Ch 3 Ch 10 or ch 11 old

***Credit Risk: Individual Loan Risk***

1. **INTRODUCTION**

*Financial intermediaries* (FIs) are special because of their ability to efficiently transform financial claims of household savers into claims issued to corporations, individuals, and governments. An FI’s ability to evaluate information and to control and monitor **borrowers** allows it to transform these claims at the lowest possible cost to all parties. *That is*, ***FIs*** transform claims of household savers (in the form of deposits) into loans issued to corporations, individuals, and governments. *The FI accepts* ***the credit risk*** *on these loans* in exchange for ***a fair return*** sufficient to cover the cost of funding (e.g., covering the costs of borrowing, or issuing deposits) to household savers and the credit risk involved in lending.

**In this chapter**, we discuss *various approaches* ***to analyzing*** *and* ***measuring the credit******or default risk*** *on individual loans (and bonds).*

*ملحوظه هامهdefault risk = مخاطر التوقف عن الوفاء او سداد القرض*

**Measurement of the credit risk** on individual loans or bonds is crucial أمر بالغ الأهمية حاسم-if ***an FI manager*** is to (1) price a loan or value a bond correctly and (2) set appropriate limits on the amount of credit extended to any one borrower or the loss exposure it accepts from any particular counterparty. The Ethical Dilemmas box صندوق المآذق أو الورطات الأخلاقية highlights how the default of one major borrower, **WorldCom** (see below ***Ethical Dilemmas)***  can have a significant impact on the value and reputation of many FIs. ***Similarly***, a single major economic event can cause losses to many FIs’ loan portfolios. ***For example***, in 2005 *Hurricanes Katrina and Rita resulted in over $1.3 billion in* ***bad loans*** *for major banks operating in areas hit by the storm.* Thus, managers need to manage **the FI’s loan portfolio** to protect the overall FI from the failure of a single borrower.

We begin this chapter with

* 1- ***a look at the types of loans (commercial and industrial*** [C&I], ***real estate***, ***individual***, ***consumer, and others***) as well as ***the characteristics of those loans—made by U.S. FIs.***
* a look at how both *interest* and *fees* are incorporated to calculate ***the return on a loan***.
* *How the* ***return on a loan*** versus ***the quantity of credit*** made available for lending is used by FIs to make decisions on wholesale (C&I) versus retail (consumer) lending.

***Finally,*** we examine ***various models*** *used to* ***measure credit risk***, including qualitative models, credit-scoring models, and newer models of credit risk measurement.

***Ethical Dilemmas***

**BANKS’ WORLDCOM RISK SAID BELOW ENRON LEVELS**

Fueled by memories of bad loans to the bankrupt energy trader Enron Corp., investors on Wednesday ignored analyst warnings not to flee bank stocks in response to the news of alleged accounting fraud at WorldCom Inc. Late Tuesday the Clinton, Miss.– based company, which operates MCI, the country’s second biggest long-distance telephone company, said that it had improperly booked $3.9 billion of expenses. Some observers said that it may be forced to file for bankruptcy. . . . WorldCom currently has $2.65 billion of outstanding loans, and U. S. banking companies are on the book for about a third of that. Though analysts disagree about the total U.S. bank exposure, forecasts range from $670 million to $955 million. All day Wednesday, analysts kept revising their estimates for bank exposure. They also downplayed the fraud’s impact on the large commercial banking companies that extended credit to WorldCom, including Mellon Financial Corp., J. P. Morgan Chase & Co., Citigroup Inc., FleetBoston Financial Corp., Bank One Corp., Bank of America Corp., and Wells Fargo & Co. While most of the banks, citing client confidentiality, would not comment on their exposure, Mellon said it has $100 million of exposure to WorldCom. Lori Appelbaum, an analyst at Goldman Sachs Group Inc., said it would lower Mellon’s earnings per share this year by 12 cents, or 6 percent. Of the U. S. banking companies involved in the internationally shared credit, Mellon has the most exposure in proportion to its

size, said Ms. Appelbaum. In a report issued Wednesday, Ms. Appelbaum estimated that WorldCom exposure would lower Morgan Chase’s earnings per share by 5 cents, or nearly 2 percent; Fleet’s by 5 cents, or nearly 2 percent; Bank One’s by 3 cents, or 1 percent; Bank of America’s by 5 cents, or 1 percent; Wells Fargo’s by 2 cents, or 0.7 percent; and Citi’s by 1 cent, or 0.3 percent. Some banks will be able to cover their charge-offs with existing reserves, she said.

Morgan Chase could have the most exposure to WorldCom, with $133 million of outstanding loans and $268 million of undrawn commitments, according to Ruchi Madan, an analyst at Citi’s Salomon Smith Barney. In a report Wednesday, Ms. Madan estimated that WorldCom has $5.4 billion of credit lines outstanding. Analysts agree that banks probably will not be obligated to honor these lines. Because the company has admitted to improper accounting, it is prevented from drawing down untapped credit lines.

Source: Veronica Agosta, The American Banker, June 27, 2002, p. 20. [www.americanbanker.com](http://www.americanbanker.com)

1. **CREDIT QUALITY PROBLEMS**

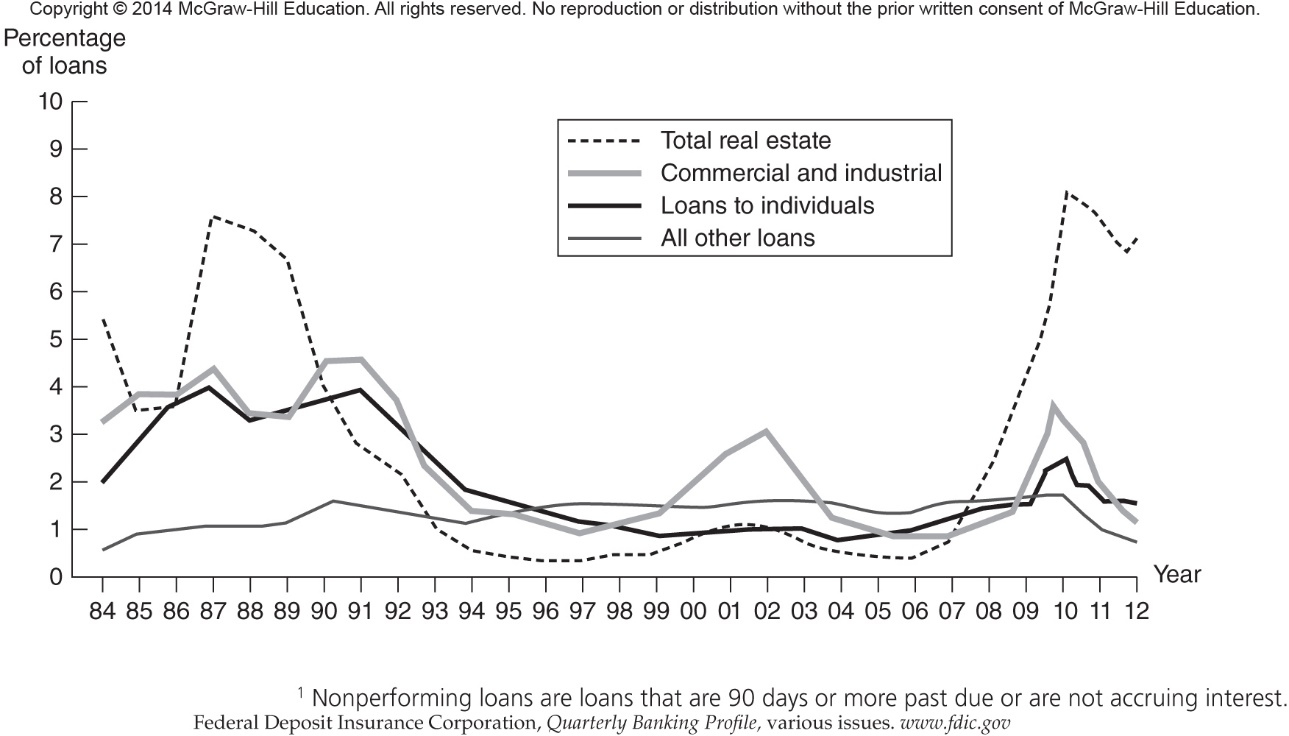
Over the past two decades the credit quality of many FIs’ lending and investment

decisions have attracted a great deal of attention. In the **1980s** there were ***tremendous problems*** *with* ***bank loans*** *to* ***less developed countries*** *(LDCs) as well as with* ***thrift and bank residential and farm mortgage loans****.* In the late 1990s, concerns shifted to the rapid growth in low-quality auto loans and credit cards as well as the declining quality in commercial lending standards as loan delinquencies المتأخرات في سداد القروض started to increase.

In the late 1990s and early 2000s, attention has focused on problems with **telecommunication companies**, new technology companies, and a variety of sovereign countries including at various times Argentina, Brazil, Russia, and South Korea.

**Finally**, in the mid-2000s concerns focused on *sharp increases in delinquencies on subprime mortgages.* Nevertheless, over the last decade ***the credit quality*** ***of most U.S. FIs*** has continued to improve even in the face of *a prolonged spurt* طفرة مطولة in the growth of loans (see Figure 11–1). This improvement in asset quality—measured by the decline in ***the ratio of nonperforming loans*** ***نسبة القروض المتعثرة*** to loans from 3.9 percent in 1991 to 0.74 percent in 2000—reflects, in part, the expansion of the U.S. economy in the 1990s as well as improvements in the way FIs measure and manage credit risk (see below).

**FIGURE 11–1 Loan Growth and Asset Quality**



**However**, *the recession in the U.S. economy in the early 2000s led to a turnaround in this pattern* ***as nonperforming loan rates*** *أسعار القروض المتعثرة increased to 1.5 percent*.

***For example***, J. P. Morgan Chase and Citigroup had combined loans of $1.4 billion outstanding to **Enron** when it declared **bankruptcy** in December 2001. As the U.S. economy surged انتعش الاقتصادin the mid-2000s, nonperforming loan rates fell back انخفضت معدلات القروض المتعثرة to well below 1 percent. In fact, in the second quarter of 2006 the U.S. banking industry’s noncurrent loan to assets ratio hit an all-time low of 0.70 percent.

***Junk bond :*** *A bond rated as* ***speculative*** *or less than investment grade by bond-rating agencies such as Moody’s.*

***Junk bond سند غير مرغوب فيه لانه مصنف بدرجة اقل في سوق الاستثمار =***

***الخلاصه***

**Credit quality problems**, in the worst case, can ***cause an FI to become insolvent***

or can result in drain such a significant on capital and net worth that they adversely affect its growth prospects and ability to ***compete*** with other domestic and international FIs. However, ***credit risk*** does not apply only to traditional areas of lending and bond investing.

***Thus***, *credit risk analysis* is now important for a whole variety of contractual agreements between FIs and counterparties.

1. ***TYPES OF LOANS***

Although most FIs make loans, the types of loans made and the characteristics

of those loans differ considerably. *This section analyzes* ***the major types of loans***

***made by U.S. commercial banks****.* Remember from Chapters 2 through 6, however,

that **other FIs**, such as *thrifts*, *finance companies*, and *insurance companies*, also

engage heavily in **lending**, especially in ***the real estate area.*** We also discuss important aspects of other FIs’ loan portfolios.

**Table 11–1** shows a recent breakdown of the aggregate loan portfolio of U.S. commercial banks into ***four broad classes:*** commercial and industrial (C&I), real estate, individual, and all others. We look briefly at each of these loan classes in turn.

**3.1 Commercial and Industrial Loans**

The figures in **Table 11–1** disguise أخفى a great deal of heterogeneity in the commercial and industrial loan portfolio. Indeed, commercial loans can be made for periods as short as a few weeks to as long as eight years من عدة أسابيع الى 8 سنوات or more.

Traditionally,

A- ***short-term commercial loans*** (those with an original maturity of one year or less) are used to finance firms’ working capital needs and other short-term funding needs, while

B- ***long-term commercial loans*** are used to finance credit needs that extend beyond one year, such as the purchase of real assets (machinery), new venture start-up costs, and permanent increases in working capital. They can be made in quite small amounts, such as $100,000, to small businesses or in packages as large as $10 million or more to major corporations. ***Large C&I loans*** are often ***syndicated.***

***Syndicated loan*** A loan provided by a group of FIs as opposed to a single lender.

**قرض مشترك : قرض مقدم من مجموعة من المؤسسات المالية كمقرضين وليس مقرض واحد**

***Secured loan* :** A loan that is backed by a first claim on certain assets (collateral) of the borrower if default occurs.

***Unsecured loan* :** A loan that has only a general claim to the assets of the borrower if default occurs.

***A syndicated loan*** is structured by ***the lead FI (or agent) and the borrower***. Once

the terms (rates, fees, and covenants) are set, pieces of the loan are sold to other

FIs. In addition, ***C&I loans*** can be secured or unsecured. ***A secured loan*** (or asset backed loan) is backed by specific assets of the borrower; if the borrower defaults, the lender has a first lien or claim on those assets. *In the terminology of finance*, ***secured debt*** is senior to an unsecured loan (or junior debt) that has only a general claim on the assets of the borrower if default occurs.

In addition, **commercial loans** can be made at either *fixed* or *floating rates of interest*

***TABLE 11–1 Types of U.S. Bank Loans, September 2006 (in billions of dollars)***

**Amount Percent**

Total loans\* $ 5,838.8 100.0%

C&I 1,444.3 24.7

Real estate 3,120.9 53.5

Individual 721.4 12.3

Other 552.2 9.5

**Finally**, loans can be made either 1-*spot* or 2- *under commitment*.

أخيرًا، يمكن منح القروض إما على دفعة واحدة أو على دفعتين.

***أنواع القروض***

**A spot loan** is made by the FI, and the borrower uses or takes down the entire loan amount immediately. **With a loan commitment**, or line of credit, by contrast, the lender makes an amount of credit available, such as $10 million; the borrower has the option to take down any amount up to the $10 million at any time over the commitment period. ***In a fixed-rate*** loan commitment, the interest rate to be paid on any takedown is established when the loan commitment contract originates. ***In a floating-rate*** commitment, the borrower pays the loan rate in force when the loan is actually taken down.

***3.2 Real Estate Loans***

***Real estate loans*** are primarily **mortgage loans** and ***some revolving*** **home equity loans قروض حقوق الملكية المتجددة** (approximately 14 percent of the real estate loan portfolio in September 2006). We show the distribution of mortgage debt for U.S. banks for the second quarter of 2006 in Table 11–3. For banks (as well as thrifts), ***residential mortgages*** *are still the largest component of* ***the real estate loan portfolio***; until recently, however, commercial real estate mortgages were the fastest-growing component of real estate loans. Moreover, commercial real estate loans make up more than 80 percent of life insurance companies’ real estate portfolios. These loans caused banks, thrifts, and insurance companies’ significant default and credit risk problems in the early 1990s.

**TABLE 11–3 Distribution of U.S. Commercial Bank Real Estate Mortgage Debt,**

**Second Quarter 2006**

***Percent***

One- to four-family residences 70.5%

Multifamily residences 3.2

Commercial 24.7

Farm 1.6

------------

100.0%

As with **C&I loans**, ***the characteristics of residential mortgage loans*** differ widely. These characteristics include the size of the loan, the ratio of the loan to the property’s price (the loan price or loan value ratio), and the maturity of the mortgage. Other important characteristics are the mortgage interest (or commitment) rate, fees, and charges on the loan, such as commissions, discounts, and points paid by the borrower or the seller to obtain the loan.

In addition, ***the mortgage rate*** differs according to whether the mortgage has ***a fixed*** ***rate*** or ***a floating rate***, also called an adjustable rate. **Adjustable rate mortgages** (ARMs) have their contractual rates periodically adjusted to some underlying index, such as the one-year T-bill rate.

**Table 11–4** presents *a summary of the major contractual terms on conventional fixed-rate mortgages* as of June 2006.

**TABLE 11–4**: ***Contractual Terms on Conventional New Home Mortgages, June 2006***

Purchase price ($ thousands) $355.5

Amount of loan ($ thousands) $258.5

Loan-to-value ratio (percent) 75.0%

Maturity (years) 29.4

Fees and charges (percent of loan amount) 0.70%

Contract rate (percent) 6.69%

**3*.3 Individual (Consumer) Loans ( nonrevolving consumer loans***, and ***revolving loans***)

Another major type of loan is the *individual, or consumer, loan, such as* ***personal***

***and auto loans.*** Commercial banks, finance companies, retailers, savings institutions, credit unions, and oil companies also provide consumer loan financing through credit cards, such as Visa, MasterCard, and proprietary credit cards issued by, for example, Sears and AT&T.

The five largest credit card issuers and their outstanding balances in 2006 are shown in Table 11–5.

**TABLE 11–5 : Biggest Credit Card Issuers as of December 2005**

**Total Outstanding** **Change from**

**Balances ($ billions ) Year Earlier (%)**

**Card Issuer**

J.P. Morgan Chase $138.9 -2%

Bank of America 60.8 -3

Citigroup 136.5 -2

MBNA America 104.9 -2

Capital One Financial 49.5 -1

**In Table 11–6** are the ***two major classes of consumer loans*** at U.S. banks. The largest class of loans is ***nonrevolving consumer loans***, which include new and used automobile loans, mobile home loans, and fixed-term consumer loans such as 24-month personal loans. The other major class of consumer loans is ***revolving loans***,

such as credit card debt.

**TABLE 11–6 Types of Consumer Loans at Commercial Banks, July 2006**

**Percent**

Revolving 35.8%

Nonrevolving 64.2

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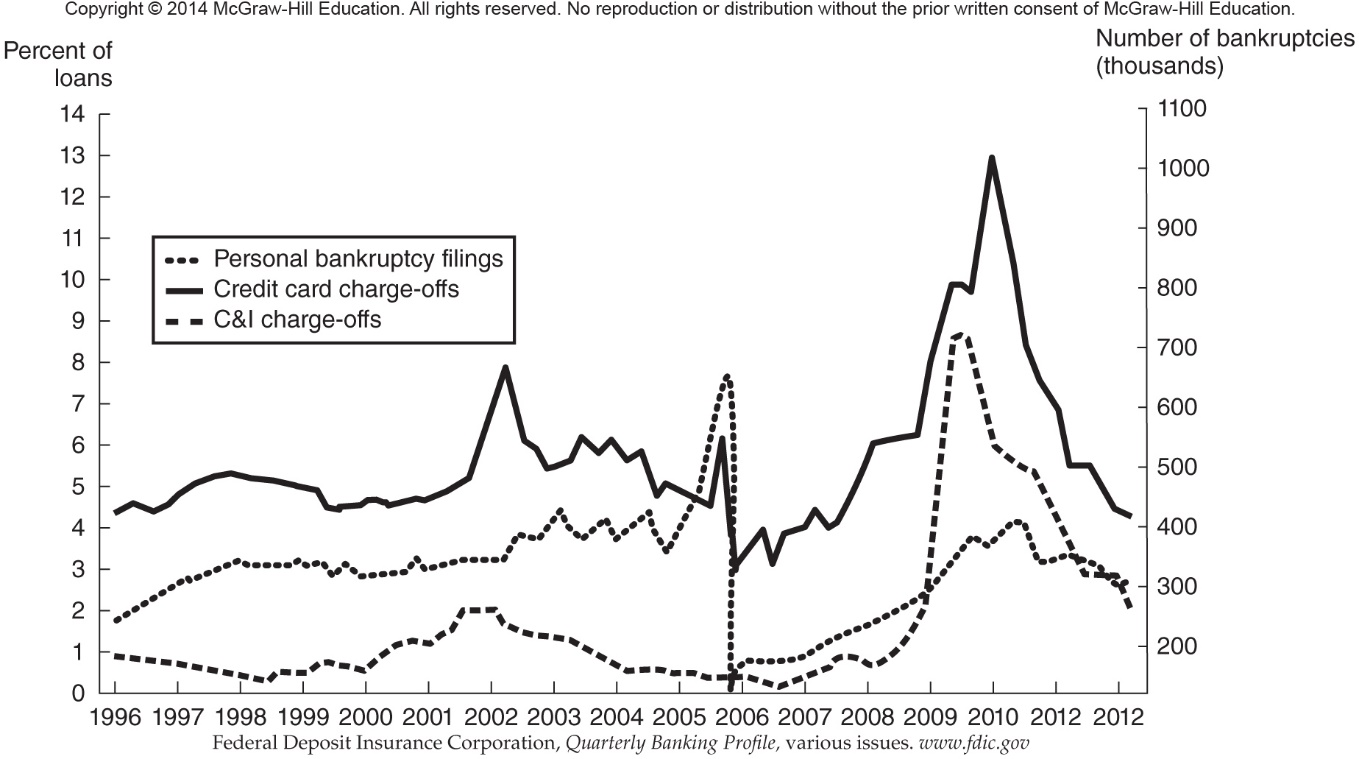
100.0%

**Revolving loan قرض متجدد :** A credit line on which a borrower can both draw and repay many times over the life of the loan contract

With a revolving loan, the borrower has a credit line on which to draw as well as to repay up to some maximum over the life of the credit contract.

This act made it more difficult for consumers to declare bankruptcy. **As a result,** there was ***a surge in bankruptcy filings*** ارتفاع في طلبات الإفلاس in the summer and early fall of 2005, just before the new rules went into effect. Consequently, banks saw a surge in credit card charge-offs. These charge-off rates are significantly higher than those on commercial loans (see Figure 11–4). Such relatively high default rates again point to the importance of risk evaluation prior to the credit decision.

Figure 11–4



**In Table 11–7** we show indicative interest rates أسعار الفائدة الإرشادية on **car**, **personal**, and **credit card loans** as of August 2006. These rates differ widely depending on features such as collateral backing, maturity, default rate experience, and non–interest rate fees.

**In addition**, competitive conditions in each market as well as regulations such as national-, state-, or city-imposed **usury ceilings** (maximum rates FIs can charge on consumer and mortgage debt) all affect the rate structure for consumer loans.

***For example***, in 2006 federally chartered credit unions were prohibited from charging more than 15 percent on any loan.

**TABLE 11–7 : Interest Rate Terms on Consumer Loans, May 2006**

**Percent**

48-month car loan 7.53%

24-month personal loan 12.63

Credit card 13.14

**Usury ceilings** : National-, state-, or city-imposed ceilings on the maximum rate FIs can charge on consumer and mortgage debt.

***3.4 Other Loans***

The “other loans” category can include a wide variety of borrowers and types,

including farmers, other banks, nonbank financial institutions, such as broker margin loans (loans financing a percentage of an individual investment portfolio), state and local governments, foreign banks, and sovereign governments.

***4.* CALCULATING THE RETURN ON A LOAN**

An important element in the ***c*redit management process**, once the decision to make a loan has been made, is ***its pricing***. This includes *adjustments for the perceived credit risk or default risk of the borrower* as well as *any fees* and *collateral backing the loan*. This section demonstrates *one method used to calculate the return* on a loan: **the traditional return on assets approach**.

Although we demonstrate the return calculations using examples of commercial and industrial loans, the techniques can be used to calculate the return on other loans (such as credit card or mortgage loans) as well. And we will indicate that in 4.1 and 4.2

***4.1 The Contractually Promised Return on a Loan***

The previous description of loans makes it clear that *a number of factors impact the promised return* an FI achieves on *any given dollar loan (asset) amount.* These factors include the following:

1. The interest rate on the loan.
2. Any fees relating to the loan.
3. The credit risk premium on the loan.
4. The collateral backing of the loan.(د عم ضمان سداد القرض )
5. Other nonprice terms (especially compensating balances and reserve

requirements).

**First**, let us consider ***an example of how to calculate the promised return on a C&I loan.***

*Suppose that an FI makes* ***a spot one-year, $1 million loan****. The loan rate is set as follows:*

*Base lending rate = 12 %*

*+Credit risk premium or margin ( ) = 2%*

*- - ------*

*(BR) +  = 14*

***The base lending rate (BR*)** could reflect the FI’s weighted-average cost of capital

or its marginal cost of funds, such as the commercial paper rate, the federal funds rate, or **LIBOR** —*the London Interbank Offered Rate*, which is the rate for interbank dollar loans of a given maturity in the Eurodollar market.

**Alternatively**, it could reflect ***the prime lending rate سعر الإقراض الأساسي*** . The prime rate is most commonly used in ***pricing longer-term loans***, while ***the fed funds rate*** and ***LIBOR rate*** are most commonly used in ***pricing short-term loans***.

**Now ,we would like to know the answer of the following question**

***What are the fees that have to added to the loan ?***

**Direct and indirect fees and charges** relating to **a loan** generally fall into three

categories:

1. *A loan origination fee ( of ) charged to the borrower for processing the application.*
2. *A compensating balance requirement ( b ) to be held as non-interest-bearing*

*demand deposits*.

***A Notice : Compensating balances*** are a percentage of a loan that a borrower cannot actively use for expenditures. Instead, these balances must be kept on deposit at the FI. ***For example***, a borrower facing a 10 percent compensating balance requirement on a $100 loan would have to place $10 on deposit with the FI and could use only $90 of the $100 borrowed.

3-*A reserve requirement ( RR ) imposed by* ***the Federal Reserve on the FI’s*** *(specifically*

*depository institution’s) demand deposits, including any compensating balances.*

***Then***, The ***contractually*** ***promised*** ***gross return on the loan***, **k** , per dollar lent—or

**ROA** per dollar lent—equals:

***1 + k = 1 +  = the promised return on the loan (1 + k)***

By looking at the previous formula we find that.

1. **The numerator** is the promised gross- cash inflow to the FI per dollar, reflecting *direct fees* ( ***of*** ) plus *the loan interest rate* ( ***BR + m*** ).
2. **the denominator**, for every $1 in loans the FI lends, it retains ***b*** as *non-interest-bearing compensating balances.* Thus, 1 - b is the net proceeds of each $1 of loans received by the borrower from the FI, ignoring reserve requirements.

**LIBOR:** The London Interbank Offered Rate, which is the rate for interbank dollar loans

of a given maturity in the offshore or Eurodollar market.

**Prime lending rate:** The base lending rate periodically set by banks.

**Compensating balance:** A percentage of a loan that a borrower is required to hold on deposit at the

lending institution

***Now, we would like to know. How can Calculate ROA on a Loan ?***

**EXAMPLE 11–1 Calculation of ROA on a Loan**

*Suppose* ***a bank*** *does the following:*

1. *Sets the loan rate on* ***a prospective loan*** *at 14 percent (where BR = 12% and  =2%).*
2. *Charges a 1/8 percent (or 0.125 percent) loan origination fee to the borrower.*
3. *Imposes a 10 percent* ***compensating balance requirement*** *to be held as non-interest-bearing demand deposits.*
4. *Sets aside,* ***reserves****, at a rate of 10 percent of deposits, held at the Federal Reserve (i.e., the Fed’s cash-to-deposit reserve ratio is 10 percent).*

*Plugging the numbers from our example into* **the return formula***, we have:*

*1 + k = 1 + *

*1 + k = 1 + *

*1 + K =1 .1552 OR K= 0.15 52 = 15.52 %*

***This is****, of course, greater than* ***the simple promised interest return on the loan,***

*BR + = 14%.*

***In the special case***

Then , we can say : ***In the special case*** where fees (of) are zero and the compensating balance (b) is zero:

of = 0

b =0

***The contractually promised return formula*** reduces to:

***1 + k = 1 + (BR + )***

**Notice that**:

*The* ***credit risk premium or margin*** (**) is ***the fundamental factor*** *driving*

***the promised return*** *on a loan once the base rate on the loan is set*.

**But**, ***compensating balance requirements (b)*** are very ***rare on international loans*** such as Eurodollar loans.

**Finally**, note that for ***a given promised*** ***gross return on a loan***, **k**, FI managers can use ***the pricing formula*** to find various combinations of fees, compensating balances, and risk premiums they may offer their customers that generate the same returns.

***4.2 The Expected Return on a Loan***

**Since, the promised return on the loan (1 + k)** that the borrower and lender contractually agree on includes both the loan interest rate and non–interest rate features such as fees. However, **the promised return on the loan**, **may well differ from the expected** and, indeed, **actual return on a loan** because of **default risk**.

***Default risk*** is the risk that the borrower is unable or unwilling to fulfill the terms promised under the loan contract. **Default risk** is usually present to some degree in all loans. **Thus**, at the time the loan is made, ***the expected return [E (r)]*** per dollar lent is related to ***the promised return*** as follows:

***1 + E(r) = p (1 + k) + (1 - p) 0***

where **p** is the probability of complete repayment of the loan (such that the FI

receives the *principal and interest* as promised) and **(1 - p )** is the probability of

default (in which the FI receives nothing, i.e., 0). *Rearranging this equation, we*

*get:*

***E(r) = p (1 + k) – 1 = the expected return [E (r)] formula***

***Notices:-***

If p is less than 1 , ***default risk*** is present.

***This means*** the FI manager must

(1) set the risk premium (**) sufficiently high to compensate for this risk and

(2) recognize that setting *high risk premiums* as well as *high fees* and *base rates* may actually reduce **the probability of repayment ( p ).**

**As well**, k and p are not independent. Indeed, over some range, ***as fees and loan rates*** increase, ***the probability that the borrower pays the promised return*** may decrease (i.e., k and p may be negatively related).

**As a result**, FIs usually have to control for ***credit risk*** along **two dimensions**: the price or promised return dimension (1 + k ) and the quantity or credit availability dimension. Further, even after adjusting the loan rate (by increasing the risk premium on the loan) for the default risk of the borrower, there is no guarantee that the FI will actually receive the promised payments.

**In general,** compared with ***wholesale*** (e.g., C&I*)* ***loans***, the quantity dimension

controls credit risk differences on ***retail*** (e.g., consumer) ***loans*** more than the price

dimension does. We discuss the reasons for this in the next section. That is followed by a section that evaluates various ways FI managers can assess the appropriate size of **, *the risk premium on a loan*. This is the key to pricing wholesale loan and debt risk exposures correctly.

**Default risk** : The risk that the borrower is unable or unwilling to fulfill the terms promised under the loan contract.

***4.3 RETAIL VERSUS WHOLESALE CREDIT DECISIONS***

***4.3.1* Retail Loans( small size loans)**

Because of *the small dollar size of the loans* in the context of an FI’s overall investment portfolio *and the higher costs of collecting information on household borrowers (consumer loans)*, ***most loan*** ***decisions made at the retail level*** tend to be ***accept or reject decisions***. Borrowers who are accepted are often charged *the same rate of interest* and by implication *the same credit risk premium*.

***For example***

***A wealthy individual*** borrowing from **a credit union** to *finance the purchase of a Rolls-Royce* is likely to be charged ***the same auto loan rate*** as ***a less wealthy individual*** borrowing from that credit union to *finance the purchase of a Honda*.

**In the terminology of finance**, retail customers (consumer loans) are more likely to be sorted or rationed by ***loan quantity restrictions*** than by ***price or interest rate*** differences**. *That is***, at ***the retail level an FI controls its credit risks by credit rationing rather than by using a range of interest rates or prices.***

**Credit rationing:** Restricting the quantity of loans made available to individual borrowers

تقنين الائتمان: تقييد كمية القروض المتاحة للمقترضين الافراد

**4.3.2 Wholesale Loans ( high or large size loans)**

In contrast to the retail level, at the wholesale (C&I) level FIs use both

1. interest rates and
2. credit quantity to control **credit risk**.

Thus, when FIs quote a prime lending rate ( BR ) to C&I borrowers, ***lower-risk borrowers*** may be charged a lending rate ***below*** the prime lending rate. ***Higher-risk borrowers*** are charged a markup on the prime rate, يتم تحصيل هامش ربح على المقترضين ذوي المخاطر العالية على السعر الأساسي or a credit (default) risk premium (**), to compensate the FI for the additional credit risk involved.

This relationship between contractually promised interest rates and the

expected returns on loans suggests that beyond some interest rate level, it may be

best for the FI to credit ration ***its wholesale loans***.

1. ***MEASUREMEN OF CREDIT RISK***

To calibrate ***the default risk exposure of credit*** and ***investment decisions*** as well as to ***assess the credit risk exposure in off-balance-sheet*** contractual arrangements

such as loan commitments, an FI manager needs to measure ***the probability of borrower default*.** The ability to do this depends largely on ***the amount of information*** the FI has about the borrower.

**At the retail level**, (قروض الأفراد)much of the information needs to be collected internally or purchased from external credit agencies.

**At the wholesale level,** (القروض الصناعية والتجارية) these information sources are bolstered تدعم by ***publicly*** ***available information***, such as certified accounting statements, stock and bond prices, and analysts’reports. Thus, for a publicly traded company, more information is produced and is available to an FI than is available for a small, single-proprietor corner store.

**In principle**, FIs can use very ***similar methods and models*** to assess the probabilities of default on both bonds and loans. Even though **loans** tend to involve fewer lenders to any single borrower as opposed to multiple bondholders, in essence, both loans and bonds are contracts that promise fixed (or indexed) payments at regular intervals in the future. Loans and bonds stand ahead of the borrowing firm’s equity holders in terms of the priority of their claims if things go wrong. ***Also, bonds, like loans,*** include **covenants** restricting or encouraging various actions to enhance **the probability of repayment**. ***Covenants*** can include limits on the type and amount of new debt, investments, and asset sales the borrower may undertake while the loan or bonds are outstanding. **Financial covenants** are also often imposed restricting changes in the borrower’s financial ratios such as its ***leverage ratio*** or current ratio. ***For example***

A common restrictive covenant included in many bond and loan contracts limits the amount of dividends a firm can pay to its **equity holders أصحاب الأسهم** . Clearly, for any given cash flow, a high dividend payout to stockholders means that less is available for repayments to bondholders and lenders

***Covenants:*** *Restrictions written into bond and loan contracts either limiting or encouraging the borrower’s actions that affect the probability of repayment*

***التعهدات****: القيود المفروضة على عقود السندات والقروض إما تحد من أو تشجع على إجراءات المقترض التي تؤثر على احتمال السداد*

***5.1 DEFAULT RISK MODELS ( crdit risk Models)***

Economists, analysts, and FI managers have employed ***many different models*** to assess ***the default risk*** on loans and bonds. These vary from relatively ***qualitative*** to the highly ***quantitative*** ***models***.

***Notice***

Further, these models are not mutually exclusive; an FI manager may use more than one model to reach ***a credit pricing*** or *loan quantity rationing decision*.

We analyze ***a number of models*** in three broad groups:

1- qualitative models, 2- credit scoring models, and 3- newer models as follows:-

***5.1.1 Qualitative Models***

In the absence of *publicly available information on the quality of borrowers*, the FI manager has to *assemble يجمع information from private sources*—such as credit and deposit files—and/or purchase such information from external sources—such as ***credit rating agencies***. This information helps a manager make an informed judgment on ***the probability of default of the borrower and price the loan or debt correctly.***

**In general**, **the amount of information assembled** varies with the size of the potential debt exposure and the costs of collection.

**However**, **a number of key factors** enter into the credit decision. These include

*(1) borrower-specific factors* العوامل الخاصة بالمقترضwhich are idiosyncratic تمييزى to the individual borrower, and

*(2) market-specific factors*, which have an impact on all borrowers at the time of the credit decision.

The **FI manager** then ***weights these factors*** subjectively to come to **an overall credit decision.** Because of their reliance on the subjective judgment of the FI manager, these models are often called **expert systems**. نظم خبرة

We can discuss these factors as follows:-

1. ***Borrower-Specific Factors***

* ***Reputation*** The borrower’s reputation involves the borrowing–lending history of the credit applicant.
* **Leverage** A borrower’s leverage or capital structure—*the ratio of debt to equity*—*affects the probability of its default* because large amounts of debt, such as bonds and loans, increase the borrower’s interest charges and pose a significant claim on its cash flows.
* **Volatility of Earnings** As with leverage, **a highly volatile earnings stream** increases *the probability that the borrower cannot meet fixed interest and principal charges for any given capital structure*. **Consequently**, newer firms or firms in high-tech industries with a high earnings variance over time are less attractive credit risks than are those with long and more stable earnings histories. هي مخاطر ائتمانية أقل جاذبية من تلك التي لديها تاريخ أرباح طويل وأكثر استقرارًا.
* **Collateral *الضمانات*** As discussed earlier, a key feature in any lending and loan-pricing decision is the degree of collateral, or **assets** backing the security of the loan الأصول التي تدعم ضمان القرض. Many loans and bonds are backed by ***specific assets*** should a borrower default on repayment obligations

1. ***Market-Specific Factors***

* ***The Business Cycle*** The position of the economy in the business cycle phase is enormously important to an FI in assessing *the probability of borrower default.*

***For example***, during recessions, firms in the consumer durable goods sector قطاع السلع المعمرة that produce autos, refrigerators, or houses do ***badly compared with*** those in the nondurable goods sector producing tobacco and foods. People cut back يقلص on luxuries during a recession but are less likely to cut back on necessities such as food.

* ***The Level of Interest Rates*** High interest rates indicate *restrictive monetary policy* actions by the Federal Reserve. FIs not only find funds to finance their lending decisions scarcer and more expensive but also must recognize that high interest rates are correlated with higher credit risk in general.

**5.1.2 Quantitative Models (*Credit scoring models)***

***Credit scoring models*** نماذج درجات الائتمانare ***quantitative models*** that use observed borrower characteristics either to calculate ***a score representing the applicant’s probability of default*** or ***to sort borrowers into different default risk classes.( discriminant analysis)***

By selecting and combining different economic and financial borrower characteristics, **an FI manager** may be able to:

1. Numerically establish which factors are important *in explaining default risk*.
2. Evaluate the relative degree or importance of these factors.
3. Improve the pricing of default risk.
4. Be better able to screen out غربل او يفحص bad loan applicants.
5. Be in a better position to calculate any reserves needed to meet expected future loan losses.

**It is worthwhile that**, ***The primary benefit from credit scoring*** is that can more ***accurately predict a borrower’s performance*** without having to use more resources.

***To use credit scoring models***, the manager must identify **objective economic and financial measures of risk** for any particular class of borrower.

**For consumer debt**, the objective characteristics in a credit-scoring model might include income, assets, age, occupation, and location.

**For commercial debt**, cash flow information and financial ratios such as the debt–equity ratio are usually key factors.

After data are identified, **a statistical technique** quantifies, or scores, *the default risk probability* or default risk classification.

***\*\*\*\*Credit scoring models*** ( Quantitative Models)include these **three broad types**: (1) linear probability models, (2) logit models, and (3) linear discriminant analysis.

Now, we can discuss the different types of ***Credit scoring models*** *as follows:-*

* + - 1. ***Linear Probability Model and Logit Model***
  + **The linear probability model** uses **past data**, such as financial ratios, as **inputs** into a model to explain **repayment experience** on old loans. The relative importance of the factors used in explaining *past repayment performance* then *forecasts repayment probabilities on new loans. بمعنى من الخبره في الماضى للمقترض نتنبأ بالمستقبل اى نسبة دفعه للقرض*

**That is**, **factors** explaining *past repayment performance* can be used for assessing ***P , the probability of repayment*** discussed earlier in this chapter (a key input in setting the credit premium on a loan or determining the amount to be lent) and ***the probability of default (PD).***

***Briefly***, we divide **old loans** ( i ) into two observational groups: those that defaulted ( PD i =1) التى تعثرت في السداد and those that did not default PD i =0). Then we relate these observations by ***linear regression*** to a set of j causal variables المتغيرات السببية (X ij) that reflect quantitative information about the ith borrower, such as leverage or earnings. We estimate the model by ***linear regression of this form***:

*PDi  =  معادلة لحساب معادلة التعثر في دفع القرض*

) **the probability of default for the borrower(**

where **** is the estimated importance of the ***jth***variable (e.g., leverage) in explaining past repayment experience.

If we then take these estimated ****s and multiply them by the observed **X ij** for a ***prospective borrower***, we can derive ***an expected value of PDi for the prospective borrower***. That value can be interpreted as **the probability of default for the borrower:**

***E ( PD i ) = (1 - p i ) = expected probability of default***.

where pi is *the probability of repayment on the loan.*

***Credit scoring models:*** *Mathematical models that use observed loan applicant’s characteristics either to calculate* ***a score*** *representing the applicant’s probability of default or to sort borrowers into different default risk classes.*

***EXAMPLE 11–2*** **Estimating the Probability of Repayment on a Loan Using Linear Probability Credit Scoring Models**

*Suppose there were two factors influencing the past default behavior of borrowers: the leverage or debt–equity ratio (D/E) and the sales–asset ratio (S/A). Based on* ***past default*** *(repayment) experience,* ***the linear probability model*** *is estimated as:*

***PDi = .5(D/Ei) +.1(S/Ai)***

*Assume* ***a prospective borrower*** *has a D/E =.3 and an S/A = 2.0. Its* ***expected probability of default (PDi)*** *can then be estimated as:*

*PDi = .5(.3) + .1(2.0) = .35*

*----*

While this technique is ***straightforward*** بسيطة دقيقة -as long as current information on the **Xij** is available for the borrower; ***its major*** ***weakness*** is that *the estimated probabilities of default* can often lie outside the interval 0 to 1.

* **The logit model** overcomes this weakness by restricting the estimated range of default probabilities from the linear regression model to lie between 0 and 1. Essentially this is done by plugging the estimated value of PDi from the linear probability model (in our example, PDi = .35) into the following formula:

***F (PDi) =  ***

where ***e*** is *exponential* (equal to 2.718) and ***F ( PDi )*** is the *logistically transformed value of* ***PDi*** *.*

* + - 1. ***Linear Discriminant Models***

While linear probability and logit models project **a value** ***for the expected probability of default*** if a loan is made, ***discriminant models*** divide borrowers into high or low default risk classes contingent on their observed characteristics ( X j ).

Similar to these models, however, **linear discriminant models** use **past data** as ***inputs*** into a model to explain repayment experience on old loans. The relative importance of the factors used in explaining past repayment performance then forecasts whether the loan falls into the **high** or **low** default class.

Consider ***the discriminant analysis model*** developed ***by E. I. Altman*** for ***publicly traded manufacturing firms*** in the United States. **The indicator** variable **Z** is an overall measure of the default risk classification of **a commercial borrower**.

This in turn depends on the values of various financial ratios of the borrower (Xj) and the weighted importance of these ratios based on the past observed experience of defaulting versus nondefaulting borrowers derived from a discriminant analysis model.

***Altman’s discriminant function*** (**credit-classification model**) takes the form:

***Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 1.0X5***

Where :

earnings/total assets ratio

X 3 = Earnings X 1 = Working capital / total assets ratio

X 2 = Retained before interest and taxes/total assets ratio

X 4 = Market value of equity/book value of long-term debt ratio

X 5 = Sales/total assets ratio

According to **Altman’s credit scoring model**, any firm with a **Z** score of less than 1.81 should be considered **a high default risk firm**; between 1.81 and 2.99, an **indeterminant default risk firm**; and greater than 2.99, **a low default risk firm**.

***EXAMPLE 11–3* Calculation of Altman’s Z score**

*Suppose that the financial ratios of a potential borrowing firm took the following values:*

*X1 = 0.2*

*X2 = 0*

*X3 = -.20 =* ***negative earnings or losses ?***

*X4 = .10*

*X5 = 2.0*

*The ratio X2 is zero and X3 is negative, indicating that the firm has had* ***negative earnings or losses in recent periods****. Also, X4 indicates that the borrower is highly leveraged. However, the working capital ratio (X1) and the sales/assets ratio (X5) indicate that the firm is reasonably liquid and is maintaining its sales volume. The* ***Z score*** *provides* ***an overall score or indicator of the borrower’s credit risk*** *since it combines and weights these five factors according to their past importance in explaining borrower default.* ***For the borrower in question****:*

***Z = 1.2(.2) +1.4(0) + 3.3(-.20) + 0.6(.10) +1.0(2.0)***

*= 0.24 + 0 - 0.66 +0. 06 + 2.0*

***Z******=1. 64***

**Conclusion**

*With a* ***Z score*** *less than 1.81 (i.e.,* ***in the high default risk region****), the FI should not make a loan to this borrower until it improves its earnings. هذه هي الخلاصة*

**There are** **a number of problems** in using **the discriminant analysis model** to make credit risk evaluations. They are:-

***The first problem*** is that these models usually discriminate only between **two extreme cases** of borrower behavior: **no default** and **default**. This problem suggests that a more accurate or finely calibrated sorting among borrowers may require **defining more classes** in the discriminant analysis model.

***The second problem*** is that there is no obvious economic reason to expect that the weights in the discriminant function—or, more generally, the weights in any credit scoring model—will be **constant** over any but very short periods. Moreover, the linear discriminant model assumes that the X j variables are independent of one another.

***The third problem*** is that these models *ignore important, hard-to-quantify factors تتجاهل هذه النماذج عوامل مهمة يصعب تحديدها* that may play *a crucial role* in the default or no default decision.

***For example***,

reputation of the borrower and the nature of long-term borrower–lender relationships could be important borrower-specific characteristics, as could macro factors such as the phase of the business cycle. These variables are often ignored in credit scoring models.

***A fourth problem*** relates to **default records kept by FIs**. Currently, no centralized database on defaulted business loans لا توجد قاعدة بيانات مركزية حول القروض التجارية المتعثرة for proprietary and other reasons exists.

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**Below** we consider a number of these ***newer approaches*** or ***models of credit risk,*** including:

1. Term structure of credit risk approach.
2. Mortality rate approach.
3. RAROC models.
4. Option models (including the KMV credit monitor model).

While some of these models focus on ***different aspects of credit risk***, they are ***all linked b***y a strong reliance on modern financial theory and financial market data.

***5-2 NEWER MODELS OF CREDIT RISK MEASUREMENT AND PRICING لا تشرح في المحاضره***

**Actually, we study just one of the NEWER MODELS. It is Term Structure Derivation of Credit Risk as indicated As Follows:-**

**Term Structure Derivation of Credit Risk**

*One market-based method of assessing* ***credit risk exposure and default probabilities***is to ***analyze the risk تحليل أقساط المخاطر الملازمة للهيكل الحالي للعائدات على ديون الشركات أو القروض للمقترضين المشابهين للمخاطر. premiums inherent in the current structure of yields on corporate debt or loans to similar risk-rated borrowers***.

Rating agencies such as Standard & Poor’s (S&P) categorize corporate bond issuers into at least seven major classes according to *perceived credit quality*. The first four quality ratings—AAA, AA, A, and BBB—indicate investment-quality borrowers.

***For example***

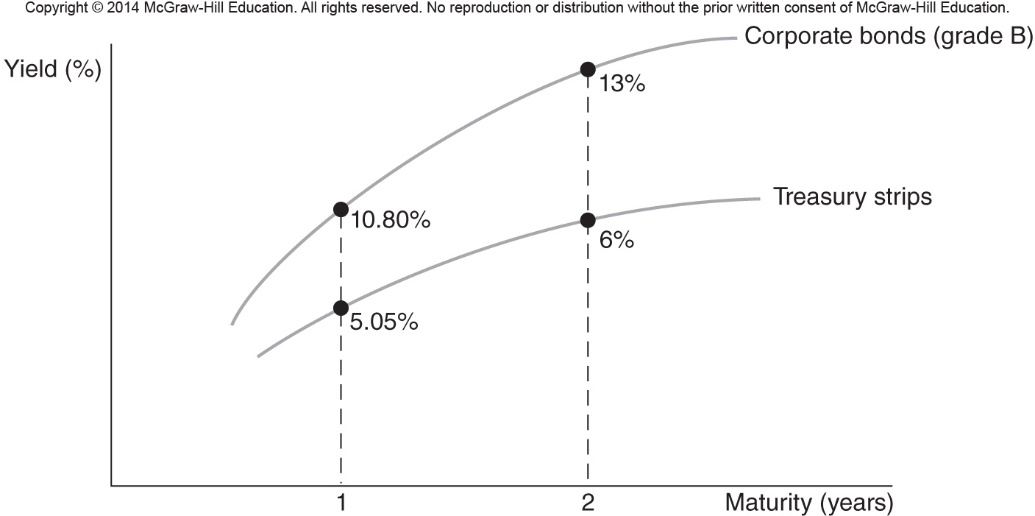
The Office of the Comptroller of the Currency, which regulates national banks, restricts the ability of banks to purchase securities rated outside these classes. By comparison, insurance company regulators have permitted these FIs to purchase noninvestment-grade securities with ratings such as BB, B, and CCC, but with restrictions on the aggregate amounts, they can include in their portfolios.

These three classes are known as high-yield or junk bonds. Different quality ratings are reflected in the degree to which corporate bond yields exceed those implied by the Treasury (credit risk–free) yield curve.

Look at the spreads shown in Figure 11–7 for zero-coupon corporate (grade B) bonds over similar maturity zero-coupon Treasuries (called Treasury strips).

Because **Treasury strips and zero-coupon corporate bonds شرائح الخزينة وسندات الشركات ذات القسيمة الصفرية**  are single-payment discount bonds, it is possible to extract required credit risk premiums and implied probabilities of default from actual market data on interest rates. That is, the spreads between risk-free discount bonds issued by the Treasury and discount bonds issued by corporate borrowers of differing quality reflect perceived credit risk exposures of corporate borrowers for single payments at different times in the future. FIs can use these credit risk probabilities on existing debt to decide whether or not to issue additional debt to a particular credit risk borrower. Note that in market-based models of assessing default risk, FIs use information on credit quality processed by rating agencies rather than by the FI itself. Thus, the use of market-based models abstracts the FI’s role as an information processor. Rather, the unique role played by the FI is to process market-based information to assess default probabilities.

**FIGURE 11–7 Corporate and Treasury Discount Bond Yield Curves الشكل 11-7 منحنيات عائد سندات الشركات والخصم على السندات**



**Next**, we look at the simplest case of extracting ***an implied probability of default for an FI*** considering buying one-year bonds from or making one-year loans to a risky borrower. Then, we consider multiyear loans and bonds. In each case, we show that we can extract *a market view of the credit risk*—the expected probability of default—of an individual borrower.

***5.2.1 Probability of Default on a One-Period Debt Instrument***

Assume that the FI requires an expected return on a one-year (zero-coupon) corporate debt security equal to at least the risk-free return on one-year (zero-coupon). Treasury bonds. Let **p** be the probability that the corporate debt, both principal and interest, will be repaid in full; therefore, 1 - p is the probability of default. If the borrower defaults, the FI is (for now) assumed to get nothing (i.e., the recovery rate is zero or the loss given default is 100 percent).

By denoting the contractually promised return on the one-year corporate debt security as 1 + k and on the credit risk–free one-year Treasury security as 1 + i , the FI manager would just be indifferent غير مبال فقط between corporate and Treasury securities when:

P (1 + k) = 1 + i

So

***P = ***

or, the expected return on corporate securities is equal to the risk-free rate. معدل خالي من المخاطر

**Treasury strips and zero-coupon corporate bonds :** Bonds that are created or issued bearing no coupons and only a face value to be paid on maturity. As such, they are issued at a large discount from face value. (Also called *deep-discount bonds.)*

***EXAMPLE 11–4* Calculating the Probability of Default on a One-Year Bond (Loan) Using**

**Term Structure Derivation of Credit Risk**

*Suppose, as shown in Figure 11–7, the interest rates in the market for one-year zero-coupon Treasury bonds and for one-year zero-coupon grade B corporate bonds are, respectively:*

*i = 10%*

*and*

*k = 15 .8 %*

*This implies that the probability of repayment on the security as perceived by the market is:*

*P =  =  = 0.95*

*If the probability of repayment is .95, this implies a probability of default (1 - p) equal to .05. Thus, in this simple one-period framework, a probability of default of 5 percent on the corporate bond (loan) requires the FI to set a risk premium () of 5.8 percent.*

*= k - i = 5.8%*

*Clearly, as the probability of repayment (p) falls and the probability of default (1 - p) increases, the required spread  between k and i increases.*

*--*

This analysis can easily be extended to the more realistic case in which the FI does not expect to lose all interest and all principal if the corporate borrower defaults. Realistically, the FI lender can expect to receive some partial repayment even if the borrower goes into bankruptcy. **For example**, **Altman** estimated that when firms defaulted on their bonds in 2002, the investor lost on average 74.7 cents on the dollar (i.e., recovered around 25.3 cents on the dollar).

**TABLE 11–8** **Recovery Rates (RR) on Defaulted Debt, 1988–2004**

***Type of Debt Recovery Rate Number of Observations***

Bank debt 77.1% 1,023

Senior secured bonds 63.3 259

Senior unsecured bonds 42.7 587

Senior subordinated bonds 31.2 433

Subordinated bonds 30.1 374

Table 11–8 gives *recovery rates* on defaulted debt by type of debt from 1988 to 2004. As discussed earlier in this chapter, many loans and bonds are secured or collateralized by first liens on various pieces of property or real assets should a borrower default.

Let **** be *the proportion of the loan’s principal and interest that is collectible on default,* where in general  is positive. The FI manager would set **the expected return on the loan** to equal **the risk-free rate** in the following manner:

[(1 - p) γ (1 + k)] + [p (1 + k)] = 1 + i

The new term here is **(1 − p)  (1 + k);** this is the payoff the FI expects to get if the borrower defaults.

As might be expected, if the loan has collateral backing such that  > 0, the required risk premium on the loan will be less for any given default risk probability (1 − p). Collateral requirements are a method of controlling default risk; they act as a direct substitute for risk premiums in setting required loan rates.

To see this, solve for **the risk premium**  between k (the required yield on risky corporate debt) and i (the risk-free rate of interest):

**k - i =  =  - (1 +i)**

If i = 10 percent and p = .95 as before but the FI can expect to collect 90 percent of the promised proceeds if default occurs ( = .9), then ***the required risk premium  = 0.6 percent.***

Interestingly, in this simple framework,  and p are perfect substitutes for each other. **That is**, a bond or loan with collateral backing of  = .7 and p = .8 would have the same required risk premium as one with  = .8 and p = .7. An increase in collateral  is a direct substitute for an increase in default risk (i.e., a decline in p ).

***5-2.2 Probability of Default on a Multiperiod Debt Instrument***

We can extend this type of analysis to derive the credit risk or default probabilities

occurring in the market for longer-term loans or bonds (i.e., two-year bonds). To

do this, the manager must estimate the probability that the bond will default in the

second year conditional on the probability that it does not default in the first year.

The probability that a bond will default in any given year is clearly conditional

on the fact that the default has not occurred earlier. The probability that a bond

will default in any given year, t , is ***the marginal default probability*** for that year,

1 − pt . However, for, say, a two-year loan, the marginal probability of default in

the second year (1 − p2 ) can differ from the marginal probability of default in the

first year (1 − p1 ). If we use these marginal default probabilities, ***the cumulative***

***default probability at some time between now and the end of year 2*** is:

***Cp = 1 – [(p1) (p2)]***

**Marginal default probability:** the probability that a borrower will default in any given year.

**Cumulative default probability:** the probability that a borrower will default over a specified multiyear period

***EXAMPLE 11–5 Calculating the Probability of Default on a Multiperiod Bond***

*Suppose the FI manager wanted to find out the probability of default on a two-year bond.*

*For the one-year loan, 1 - p1 = .05 is the marginal and total or cumulative probability (Cp)of default in year 1. Later in this chapter we discuss ways in which p2 can be estimated by the FI manager, but for the moment suppose that 1 - p2 =.07. Then:*

*1 - p1 = 0.05 marginal probability of default in year 1*

*1 - p2 = 0.07 marginal probability of de fault in year 2*

*The probability of the borrower surviving—not defaulting at any time between now (time 0) and the end of period 2—is p1 × p2 = (.95) (.93) = .8835.*

*Cp = 1 - [(.95)(.93)] = .1165*

*There is an 11.65 percent probability of default over this period.*

------

We have seen how to derive the one-year probability of default from yield spreads on one-year bonds. We now want to derive ***the probability of default in year 2, year 3, and so on***. Look at Figure 11–7; as you can see, yield curves are rising for both Treasury issues and corporate bond issues. We want to extract from these yield curves the market’s expectation of the multiperiod default rates for corporate borrowers classified in the grade B rating class.

Look first at the Treasury yield curve. The condition of efficient markets and thus **no arbitrage** profits by investors requires that the return on buying and holding the two-year Treasury discount bond to maturity just equals the expected return from investing in the current one-year discount T-bond and reinvesting the principal and interest in a new one-year discount T-bond at the end of the first year at the expected one-year **forward rate**. That is:

**(1+ i2)2 = (i + i1) (1 + f1) (1)**

*The term on the left side* is the return from holding the two-year discount bond

to maturity. The term on the right side results from investing in two successive

one-year bonds, where i 1 is the current one-year bond rate and f 1 is the expected

one-year bond rate or forward rate next year. Since we can observe directly from

the T-bond yield curve the current required yields on one- and two-year Treasuries,

we can directly infer the market’s expectation of the one-year T-bond rate next

period or the one-year forward rate, f 1 :

**1 + f1 =  (2)**

We can use the same type of analysis with the corporate bond yield curve to infer the one-year forward rate on corporate bonds (grade B in this example). The one-year rate expected on corporate securities (c 1) one year into the future reflects

the market’s default risk expectations for this class of borrower as well as the more

general time value factors also affecting f 1 :

**1 + c1 =  (3)**

The expected rates on one-year bonds can generate an estimate of the expected

probability of repayment on one-year corporate bonds in one year’s time, or what

we have called p2 . Since:

p2 (1 + c1) = (1 + f1)

Then **p2 =  (4)**

**Thus**, ***the expected probability of default in year 2*** is:

1 - **p2** (5)

In a similar fashion, the one-year rates expected in two years’ time can be derived

from the Treasury and corporate term structures so as to derive **p3** , and so on.

**No arbitrage the** inability to make a profit without taking risk.

**Forward rate a** one-period rate of interest expected on a bond issued at some date in the future

***EXAMPLE 11–6 Calculating the Probability of Default on a Multiperiod Bond Using Term***

***Structure Derivation of Credit Risk***

*From the T-bond yield curve in Figure 11–7, the current required yields on one- and two-year Treasuries are i1 = 10 percent and i2 = 11 percent, respectively. If we use equation (2), the one-year forward rate, f1, is:*

*1 + f1 =  = 1.12*

*or*

*f1 = 12%*

*The expected rise in one-year rates from 10 percent (i1) this year to 12 percent (f1) next year reflects investors’ perceptions regarding inflation and other factors that directly affect the time value of money.*

*Further, the current yield curve, in Figure 11–7, indicates that appropriate one-year discount bonds are yielding k1 \_ 15.8 percent and two-year bonds are yielding k2 \_ 18 percent. Thus, if we use equation (3), the one-year rate expected on corporate securities, c1, is:*

*1 + c1 =  = 1.202*

*Or*

*c1 = 20.2%*

**( EXAMPLE 11–6 (continued**)

*We summarize these calculations in Table 11–9. As you can see, the expected spread between one-year corporate bonds and Treasuries in one year’s time is higher than the spread for current one-year bonds. Thus, the default risk premium increases with the maturity on the corporate (risky) bond.*

*From these expected rates on one-year bonds, if we use equations (4) and (5), the expected probability of repayment on one-year corporate bonds in one year’s time,*

*and the expected probability of default in year 2 is:*

*p2 =  = 0.9318*

*and the expected probability of default in year 2 is:*

*1 - p2 = 1- 0.9318 = 0.0682*

*or*

*6.82%*

**TABLE 11–9 Treasury and Corporate Rates and Rate Spreads**

**Current One-Year Rate Expected One-Year Rate**

Treasury 10.0% 12.0%

Corporate (B) 15.8 20.2

Spread 5.8 8.2

The probabilities we have estimated are marginal probabilities conditional on

default not occurring in a prior period. We also discussed the concept of the cumulative probability of default that would tell the FI the probability of a loan or bond investment defaulting over a particular time period. In the example developed

earlier, *the cumulative probability that corporate grade B bonds would default over the next two years* is:

Cp = 1 - [( p1) (p2 ) ]

Cp = 1 - [( 0.95) (0.9318 ) ] = 11.479 %

As with **the credit scoring approach**, this model creates some potential problems.

Its principal advantages are that it is clearly forward-looking and based on market expectations. Moreover, if there are liquid markets for Treasury and corporate discount bonds—such as Treasury strips and corporate zero-coupon bonds— then we can easily estimate expected future default rates and use them to value and price loans. However, while the market for Treasury strips is now quite deep, the market for corporate discount bonds is quite small.

Although a discount yield curve for corporate bonds could be extracted mathematically from the corporate bond coupon yield curve (see Chapter 25), these bonds often are not very actively traded and prices are not very transparent. Given this, the FI manager might have to consider an alternative way to use bond or loan data to extract default rate probabilities for all but the very largest corporate borrowers. We consider a possible alternative next.

***Summary***

This chapter discussed different approaches to measuring credit or default risk on individual loans (bonds). The different types of loans made by FIs and some of their basic characteristics were first examined. The expected return on a loan was shown to depend on factors such as origination fees, compensating balances, interest rates, and maturity. The various models to assess default risk include both qualitative and quantitative models. The qualitative models usually contain both firm-specific factors, such as reputation and leverage, and market-specific factors,

such as the business cycle and the level of interest rates. Quantitative models, such as the linear probability model, the logit model, and the linear discriminant model, were shown to provide credit scores that can rank or classify loans by expected [www.mhhe.com/saunders6e](http://www.mhhe.com/saunders6e) default risk. The more rigorous of the quantitative models make use of both financial theory and financial data.