1 Bonds and Money-Market Instruments

Fixed-income markets are populated with a vast range of instruments. In the present chapter, we provide a typology of the most simple of these instruments, namely bonds and money-market instruments, and describe their general characteristics.

1.1 Bonds

1.1.1 General Characteristics of Bonds

Definition of a Standard Bond

A debt security, or a bond, is a financial claim by which the issuer, or the borrower, is committed to paying back to the bondholder, or the lender, the cash amount borrowed, called *principal*, plus periodic interests calculated on this amount during a given period of time. It can have either a standard or a nonstandard structure. A standard bond is a fixed-coupon bond without any embedded option, delivering its coupons on periodic dates and principal on the maturity date.

For example, a US Treasury bond with coupon 3.5%, maturity date 11/15/2006 and a nominal issued amount of \$18.8 billion pays a semiannual interest of \$329 million (\$18.8 billion $\times$ 3.5%/2) every six months until 11/15/2006 included, as well as \$18.8 billion on the maturity date. Another example would be a Euro Treasury bond with coupon 4%, maturity date 07/04/2009 and a nominal issued amount of Eur11 billion, which pays an annual interest of Eur440 million (Eur11 billion $\times$ 4%) every year until 07/04/2009 included, as well as Eur11 billion on the maturity date.

The purpose of a bond issuer (the Treasury Department, a government entity or a corporation) is to finance its budget or investment projects (construction of roads, schools, development of new products, new plants) at an interest rate that is expected to be lower than the return rate of investment (at least in the private sector). Through the issuance of bonds, it has a direct access to the market, and so avoids borrowing from investment banks at higher interest rates. In the context of financial disintermediation, this practice tends to increase rapidly. One point to underscore is that the bondholder has the status of a creditor, unlike the equity holder who has the status of an owner of the issuing corporation. This is by the way the reason why a bond is, generally speaking, less risky than an equity.

Terminology and Convention

A bond issue is characterized by the following components:

- ***The issuer's name*** *For example, Bundesrepublik Deutschland for a Treasury bond issued in Germany.*
- ***The issuer's type*** *This is mainly the sector it belongs to: for example, the oil sector, if Total Fina Elf is the bond issuer.*

- ***The market in which the bond is issued*** *It can be the US domestic market, the Euro zone domestic market, the domestic market of any country, the eurodollar market, which corresponds to bonds denominated in USD and issued in any other country than the US.*
- ***The issuer's domicile***
- ***The bond's currency denomination*** *An example is US$ for a US Treasury bond.*
- ***The method used for the calculation of the bond price/yield*** *The method depends on the bond category. For US Treasury bonds, the method used is the street convention, which is the standard calculation method used by the market.*
- ***The type of guarantee*** *This is the type of underlying guarantee for the holder of the security. The guarantee type can be a mortgage, an automobile loan, a government guarantee...*
- ***The maturity date*** *This is the date on which the principal amount is due.*
- ***The coupon type*** *It can be fixed, floating, a multicoupon (a mix of fixed and floating or different fixed). For example, a step-up coupon bond is a kind of multicoupon bond with a coupon rate that increases at predetermined intervals.*
- ***The coupon rate*** *It is expressed in percentage of the principal amount.*
- ***The coupon frequency*** *The coupon frequency for Treasury bonds is semiannual in the United States, the United Kingdom and Japan, and annual in the Euro zone, except for Italy where it is semiannual.*
- ***The day-count type*** *The most common types are Actual/Actual, Actual/365, Actual/360 and 30/360. Actual/Actual (Actual/365, Actual/360) means that the accrued interest between two given dates is calculated using the exact number of calendar days between the two dates divided by the exact number of calendar days of the ongoing year (365, 360). 30/360 means that the number of calendar days between the two dates is computed assuming that each month counts as 30 days. For example, using the 30/360 day-count basis, there are 84 days $(2 \times 30 + 24)$ from 01/01/2001 to 03/25/2001 and 335 $(11 \times 30 + 5)$ from 01/01/2001 to 12/06/2001. Using the Actual/Actual or Actual/365 day-count basis, there are 83 days from 01/01/2001 to 03/25/2001 and 339 days from 01/01/2001 to 12/06/2001. Using the Actual/Actual day-count basis, the period from 08/01/1999 to 09/03/2001 converted in years is $\frac{152}{365} + 1 + \frac{246}{365} = 2.0904$. Using the Actual/365 day-count basis, the period from 08/01/1999 to 09/03/2001 converted in years is $764/365 = 2.0931$. Using the Actual/360 day-count basis, the period from 08/01/1999 to 09/03/2001 converted in years is $764/360 = 2.1222$. Using the 30/360 day-count basis, the period from 08/01/1999 to 09/03/2001 converted in years is $752/360 = 2.0888$.*
- ***The announcement date*** *This is the date on which the bond is announced and offered to the public.*
- ***The interest accrual date*** *This is the date when interest begins to accrue.*
- ***The settlement date*** *This is the date on which payment is due in exchange for the bond. It is generally equal to the trade date plus a number of working days. For example, in Japan, the settlement date for Treasury bonds and T-bills is equal to the trade date plus three working days. On the other hand, in the United States, the settlement date for Treasury bonds and T-bills is equal to the trade date plus one working day. In the United Kingdom, the settlement date for Treasury bonds and T-bills is equal to the trade date plus one and two working days,*

respectively. In the Euro zone, the settlement date for Treasury bonds is equal to the trade date plus three working days, as it can be one, two or three workings days for T-bills, depending on the country under consideration.

- ***The first coupon date*** *This is the date of the first interest payment.*
- ***The issuance price*** *This is the percentage price paid at issuance.*
- ***The spread at issuance*** *This is the spread in basis points to the benchmark Treasury bond (see the next section called "Market Quotes").*
- ***The identifying code*** *The most popular ones are the ISIN (International Securities Identification Number) and the CUSIP (Committee on Uniform Securities Identification Procedures) numbers.*
- ***The rating*** *The task of rating agencies' consists in assessing the default probability of corporations through what is known as rating. A rating is a ranking of a bond's quality, based on criteria such as the issuer's reputation, management, balance sheet, and its record in paying interest and principal. The two major ones are Moody's and Standard and Poor's (S&P). Their rating scales are listed in Table 1.1. We get back to these issues in more details in Chapter 13.*

Table 1.1 Moody's and S&P's Rating Scales.

Moody's	S&P	Definition
Investment Grade (High Creditworthiness)		
Aaa	AAA	Gilt-edged, best quality, extremely strong creditworthiness
Aa1	AA+	
Aa2	AA	Very high grade, high quality, very strong creditworthiness
Aa3	AA−	
A1	A+	
A2	A	Upper medium grade, strong creditworthiness
A3	A−	
Baa1	BBB+	
Baa2	BBB	Lower medium grade, adequate creditworthiness
Baa3	BBB−	
Speculative Grade (Low Creditworthiness)		
Ba1	BB+	
Ba2	BB	Low grade, speculative, vulnerable to nonpayment
Ba3	BB−	
B1	B+	
B2	B	Highly speculative, more vulnerable to nonpayment
B3	B−	
	CCC+	
Caa	CCC	Substantial risk, in poor standing, currently vulnerable to nonpayment
	CCC−	
Ca	CC	May be in default, extremely speculative, currently highly vulnerable to nonpayment
C	C	Even more speculative
	D	Default

Note: The modifiers 1, 2, 3 or +, − account for relative standing within the major rating categories.

- ***The total issued amount*** *It appears in thousands of the issuance currency on Bloomberg.*
- ***The outstanding amount*** *This is the amount of the issue still outstanding, which appears in thousands of the issuance currency on Bloomberg.*
- ***The minimum amount and minimum increment that can be purchased*** *The minimum increment is the smallest additional amount of a security that can be bought above the minimum amount.*
- ***The par amount or nominal amount or principal amount*** *This is the face value of the bond. Note that the nominal amount is used to calculate the coupon bond. For example, consider a bond with a fixed 5% coupon rate and a $1,000 nominal amount. The coupon is equal to* $5\% \times \$1{,}000 = \$50$.
- ***The redemption value*** *Expressed in percentage of the nominal amount, it is the price at which the bond is redeemed on the maturity date. In most cases, the redemption value is equal to 100% of the bond nominal amount.*

We give hereafter some examples of a Bloomberg bond description screen (DES function), for Treasury and corporate bonds.

Example 1.1 A US T-Bond Description on Bloomberg

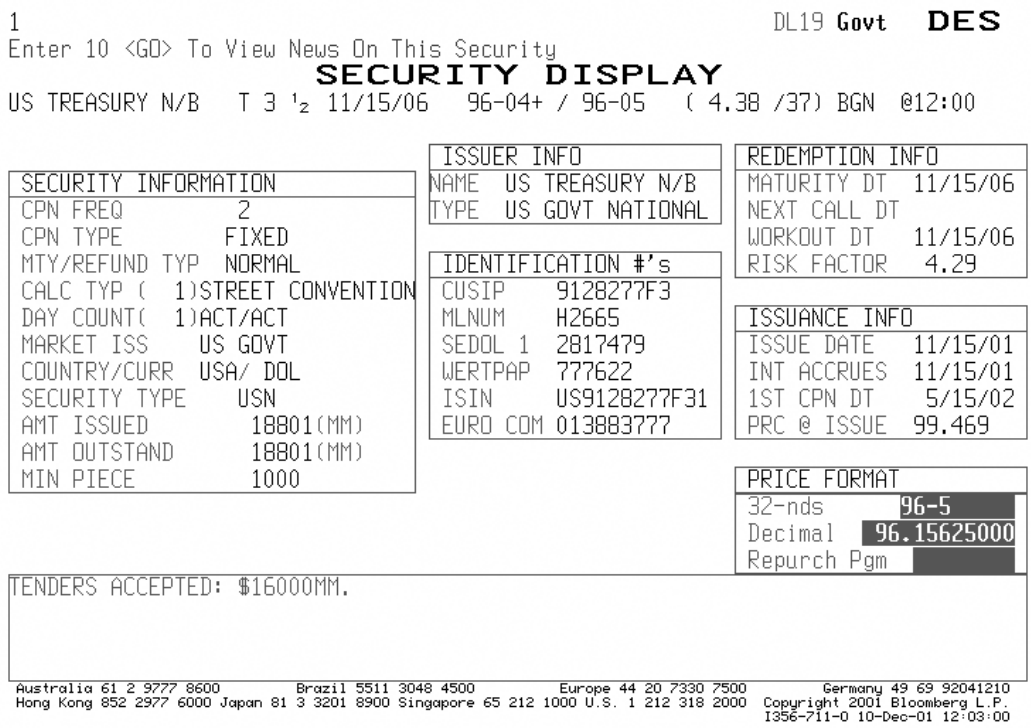
The T-bond (Figure 1.1), with coupon rate 3.5% and maturity date 11/15/2006, bears a semiannual coupon with an Actual/Actual day-count basis. The issued amount is equal to $18.8 billion; so is the outstanding amount. The minimum amount that can be purchased is equal to $1,000. The T-bond was issued on 11/15/01 on the US market, and interests began to accrue from this date on. The price at issuance was 99.469. The first coupon date is 05/15/02, that is, 6 months after the interest accrual date (semiannual coupon). This bond has a AAA rating.

Example 1.2 A German Government Bond Description on Bloomberg

In comparison with the previous US T-bond, the German T-bond (called *Bund*) (Figure 1.2) with coupon rate 4% and maturity date 07/04/2009 has an annual coupon with an Actual/Actual day-count basis. It was issued on the market of the Euro zone, for an amount of Eur11 billion, on 03/26/1999. The price at issuance was 100.17. The minimum amount that can be purchased is equal to Eur0.01. The first coupon date was 07/04/2000. The minimum amount that can be purchased is equal to Eur0.01. This bond has a AAA rating.

Example 1.3 An Elf Aquitaine Corporate Bond Description on Bloomberg

In comparison with the two previous bonds, the Elf Aquitaine (now Total Fina Elf) bond (Figure 1.3) has a Aa2 Moody's rating. It belongs to the oil sector. The issued amount is



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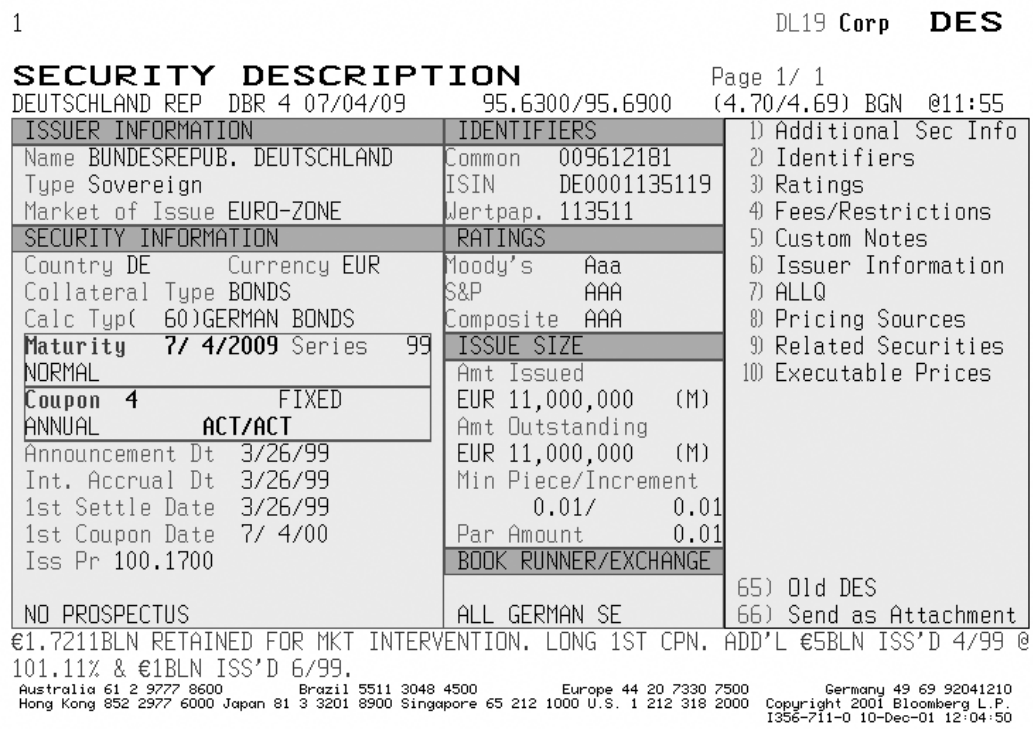
Eur1 billion and the minimum purchasable amount is Eur1,000. The price at issuance was 98.666. It delivers an annual fixed 4.5% coupon rate. Its maturity date is 03/23/09. Its spread at issuance amounted to 39 basis points over the French T-bond (Obligation Assimilable du Trésor (OAT)) with coupon 4% and maturity date 04/25/2009.

Market Quotes

Bond securities are usually quoted in price, yield or spread over an underlying benchmark bond.

Bond Quoted Price The quoted price (or market price) of a bond is usually its *clean price*, that is, its *gross price* minus the *accrued interest*. We give hereafter a definition of these words. Note first that the price of a bond is always expressed in percentage of its nominal amount.[1] When an investor purchases a bond, he is actually entitled to receive all the future cash flows of this bond, until he no longer owns it. If he buys the bond between two coupon payment dates, he logically must pay it at a price reflecting the fraction of the next coupon that the seller of the bond is entitled to receive for having held it until the sale. This price is called the *gross price* (or *dirty price* or

[1] When the bond price is given as a $ (or Eur or £...) amount, it is directly the nominal amount of the bond multiplied by the price in % of the nominal amount.



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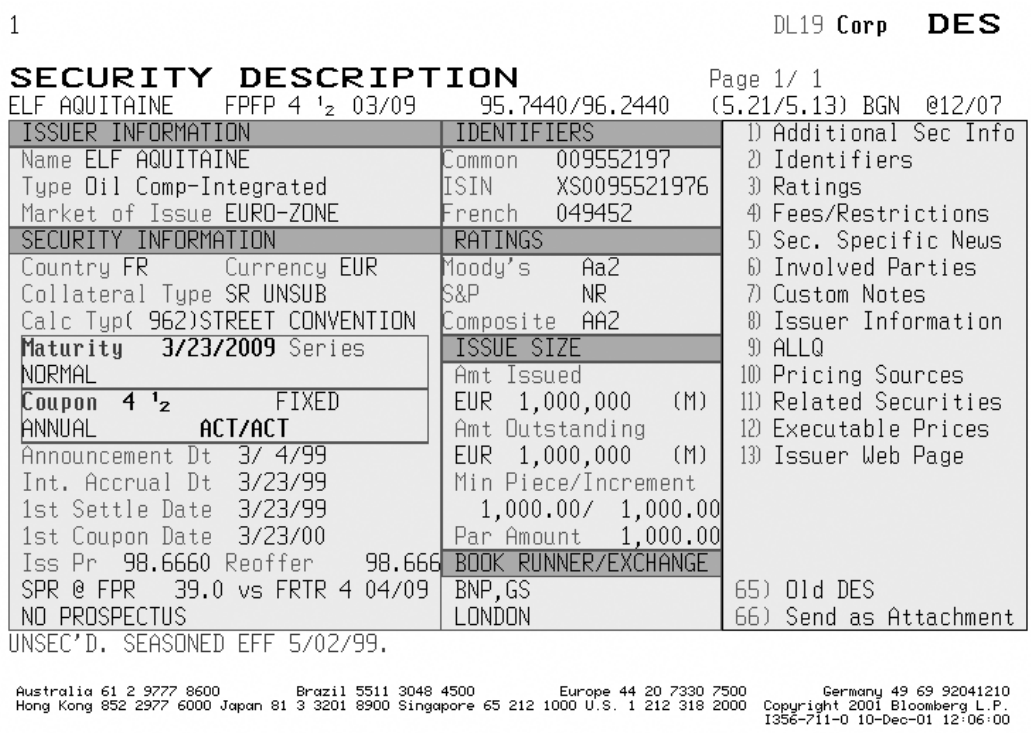
full price). It is computed as the sum of the clean price and the portion of the coupon that is due to the seller of the bond. This portion is called the *accrued interest*. Note that the accrued interest is computed from the settlement date on.

Example 1.4 An investor buys on 12/10/01 a given amount of the US Treasury bond with coupon 3.5% and maturity 11/15/2006. The current clean price is 96.15625. Hence the market value of \$1 million face value of this bond is equal to 96.15625% × \$1 million = \$961,562.5. The accrued interest period is equal to 26 days. Indeed, this is the number of calendar days between the settlement date (12/11/2001) and the last coupon payment date (11/15/2001). Hence the accrued interest is equal to the last coupon payment (1.75, because the coupon frequency is semiannual) times 26 divided by the number of calendar days between the next coupon payment date (05/15/2002) and the last coupon payment date (11/15/2001). In this case, the accrued interest is equal to $1.75 \times (26/181) = 0.25138$. The gross price is then 96.40763. The investor will pay \$964,076.3 (96.40763% × \$1 million) to buy this bond.

Note that the *clean price* of a bond is equal to the gross price on each coupon payment date and that US bond prices are commonly quoted in /32ths.



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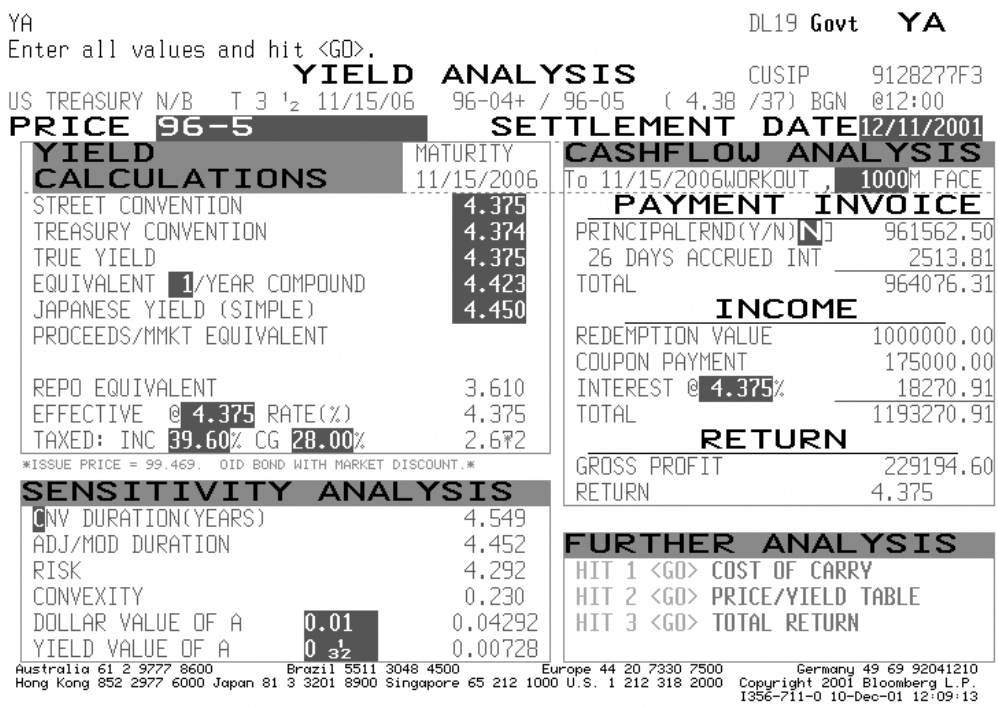
Example 1.5 A T-bond quoting a price of 98−28 has actually a price of $98 + 28/32 = 98.875$.

Bond Quoted Yield The quoted yield of a bond is the discount yield that equalizes its gross price times its nominal amount to the sum of its discounted cash flows (see Chapter 2 for a mathematical definition of a bond yield and for calculations).

Example 1.6 Bond Yield Quotes on Bloomberg

In the previous example, the cash flow schedule of the bond with $1 million face value is the following:

Date	Cash flow	Date	Cash flow	Date	Cash flow	Date	Cash flow
05/15/02	17,500	11/15/03	17,500	05/15/05	17,500	05/15/06	17,500
11/15/02	17,500	05/15/04	17,500	11/15/05	17,500	11/15/06	1,017,500
05/15/03	17,500	11/15/04	17,500				



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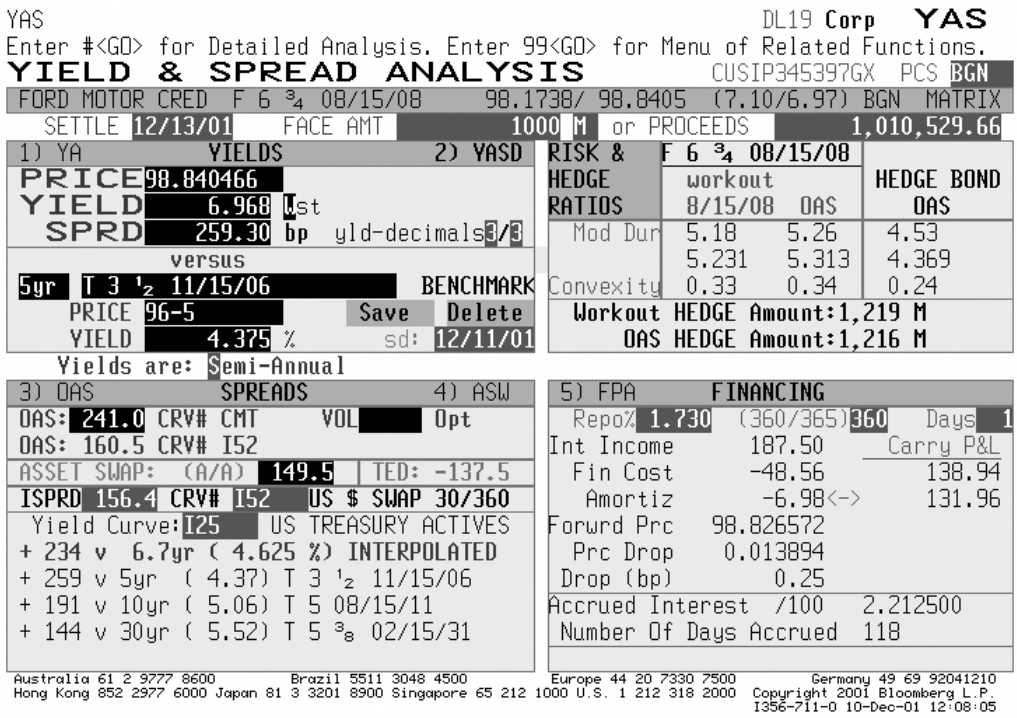
The table hereafter shows the Bloomberg yield analysis screen (YA function) (Figure 1.4) associated with this bond. Its quoted yield is equal to 4.375% (see street convention). The equivalent 1-year compounded yield of this bond is equal to 4.423% (see Chapter 2 on this point).

Bond Quoted Spread Corporate bonds are usually quoted in price and in spread over a given benchmark bond rather than in yield. So as to recover the corresponding yield, you simply have to add this spread to the yield of the underlying benchmark bond.

Example 1.7 The table hereafter gives an example of a bond yield and spread analysis as can be seen on a Bloomberg screen (Figure 1.5). The bond bears a spread of 156.4 basis points (see Interpolated Spread (ISPRD) function) over the interpolated US$ swap yield, whereas it bears a spread of 234 basis points over the interpolated US Treasury benchmark bond yield. Furthermore, its spread over the US Treasury benchmark bond with the nearest maturity amounts to 259.3 basis points (Spread (SPRD) function). It is 191 and 144 basis points over the 10-year Treasury benchmark bond and the 30-year Treasury benchmark bond, respectively.



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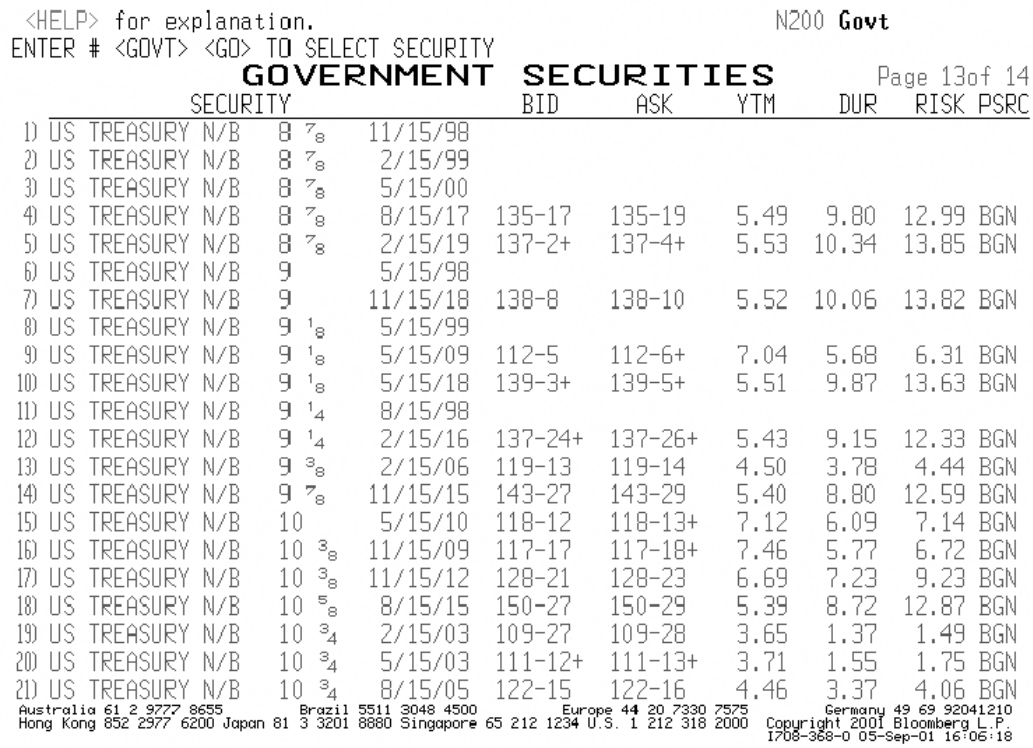
Note that this last way of quoting spreads over treasury bonds is fairly common on bond markets. Indeed, in this case the underlying treasury bond is clearly identified, whereas using an interpolation on the treasury bond curve may lead to different results depending on the two bonds as well as the kind of interpolation considered. To finish, it is worth mentioning that every traded bond has a bid as well as an ask quoted price. The bid price is the price at which an investor can sell a bond, whereas the ask price is the price at which he can buy it. The ask price is of course higher than the bid price, which means that the ask yield is lower than the bid yield. The difference between the two yields is known as the bid–ask spread. It is a kind of transaction cost. It is very small for liquid bonds such as US or Euro Treasury bonds and is large for fairly illiquid bonds. The bond's mid price is simply the average of its bid and ask prices. The same holds for the mid yield.

Example 1.8 Illustration of the Bid–Ask Price Spread on the US T-Bond Market

The following Bloomberg screen (Figure 1.6) provides the bid–ask spread price for some of the US T-bonds quoted on the market. In columns 2 and 3, you can see the coupon rate and the maturity of the instrument. The bid–ask spread appears in the next two columns. Note that prices are quoted in 32ths. The sixth column gives the yield to maturity (YTM) for each instrument (see Chapter 2 for large developments concerning the yield to maturity)



<HELP> for explanation. N200 Govt
ENTER # <GOVT> <GO> TO SELECT SECURITY

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	SECURITY		BID	ASK	YTM	DUR	RISK	PSRC
1)	US TREASURY N/B	8 7/8 11/15/98						
2)	US TREASURY N/B	8 7/8 2/15/99						
3)	US TREASURY N/B	8 7/8 5/15/00						
4)	US TREASURY N/B	8 7/8 8/15/17	135-17	135-19	5.49	9.80	12.99	BGN
5)	US TREASURY N/B	8 7/8 2/15/19	137-2+	137-4+	5.53	10.34	13.85	BGN
6)	US TREASURY N/B	9 5/15/98						
7)	US TREASURY N/B	9 11/15/18	138-8	138-10	5.52	10.06	13.82	BGN
8)	US TREASURY N/B	9 1/8 5/15/99						
9)	US TREASURY N/B	9 1/8 5/15/09	112-5	112-6+	7.04	5.68	6.31	BGN
10)	US TREASURY N/B	9 1/8 5/15/18	139-3+	139-5+	5.51	9.87	13.63	BGN
11)	US TREASURY N/B	9 1/4 8/15/98						
12)	US TREASURY N/B	9 1/4 2/15/16	137-24+	137-26+	5.43	9.15	12.33	BGN
13)	US TREASURY N/B	9 3/8 2/15/06	119-13	119-14	4.50	3.78	4.44	BGN
14)	US TREASURY N/B	9 7/8 11/15/15	143-27	143-29	5.40	8.80	12.59	BGN
15)	US TREASURY N/B	10 5/15/10	118-12	118-13+	7.12	6.09	7.14	BGN
16)	US TREASURY N/B	10 3/8 11/15/09	117-17	117-18+	7.46	5.77	6.72	BGN
17)	US TREASURY N/B	10 3/8 11/15/12	128-21	128-23	6.69	7.23	9.23	BGN
18)	US TREASURY N/B	10 5/8 8/15/15	150-27	150-29	5.39	8.72	12.87	BGN
19)	US TREASURY N/B	10 3/4 2/15/03	109-27	109-28	3.65	1.37	1.49	BGN
20)	US TREASURY N/B	10 3/4 5/15/03	111-12+	111-13+	3.71	1.55	1.75	BGN
21)	US TREASURY N/B	10 3/4 8/15/05	122-15	122-16	4.46	3.37	4.06	BGN

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.
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as the seventh column provides the duration (see Chapter 5). The pricing source is BGN (Bloomberg Generic Value). It is the average of the prices given by the five most active providers in the market.

Nonstandard Bonds

We discuss hereafter strips, floating-rate notes and inflation-indexed bonds. Convertible bonds and bonds with embedded options are discussed in depth in Chapter 14.

Strips Strips (Separate Trading of Registered Interest and Principal) are zero-coupon bonds mainly created by stripping government bonds of the G7 countries.[2] The strips program was created in 1985 by the US Treasury Department in response to investment banks who, in the early 1980s, had been buying long-term Treasury bonds and then issuing their own zero-coupon bonds, collateralized by the payments on the underlying Treasury bonds. These so-called trademark zeros were a success, but because of the higher liquidity of strips, they were dominated by them.

The only cash flow distributed by strips is the principal on the maturity date.

[2] Strips are also traded in other countries and in New Zealand, in particular.

Example 1.9 An investor buys for $20,000 the Treasury strip bond with maturity 05/15/30 and nominal amount $100,000. As a bondholder, he is entitled to receive back $100,000 on 05/15/30, if he has of course not sold the bond meanwhile.

Such a bond that yields no coupon interest over the investment period may seem rather peculiar and unattractive. In fact, it typically bears interest on the maturity date as it is bought at a price that is lower than its maturity price. The investors who buy these bonds are usually long-term investors like pension funds and insurance companies, and have at least one main purpose, which is securing a return over their long-term investment horizon. To understand this point, consider an investor who is supposed to guarantee 6% per annum over 20 years on its liabilities. If he buys and holds a strip with a maturity equal to its investment horizon, that is 20 years, and a YTM of 6%, he perfectly meets his objective because he knows today the return per annum on that bond, which is 6%. In contrast, coupon-bearing bonds do not allow him to do so, because first they bear an interest reinvestment risk and second their duration hardly ever, if not never, reaches 20 years (see Chapter 5 on this point).

There exist two types of strips—coupon strips and principal strips. Coupon strips and principal strips are built by stripping the coupons and the principal of a coupon-bearing bond, respectively. The main candidates for stripping are government bonds (Treasury bonds and government agency bonds).

Strips are not as liquid as coupon-bearing bonds. Their bid–ask spread is usually higher.

Floating-Rate Notes

Definition and Characteristics Floating-Rate Notes (FRN) are bond securities that bear floating coupon rates. Actually, this generic denomination encompasses two categories of bonds:

- *Floating-rate bonds*
- *Variable-rate bonds or adjustable-rate bonds.*

The former category denotes bonds whose coupon rates are indexed on a short-term reference with a maturity inferior to 1 year, like the 3-month Libor, whereas the latter designates bonds whose coupon rates are indexed on a longer-term reference with a maturity superior to 1 year, like the 10-year Constant Maturity Treasury (CMT) bond yield (see the following example entitled "The French 10-Year CMT Bond Description on Bloomberg"). The coupons of floating-rate bonds are reset more than once a year. This is not necessarily the case for variable-rate bonds, which may have a reset frequency exceeding 1 year. Usually, the reset frequency is equal to the coupon payment frequency.

Furthermore, FRNs differ from each other as regards the nature of the coupon rate indexation. Coupon rates can be determined in three ways:

- *First, as the product of the last reference index value and a multiplicative margin.*
- *Second, as the sum of the last reference index value and an additive margin.*
- *Third, as a mix of the two previous methods.*

Note that when the sign of the multiplicative margin is negative, the bond is called *an inverse floater*. The coupon rate moves in the opposite direction to the reference index. So as to prevent it from becoming negative, a floor is determined that is usually equal to zero. Such bonds have become fairly popular under a context of decreasing interest rates. Let us now develop some examples.

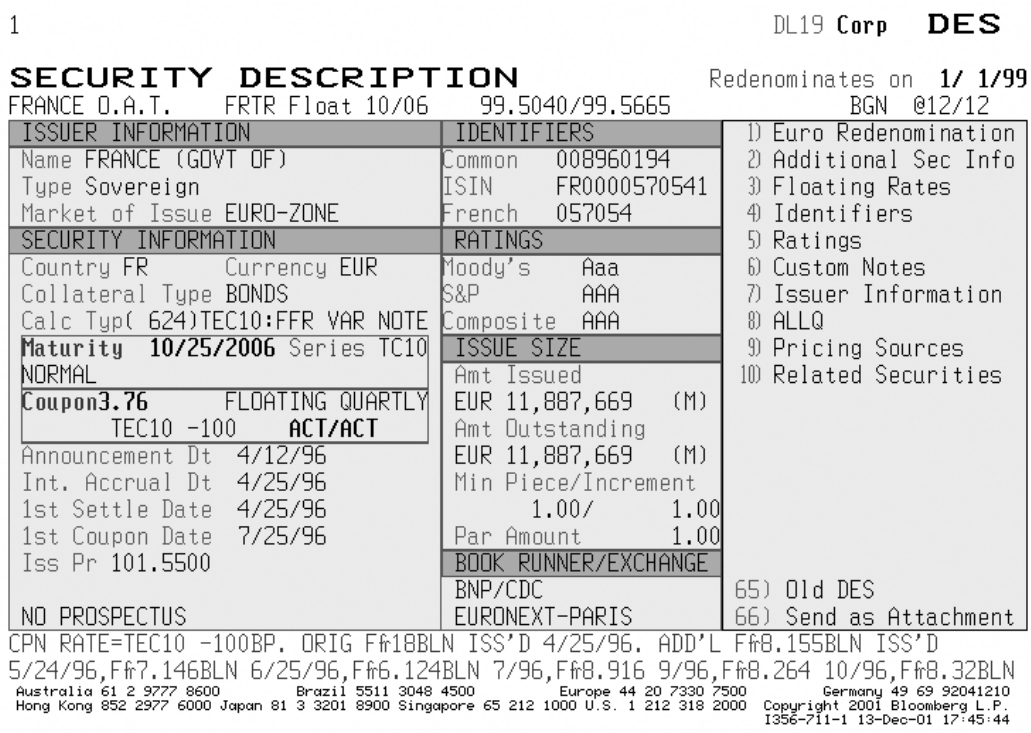
Example 1.10 An investor buying a floating-rate bond whose coupon rate is equal to 3-month Libor + 20 bp is entitled to receive, every period determined in the contract (usually every 3 months), a coupon payment inversely proportional to its annual frequency and principal payment on the maturity date. The coupon rate will be reset every 3 months in order to reflect the new level of the 3-month Libor.

Example 1.11 An investor buying an inverse floater whose coupon rate is equal to $16\% - 2x$, where x is the 2-year T-Bond yield, is entitled to receive, every period determined in the contract (usually every year), a coupon payment inversely proportional to its annual frequency and principal payment on the maturity date. The coupon rate will be reset every 2 years in order to reflect the new level of the 2-year bond yield.

Example 1.12 The French 10-Year CMT Bond Description on Bloomberg

The French 10-year CMT bond (Figure 1.7) with maturity date 10/25/2006 bears a quarterly floating coupon that is indexed on TEC 10. TEC 10 is a French 10-year Constant Maturity Treasury reference. It is determined on a daily basis as the 10-year interpolated yield between two active Treasury bond yields with very close maturity dates. The coupon rate is equal to TEC10 − 100 bp and entitles the bondholder to receive every quarter on January 25th, April 25th, July 25th and September 25th a coupon payment equal to $(1 + \text{TEC10} - 100\text{ bp})^{\frac{1}{4}} - 1$, and principal payment on 10/25/2006. Coupon rates are reset every quarter with an Actual/Actual day-count basis. For example, the coupon paid on April 25th is determined using the TEC 10 index five working days before January 25th. The issued amount is equal to Eur11.888 billion, like the outstanding amount. The minimum amount that can be purchased is equal to Eur1. The bond was issued in the Euro zone. It has a AAA rating. Its price at issuance was 101.55. The bid–ask prices on 12/13/01 were 99.504/99.5665.

Uses When buying a FRN, an investor is typically hedged against parallel shifts of the interest-rate curve because the coupons of the bond reflect the new level of market interest rates on each reset date. So, FRNs usually outperform fixed-rate bonds with the same maturity when interest rates shift upwards and underperform them when interest rates shift downwards. Regarding inverse floaters, the issue is more complex because of the way they are structured. A decrease in interest rates will not necessarily result in the price appreciation of inverse floaters despite the increase in the coupon rate. Their performance depends actually on the evolution of the interest-rate curve shape.



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Inflation-Indexed Bonds

Definition and Characteristics Inflation-indexed bonds deliver coupons and principal that are indexed on the future inflation rates. They are structured so as to protect and increase an investor's purchasing power. They are mainly issued by governments to make it clear that they are willing to maintain a low inflation level. They are more developed in the United Kingdom where they represent over 20% of outstanding treasury bonds. In the United States, they represented only 7% of the issued treasury debt in 1999. In France, there were only three inflation-indexed bonds (OATi) in December 2001.

The inflation rate between date t and date $t+1$, denoted by $IR_{t,t+1}$, is defined as

$$IR_{t,t+1} = \frac{CPI_{t+1}}{CPI_t} - 1$$

where CPI_t is the consumer price index on date t.

The major characteristic of inflation-indexed bonds is that they deliver coupons and redemption values linked to the increase in the CPI index. We treat hereafter the case of French Treasury inflation-indexed bonds called *OATi*:

- *The daily inflation reference on date t, denoted by DIR_t, is computed by using a linear interpolation of two CPIs as follows:*

$$DIR_t = CPI_{m-3} + \frac{nt - 1}{ND_m} \times (CPI_{m-2} - CPI_{m-3})$$

where

CPI_m *is the consumer price index of month* m.

ND_m *is the number of days of month* m.

nt *is the day of date* t *(for example, the day of 04/26/01 is 26).*

- *The coupon payment of an OATi received on date* t*, denoted by* C_t*, is*

$$C_t = FV \times RC \times \left(\frac{DIR_t}{DIR_{initial}}\right)$$

where

FV *is the face value*

RC *is the real coupon*

$DIR_{initial}$ *is the daily inflation reference on the initial date, which is a date varying with each OATi.*

Example 1.13 The initial date of the OATi maturing on 07/25/29 is 07/25/99.

- *The redemption value of an OATi received on date* T*, denoted by* RV_T*, is obtained using the following formula:*

$$RV_T = FV \times \left(\frac{DIR_T}{DIR_{initial}}\right)$$

- *The accrued interest of an OATi on date* t*, denoted by* AC_t*, is*

$$AC_t = FV \times RC \times \frac{\text{number of accrued days}}{\text{actual number of days of the coupon period}} \times \left(\frac{DIR_t}{DIR_{initial}}\right)$$

Example 1.14 A French Inflation-Indexed Treasury Bond Description on Bloomberg

The OATi, with real coupon 3% and maturity date 07/25/2012, bears an annual coupon with an Actual/Actual day-count basis. The issued amount is equal to Eur6.5 billion, like the outstanding amount. The minimum amount that can be purchased is equal to Eur1. The first coupon date is 07/25/02. This bond has a AAA rating. The bid–ask price on 12/13/01 was 99.09/99.22 (Figure 1.8).

Uses An inflation-indexed bond can be used to hedge a portfolio, to diversify a portfolio or to optimize asset–liability management.

- *When buying an inflation-indexed bond, an investor is typically hedged against a rise in the inflation rate.*
- *This product presents a weak correlation with other assets such as stocks, fixed-coupon bonds and cash, which makes it an efficient asset to diversify a portfolio.*

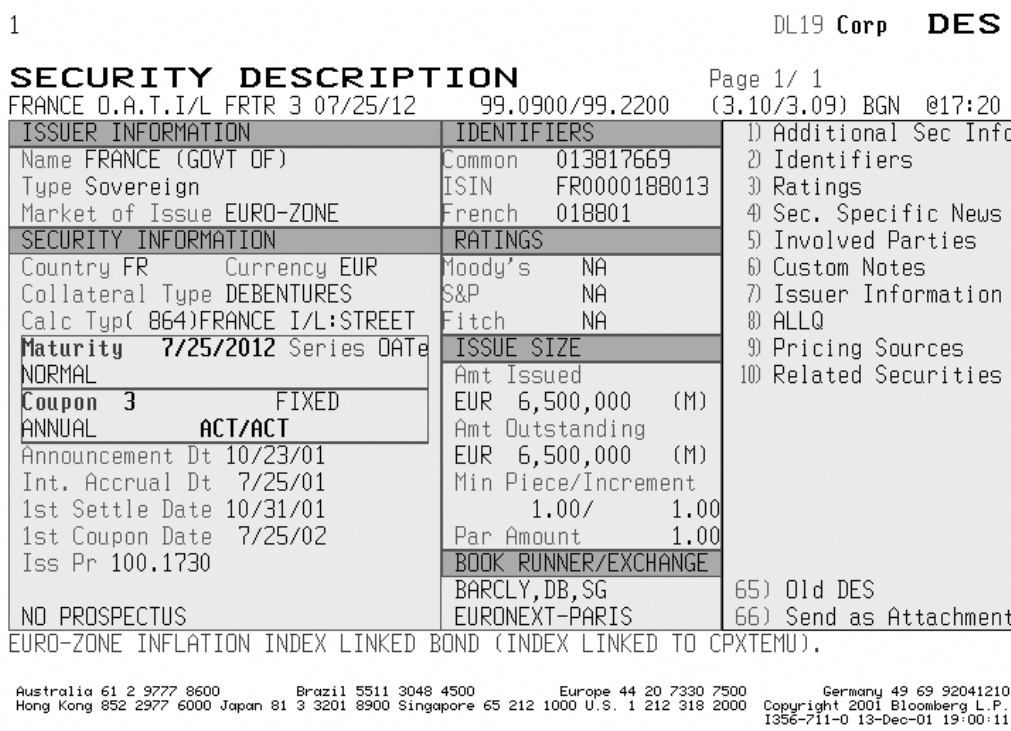

Figure 1.8 © 2003 Bloomberg L.P. All rights reserved. Reprinted with permission.

- *Insurance companies can use this product to hedge inflation risk between the time a sinister appears and the time it is paid to the client; some pension funds guarantee a performance indexed on inflation to their clients, and so buy inflation-indexed bonds to reduce the mismatch between assets and liabilities.*

1.1.2 Bonds by Issuers

Government and Municipal Bonds

Main Characteristics of the US Market

- *Government securities can be divided into two categories: Treasury securities and Federal Agency securities. We treat the US case below.*
  - *Treasury securities are issued by the US Department of the Treasury and backed by the full faith and credit of the US government. The Treasury market is the most active market in the world, thanks to the large volume of total debt and the large size of any single issue. The amount of outstanding marketable US Treasury securities is huge, with $3.0 trillion as of December 31, 2000. The Treasury market is the most liquid debt market, that is, the one where pricing and trading are most efficient. The bid–ask spread is by far lower than in the rest of the bond market. Recently issued Treasury securities are referred to as on-the-run securities, as opposed to off-the-run securities, which are old issued securities.*

Special mention must be made of benchmark securities, which are recognized as market indicators. There typically exists one such security on each of the following curve points: 2 years, 5 years, 10 years and 30 years. As they are overliquid, they trade richer than all their direct neighbors.

Example 1.15 On 12/07/2001, the 5-year US Treasury benchmark bond had a coupon of 3.5% and a maturity date equal to 11/15/2006. It had been issued on 11/15/2001. In contrast, a 5-year off-the-run US T-bond had a coupon of 7% and a maturity date equal to 07/15/2006. Its issuance date was 07/15/1996. Note the difference of coupon level between the two. There are two reasons for that: first, the 5-year off-the-run T-bond was originally a 10-year T-bond. Its coupon reflected the level of 10-year yields at that time. Second, the level of the US government yield curve on 07/15/96 was at least 200 basis points over the level of the US government yield curve on 11/15/2001. Furthermore, on 12/07/2001, the yield of the off-the-run bond was 4.48% as opposed to a yield of 4.45% for the benchmark bond, which illustrates the relative richness of the latter (see Chapter 2 for more details about the notion of bond yield).

  - *Agency securities are issued by different organizations, seven of which dominate the market in terms of outstanding debt: the Federal National Mortgage Association (Fannie Mae), the Federal Home Loan Bank System (FHLBS), the Federal Home Loan Mortgage Corporation (Freddie Mac), the Farm Credit System (FCS), the Student Loan Marketing Association (Sallie Mae), the Resolution Funding Corporation (REFCO) and the Tennessee Valley Authority (TVA). Agencies have at least two common features. First, they were created to fulfill a public purpose. For example, Fannie Mae and Freddie Mac aim to provide liquidity for the residential mortgage market. The FCS aims at supporting agricultural and rural lending. REFCO aims to provide financing to resolve thrift crises. Second, the debt of most agencies is not guaranteed by the US government. Whereas federally sponsored agency securities (Fannie Mae, FHLBS, Freddie Mac, FCS, Sallie Mae, REFCO) are generally not backed by the full faith and credit of the US government, and so contain a credit premium, federally related institution securities (GNMA: Government National Mortgage Association) are generally backed by the full faith and credit of the US government, but as they are relatively small issues, they contain a liquidity premium. Agencies are differently organized. While Fannie Mae, Freddie Mac and Sallie Mae are owned by private-sector shareholders, the Farm Credit System and the Federal Home Loan Bank System are cooperatives owned by the members and borrowers. One sizeable agency, the Tennessee Valley Authority, is owned by the US government.*

- *Municipal securities constitute the municipal market, that is, the market where state and local governments, such as counties, special districts, cities and towns, raise funds in order to finance projects for the public good such as schools, highways, hospitals, bridges and airports. Typically, bonds issued in this sector are exempt from federal income taxes, which makes this sector referred to as the tax-exempt sector. There are two generic types of municipal bonds: general obligation bonds and revenue bonds. The former have principal and interest secured by the full faith and credit of the issuer and are usually supported by either the issuer's unlimited or limited taxing*

Table 1.2 Sector Breakdown of the US Broad Investment-Grade Index as of June 30, 2001.

	Market weight (%)
Treasury	**25.81**
Government sponsored	**12.06**
• Agency	11.06
• Supranational	1.00
Collateralized	**36.96**
• Mortgage	36.13
• Asset-backed	0.83
Credit	**25.16**
• AAA/AA	4.93
• A	11.48
• BBB	8.74

Source: Salomon Smith Barney.

power. The latter have principal and interest secured by the revenues generated by the operating projects financed with the proceeds of the bond issue. Many of these bonds are issued by special authorities created for the purpose.

We provide in Table 1.2 the sector breakdown of the US broad investment-grade index as of June 30, 2001.

Credit Risk

- *Treasury securities are considered to have no credit risk. The interest rates they bear are the key interest rates in the United States as well as in the international capital markets.*
- *Agency securities' debt is high-quality debt. As a matter of fact, all rated agency senior debt issues are triple-A rated by Moody's and Standard & Poor's. This rating most often reflects healthy financial fundamentals and sound management, but also and above all, the agencies' relationship to the US government. Among the numerous legal characteristics of the Government Agencies' debt, one can find that*
  - *agencies' directors are appointed by the President of the United States,*
  - *issuance is only upon approval by the US Treasury,*
  - *securities are issuable and payable through the Federal Reserve System,*
  - *securities are eligible collateral for Federal Reserve Bank advances and discounts,*
  - *securities are eligible for open market purchases.*
- *Municipal debt issues, when rated, carry ratings ranging from triple-A, for the best ones, to C or D, for the worst ones. Four basic criteria are used by rating agencies to assess municipal bond ratings:*
  - *the issuer's debt structure;*
  - *the issuer's ability and political discipline for maintaining sound budgetary operations;*
  - *the local tax and intergovernmental revenue sources of the issuer;*
  - *the issuer's overall socioeconomic environment.*

Other Characteristics Government and municipal securities can be distinguished by their cash flow type, their maturity level, their maturity type and their interest-rate type.

Regarding the cash flow type, there exist, on the one hand, discount securities and, on the other hand, fixed and floating coupon securities. As for maturity level, the 1-year maturity is the frontier separating money-market instruments (with maturity below it) from bond instruments (with maturity above it). For example, Treasury securities with original maturity equal or below 1 year are called *Treasury bills*; they are discount securities. Treasury securities with original maturity between 2 years and 10 years are called *Treasury notes*, and *Treasury securities* with original maturity over 10 years are called *Treasury bonds*; both are coupon securities, and some of them are stripped. According to the maturity type, the security can be retired or not prior to maturity. A security with a single maturity is called *a term security* while a security that can be retired prior to maturity is called *a callable security*. Although the US government no longer issues callable bonds, there are still outstanding issues with this provision. Apart from this, Treasury bonds are bullet bonds, meaning that they have no amortization payments. Concerning the interest-rate type, agency securities, municipal securities and most Treasury securities are nominal coupon-bearing securities. Only a few Treasury securities are inflation-linked, that is, they bear real coupons. They are called *TIPS* (Treasury Inflation Protected Securities).

Markets Treasury securities are traded on the following four markets: the primary market, the secondary market, the when-issued market and the repo market.

- *The primary market is the market where newly issued securities are first sold through an auction which is conducted on a competitive bid basis. The auction process happens between the Treasury and primary/nonprimary dealers according to regular cycles for securities with specific maturities. Auction cycles are as follows: 2-year notes are auctioned every month and settle on the 15th. Five-year notes are auctioned quarterly, in February, May, August and November of each year, and settle at the end of the month. Ten-year notes are auctioned quarterly, in February, May, August and November of each year, and settle on the 15th of the month. Thirty-year bonds are auctioned semiannually, in February and August of each year, and settle on the 15th of the month. Auction is announced by the Treasury one week in advance, the issuance date being set one to five days after the auction.*
- *The secondary market is the market where previously issued securities are bought and sold, a group of US government security dealers offering continuous bid and ask prices on specific outstanding Treasury securities. It is an over-the-counter market.*
- *The when-issued market is the market where Treasury securities are traded on a forward basis before they are issued by the Treasury.*
- *Finally, the repo market is the market where securities are used as collateral for loans. A distinction must be made between the general-collateral (GC) repo rate and the special repo rate. The GC repo rate applies to the major part of Treasury securities. Special repo rates are specific repo rates. They typically concern on-the-run and cheapest-to-deliver securities, which are very expensive. This is the reason why special repo rates are at a level below the GC repo rate. Indeed, as these securities are very much in demand, the borrowers of these securities on the repo market receive a relatively lower repo rate compared to normal Treasury securities.*

Table 1.3 JP Morgan Global Government Bond Index Country Weights as of June 1, 2001 and September 1, 1997.

	Market weights as of 06/01/01 (%)	Market weights as of 09/01/97 (%)	Weights' evolution between 09/97 and 06/01 (%)
Euroland*	33.24	30.94	+7.43
Japan	30.27	14.72	+105.67
US	25.37	39.84	−36.32
UK	5.80	6.73	−13.87
Canada	3.12	3.11	—
Denmark	1.14	1.80	—
Sweden	0.68	1.74	—
Australia	0.38	1.12	—

*Belgium, France, Germany, Italy, Netherlands, Spain.
Source: JP Morgan.

Main Issuers Overview

The four major government bond (government bond refers here to bond and note issued by the Treasury of each country) issuers in the world are Euroland, Japan, the United States and the United Kingdom. Table 1.3 gives a country percentage breakdown of the JP Morgan Global Government Bond Index, which is a benchmark index for developed government debt markets. Note that if we include the remaining EMU (European Monetary Union) countries, Euroland's weight is slightly higher.

It is worth noting that between 1997 and 2001 Japan's weight has more than doubled, whereas the US weight has decreased by approximately one-third and the UK weight has fallen by nearly 15%. Meanwhile, Euroland's weight has slightly increased. Typical reasons for this are the US budget surpluses and the Treasury buyback program, as well as the credit crunch situation in Japan, having led to tremendous JGBs (Japanese Government Bonds) issuance programs.

Corporate Bonds

Main Characteristics

Corporate bonds are issued by entities (firms, banks) belonging to the private sector. They represent what market participants call *the credit market*. They are far less liquid than government bonds: they bear higher bid–ask spreads.

Example 1.16 On 12/10/2001, the bid–ask price spread for the T-bond 6% 08/15/2009 amounted to 1.5 cents, whereas for the Ford corporate bond 7.375% 10/28/2009 it amounted to 60 cents. The pricing source that is used is the BGN, which is the average of the prices of the most active contributors. It is a market consensus price.

As is the case for government and municipal bonds, the issuer of a corporate bond has the obligation to honor his commitments to the bondholder.

A failure to pay back interests or principal according to the terms of the agreement constitutes what is known as default. Basically, there are two sources of default. First, the shareholders of a

corporation can decide to break the debt contract. This comes from their limited liability status: they are liable of the corporation's losses only up to their investment in it. They do not have to pay back their creditors when it affects their personal wealth. Second, creditors can prompt bankruptcy when specific debt protective clauses, known as covenants, are infringed.

Corporate bonds are said to be affected by default or credit risk. Their yields contain a default premium over Treasury bonds, accounting for total default or credit risk, as well as over swaps,[3] accounting for specific default or credit risk. In case of default, there are typically three eventualities:

- *First, default can lead to immediate bankruptcy. Depending on their debt securities' seniority and face value, creditors are fully, partially or not paid back, thanks to the sale of the firm's assets. The percentage of the interests and principal they receive, according to seniority, is called recovery rate.*
- *Second, default can result in a reorganization of the firm within a formal legal framework. For example, under Chapter 11 of the American law, corporations that are in default are granted a deadline so as to overcome their financial difficulties. This depends on the country's legislation.*
- *Third, default can lead to an informal negotiation between shareholders and creditors. This results in an exchange offer through which shareholders propose to creditors the exchange of their old debt securities for a package of cash and newly issued securities.*

We now refer the reader to Chapter 13 "Modeling the Credit Spreads Dynamics" for more information on the assessment of default.

The Corporate Bond Market

The Market Size In the context of a historically low level of interest rates, linked to a decreasing trend in inflation as well as in budget deficits, the corporate bond market is rapidly developing and growing. This strong tendency affects both supply and demand. While corporate supply is expanding, in relation with bank disintermediation, corporate demand is rising as more and more investors accustomed to dealing with only government bonds are including corporate bonds in their portfolios so as to capture spread and generate performance. Within the four major bond markets in the world, the US Dollar (USD) corporate market is the most mature, followed by the Sterling (GBP) market and the Euro (EUR) market, the growth of the latter being reinforced by the launching of the Euro. The Japanese Yen (JPY) market differentiates itself from the others, because of the credit crunch situation and economic difficulties it has been facing since the Asian crisis. Tables 1.4, 1.5, 1.6 and 1.7 hereafter give an appraisal of the corporate bond market size and weight for the four previous markets, as of September 2001 (source: Merrill Lynch, Master and Broad indices). The USD corporate bond market appears much bigger and also more diversified than the others: it is, for instance, more than twice as big as the Euro market, and low investment-grade ratings are much more represented (over 80%).

[3] Swap spread, which is the difference between swap yield and Treasury yield with same maturity, is regarded as systematic credit premium. The reason is that swap yields reflect bank risk with rating AA, which is the first rating grade below AAA, the rating for Treasury bonds.

Table 1.4 Market Weight of the US Corporate Bond Market as of September 2001.

Description	Par amount (in billion USD)	Weight (in %)
USD broad investment-grade bond market	6,110.51	100.00
USD govt./govt. sponsored	2,498.23	40.88
USD collateralized	2,216.73	36.28
USD corporate	1,395.56	22.84
USD corporate (large capitalizations)	869.96	14.24
USD corporate	1,395.56	100.00
AAA	35.33	2.53
AA	200.81	14.39
A	653.76	46.90
BBB	505.65	36.23

Table 1.5 Market Weight of the Euro Corporate Bond Market as of September 2001.

Description	Par amount (in billion USD)	Weight (in %)
EUR broad investment-grade bond market	3,740.77	100.00
EUR govt./govt. sponsored	2,455.24	65.63
EUR collateralized	685.78	18.33
EUR corporate	599.75	16.03
EUR corporate (large capitalizations)	416.96	11.15
EUR corporate	599.75	100.00
AAA	143.10	23.86
AA	151.55	25.27
A	220.36	36.74
BBB	84.74	14.13

Table 1.6 Market Weight of the UK Corporate Bond Market as of September 2001.

Description	Par amount (in billion USD)	Weight (in %)
GBP broad investment-grade bond market	529.84	100.00
GBP govt./govt. sponsored	359.58	67.87
GBP collateralized	1.41	0.27
GBP corporate	168.85	31.87
GBP corporate (large capitalizations)	83.49	15.76
GBP corporate	168.85	100.00
AAA	32.41	19.19
AA	45.29	26.82
A	65.36	38.71
BBB	25.79	15.27

Table 1.7 Market Weight of the Japan Corporate Bond Market as of September 2001.

Description	Par amount (in billion USD)	Weight (in %)
JPY broad investment-grade bond market	2,183.33	100.00
JPY govt./govt. sponsored	1,726.55	79.08
JPY collateralized	0.58	0.03
JPY corporate	456.20	20.89
JPY corporate (large capitalizations)	252.87	11.58
JPY corporate	456.20	100.00
AAA	7.27	1.59
AA	198.79	43.59
A	193.30	42.39
BBB	56.66	12.43

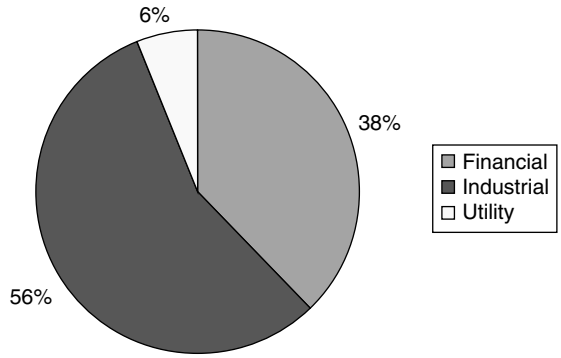

Figure 1.9

Sector breakdown of the US corporate bond market.

The Sector Breakdown The corporate bond market can be divided into three main sectors: financial, industrial and utility. Figures 1.9, 1.10 and 1.11 hereafter show the breakdown of the US market into these sectors, and, furthermore, the breakdown of each sector into subsectors.[4] Sources come from Merrill Lynch (Broad corporate indices as of September 2001).

Note that apart from the USD market, the financial sector is overrepresented. It is another proof of the maturity of the USD market, where the industrial sector massively uses the market channel in order to finance investment projects. It is also worth noting that the sector composition in the USD market is far more homogeneous than in the other markets. For example, the banking sector is systematically predominant in the GBP, EUR and JPY financial markets (see the Appendix of this chapter), while the telecommunication sector exceeds one-third of the Euro industrial market. As a result, local credit portfolio diversification can be better achieved in the USD market than in the others.

[4]See the Appendix at the end of this chapter for the sector breakdown of the Euro, the UK and the Japan corporate bond markets.

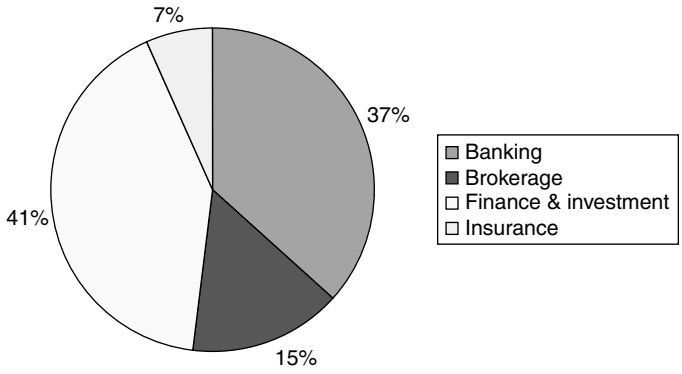

Figure 1.10

Subsector breakdown of the US financial sector.

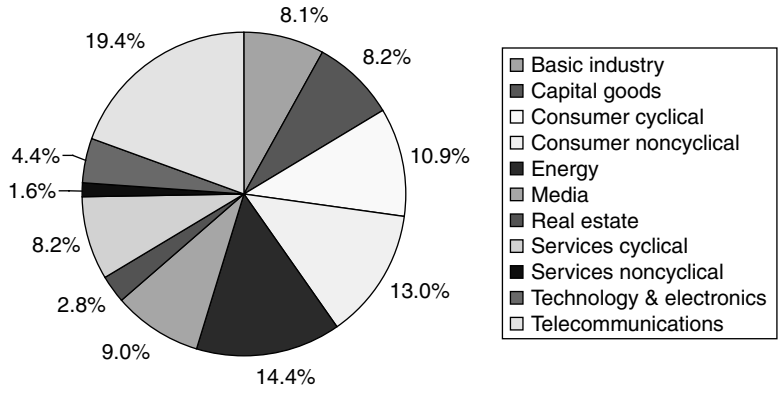

Figure 1.11 Subsector breakdown of the US industrial sector.

1.2 Money-Market Instruments

1.2.1 Definition

Money-market instruments are short-term debt instruments with a maturity typically inferior or equal to 1 year. Some of these instruments such as certificates of deposit may have a maturity exceeding 1 year. These instruments are very sensitive to the Central Bank monetary policy. There are basically three categories of issuers on this market: government (at both the federal and local levels), banks and corporations. We will review the following instruments: *Treasury Bills*, *Certificates of Deposit*, *Bankers' acceptances* and *Commercial papers*. We will also have a close look at *interbank deposits* and *repo transactions*.

1.2.2 The Role of the Central Bank

Before we start describing money-market instruments, let us focus on the essential role of the Central Bank. Through its privileged triple status of government's banker, banks' banker and nation's banker, it literally steers the general level of interest rates. Indeed, as the government's banker, it finances budget deficits; as the banks' banker, it supervises and regulates the banking system; as the nation's banker, it conducts the monetary policy of the nation. All these tasks are guided by two objectives: first, the stability of prices, and second, the support of a sustainable

economic growth. In order to meet these targets, the Central Bank has the responsibility of setting the official interest rate of the nation, through its open market operations, that is, the purchase and sale of government securities, which allows it to control money supply. This key interest rate is basically an interest rate at which banks can borrow. It is

- *either the overnight interest rate at which banks can borrow from the Central Bank (UK, Euro area) in exchange for eligible securities such as Treasury Bills. In this case, it is called a repo rate;*

  Definition 1.1 Overnight means for one trading day.

- *or the overnight interest rate set in the Central Bank funds market, at which banks can borrow or lend Central Bank funds so as to meet their reserve requirements (US, Japan) with the Central Bank. It is called the Fed Funds rate in the United States and the unsecured overnight call rate in Japan.*

Remark 1.1 Central Bank funds are called *Fed funds* in the United States.

Remark 1.2 The Central Bank is called the *Federal Reserve* in the United States. It is called the *European Central Bank* in the Euro area.

Remark 1.3 Depository institutions (commercial banks and thrifts) are required to maintain a specific amount of reserves (what we call Fed Funds in the United States) at their Central Bank.

Note that these two types of interest rates, which both exist in each of the above-mentioned countries, are very close to one another, the repo rate being lower owing to the fact that the corresponding loan is collateralized by a security. This key interest rate then affects the whole spectrum of interest rates that commercial banks set for their customers (borrowers and savers), which in turn affects supply and demand in the economy, and finally the level of prices. The shorter the debt instrument, the greater its sensitivity to monetary policy action. Indeed, as shown in Chapter 3 devoted to the theories of the term structure of interest rates, medium-term and long-term debt instruments are more sensitive to the market expectations of future monetary policy actions than to the current Central Bank action itself.

1.2.3 T-Bills

Treasury Bills are Treasury securities with a maturity below or equal to 1 year. They entail no default risk because they are backed by the full faith and creditworthiness of the government. They bear no interest rate and are quoted using the yield on a discount basis or on a money-market basis depending on the country considered.

- *The yield on a discount basis denoted by y_d is computed as*

$$y_d = \frac{F - P}{F} \times \frac{B}{n}$$

where F is the face value (redemption value), P the price, B the year-basis (360 or 365) and n the number of calendar days remaining to maturity.

It is the yield calculation used in the Euro zone, in the United States and in the United Kingdom. The year-basis is 360 in the United States, 365 in the United Kingdom and can be 360 or 365 in the Euro zone depending on the country considered.

Example 1.17 Compute on a discount basis the yield on a 90-day US T-bill with price $P = \$9{,}800$, and face value \$10,000.

$$y_d = \frac{10{,}000 - 9{,}800}{10{,}000} \times \frac{360}{90} = 8\%$$

When you know the yield on a discount basis, you can retrieve the T-bill price using

$$P = F \times \left(1 - \frac{n \times y_d}{B}\right)$$

Example 1.18 The US T-bill with maturity 03/28/2002 and a discount yield of 1.64% as of 12/17/2001 has a price P equal to

$$P = 100 \times \left(1 - 1.64\% \times \frac{101}{360}\right) = 99.5399$$

Indeed, there are 101 calendar days between 12/17/2001 and 03/28/2002.

- *The yield on a money-market basis denoted by y_m is computed as*

$$y_m = \frac{B \times y_d}{B - n \times y_d}$$

It is the yield calculation used in Japan where the year-basis is 365.

Example 1.19 Compute the yield on a money-market basis on a 62-day Japan T-bill with price $P = 99$ yens and face value 100 yens. The yield on a discount basis is

$$y_d = \frac{100 - 99}{100} \times \frac{365}{62} = 5.887\%$$

The yield on a money-market basis is

$$y_m = \frac{365 \times 5.887\%}{365 - 62 \times 5.887\%} = 5.947\%$$

When you know the yield on a money-market basis, you can retrieve the T-bill price using

$$P = \frac{F}{\left(1 + \frac{n \times y_m}{B}\right)}$$

Example 1.20 The French T-bill (BTF) with maturity 03/07/2002 and a money-market yield of 3.172% as of 12/17/2001 has a price P equal to

$$P = \frac{100}{\left(1 + 3.172\% \times \frac{80}{360}\right)} = 99.30$$

Indeed, there are 80 calendar days between 12/17/2001 and 03/07/2002.

The liquidity of T-Bills may be biased by the so-called squeeze effect, which means that the supply for these instruments is much lower than the demand, because investors buy and hold them until maturity. This phenomenon is particularly observable in the Euro market.

1.2.4 Certificates of Deposit

Certificates of Deposit are debt instruments issued by banks in order to finance their lending activity. They entail the credit risk of the issuing bank. They bear an interest rate that can be fixed or floating, and that is paid either periodically or at maturity with principal. Their maturity typically ranges from a few weeks to three months, but it can reach several years. They trade on a money-market basis. The price is computed using the following equation

$$P = F \times \frac{\left(1 + c \times \frac{n_c}{B}\right)}{\left(1 + y_m \times \frac{n_m}{B}\right)}$$

where F is the face value, c the interest rate at issuance, n_c is the number of days between issue date and maturity date, B is the year-basis (360 or 365), y_m is the yield on a money-market basis, n_m is the number of days between settlement and maturity.

Example 1.21 The Certificate of Deposit issued by the French bank Credit Lyonnais on 07/27/2001, with maturity 04/29/2002, face value Eur80 million, an interest rate at issuance of 4.27% falling at maturity and a yield of 4.19% as of 08/13/2001, has a price P equal to

$$P = 100 \times \frac{\left(1 + 4.27\% \times \frac{276}{360}\right)}{\left(1 + 4.19\% \times \frac{259}{360}\right)} = 100.25$$

which corresponds to a market value of Eur80.201 million (80 million$\times$100.25%) on 08/13/2001.

Indeed, there are 276 calendar days between 07/27/2001 and 04/29/2002, and 259 calendar days between 08/13/2001 and 04/29/2002.

1.2.5 Bankers' Acceptances

Bankers' acceptances are drafts that are drawn and accepted, and therefore guaranteed by banks. These bills of exchange mainly guarantee foreign trade transactions: they often work as guarantees of business between a manufacturer and an importer. Typically, the importer, who cannot pay for the goods imported on the date set by the manufacturer, asks its bank to guarantee the payment. For this purpose, the bank issues a letter of credit according to which it agrees to pay to the holder of this letter the face value of the transaction at maturity. Bankers' acceptances are traded on a discount basis in the United States and a money-market basis in the Euro area. They bear no interest rate. So, the market price of a bankers' acceptance is calculated in the same manner as the price of a T-Bill. Its discount or money-market yield accounts for the credit risk that neither the importer nor the bank honor their commitment.

Example 1.22 An investor buying a banker's acceptance with maturity 04/10/2002 and a discount yield of 1.90% as of 12/14/2001 for a face value of \$30 million will pay a price P equal to

$$P = 100 \times \left(1 - 1.90\% \times \frac{117}{360}\right) = 99.3825$$

that is, a market value of \$29.815 million (30 million $\times$ 99.3825%). Indeed, there are 117 calendar days between 12/14/2001 and 04/10/2002.

1.2.6 Commercial Papers

Commercial papers are unsecured short-term debt securities issued by corporations including industrial and financial companies. Their maturity ranges from 2 to 270 days. They bear no interest rate and are traded on a discount basis in the United States and on a money-market basis in the Euro area. They entail the credit risk of the issuing entity. Note that they are slightly riskier than bankers' acceptances as the latter are guaranteed by the accepting bank beside the guarantee of the issuing company. Corporations typically use them either as a way of raising short-term funds or as interim loans to finance long-term projects while awaiting more attractive long-term capital market conditions, which is called *bridge financing*. Regarding short-term financing, commercial papers are simply rolled over by the issuing corporation until reaching its lending horizon.

Example 1.23 Consider the commercial paper issued by L'Oreal on 10/11/2001 and maturing on 01/15/2002. At issuance, its money-market yield amounts to 3.62%, its nominal value to Eur70 million. Its market value MV is equal to

$$MV = \frac{70{,}000{,}000}{\left(1 + 3.62\% \times \frac{96}{360}\right)} = \text{Eur}69{,}330{,}727$$

Indeed, there are 96 calendar days between 10/11/2001 and 01/15/2002.

1.2.7 Interbank Deposits

Interbank deposits are short-term deposits made between banks, which use them to place surplus funds. These instruments are also accessible to investors with large amounts of cash. They are traded over the counter, which means that the interest rate of the deposit depends on the counterparts that bid for and offer deposits to each other. The interbank bid rate (for example, Libid, Euribid) and the interbank offered rate (for example, Libor, Euribor) serve as reference rates for these transactions. These rates are fixed for maturities ranging basically from 1 day to 12 months.

Remark 1.4 The interbank overnight rate is the 1-day interbank rate. For example, it is called the *Eonia* (Euro overnight index average deposit rate) in the Euro area and the *Sonia* (Sterling overnight index average deposit rate) in the United Kingdom. The equivalent rate in the United States is the *Fed Fund rate*, and in Japan *the unsecured overnight call rate*.

The fixing is the average of the rates quoted by the major banks of a market place. For example, the Libor and Libid rates are derived from the quotations of the major banks in London. The interbank bid rate is of course lower than the interbank offered rate, usually by 12.5 basis points. Interbank deposits entail the credit risk of the quoting banks, that is a AA credit risk. As these instruments are very closely associated with the money-market core institutions and the quotations of the reference rates are widely publicized, interbank rates are regarded as the main money-market benchmark rates. Interbank deposits bear a fixed interest rate paid on the deposit amount.

Remark 1.5 The coupon interest rate is calculated on an Actual/360 daily basis in the United States, the Euro area and Japan, and on an Actual/365 daily basis in the United Kingdom, on the basis of the interbank fixing rate that prevailed 2 days before the coupon starting date in the United States, the Euro area and Japan, and that prevails on the coupon starting date in the United Kingdom.

Example 1.24 Consider an investor who deposits \$100 million on 12/14/2001 at an interest rate of 3.35% until 03/14/2002. At maturity, he receives the amount of its deposit plus the interest earned over the period, that is,

$$\$100 \text{ million} \times \left(1 + 3.35\% \times \frac{90}{360}\right) = \$100.8375 \text{ million}$$

1.2.8 Repo and Reverse Repo Market Instruments

Repurchase (repo) and reverse repurchase (reverse repo) agreement transactions are commonly used by traders and portfolio managers to finance either long or short positions (usually in government securities).

A repo is for an investor a means to lend bonds in exchange for a loan of money, while a reverse repo is a means for an investor to lend money in exchange for a loan of securities. More precisely,

a repo agreement is a commitment by the seller of a security to buy it back from the buyer at a specified price and at a given future date. It can be viewed as a collateralized loan, the collateral here being the security. A reverse repo agreement is the same transaction viewed from the buyer's perspective. The repo desk acts as the intermediary between the investors who want to borrow cash and lend securities and the investors who want to lend cash and borrow securities. The borrower of cash will pay the bid repo rate times the amount of cash borrowed, while the lender of cash will get the ask repo rate times the amount of cash lent. The repo desk gains the bid–ask spread on all the transactions that it makes. The repo rate is computed on an Actual/360 day-count basis. In the following examples, we do not take into account the bid–ask spreads. First, let us give an example of a repo transaction.

Example 1.25 An investor lends Eur1 million of the 10-year Bund benchmark bond (i.e., the Bund 5% 07/04/2011 with a quoted price of 104.11, on 10/29/2001) over 1 month at a repo rate of 4%. There is 117 days accrued interest as of the starting date of the transaction.

At the beginning of the transaction, the investor will receive an amount of cash equal to the gross price of the bond times the nominal of the loan, that is,

$$(104.11 + 5 \times 117/360)\% \times 1{,}000{,}000 = \text{Eur}1{,}057{,}350$$

At the end of the transaction, in order to repurchase the securities he will pay the amount of cash borrowed plus the repo interest due over the period, that is,

$$1{,}057{,}350 \times (1 + 4\% \times 30/360) = \text{Eur}1{,}060{,}875$$

We now describe two examples of financing a short position and a long position using repos.

Example 1.26

Financing a Long Position

An investor wants to finance a long position of Eur1 million Bund with coupon 5% and maturity date 07/04/2011.

He can purchase these securities and then lend them through a repo transaction, like the one that has just been described. He will use the resulting borrowed cash to pay for them. On the one hand, the investor will gain the coupon income times the nominal amount of the securities he owns, that is, he will gain $5\% \times 1{,}000{,}000/360 = \text{Eur}\ 138.89$ a day. On the other hand, he will lose the repo rate times the borrowed amount of cash, which is equal to the full price of the bond securities times the nominal amount, that is, he will lose $1{,}057{,}350 \times 4\%/360 = \text{Eur}117.48$ a day. His net gain per day equals $138.89 - 117.48 = \text{Eur}21.41$.

Financing a Short Position

An investor has to make delivery of Eur1 million Bund on his short sale position. He can borrow the securities through a reverse repo transaction and then lend the money resulting

from the short sale to the repo desk as collateral. Suppose the reverse repo is 4%. On the one hand, the investor will gain the reverse repo rate times the lent amount of cash, which is equal to the full price of the bond securities times the nominal amount. On the other hand, he will lose the coupon income times the nominal amount of the securities sold. His net loss per day amounts to Eur 21.41.

Note that financing a long (short, respectively) position may result in either a net gain or a net loss, equal to the difference between the coupon income and the repo interest (the difference between the reverse repo interest and the coupon income, respectively).

When the maturity of the loan is 1 day, the repo is called an *overnight repo*. When the maturity exceeds 1 day, the repo is called a *term repo*.

From an investment point of view, the repo market offers several opportunities:

- *The opportunity of contracting less expensive loans than traditional bank loans (because repo loans are secured loans).*
- *The opportunity of investing in a very liquid short-term market.*
- *The opportunity of investing cash over tailor-made horizons, by rolling over either several overnight transactions or different repo transactions with various maturity horizons. This is particularly attractive for an investor who has a short-term undefined horizon. It allows him to avoid the price risk he would incur if he had chosen to invest in a money-market security.*
- *The opportunity for a buy-and-hold investor of putting idle money to work. Indeed, by lending the securities he owns in his portfolio, he receives some cash that he can invest in a money-market instrument. His gain will be the difference between the money-market income and the repo cost.*
- *The opportunity to take short positions that enable portfolio managers to construct alternative strategies by combining long and short positions (see Chapter 8 "Active Fixed-Income Portfolio Management" for some more details on these strategies).*

Lastly, note that for a short-term investor with an unknown investment horizon, the strategy of buying a money-market security and the strategy of rolling over cash on the repo market do not entail the same interest-rate risk. The former bears the risk that the security may be sold before its maturity date (price risk) at an unknown price, while the latter bears the risk that the cash may be reinvested at an unknown repo rate (reinvestment risk). We will come back to that issue in Chapters 2 and 5.

1.3 End of Chapter Summary

Fixed-income markets are populated with a vast range of instruments. In this chapter, we provide a typology of the most simple of these instruments, namely, bonds and money-market instruments, and describe their general characteristics.

A *bond* is a financial claim by which the issuer, or the borrower, is committed to paying back to the bondholder, or the lender, the cash amount borrowed (called *the principal*), plus periodic interests calculated on this amount during a given period of time. It can have either a standard or a nonstandard structure. A standard bond is a fixed-coupon bond without any embedded option, delivering its coupons on periodic dates and the principal on the maturity date. Nonstandard bonds such as strips, floating-rate notes and inflation-indexed bonds are also traded on bond markets. Other types of bonds exist that contain embedded options; they are discussed in Chapter 14. These bonds can be issued by government agencies, municipalities, or corporations. Bond quotes are usually expressed in terms of price, yield or spread over an underlying benchmark bond. The quoted price of a bond is usually its *clean price*, that is, its *gross price* minus the *accrued interest*. The quoted yield of a bond is the discount yield that equalizes its gross price times its nominal amount to the sum of its discounted cash flows. Corporate bonds are usually quoted in price and in spread over a given benchmark bond rather than in yield; to recover the corresponding yield, you simply have to add this spread to the yield of the underlying benchmark bond.

Money-market instruments are short-term debt instruments with a maturity typically inferior or equal to 1 year. These instruments are very sensitive to the Central Bank monetary policy. There are again three categories of issuers on this market: government (at both the federal and local levels), banks and corporations. Treasury bills, certificates of deposit, bankers' acceptances and commercial paper are common money-market instruments. We also discuss interbank deposits and repo transactions, which are over-the-counter transactions.

1.4 References and Further Reading

1.4.1 Books and Papers

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Youngdahl, J., B. Stone, and H. Boesky, 2001, "Implications of a Disappearing Treasury Debt Market", *Journal of Fixed Income*, **10** (4), 75–86.

1.4.2 Websites and Others

Websites of Treasury Bond Issuers and Central Banks

www.treas.gov

www.francetresor.gouv.fr

www.bankofengland.co.uk

www.publicdebt.treas.gov

www.federalreserve.gov

www.ecb.int

www.boj.or.jp

www.bankofcanada.ca

www.bis.org/cbanks.htm

Websites of Data and Information Providers

www.bloomberg.com

www.reuters.com

www.YieldCurve.com

www.bondsonline.com

www.bondtalk.com

www.bondsinasia.com

www.bondmarkets.com

www.investinginbonds.com

www.buybonds.com

www.YieldCurve.com

See HSBV, the Bloomberg site of the global fixed-income strategy of HSBC.

1.5 Problems

1.5.1 Problems on Bonds

Exercise 1.1 On 12/04/01 consider a fixed-coupon bond whose features are the following:

- face value: $1,000
- coupon rate: 8%
- coupon frequency: semiannual
- maturity: 05/06/04

What are the future cash flows delivered by this bond?

Exercise 1.2 Consider the same bond as in the previous exercise. We are still on 12/04/01.

1. Compute the accrued interest, taking into account the Actual/Actual day-count basis.
2. Same question if we are now on 09/06/02.

Exercise 1.3 An investor has a cash of $10,000,000 at disposal. He wants to invest in a bond with $1,000 nominal value and whose dirty price is equal to 107.457%.

1. What is the number of bonds he will buy?
2. Same question if the nominal value and the dirty price of the bond are respectively $100 and 98.453%.

Exercise 1.4 On 10/25/99 consider a fixed-coupon bond whose features are the following:

- face value: Eur100
- coupon rate: 10%
- coupon frequency: annual
- maturity: 04/15/08

Compute the accrued interest, taking into account the four different day-count bases: Actual/Actual, Actual/365, Actual/360 and 30/360.

Exercise 1.5 Some bonds have irregular first coupons.

- A long first coupon is paid on the second anniversary date of the bond and starts accruing on the issue date. So, the first coupon value is greater than the normal coupon rate.
- A long first coupon with regular value is paid on the second anniversary date of the bond and starts accruing on the first anniversary date. So, the first coupon value is equal to the normal coupon rate.
- A short first coupon is paid on the first anniversary date of the bond and starts accruing on the issue date. The first coupon value is smaller than the normal coupon rate.
- A short first coupon with regular value is paid on the first anniversary date of the bond and has a value equal to the normal coupon rate.

Consider the following four bonds with nominal value equal to Eur 1 million and annual coupon frequency:

- Bond 1: issue date 05/21/96, coupon 5%, maturity date 05/21/02, long first coupon, redemption value 100%;
- Bond 2: issue date 02/21/96, coupon 5%, maturity date 02/21/02, long first coupon with regular value, redemption value 99%;
- Bond 3: issue date 11/21/95, coupon 3%, maturity date 3 years and 2 months, short first coupon, redemption value 100%;
- Bond 4: issue date 08/21/95, coupon 4.5%, maturity date 08/21/00, short first coupon with regular value, redemption value 100%.

Compute the future cash flows of each of these bonds.

Exercise 1.6 The ex-dividend date is the date at which the gross price of a bond decreases by the present value of the next coupon. Some Treasury bonds trade ex-dividend. During this period (seven business days between the ex-dividend date and the next coupon date for UK Gilts), the accrued interest is negative. Explain why.

Exercise 1.7 What is a discount security? Give two examples.

Exercise 1.8 An investor wants to buy a standard bond of the automotive sector. He has two choices: either invest in a US corporate bond denominated in euros or in a French corporate bond with same maturity and coupon. Are the two bonds comparable?

Exercise 1.9

1. Consider the inverse floater with coupon $M - I_t$ (M being a constant rate, I_t a floating rate) and maturity n.
   How can you replicate a long position in that bond? What is its price equal to?
2. Consider the inverse floater with coupon $M - k \times i_t$ and maturity n.
   How can you replicate a long position in that bond? What is its price equal to?

Exercise 1.10 Some US government agency bonds, known as federally related institution bonds, like those of GNMA, are backed by the full faith and credit of the US government, which makes them as safe as Treasury bonds. Yet the yields on these securities trade at 20 to 50 basis points over Treasury bonds. Explain why.

Exercise 1.11 What does it mean when a Treasury bond trades "on special"? If you own such a bond, how can you profit from the fact that it is "on special"?

Exercise 1.12 Consider two US Treasury bonds with the same maturity date. One has a higher YTM than the other. Explain why.

1.5.2 Problems on Money-Market Instruments

Exercise 1.13 Treasury bills are quoted using the yield on a discount basis or on a money-market basis.

1. The yield on a discount basis denoted by y_d is computed as

$$y_d = \frac{F - P}{F} \times \frac{B}{n}$$

   where F is the face value, P the price, B the year-basis (365 or 360) and n is the number of calendar days remaining to maturity.

   Prove in this case that the price of the T-bill is obtained using the following equation:

$$P = F\left(1 - \frac{n \times y_d}{B}\right)$$

2. The yield on a money-market basis denoted by y_m is computed as

$$y_m = \frac{B \times y_d}{B - n \times y_d}$$

   Prove in this case that the price of the T-bill is obtained using the following equation:

$$P = \frac{F}{\left(1 + \frac{n \times y_m}{B}\right)}$$

3. Show that

$$y_d = \frac{B \times y_m}{B + n \times y_m}$$

Exercise 1.14
1. What is the yield on a discount basis of a bill whose face value F is 1,000, price P is 975 and n the number of calendar days remaining to maturity is 126? We assume that the year-basis is 360.
2. What is the yield on a money-market basis of the same bill?

Exercise 1.15 What is the price P of the certificate of deposit issued by bank X on 06/06/00, with maturity 08/25/00, face value \$10,000,000, an interest rate at issuance of 5% falling at maturity and a yield of 4.5% as of 07/31/00?

Exercise 1.16 On 01/03/2002 an investor buys \$1 million US T-Bill with maturity date 06/27/2002 and discount yield 1.76% on the settlement date.

1. What is the price of the T-Bill?
2. What is the equivalent money-market yield?

Exercise 1.17 On 01/03/2002 an investor buys Eur1 million BTF (French T-Bills) with maturity date 04/11/2002 and money-market yield 3.18% on the settlement date.

1. What is the price of the BTF?
2. What is the equivalent discount yield?

Exercise 1.18 Consider the following list of money-market instruments:

- Bankers' acceptances
- Treasury Bills
- Commercial papers

Order them from the least risky to the most risky and explain your choice.

Exercise 1.19 What is the difference between the Euro-Libor and the Euribor?

1.6 Appendix: Sector Breakdown of the Euro, the UK and the Japan Corporate Bond Markets

Table A1 Sector Breakdown of the European Corporate Bond Market.

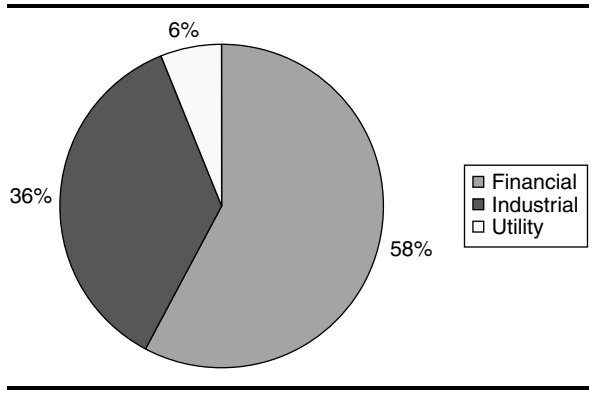

Table A2 Subsector Breakdown of the European Financial Sector.

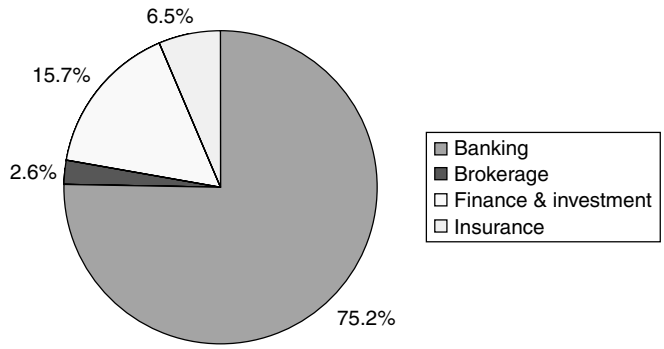

Table A3 Subsector Breakdown of the European Industrial Sector.

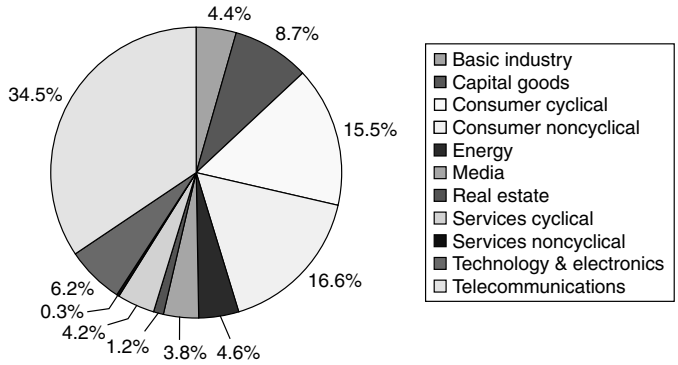

Table A4 Sector Breakdown of the UK Corporate Bond Market.

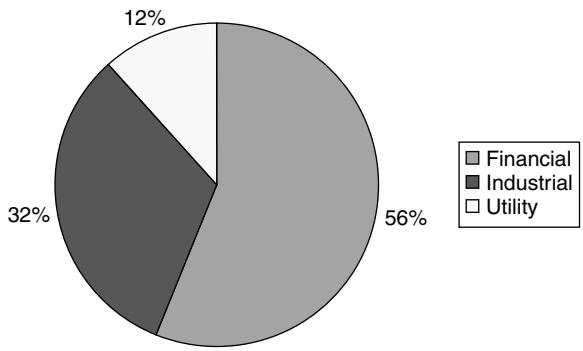

Table A5 Subsector Breakdown of the UK Financial Sector.

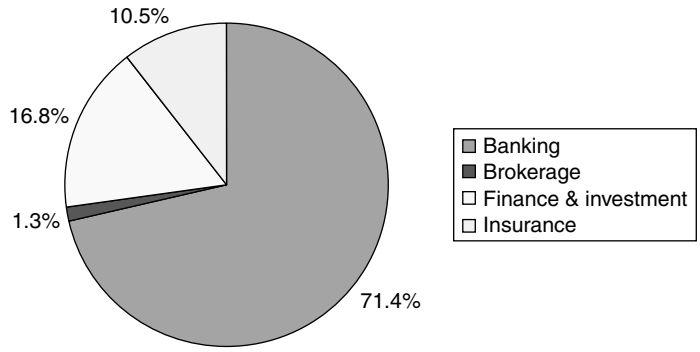

Table A6 Subsector Breakdown of the UK Industrial Sector.

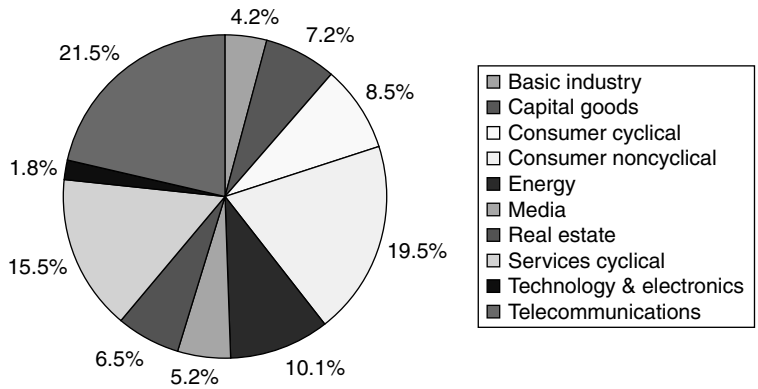

Table A7 Sector Breakdown of the Japan Corporate Bond Market.

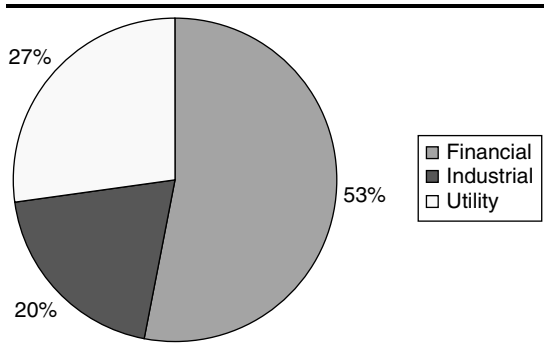

Table A8 Subsector Breakdown of the Japan Financial Sector.

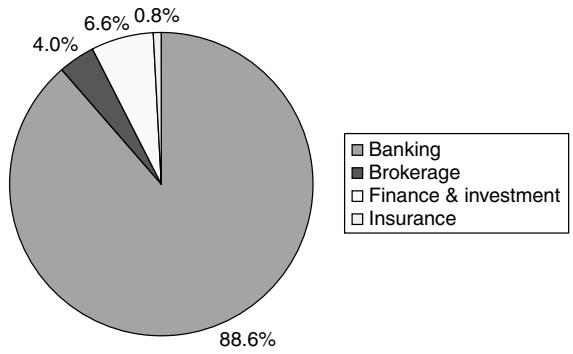

Table A9 Subsector Breakdown of the Japan Industrial Sector.