CHAPTER 10

Credit Risk: Individual Loan Risk

Overview

- This chapter discusses types and characteristics of loans made by U.S. FIs, models for measuring credit risk, and applicable technological advances.
- Important for purposes of:
  - Pricing loans and bonds
  - Setting limits on credit risk exposure

Credit Quality Problems

- Problems with junk bonds, LDC loans, and residential and farm mortgage loans
- Late 1990s, credit card and auto loans
- Crises in other countries such as Argentina, Brazil, Russia, and South Korea
- 2006-2007, mortgage delinquencies on subprime loans surged
- Emphasizes importance credit risk analysis

Web Resources

- For further information on credit ratings visit:

Moody's

www.moodys.com

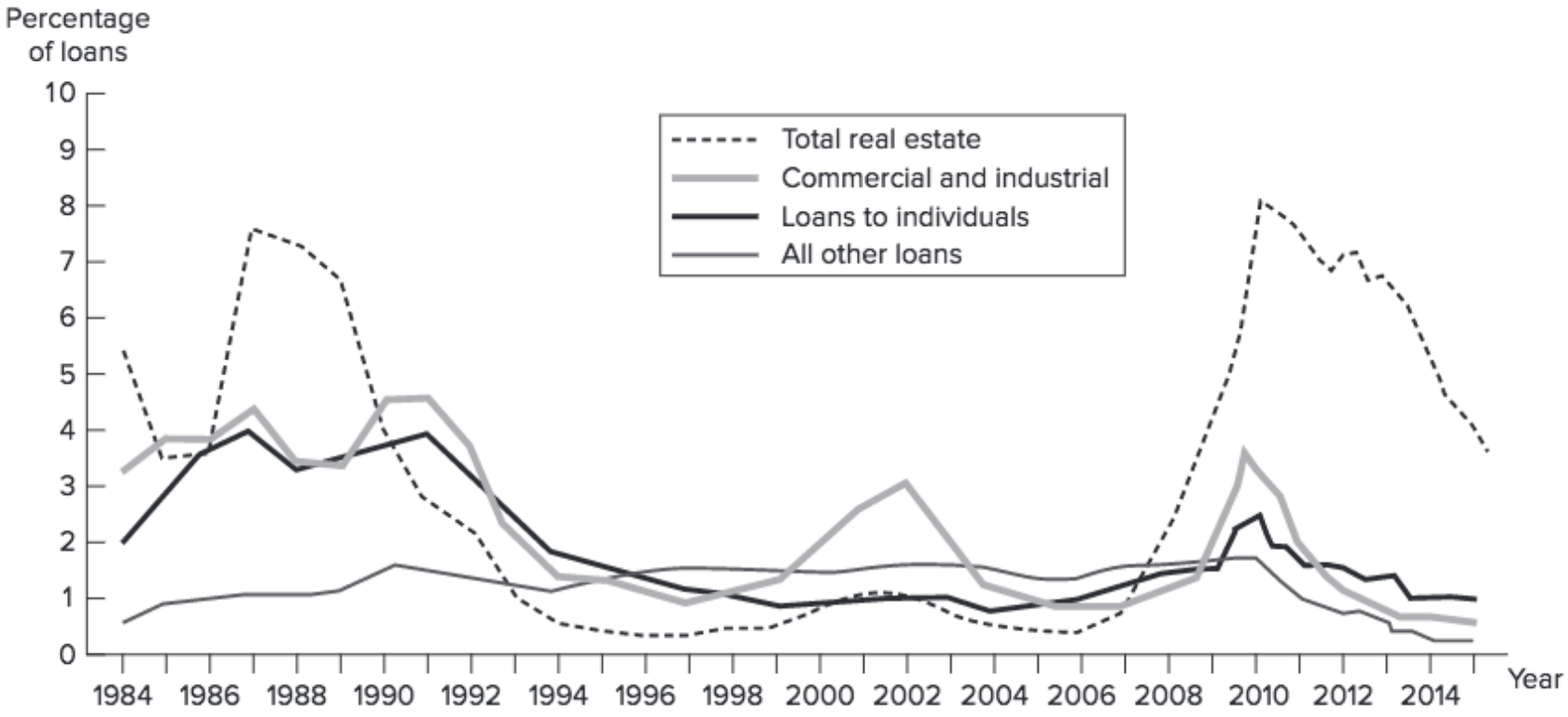
Standard & Poor's

www.standardandpoors.com

Credit Quality Problems Continued

- Over the early to mid 1990s, improvements in NPLs for large banks and overall credit quality
- Late 1990s and early 2000, Telecommunication and tech companies
- Mid 2000s, economic growth accompanied by reduction in NPL rates
- Mortgage crisis
- Increased emphasis on credit risk evaluation

Nonperforming Asset Ratio for U.S. Commercial Banks

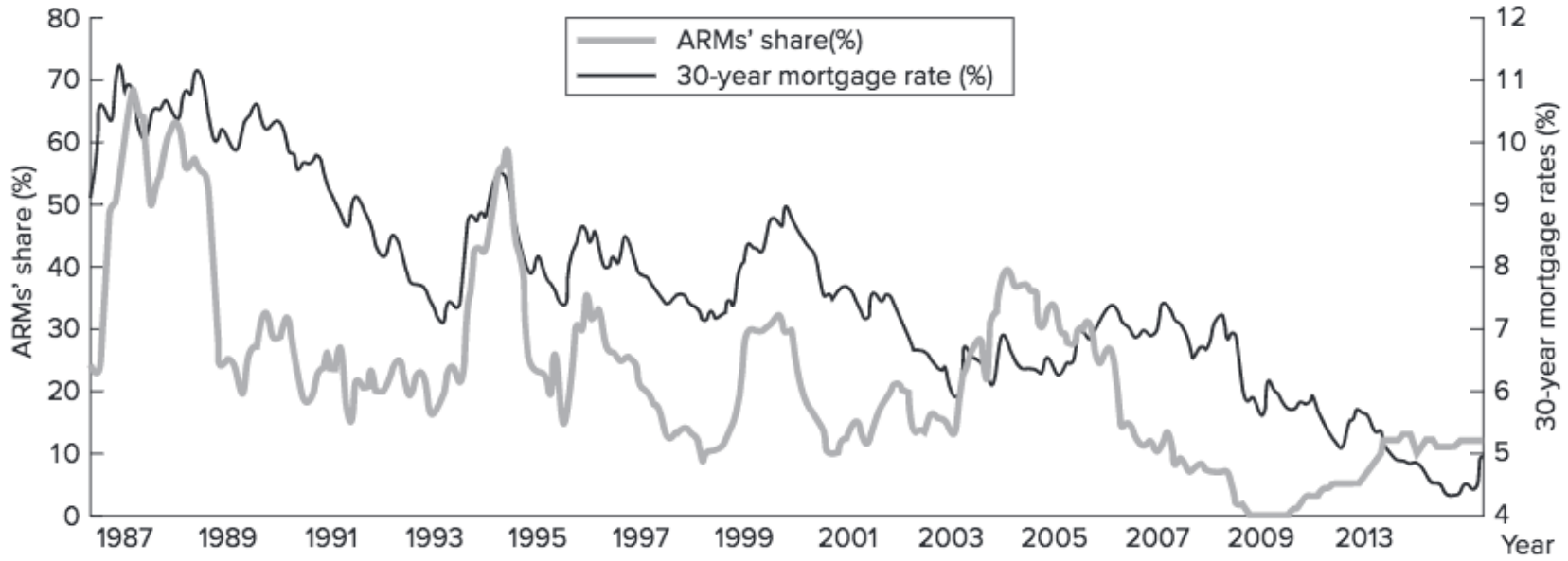


Types of Loans

- C&I loans: secured and unsecured
  - Syndication
  - Spot loans, loan commitments
  - Decline in C&I loans originated by commercial banks and growth in commercial paper market
  - Effect of financial crisis on commercial paper market

- RE loans: Primarily mortgages
  - Fixed-rate, ARMs
  - Mortgages can be subject to default risk when loan-to-value rises and house prices fall below amount of loan outstanding

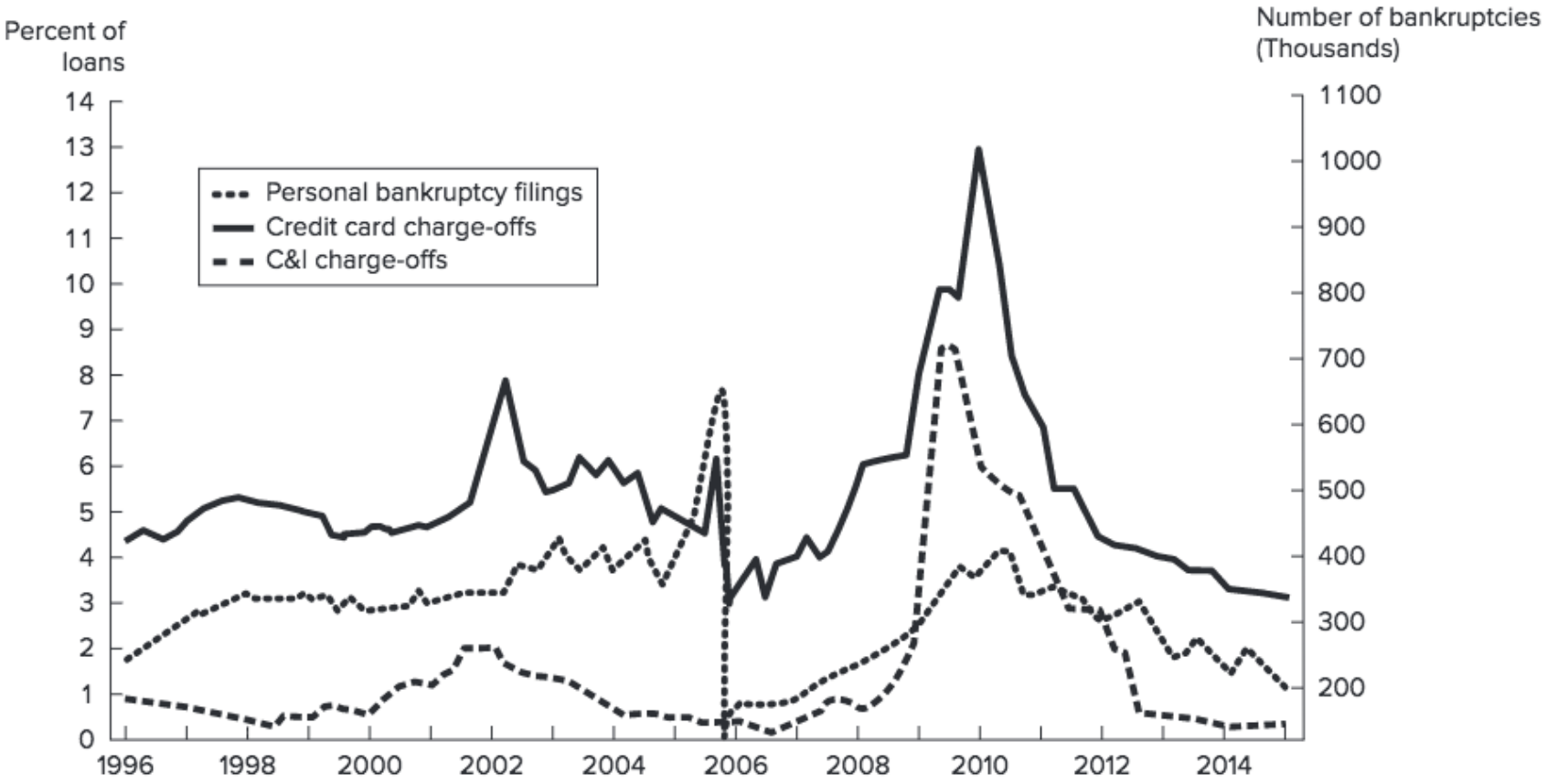
ARMs' Share of Total Loans Closed, 1987-2014



Individual (Consumer) Loans

- Consumer loans: personal, auto, credit card
  - Nonrevolving loans
    - Automobile, mobile home, personal loans
  - Revolving loans
    - Credit card debt (i.e., Visa, MasterCard)
    - Proprietary cards, such as Sears and AT&T
  - Risks affected by competitive conditions and usury ceilings
  - Bankruptcy Reform Act of 2005
- High default rates during finance crisis highlight the importance of risk evaluation prior to making a credit decision

Annual Net Charge-Off Rates on Loans



Other Loans

- Other loans include:
  - Farm loans
  - Other banks
  - Nonbank FIs, such as broker margin loans
  - Foreign banks and sovereign governments
  - State and local governments

Calculating Return on a Loan

- Factors: Interest rate, fees, credit risk premium, collateral, and other nonprice terms, such as compensating balances and reserve requirements
- Return = inflow/outflow

$$1+k = 1+(of + (BR + \text{ø}))/(1-[b(1-RR)])$$

- Expected return: $1 + E(r) = p(1+k)$ where p equals probability of complete repayment
- Note that *realized* and *expected return* may not be equal

Retail versus Wholesale Credit Decisions

- At retail
  - Usually a simple accept/reject decision rather than adjustments to the rate
  - Credit rationing
  - If accepted, customers sorted by loan quantity
  - For mortgages, discrimination occurs via loan-to-value rather than adjusting rates
- At wholesale
  - Use both quantity and pricing adjustments

Risk Models

- Availability, quality, and cost of information are critical factors in credit risk assessment
  - Facilitated by technology and information
- Qualitative models consider borrower specific factors as well as market, or systematic, factors
  - Borrowed-specific factors include reputation, leverage, volatility of earnings, and collateral
  - Market specific factors include business cycle and interest rate levels

Linear Probability Model

- **Credit scoring models** are quantitative models that use borrower characteristics to gauge an applicant's probability of default

$$PD_i = \sum_{j=1}^{n} \beta_j X_{i,j} + \text{error}$$

– Major weakness is that estimated probabilities of default can often lie outside of the [0,1] interval

– Since superior statistical techniques are readily available, there is rarely justification for employing linear probability models

Logit Model

- Logit models
  - Overcomes weakness of the linear probability model by restricting the estimated range of default probabilities from the linear regression model to lie between 0 and 1

- Quality of credit scoring models have improved, providing positive impact on controlling write-offs and default

Altman's Discriminant Function

$$Z=1.2X_1+ 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$$

Critical value of Z = 1.81

- X_1 = Working capital/total assets ratio
- X_2 = Retained earnings/total assets ratio
- X_3 = EBIT/total assets ratio
- X_4 = Market value equity/ book value of total liabilities
- X_5 = Sales/total assets ratio

Linear Discriminant Model

- Problems associated with discriminant analysis model:
  - Only considers two extreme cases (default/no default)
  - No reason to expect that the weights in a credit scoring model will be constant long-term; sensitivity to variable weights
  - Ignores hard to quantify factors, including business cycle effects and reputation
  - Database of defaulted loans is not available to benchmark the model

Term Structure Derivation of Credit Risk

- If the risk premium is known, we can infer the probability of default

- Risk premium can be computed using Treasury strips and zero-coupon corporate bonds

$$p\,(1+k) = 1+i$$

Mortality Rate Models

- Similar to the process employed by insurance companies to price policies; the probability of default is estimated from past data on defaults
- Marginal Mortality Rates:

$$\mathbf{MMR_1} = \frac{\text{(Value Grade B default in year 1)}}{\text{(Value Grade B outstanding yr.1)}}$$

$$\mathbf{MMR_2} = \frac{\text{(Value Grade B default in year 2)}}{\text{(Value Grade B outstanding yr.2)}}$$

- Has many of the problems associated with credit scoring models, such as sensitivity to the period chosen to calculate the MMRs

RAROC Models

- Risk-adjusted return on capital
  - One of the most widely used models

RAROC = (One year NI on a loan)/(loan risk)

- Loan risk estimated from loan default rates, or using duration

Using Duration to Estimate Loan Risk

- For denominator of RAROC, duration approach used to estimate loss in value of the loan:

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

Option Models

- Employ option pricing methods to evaluate the option to default
- Used by many of the largest banks to monitor credit risk
- KMV Corporation markets this model widely

Applying Option Valuation Model

- Merton showed value of a risky loan:

$$L(\tau) = Be^{-i\tau}[(1/d)N(h_1) + N(h_2)]$$

- Written as a yield spread:

$$k(\tau) - i = (-1/\tau)ln[N(h_2) + (1/d)N(h_1)]$$

where

$k(\tau)$ = Required yield on risky debt

ln = Natural logarithm

i = Risk-free rate on debt of equivalent maturity

τ = Remaining time to maturity

Pertinent Websites

Federal Reserve Bank	www.federalreserve.gov
Comptroller of the Currency	www.occ.treas.gov
FDIC	www.fdic.gov
Risk Management Association	www.rmahq.org
Federal Housing Finance Agency	www.fhfa.gov
Moody's	www.moodys.com
Standard and Poor's	www.standardandpoors.com

Credit Analysis and Loan Underwriting

- Real Estate Lending
  - Two considerations dominate FI's decision to approve mortgage application:
    - Applicant's ability and willingness to make timely interest and principal repayments
    - Value of borrower's collateral

Real Estate Lending

- Determining a customer's ability to maintain mortgage payments:

GDS = (Annual mortgage payments + Property taxes) / Annual gross income

TDS = Annual total debt payments / Annual gross income

Lending

- Consumer and small-business
  - Similar techniques as mortgage loans
- Mid-market commercial and industrial
  - Annual sales revenues from $5 million to $100 million, recognizable corporate structure, but no access to liquid capital markets
- 5 C's of credit are: character, capacity, collateral, conditions, and capital

Black-Scholes Option Pricing Model

- Model used to value European options:

$$C = N(d_1)S - E(e^{-rT})N(d_2)$$

$$d_1 = \frac{\ln(S/E) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

Model Assumptions

- Capital markets are frictionless
- Constant variability in underlying asset's return
- Log normal probability distribution of underlying asset's price
- Constant risk-free rate that is known over time
- No dividends on underlying asset
- No early exercise on option