk, and so on. Hence this would include profile of the ALM book, including maturity profile of the loan book, interest-rate risk, other market risk, essentially the sum of the exposures measured and monitored by a bank's risk management department.

As part of Pillar 3, banks using an IRB approach when calculating their capital requirement are required to disclose their internal policies and procedures used as part of the approach.

In compiling the new Accord, the Basel committee wished to expand capital requirements to cover other areas of risk, such as market risk and operational risk. It recognizes that a bank's capital should reflect the level of risk of its own portfolio, but also that this may best be estimated by a bank's own internal model rather than any standard ruling provided by a body such as the BIS.

In any event the proposed rule changes have attracted considerable comment and the final form of the rules that are eventually adopted may bear little resemblance to the proposals listed above. There is a growing consensus among practitioners that perhaps the markets themselves should carry more of the supervisory burden rather than regulators, for example narrowing the scope of deposit insurance,[7] or by requiring banks to issue specific kinds of uninsured debt. Holders of such subordinated debt are more concerned with the financial health of a bank because their investment is not guaranteed, and at the same time they are not interested in high-risk strategies because their return is the same every year regardless of the profit performance of the bank (i.e., the fixed coupon of their subordinated bond). Therefore the yield on this subordinated debt is in effect the market's assessment of the risk exposure of the bank. Charles Calomiris of Columbia University[8] has suggested that regulators should place a cap on this yield, which would force the bank to cap the level of its risk exposure, but this level would have been evaluated by the market, and not the regulatory authority.

One improvement of Basel II over Basel I is that it acknowledges that "one size" does not fit all banks, and that greater flexibility is required in the capital allocation process. The IRB approach should result in a lower capital charge than the standardized approach, and as such should encourage the development of risk management systems in banks that are incentivized to adopt this approach. Depending on the nature of their activities, some banks will have higher risk profiles compared to others, and as such need more risk management than would be provided simply by a minimum capital level. This is the reasoning behind the three Pillar approach, and principally Pillar 2, which empowers supervisors to intervene if they feel steps taken by an individual bank are not adequate. This is meant to extend beyond a requirement to increase capital levels. Pillar 3 is also crucial to this overall process, as it is designed to ensure that there is adequate disclosure, not just of risk exposure but also of the procedures used to calculate capital under the IRB approach.

[7] Many countries operate a deposit insurance scheme that guarantees the level of a private customer's deposits in a bank should that bank fail. In the UK for example, the arrangement is that if a bank or building society is declared bankrupt, individuals are entitled to compensation of 90% of their savings with that institution, up to a maximum of £18,000 per individual.

[8] As described in "Better than Basle," *The Economist*, June 19, 1999.

REACTION AND CRITIQUE

The weight of market reaction and comment to the Basel proposals initially led to a second draft of the proposals being introduced, in January 2000, following the first draft in June 1999. The consultative period was also extended by one year, so that final implementation of the Accord will not take place until 2005.

The general market opinion has been that Basel II does at least attempt to focus on the economic substance and risk characteristics of new market instruments, as opposed to their structural form. With one or two notable exceptions, banks should find that their overall level of capital allocation remains broadly similar to that under the previous regime. The IRB approach, by being split into a foundation and advanced options,[9] enables a larger range of banks the option of adopting it, rather than just the larger ones that might be expected to have the requisite internal systems.

The most contentious element of the proposals is the charge for operational risk. The Accord allows three approaches for determining this charge. The first, the "basic indicator," uses a simple one-level indicator, while the second is a standardized approach that specifies different levels of charge for different business lines. The third option is an internal measurement mechanism that enables banks to use their own internal loss data to estimate the charge. The overwhelming market response to these proposals was that they resulted in too high a charge for an element of risk that is still vaguely defined. However the three different options will produce different results, and this flexibility was introduced in the second draft after the market's negative reaction to the blanket 20% operational risk charge stated in the first draft. For instance, a senior vice-president of a middle-tier investment bank has stated that using the third approach produces a capital charge that is $500 million lower than that produced by the flat 20% charge.[10] Therefore banks will probably wish to ensure that their internal systems and procedures are developed such that they can employ the internal method. Nevertheless, it remains to be seen if the proposals are adopted in their current form.

Under the proposals, capital relief can be obtained by the use of collateral, bank guarantees, and credit derivatives. These proposals should result in a rise in the use of synthetic securitizations such as synthetic collateralized debt obligations transactions, to reduce capital exposure of bank balance sheets. The Accord stipulates a haircut (denoted by H in the draft) to be applied to collateral, in accordance with its credit quality, as a protection against market risk. This is not controversial. Collateral,

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[9] This was introduced at the time of the second draft proposals.

[10] *RISK*, February 2001, p. 27.

non-bank and non-sovereign guarantees and credit derivatives also will be subject to a charge of 0.15 of the original charge on the exposure, known as *w*. This charge is designed to reflect risks associated with these instruments, such as legal and documentation risks. However the credit derivatives market has reacted negatively to this proposal, suggesting that *w* is not required and will have an impact on the liquidity of the default swap market. The *w* factor is expected to be modified or removed in the final draft.

The Accord has greatest impact on emerging markets, and has been welcomed for instanced by non-sovereign issuers in these markets. This is because under the new Accord banks may rate other banks and corporate borrowers at a higher level than the sovereign rating of the home country. Under Basel I, no institution could be rated higher than its domicile country rating. As a result banks may target stronger corporate borrowers in lower-rated emerging market economies. In the standardized approach extra risk buckets of 50% and 150% for corporate exposures have been added to the existing 20% and 100% buckets. This makes the new Accord more risk-sensitive. The impact on bank risk weightings of the new proposals for certain sovereign credits is given in Exhibit 14.6. Higher-rated banks will probably wish to adopt the IRB approach, while smaller banks are likely to adopt the standardized approach until they have developed their internal risk management systems.

EXHIBIT 14.6 **Bank Risk Weightings under Basel II: Selected Asian Economies**

	Sovereign rating	Current risk weight (%)	Proposed risk weight (20%)
Australia	Aa2/AA+	20	20
China	A3/BBB	100	100
India	Ba2/BB	100	100
South Korea	Baa2/BBB	20	100
Malaysia	Baa2/BBB	100	100
Pakistan	Caa1/B-	100	150
Philippines	Ba1/BB+	100	100
Singapore	Aa1/AAA	100	20
Taiwan	Aa3/AA+	100	20
Thailand	Baa3/BBB-	100	100

Ratings source: Moody's/S&P

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