CREDIT RISK

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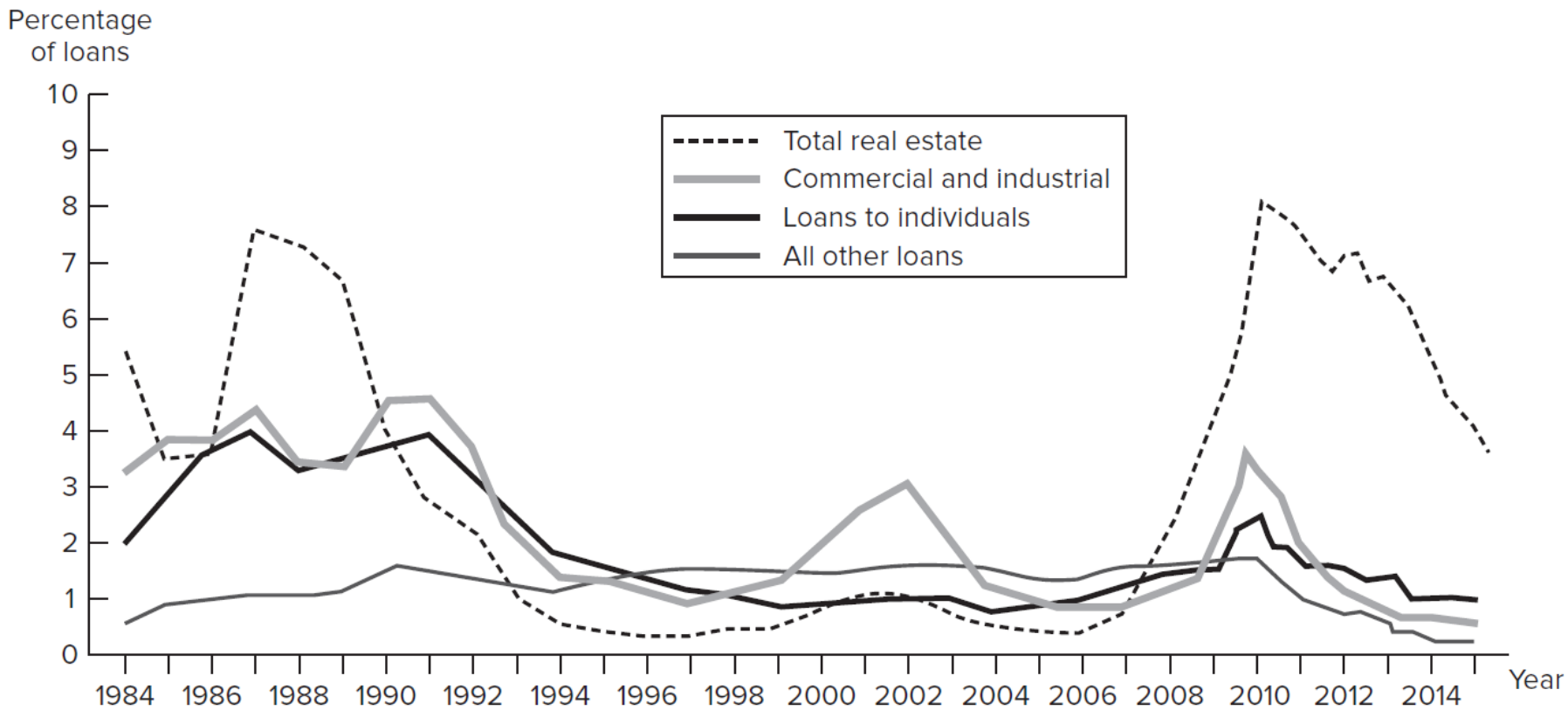
INTRODUCTION

- FIs are special because of their ability to transform financial claims of household savers into claims issued to corporations, individuals and governments.
- FIs that lend funds, should properly measure the credit risk on these loans.
- 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

CREDIT RISK MANAGEMENT

- Credit risk management is important for FI managers because it involves the determination of several features of a loan or debt instrument: interest rate, maturity, collateral, and other covenants
- Riskier projects require more analysis before loans are approved or debt instruments are purchased. If credit risk analysis is inadequate, default rates could be higher and push a bank into insolvency, especially if the markets are competitive and the margins are low

NON-PERFORMING ASSETS



TYPES OF LOANS

- A **syndicated loan** is provided by a group of FIs as opposed to a single lender. 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.
- 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
- A **spot loan** is made by the FI and the borrower uses or takes down the entire loan amount immediately
- **In a loan commitment,** or line of credit, 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
- **Commercial paper** is an unsecured short-term debt instrument issued by corporations either directly or via an underwriter to purchasers in the financial markets, such as money market mutual funds

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.
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:

$$\text{Base lending rate } (BR) = 8\%$$
$$+\text{Credit risk premium or margin } (\phi) = 2\%$$
$$BR + \phi = 10\%$$

RETURN ON A LOAN

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 offshore or Eurodollar market

Traditionally, the prime rate has been the rate charged to the FI's lowest-risk customers. Now, it is more of a base rate to which positive or negative risk premiums (ϕ) can be added. In other words, the best and largest borrowers now commonly pay below prime rate to be competitive with the commercial paper market.

FEES

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 (generally noninterest-bearing demand) deposits. **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.

3) A reserve requirement (RR) imposed by the Federal Reserve on the FI's (specifically depository institution's) demand deposits, including any compensating balances.

RETURN ON A LOAN

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

$$1 + k = \frac{of + (BR + \phi)}{1 - b(1 - RR)}$$

The numerator is the promised gross cash inflow to the FI per dollar lent, reflecting direct fees (of) plus the loan interest rate ($BR + \phi$). In the denominator, for every $1 the FI lends, it retains b as noninterest-bearing compensating balances

RETURN ON A LOAN

Suppose a bank does the following:

1. Sets the loan rate on a prospective loan at 10 percent (where $BR = 6\%$ and $\phi = 4\%$).
2. Charges a 1/8 percent (or 0.125 percent) loan origination fee to the borrower.
3. Imposes an 8 percent compensating balance requirement to be held as noninterest-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:[10]

$$1 + k = 1 + \frac{0.00125 + (0.06 + 0.04)}{1 - [(0.08)(0.9)]}$$

$$1 + k = 1 + \frac{0.10125}{0.928}$$

$$1 + k = 1.1091 \text{ or } k = 10.91\%$$

This is, of course, higher than the simple promised interest return on the loan, $BR + \phi = 10\%$.

THE EXPECTED RETURN ON A LOAN

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:

$$1 + E[r] = p(1 + k) + (1 - p) \times 0 \rightarrow E[r] = p(1 + k) - 1$$

RETAIL VERSUS WHOLESALE CREDIT DECISIONS

Because of the small dollar size of the loans in the context of an FI's overall asset 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. Regardless of their credit risk, 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.

At the retail level, an FI controls its credit risks by **credit rationing** rather than by using a range of interest rates or prices

WHOLESALE FINANCE

In contrast to the retail level, at the wholesale (C&I) level FIs use both interest rates and credit quantity to control credit risk

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 (i.e., $\phi < 0$). Higher-risk borrowers are charged a markup on the prime rate, or a credit (default) risk premium (i.e., $\phi > 0$), to compensate the FI for the additional credit risk involved.

As long as they are compensated with sufficiently high interest rates (or credit risk premiums), over some range of credit demand, FIs may be willing to lend funds to high-risk wholesale borrowers. However, as discussed earlier, increasing loan interest rates (k) may decrease the probability (p) that a borrower will pay the promised return.

MEASUREMENT 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, much of the information needs to be collected internally or purchased from external credit agencies. At the wholesale level, these information sources are bolstered 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.
- 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

DEFAULT RISK MODEL

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. 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

Qualitative Models: General assessment based on specific and macro factors

Quantitative Models:

- Credit Scoring Models: Observables to probability (default) categories.
- Linear, Logit, and Probit probability models. $p = f(x)$
- Linear Discriminant Models (e.g. Altman's Z): Discriminant models divide borrowers into high or low default risk classes contingent on their observed characteristics

NEWER CREDIT MODELS

- Newer credit risk models use *financial theory* and more widely available *financial market* data to make inferences about default probabilities on debt and loan instruments.
- Consequently, these models are most relevant in evaluating loans to larger borrowers in the corporate sector. This is the area in which a great deal of current research is taking place by FIs

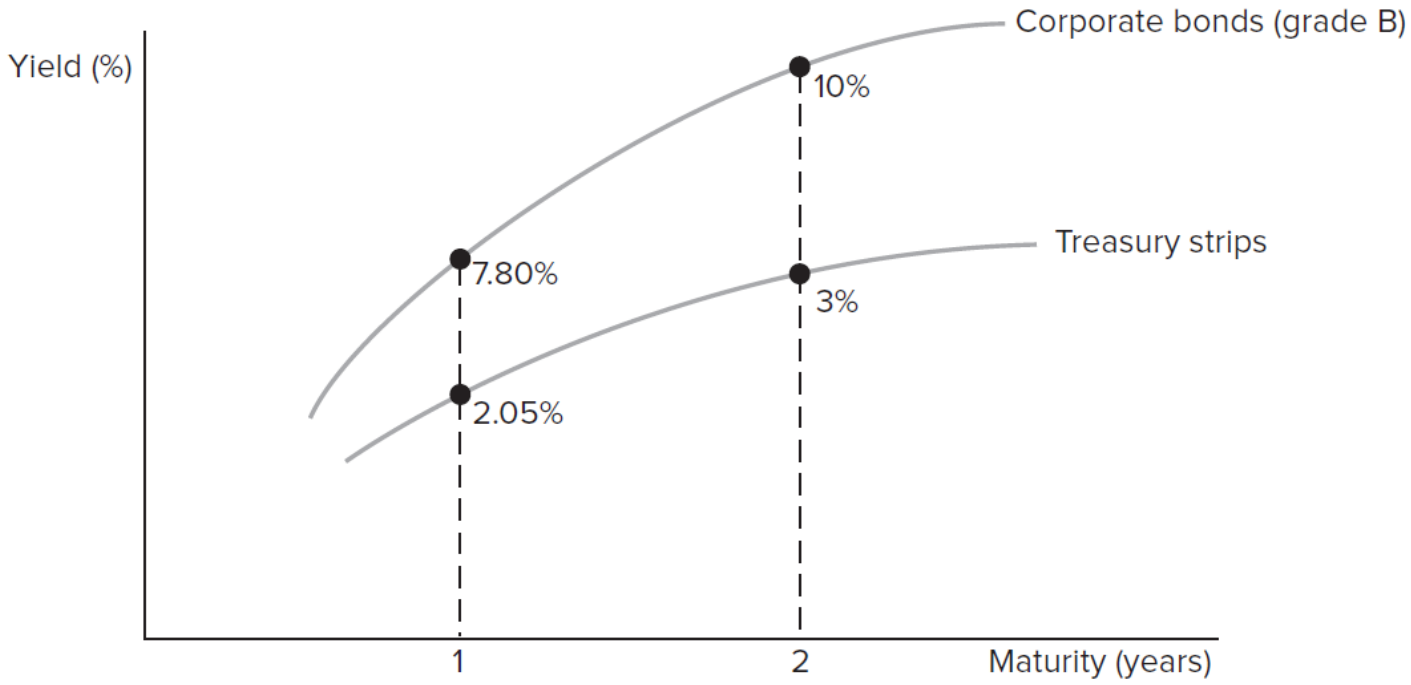
Models:

- Term structure of credit risk approach (also called reduced-form models).
- Mortality rate approach
- RAROC models
- Option models (also called structural models since they are based on an economic model explaining why firms default)
- Big Data

NEWER CREDIT MODELS

Term Structure Derivation of Credit Risk

One market-based method of assessing credit risk exposure and default probabilities is to analyze the risk premiums inherent in the current structure of yields on corporate debt or loans to similar risk-rated borrowers



Probability of Default on a One-Period Debt Instrument based on market data

$$p(1+k) = 1+i \rightarrow p = \frac{1+i}{1+k}$$

Suppose, as shown in Figure 10–6, the interest rates in the market for one-year, zero-coupon Treasury strips and for one-year, zero-coupon grade B corporate bonds are, respectively:

$$i = 2.05\%$$

and

$$k = 7.80\%$$

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

$$p = \frac{1+i}{1+k} = \frac{1.0205}{1.0780} = 0.9467$$

If the probability of repayment is 0.9467, this implies a probability of default $(1-p)$ equal to 0.0533. Thus, in this simple one-period framework, a probability of default of 5.33 percent on the corporate bond (loan) requires the FI to set a risk premium (ϕ) of 5.75 percent.[24]

$$\phi = k - i = 5.75\%$$

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

RECOVERY RATE

In case of default, debt-holders might still be able to recover a fraction γ of the principal.

$$1 + i = p(1 + k) + (1 - p)(1 + k)\gamma$$

$$k - i = \phi = \frac{1 + i}{\gamma + p(1 - \gamma)} - (1 + i)$$

MORTALITY RATE DERIVATION OF CREDIT RISK

Rather than extracting *expected* default rates from the current term structure of interest rates, the FI manager may analyze the *historic* or past default risk experience, the **mortality rates,** of bonds and loans of a similar quality

$$MMR_1 = \frac{\text{Total value of grade B bonds defaulting in year 1 of issue}}{\text{Total value of grade B bonds outstanding in year 1 of issue}}$$

$$MMR_2 = \frac{\text{Total value of grade B bonds defaulting in year 2 of issue}}{\text{Total value of grade B bonds outstanding in year 2 of issue adjusted for defaults, calls, sinking fund redemptions, and maturities in the prior year}}$$

MORTALITY RATES

		Years after Issuance									
		1	2	3	4	5	6	7	8	9	10
AAA	Marginal	0.00%	0.00%	0.00%	0.00%	0.01%	0.02%	0.01%	0.00%	0.00%	0.00%
	Cumulative	0.00%	0.00%	0.00%	0.00%	0.01%	0.03%	0.04%	0.04%	0.04%	0.04%
AA	Marginal	0.00%	0.00%	0.22%	0.08%	0.02%	0.01%	0.01%	0.01%	0.02%	0.01%
	Cumulative	0.00%	0.00%	0.22%	0.30%	0.32%	0.33%	0.34%	0.35%	0.37%	0.38%
A	Marginal	0.01%	0.03%	0.13%	0.14%	0.11%	0.07%	0.02%	0.26%	0.08%	0.05%
	Cumulative	0.01%	0.04%	0.17%	0.31%	0.42%	0.49%	0.51%	0.77%	0.85%	0.90%
BBB	Marginal	0.34%	2.38%	1.28%	1.01%	0.51%	0.23%	0.27%	0.15%	0.15%	0.35%
	Cumulative	0.34%	2.71%	3.96%	4.93%	5.41%	5.63%	5.88%	6.03%	6.17%	6.50%
BB	Marginal	0.95%	2.03%	3.90%	1.97%	2.35%	1.53%	1.47%	1.13%	1.45%	3.15%
	Cumulative	0.95%	2.96%	6.75%	8.58%	10.73%	12.10%	13.39%	14.37%	15.61%	18.27%
B	Marginal	2.86%	7.74%	7.86%	7.81%	5.71%	4.46%	3.56%	2.09%	1.77%	0.76%
	Cumulative	2.86%	10.38%	17.42%	23.87%	28.22%	31.42%	33.86%	35.24%	36.39%	36.87%
CCC	Marginal	8.15%	12.44%	17.92%	16.35%	4.68%	11.53%	5.45%	4.86%	0.69%	4.30%
	Cumulative	8.15%	19.58%	33.99%	44.78%	46.88%	53.43%	55.97%	58.11%	58.40%	60.19%

RAROC MODELS

The **RAROC** (risk-adjusted return on capital) was pioneered by Bankers Trust (acquired by Deutsche Bank in 1998) and has now been adopted by virtually all the large banks in the United States and Europe, although with some significant proprietary differences between them

The essential idea behind RAROC is that rather than evaluating the actual or contractually promised annual ROA on a loan, as earlier in the chapter (that is, net interest and fees divided by the amount lent), the lending officer balances expected interest and fee income less the cost of funds against the loan's expected risk

$$RAROC = \frac{\text{One-year net income on a loan}}{\text{Loan (asset) risk or capital at risk}}$$

$$\text{One-year net income on loan} = (\text{Spread} + \text{Fees}) \times \text{Dollar value of the loan outstanding}$$

Capital at risk is computed using duration and convexity methods (fixed income analysis not part of this course)

USING DURATION TO ESTIMATE LOAN RISK

$$\Delta LN = -D_{LN} \times LN \times [\Delta R/(1 \times R)]$$

ΔLN	$-D_{LN}$	LN	$[\Delta R/(1 \times R)]$
(dollar capital risk exposure or loss amount)	(duration of the loan)	(risk amount or size of loan)	(expected maximum change in the loan rate due to a change in the credit risk premium [ϕ] or risk factor on the loan)

USING HISTORICAL DATA TO ESTIMATE RISK

$$RAROC = \frac{\text{One-year net income per dollar loaned}}{\text{Unexpected default rate} \times \text{Proportion of loan lost on default (loss given default)}}$$

OTHER MODELS

- Merton's model: Consider equity as a call option on assets
- Machine Learning
- Un-conventional data