Chapter 16

CREDIT RATIONING

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Contents

Handbook of Monetary Economics, Volume II, Edited by B.M. Friedman and F.H. Hahn
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1. Introduction

Credit markets differ from standard markets (for chairs, tables, and pencils) in two important respects. First, standard markets, which are the focus of classical competitive theory, involve a number of agents who are buying and selling a *homogeneous commodity*. Second, in standard markets, the delivery of a commodity by a seller and payment for the commodity by a buyer occur *simultaneously*.

In contrast, credit (in money or goods) received today by an individual or firm is exchanged for a *promise* of repayment (in money or goods) in the future. But one person's promise is not as good as another – promises are frequently broken – and there may be no objective way to determine the likelihood that the promise will be kept.[1] After all, for most *entrepreneurial* investment, the project is sui generis. The need for credit is evidence of change: those who control existing resources, or have claims on current wealth, are not necessarily those best situated to use these resources. They thus transfer control over their resources to others, in return for a promise.

The analysis of credit allocation can go astray in trying to apply the standard supply and demand model, which, as well as it may work for the market for chairs, is not totally appropriate for the market for promises. If credit markets were like standard markets, then interest rates would be the "prices" that equate the demand and supply for credit. However, an excess demand for credit is common – applications for credit are frequently not satisfied. As a result, the demand for credit may exceed the supply at the market interest rate. Credit markets deviate from the standard model because the interest rate indicates only what the individual promises to repay, not what he will actually repay (which means that the interest rate is not the only dimension of a credit contract).

In the United States, a complicated, decentralized, and interrelated set of financial markets, institutions, and instruments has evolved to provide credit. Our discussion of credit rationing will focus on one set of these instruments – loan contracts – where the promised repayments are fixed amounts. At the other extreme, equity securities are promises to repay a given fraction of a firm's profits. A spectrum of securities, including convertible bonds and preferred shares, exists between loans and equity. Each of these securities provides for the exchange of a current resource for a future promise. In our

[1]Moral hazard and adverse selection – special types of behavior we will describe later – may affect the likelihood of loan repayment.

discussion we shall uncover a number of "problems" with the loan market. While some of these problems are addressed by other instruments, these other instruments have their own problems (although we will only be able to discuss these further problems briefly in the space available).

The issue of the allocation of credit has profound implications at both the micro and macro levels. At the micro level, in the absence of a credit market, those with resources would have to invest the resources themselves, possibly receiving a lower return than could be obtained by others. When credit is allocated poorly, poor investment projects are undertaken, and the nation's resources are squandered. Credit markets, of course, do exist, but they may not function well – or at least they may not function as would a standard market – in allocating credit. The special nature of credit markets is most evident in the case of credit rationing, where borrowers are denied credit even though they are willing to pay the market interest rate (or more), while apparently similar borrowers do obtain credit.

At the macro level, changes in credit allocations are one likely source for the fluctuations which have marked capitalist economies over the past two centuries. For example, the disruption of bank lending during the early 1930s may have created, or at least greatly extended, the Great Depression of the 1930s. The availability of credit may also be an effective instrument for monetary policy. One example is that the Federal Reserve often provides liquidity when the financial system is disrupted, such as after the stock market crash of 1987. Another example is that the Federal Reserve has used credit crunches – enforced credit rationing – to slow down an overheating economy.

2. Basic notions

Our discussion of credit rationing in Section 3 relies on certain features of loan contracts and loan markets that make the standard demand and supply model inapplicable and that give rise to credit rationing phenomena. This section provides background about these special features.

2.1. Uncertainty

Differences between promised and actual repayments on loans are the result of *uncertainty* concerning the borrower's ability (or willingness) to make the repayments when they are due. This creates the risk of borrower default. Some aspects of uncertainty may be treated with the standard model, as illustrated by the capital asset pricing model or other models where there is a fixed and

known probability of default.[2] Therefore, default risk is a necessary condition but not a sufficient condition, for the standard model to be inapplicable.

Given that borrowers and lenders may have differential access to information concerning a project's risk, they may form different appraisals of the risk. We refer to *symmetric information* as the case in which borrowers and lenders have equal access to all available information. The opposite case – which we will call generically *imperfect information* – has many possibilities. *Asymmetrical information*, where the borrower knows the expected return and risk of his project, whereas the lender knows only the expected return and risk of the average project in the economy, is a particularly important case.

Uncertainty regarding consumer and (risky) government loans can be described with the same format used for firms, although, of course, the underlying sources of uncertainty are different. For individuals, future income prospects and demographic factors (children in college) illustrate the type of factors that determine repayment prospects. For governments, the willingness to repay may matter as much as the ability to repay; we discuss this special aspect of loan markets further below.

The response of both lenders and borrowers to uncertainty is determined in part by the extent of their risk aversion. Lenders may use credit rationing to reduce default risk, so credit rationing is more likely when lenders have a higher degree of risk aversion. However, we will assume that lenders are risk neutral, since we want to investigate other factors that may be sufficient to create credit rationing. To simplify matters, we will also generally assume that borrowers are risk neutral.[3]

The role of uncertainty is readily evident in loan markets where firms borrow to finance risky investment projects. We will often use a simple, but instructive, framework – where each investment project has precisely two possible outcomes – to illustrate the effects of uncertainty. We will denote the uncertain outcomes as X, with X^a the larger "good" outcome and X^b the lower "bad" outcome ($X^a > X^b$). The probabilities P^a and P^b indicate the likelihood of each outcome (with $P^a + P^b = 1$). The expected value X^c ($= P^a X^a + P^b X^b$) is the central tendency of the outcomes. Several important properties of this framework are worth highlighting.

(1) The economy may contain an array of projects with varying risks and expected returns. The risk of each project can be measured by the difference between X^a and X^b. The comparison of projects is further simplified by

[2]In particular, the standard model may be applicable to credit markets which issue and trade securities that are free of default risk. For example, U.S. Treasury securities are free of default risk because the taxation and money printing powers of the Federal government guarantee repayment. However, other risks, such as inflation risk, apply even to Treasury securities.

[3]There may be less credit rationing when borrowers are more risk averse, but only because risk-averse borrowers may not even apply for risky loans.

assuming a *mean preserving spread* – that all projects (all possible $\{X^a, X^b\}$ combinations) have the same expected value X^e [Rothschild and Stiglitz (1971)].

(2) If each firm has one project, then risk is determined at the level of the firm. If a firm has a portfolio of possible projects, then the evaluation of a firm's risk requires the further identification of which project(s) it carries out.

(3) Although we use the two discrete outcomes model for its analytic convenience, most of our results carry over when projects outcomes are described by a continuous distribution. For such cases, the probabilities associated with the continuous set of outcomes are given by a density function $f(X)$.

2.2. Loan contracts

Uncertainty is important in loan markets because it determines the likelihood of default (a broken promise for repayment). Loan contracts specify the amount borrowed B, and the interest rate r, so that the promised repayment is the fixed amount $(1 + r)B$. As a basic case, we will consider a one-period model in which the borrower repays the loan fully when the outcome X exceeds the repayment amount $(1 + r)B$, and the borrower defaults when the outcome X is less than $(1 + r)B$. We will also consider multi-period models in which more complex loan contracts may be used and where further negotiations may occur after the project outcome is known.

Default on a loan contract creates a conflict between the borrower and the lender. In past eras, lenders relied on debtor's prisons and physical punishment to enforce loan contracts or to punish default. Now, in the case of default, at least for the organized loan markets, lenders have to accept the principle of *limited liability* – a lender's only recourse is to try to claim the assets of the borrower. Specifically, when default occurs and there is only a single lender, we assume that the lender receives the realized outcome X. We comment later on the complications introduced by the costs of bankruptcy proceedings and by the existence of more than one creditor.

Limited liability and the uncertainty of project outcomes jointly determine the actual repayment received by the lender. There are three basic cases, depending on the size of the contracted repayment $(1 + r)B$ relative to the size of the two possible outcomes. If the contracted repayment $(1 + r)B$ is less than the bad outcome X^b, then the lender always receives the contracted repayment. If the contracted repayment $(1 + r)B$ exceeds the good outcome X^a, then the borrower always defaults, and the expected repayment equals the expected outcome of the project X^e.

The main case of interest occurs when the loan repayment falls between the

two possible outcomes, that is when $X^b < (1+r)B < X^a$. The expected repayment is then $P^a(1+r)B + P^bX^b$, reflecting repayment of the contracted amount $(1+r)B$ when the good outcome occurs (with probability P^a) and repayment of the available proceeds X^b when the bad outcome occurs (with probability P^b).

Two fundamental features of loan contracts are illustrated by this result. First, the *expected repayment rises as the loan rate rises*, since the promised repayment $(1+r)B$ rises as the loan rate rises. Second, the *expected repayment falls as uncertainty rises*, since the expected repayment is reduced by a lower value for the bad outcome, but is unaffected by a higher value for the good outcome [at most, the borrower pays back $(1+r)B$]. Once a specific investment project is chosen and the loan rate is set, the borrower and lender participate in a zero-sum game, with the borrower keeping that part of the outcome not repaid to the lender. Consequently, other things the same, lenders prefer safer projects and higher loan rates, while borrowers prefer just the opposite.

Loan contracts also include terms – called non-price terms – which constrain the borrower in order to reduce the likelihood of default. Collateral is among the most important of these. Collateral consists of financial and tangible capital assets that are pledged by the borrower to guarantee at least partial, if not complete, loan repayment. If a loan defaults, then the collateral is used to supplement the proceeds available to the lender (up to the repayment amount). In the extreme case of a fully collateralized loan, the collateral value is sufficient to cover any possible shortfall in loan repayment. In practice, even highly collateralized loans do not generally warrant interest rates as low as the rates on Treasury securities. We will look at some of the reasons for this, including that the value of the collateral may be uncertain and that there may be transactions costs associated with liquidating it.[4] As a result, collateral may reduce, but generally does not eliminate, the risk of default.

2.3. *The classification of borrowers*

Given that the expected repayment depends on the risk character of a project, it is natural for lenders to classify borrowers on the basis of their risk. Under an efficient classification system, riskier borrowers are charged higher interest rates to account for their higher likelihood of default. Banks, for example, use a schedule of quoted interest rates, with the safest borrowers charged the prime rate and riskier borrowers quoted a premium over the prime rate. A premium above prime reflects a higher likelihood of default.

[4]Indeed, in the absence of these problems, the borrower could sell the collateral instead of borrowing.

Borrower classification – based on risk screening – is a main function of the banking system. After appraising the risk of a firm, a bank has a basis for setting the loan interest rate and making the loan. Alternatively, another lender can make the loan, with the bank selling its "screening" service in the form of a guarantee against default.[5] However, competitors may free ride on screening information when it is publicly released. Also, the credibility of bank screening is reduced to the extent that bank funds are not at risk with respect to the outcome. Therefore, for these and other reasons, banks generally integrate their screening and lending activities.

Since a borrower's classification determines the interest rate charged, the efficiency of credit allocation in the economy is dependent on the accuracy of the classification system [see Jaffee and Modigliani (1969) and Stiglitz and Weiss (1981)]. With our decentralized system of banking, competition among suppliers of credit works to eliminate systematic misclassifications. For example, if a firm is classified as excessively risky by one lender, competitive lenders may offer a lower interest rate. However, owing to the intrinsically subjective nature of risk evaluations and judgments, competition in the market for loans is not likely to be as "perfect" as competition in the market, say, for chairs. Even in insurance markets, where actuarial data are available to measure risk, significant variations are sometimes observed in the premia charged for the same risk. All the more so, competition in loan markets will not always eliminate errors in borrower classifications.

Competition is also limited by "customer relationships" between lenders and borrowers. These relationships tend to be exclusive (the borrower has a single lender), both at a moment in time and over time. The market is, to use Okun's terminology, a customer market, not an auction market. The following comments refer to some of the loan market features that create a need for exclusive relationships between borrowers and lenders. The first three points refer to exclusivity at a point in time and the last three to exclusivity over time.

(1) Since the costs of information for determining the likelihood of default are predominantly sunk costs, there is an economy of scale in funneling all of a firm's credit needs through one lender. For similar reasons, lenders tend to specialize in making loans to particular industries. As a result, there is a tendency toward natural monopoly – not in banking as a whole, but in the supply of credit to a particular person, firm, or industry.[6]

(2) Borrowers have an incentive to take actions that raise the probability of default, as when a firm with several investment projects chooses the most risky

[5]For example, the World Bank is starting to separate its screening and lending functions by establishing an insurance firm to guarantee loans, thus enabling countries to raise funds directly in world capital markets.

[6]Risk aversion and other arguments for diversification work in the opposite direction. Large banks, however, can make large loans and still obtain the benefits of diversification. See Stiglitz (1985).

one (because it provides the highest expected return). A lender can respond by placing restrictive clauses in a loan contract, but the borrower's actions may not be fully foreseen and costs may arise in later renegotiating such clauses. Alternatively, lenders can influence the borrower's incentives, without directly monitoring the borrower's actions, by controlling the size of the loan and related terms of the loan contract. The returns from controlling the size of the loan, however, may accrue to all of the firm's lenders, which leads to the next point.

(3) Several important *public good* problems are associated with any classification of creditors. These problems arise when events occur which provide the creditors, as a class, with some discretion over the actions of the firm. For instance, many loan contracts contain a clause that states that the loan is in default if any loan of the borrower is in default. This clause ensures that the lender can maintain control of the collateral and can represent his interests in the event of a reorganization of the borrowing firm. These public good problems become paramount when bankruptcy occurs and the majority of the creditors of any class must agree to any settlement. By the same token, monitoring the firm's activities, to ensure that these adverse contingencies do not arise, is a public good, the return on which accrues, at least to some extent, to all creditors [Stiglitz (1985)]. In brief, there is a natural incentive to concentrate the sources of credit.

(4) Continuing relationships provide cost savings for lenders who make a sequence of loans to the same borrower, since information obtained at one date may also be used to assess risk at a later date. These cost savings are also important for lines of credit, which are the basis for many business, credit card, and consumer loans.[7] In these cases, continuing customer relationships provide the current lender a distinct advantage over competitors in assessing the current riskiness of its customers.

(5) As a result of the information provided by a long-term customer relationship, competitors may fear that winning away a customer means that the previous lender learned of adverse developments. This illustrates clearly why Akerlof's (1970) "lemons" principle is an important factor in loan markets.

(6) Finally, the threat of termination of credit acts as an important incentive device to encourage the firm to undertake safer actions this period [Stiglitz and Weiss (1983)]. It is sensible that these "moral hazard" problems can be better handled when there are exclusive relationships [see Arnott and Stiglitz (1985)].

Exclusivity arrangements limit, but do not eliminate, competition. When a

[7]Credit lines allow loans to be contracted on a forward basis. A credit line may serve an insurance purpose: either protecting the borrower against an unexpected change in credit rating (if the loan rate is fixed relative to the prime rate) or, less commonly, against a change in the level of interest rates (if the specific level of the loan rate is fixed).

new borrower enters the market, for example, there will be competition to become that firm's supplier of credit. Competition is limited, however, to the extent that the costs of gathering information are sunk costs. So, given the amount of ex ante competition, there will be less ex post competition. Hence, a misclassification of a borrower's risk category may not be easily corrected through competition.

2.4. *The sources of loanable funds: Banks and bank deposits*

Lenders obviously need funds to make loans, so the cost and availability of loanable funds necessarily interacts with loan market activity. We will adopt the descriptive shorthand of referring to lenders as "banks", and their sources of loanable funds as safe "deposits". However, the following points indicate how the analysis generally applies to all types of lenders.

(1) *Bank lending is typical of most lending.* Although bank loans are the dominant form of credit in many countries, capital market instruments, such as bonds, are also used for credit transactions. Capital markets and loan markets share similar problems, and solve many of them in comparable ways, as the following examples illustrate:

(a) The underwriting process for new risky bonds is intensive in gathering information concerning the borower's credit worthiness, and the likelihood of default is reflected in the rate of return required by investors.[8]

(b) Credit ratings are used to classify risk level (although the screening and lending functions tend to be separated more in capital market transactions than in lending transactions).

(c) Restrictive covenants in corporate bond contracts are comparable to non-price terms in loan contracts, both reflecting attempts by lenders to control the extent of default risk.[9]

(d) Only the low-risk bonds issued by the U.S. Treasury and AAA corporations trade in standard demand and supply markets.

(2) *Bank deposits can be treated as safe securities.* For simplicity, we treat deposits – the source of loanable funds – as though they were free of default risk. This is actually the case with respect to bank deposits insured by federal deposit insurance. Even without such insurance, depositors generally receive the fixed return promised by a bank because banks hold diversified portfolios

[8]The links between bank loan markets and the capital markets are further increased by the new process of "securitization" in which banks package portfolios of their loans for sale in the capital markets.

[9]Myers (1977) has emphasized the importance of restrictive corporate bond covenants for understanding the financing behavior of corporations (including why the Modigliani–Miller theorem may fail to hold).

of loans and their capital and loan loss reserves provide a further tier of protection.[10]

(3) *The banking industry is competitive.* This assumption applies to free entry into the banking system as a whole, even though each bank is likely to maintain exclusivity in its customer relationships. Until 1980, bank competition in the United States was limited by Regulation Q deposit rate ceilings and by various restrictions on bank charters, mergers, statewide branching, and interstate banking. However, deregulation legislation and related developments have now removed most of the reasons for expecting bank markets to be less (or more) competitive than say the market for chairs. Consequently, free entry and zero expected profits are our maintained assumption, but imperfect competition is considered where it may be relevant.

Competition causes expected bank profits to be zero, so banks pass through their expected earnings on loans (net of operating costs) to depositors as interest payments. Even though deposit rates equal expected loan returns, an additional relationship is required to determine the common *level* for the two rates. One possibility is to use the market-clearing condition of the Walrasian demand and supply model – that the demand for loans (by borrowers) equals the supply of deposits (by depositors) – to determine the equilibrium level of the two rates.

Another possibility, developed below in Section 3, is that special features of loan markets cause loan rates to be *endogenously* determined below the Walrasian market-clearing level. To illustrate how this might work, without going too far ahead, let us suppose that a binding *usury ceiling* exogenously restricts loan rates below their Walrasian equilibrium level.[11] Competition will force expected bank profits to be zero, so deposit rates must settle at the same low level as the usury ceiling (default risk aside). As a result, there will be an excess demand for loans – a simple example of credit rationing.

Imperfect competition in deposit and loan markets does not fundamentally change the situation. If the special features of loans are ignored, then following the standard model of *monopoly*, banks will maximize their profits by equating the marginal cost of deposits with the marginal expected return on loans, while satisfying all loan demand. On the other hand, if the special features of loans cause loan rates to be quoted at a level lower than the monopoly level, then a continuing state of excess demand may exist, just as in the competitive case.

[10]The recent experience of S and L's, however, suggests that in the absence of deposit insurance, the reserves and capital may not suffice to protect depositors. The losses that depositors suffer as a result of bank runs raise a different issue – bank liquidity – as discussed by Diamond and Dybvig (1983).

[11]Although the ecclesiastical sources of usury ceilings have presumably long passed, similar ceilings still exist in many states in the United States as part of consumer protection laws for unsecured consumer and credit card loans.

Banks may also internally connect loans to deposits when the external markets for these securities function imperfectly. *Compensating balance requirements*, for example, are a contractual arrangement whereby a borrower or a holder of a line of credit is required to maintain a specified level of deposits in the bank. This arrangement can be interpreted as a "time-sharing" plan, whereby a firm receives the right to borrow from time to time as part of its compensation for maintaining deposits in the bank. Such arrangements may allow banks to equilibrate the supply of deposits and the demand for loans even when Regulation Q deposit ceilings and usury loan ceilings constrain the market levels of interest rates. Banks may also use these arrangements to monitor a firm's financial condition by observing the patterns and trends in its deposit balances.

In summary, loan and deposit markets involve three different interest rates: (1) the *quoted loan rate* determines the amount that borrowers promise to repay; (2) the *expected return* on a loan is the quoted rate adjusted for the lender's expected loss if default occurs; and (3) the *deposit rate* is the rate paid to depositors to raise loanable funds. Under competition, the deposit rate determines the expected return a bank must earn on each loan. That is, a bank determines the quoted rate for each loan so that it earns the required return; or, if this is not possible, the bank will not make the loan.

2.5. *Definitions of credit rationing*

Credit rationing is broadly defined as a situation in which there exists an excess demand for loans because quoted loan rates are below the Walrasian market-clearing level. There are a number of different types of credit rationing depending on how excess demand is defined, on whether the excess demand is temporary or continuing, and most importantly, on the factors that cause the loan rate to be depressed. Given the number of possible variations, definitions of credit rationing have often been a source of confusion in the literature. For this reason, we list here several common definitions of credit rationing and remark on the extent to which they are or are not relevant to the issues we address.

(1) *Interest rate (or price) rationing*. A borrower may receive a loan of a smaller size than desired at a given loan rate. To obtain a larger loan, the borrower has to pay a higher rate.

Remark. This describes standard price rationing and is not relevant to our discussion of credit rationing. Of course, it is sensible that a borrower has to pay a higher rate on a larger loan since the probability of default tends to be higher on a larger loan. In contrast, it is striking that a large part of the literature for monetary economics and corporate finance assumes that there

exists a market in which people or firms can borrow as much as they like at fixed rate of interest [see Stigler (1967) and Stiglitz (1970)].

(2) *Divergent views rationing.* Some individuals cannot borrow at the inte est rate they consider appropriate based on what they perceive to be the probability of default.

Remark. Although lenders relative to borrowers may commonly have mo pessimistic appraisals of default risk, this is also not the focus of our analysis credit rationing.[12] For example, if the Treasury bond rate is 8 percent, the fa that most firms are "excluded" from the market for 8 percent loans simp reflects the market's judgment that loans to these firms are risky. From th perspective, a borrower's perception of his risk is mainly relevant as a fact determining his demand for credit.

There is an analogous kind of rationing in labor markets: there may be a excess supply of those willing to be president of General Motors at the goi market wage, but (at least in the neoclassic story) the reason that the preside of GM receives such a high wage is that he has "more efficiency units": he equivalent to, say, 100 ordinary laborers. A person who could only supply efficiency units (even working 24 hours a day) would thereby be excluded fro the market for GM president.

(3) *Redlining.* Given the risk classification, a lender will refuse to gra credit to a borrower when the lender cannot obtain its required return at a interest rate. Moreover, loans which are viable at one required rate of retu (as determined by the deposit rate) may no longer be viable when the require return rises. (The term redlining originally referred to the cross-hatched ma used by urban mortgage lenders to designate neighborhoods in which the would not lend. Our use of the term does not imply any type of discriminato behavior.)

Remark. The possibility of redlining is easily illustrated in an extrem example where the borrower's project has a single outcome X^m. If the require return is δ, then a loan in excess of $B^* = X^m/(1+\delta)$ clearly cannot yield th required return, so the firm will be rationed out of the market. The same resu can apply to the expected return on a loan when there are various possibl project outcomes.

In a similar fashion, a firm, which received a loan when the supply deposits was high and the deposit rate was low, may be rationed when th supply of deposits shifts and the deposit rate rises. This happens because "promise" to pay a higher rate on a loan may not translate fully (or even at al into a higher expected return for the lender. For these firms the availability credit (the supply of deposits) – not the quoted loan rate – determines whethe

[12]Divergent views on loan repayments are common because they refer to the fulfillment of promise, not to an actuarial event such as whether or not it will rain.

a they can borrow. These firms would feel they are being rationed out of the market.[13]

r- (4) *Pure credit rationing*. There may be instances in which some individuals ir obtain loans, while *apparently identical individuals*, who are willing to borrow at precisely the same terms, do not.

:e *Remark*. This is the purest form of credit rationing, and we show below how ɔf it may arise when there is imperfect information. When it does arise, changes ct in the availability of credit, not changes in the interest rate, *may* determine the ly extent of borrowing.

is We also show that redlining (type 3 credit rationing) may be nearly ɔr indistinguishable from pure credit rationing (type 4) when lenders classify borrowers into a large number of groups so that each group has a small number ın of borrowers. In this case, borrowers in a redlined group may have *nearly* the ıg same features as the borrowers in a group that does obtain loans.

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ɔ0 ### 2.6. The earlier credit rationing literature: Brief review

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The literature on credit rationing can be conveniently separated into two parts: nt an earlier literature based on various loan market imperfections; and a current ıy literature based on imperfect information. Imperfect information was sugges- rn ted as a factor in loan markets by Akerlof (1970) and Rothschild and Stiglitz ɔd (1971), and was first applied in a model of credit rationing by Jaffee and ps Russell (1976). We briefly review the earlier literature in this subsection before ɔy turning to the current imperfect information theories.

ry The earliest references to credit rationing pertain to usury ceilings [Smith (1776)] and to the English banking and currency controversies of the ne nineteenth century [Viner (1937)]. Modern references to credit rationing begin ɔd with Keynes' discussion of an "unsatisfied fringe of borrowers" in his *Treatise* he *on Money* (1930, I: pp. 212–213; II: pp. 364–367):

ılt

ıle So far, however, as bank loans are concerned, lending does not – in Great Britain at least – take place according to the principles of a perfect market. of There is apt to be an unsatisfied fringe of borrowers, the size of which can be he expanded or contracted, so that banks can influence the volume of invest- a ment by expanding or contracting the volume or their loans, without there ll) being necessarily any change in the level of bank-rate, in the demand-

of

ıer [13]It has been debated whether redlining should be called credit rationing since, in the market's judgment, redlined borrowers cannot provide the bank its required rate of return (in an expected value sense). These borrowers are "rationed" out of the market in the same way that an individual ıf a who cannot afford a $200 000 automobile is rationed out of the car market because the lender does not believe that the auto loan will be repaid.

schedule of borrowers, or in the volume of lending otherwise than through the banks. This phenomenon is capable, when it exists, of having great practical importance.

Keynes did not actively pursue this notion in his later work, but it became part of the "availability doctrine", or "new view", of monetary control at the Federal Reserve in the United States following World War II. The availability doctrine was primarily macroeconomic in its outlook (we consider it later in this regard), but it started a microeconomic literature concerned with the theoretical underpinnings of credit rationing behavior.[14]

2.6.1. *The risk of default as the basis of credit rationing*

Hodgman (1960) was among the first to consider the risk of default as the reason a rational bank might not raise its quoted loan rate even though it faces an excess demand for loans. Hodgman's model looked at a risk-neutral bank that is making a one-period loan to a firm. The firm's investment project provides possible outcomes X, bounded by $k < X < K$, with the probability density function $f[X]$. The contracted repayment equals $(1 + r)B$, based on the loan B and the lending rate r. If default occurs, the bank receives the available proceeds X.

The bank is assumed to obtain its funds in a perfect deposit market at the constant interest rate δ. For the single borrower, the bank's expected profits Φ are then written:

$$\Phi = \int_{k}^{(1+r)B} Xf[X]\,dX + \int_{(1+r)B}^{K} (1+r)Bf[X]\,dX - (1+\delta)B\,. \tag{2.1}$$

The first term accounts for the bank's income X when there is default $(X < (1 + r)B)$, the second term for the income $(1 + r)B$ when the loan is repaid in full, and the third term for the bank's cost of funds $(1 + \delta)B$. The bank's decision variables are the quoted loan rate r and the size of the loan B.

This formulation can be used to derive the bank's loan offer curve for the borrower, showing the size of the loan offered B for each loan rate r. Under competition, the offer curve is simply the zero profit locus of contracts for which the bank's expected profit Φ is zero. The loan offer curve, as illustrated in Figure 16.1, has three basic properties:

(1) It is a horizontal line at the deposit rate δ over the range of small loan sizes where the loan is risk-free $(B < k/(1 + \delta))$.

[14]This literature has been surveyed in Lindbeck (1962), Jaffee (1971), Koskela (1976, 1979), and Baltensperger (1978).

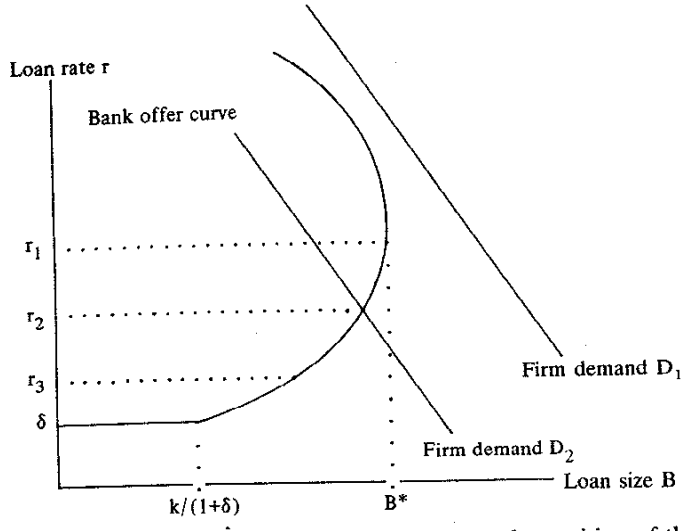

Figure 16.1. A bank loan offer curve and alternative cases for the position of the borrowing firm's demand curve.

(2) It has a positive slope over the range where the probability of default rises with the size of the loan, as higher loan rates compensate the bank for the higher likelihood of default on larger loans.

(3) There may be a maximum loan size B^* beyond which the offer curve becomes backward bending. Otherwise, were the loan rate r and the size of the loan B to rise together over the full range, at some point the contracted repayment $(1 + r)B$ would equal the firm's best possible outcome K and default would be certain.

Freimer and Gordon (1965) used the loan offer curve construction to develop a redlining theory of credit rationing. Their point was that the size of the loan demanded by an individual borrower could exceed the size of the loan offered at any interest rate, as illustrated by demand curve D_1 in Figure 16.1.[15] Hence, the size of the loan demanded might exceed the maximum size of the loan the lender was willing to offer. The model, however, did not carefully delineate between the information available to the borrower and to the lender, so that the type of credit rationing was unclear. These issues are clarified by the theories of credit rationing discussed in Section 3 that focus on imperfect information.

Rationing is eliminated when the demand curve intersects the offer curve, as illustrated by the demand curve D_2 in Figure 16.1. In this case, the loan

[15]This assumes the offer curve is the locus of contracts with zero expected profits. Freimer and Gordon, in fact, assume the lender is a monopolist making all or nothing loan offers, but similar considerations apply. In particular, along the loan offer curve, the probability of default approaches 1 as the loan rate approaches infinity.

demanded and the loan offered are equal at the market-clearing rate r_2, so credit rationing – in terms of the size of loan – will occur only if the quoted rate loan is maintained below r_2. Several alternative approaches were taken to motivate why quoted loan rates might be maintained below the market-clearing level. However, as we will now see, they are all based on exogenous institutional factors.

2.6.2. *Borrower classification*

The credit rationing theory of Jaffee and Modigliani (1969) used the fact that banks classify borrowing firms into a small number of groups based on objective factors such as industry affiliation and firm size. Each bank determines a single interest rate for each group, even though the firms within a group may be diverse with respect to risk and the amount of their loan demand. Banks deal with the diversity by rationing those firms within the group which have a loan demand that exceeds the loan offer.

The demand curve D_2 in Figure 16.1 can be interpreted as applying to a particular firm in the group for which r_3 is the group loan rate. Jaffee and Modigliani demonstrate that even when the group loan rate is selected to maximize bank profits (over the group), some firms in the group are necessarily in the situation illustrated. These firms, in other words, face credit rationing because the bank recognizes that they have above average demand or above average risk – so the size of the loan offered to these firms is smaller than the size they demand. A firm might prefer to pay a higher interest rate to obtain a larger loan, but this would conflict with the purpose of the classification scheme, namely to simplify rate-setting with just one rate for each group.

2.6.3. *Customer relationships*

In a related approach, Hodgman (1963) and Kane and Malkiel (1965) used customer relationships to motivate why banks set loan rates below the market-clearing level of r_2. These models assumed that firms provide banks with deposits on a continuing basis and in return the firms receive a priority status for their loans. A priority status for loans is valuable precisely because banks maintain loan rates below the market-clearing level. Consequently, the model implies an equilibrium in which banks set loan rates below the market-clearing level, and then give priority to borrowers with established bank relationships.[16]

The main shortcoming of these earlier formulations of the customer relationship theory is that they fail to explain why bank competition for deposits and loans does not cause deposit and loan rates to reach market-clearing levels.

[16]A similar mechanism may occur in labor markets when firms pay wages above the market-clearing level, and then use the threat of dismissal to discipline workers [see Shapiro and Stiglitz (1984)].

Federal deposit rate ceilings used to provide one explanation for why deposit rates might be constrained, but bank deregulation has now eliminated these ceilings. In contrast, the theories of credit rationing discussed in the next section show that imperfect information provides a consistent explanation of why loan rates might be maintained below the market-clearing level and why customer relationships remain so important.

As another variant of the customer relationship, Fried and Howitt (1980) provided an implicit contract theory of credit rationing in which banks provide firms with loan rate guarantees as part of risk-sharing arrangements. The implicit contract notion, adopted from labor economics, is a generalization of the customer relationship. Fried and Howitt applied the concept to cases where firms acquired protection against unexpected increases in their borrowing costs, and they showed that what may appear as credit rationing can result as long as it is costly to break contracts. The theory is subject, however, to the same objections raised with regard to implicit contracts as a theory of unemployment in labor markets.[17]

In summary, the theories reviewed in this section adopt the special characteristics of loan markets – such as the likelihood of default, the use of borrower classification schemes by banks, and the exclusive customer relationships that arise between banks and borrowers – to motivate why banks set loan rates below the market-clearing level and then use credit rationing to balance the demand and supply of credit. There is little doubt that these are important features of loan markets and are part of the credit rationing process. However, the theories fail to explain the origins of the features as an integrated part of their models. In contrast, we now turn to theories based on imperfect information, which consistently explain both credit rationing and the special characteristics of loan markets.

3. Credit markets with imperfect information[18]

In this section we present the basic argument for why there may be credit rationing in markets with imperfect information. In Figure 16.2 we have

[17]Implicit contracts do not provide a complete theory of rigid wage rates (or interest rates) because the allocative role of the wage rate depends on the shadow price of labor for the marginal worker, and this price may still be variable. See, for example, Stiglitz (1986).

[18]Large parts of this section are based on Stiglitz and Weiss (1981). The model with incentives effects was independently analyzed by Keaton (1979). Recent surveys of the literature are provided by Baltensperger and Devinney (1985) and Clemenz (1986).

The fact that markets in which there is imperfect information may be characterized by non-market-clearing equilibria was noted in Stiglitz (1976a). In labor markets, models generating these unemployment equilibria are referred to as efficiency wage models, as a result of the close affinity of these models with those in which wages affected labor quality because of nutritional effects [Leibenstein (1957), Mirrlees (1975a, 1975b), and Stiglitz (1976b)]. For recent surveys, see Stiglitz (1987) and Yellen (1984).

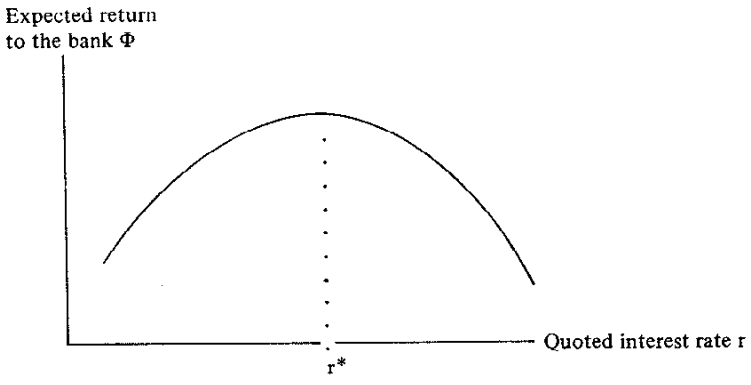

Figure 16.2. The quoted interest rate r^* maximizes the expected return to the bank.

plotted the expected return earned on a loan as a function of the *quoted* (or *promised*) interest rate. Raising the rate of interest charged does not result in a proportionate increase in the receipts of the lender, because the probability of default may rise. Indeed, if the probability of default rises enough, the return to the lender may actually decrease, as depicted in the figure. We denote the quoted rate at which the lender's expected return is maximized as r^*. No bank will ever charge more than r^*.

To see how credit rationing – a situation where there is an excess demand for credit – may persist, recall the standard argument for market clearing. There it is argued that if the demand for credit exceeds the supply of credit, lenders will raise the rate of interest charged, which will increase the supply and decrease the demand, until market clearing is restored. But at r^*, no bank has an incentive to raise its interest rate, because doing so only *reduces* the return it receives. This is why the Walrasian (market-clearing) interest rate may not be the equilibrium interest rate. Indeed, whenever the Walrasian interest rate occurs at a level in excess of r^*, the market equilibrium is characterized by credit rationing: each bank would find it in its interest to lower the interest rate to r^*, even though the demand for credit exceeds the supply.[19]

Therefore, to obtain credit rationing, it is only required that the expected (certainty equivalent) return received by the lender does not increase monotonically with the rate of interest charged.[20] There are two basic reasons why the relationship between the interest rate charged and expected receipts may not be monotonic: adverse selection effects and adverse incentive effects. These are now discussed in turn.

[19]With multiple Walrasian equilibria, if there is any Walrasian equilibrium with r in excess of r^*, then there exists a credit rationing equilibrium, though there may also exist another market-clearing equilibrium.

[20]That is, if there is ever a region of non-monotonicity, there is some supply of credit (funds) function such that the Walrasian equilibrium lies in the downward-sloping portion of the curve. In this case, there will be credit rationing.

3.1. Adverse selection effects

As the interest rate is increased, the mix of applicants changes adversely; safe potential borrowers drop out of the market. This is the *adverse selection effect.* Stiglitz and Weiss (1981) suggested several reasons why there might be an adverse selection effect.

They couched their analysis in terms of a specific example, where the bank (lender) had categorized potential borrowers by the mean return on their investment projects. For simplicity, all investment projects were assumed to be of the same size, and there was no collateral.[21] The return to the lender is

$$\Phi = \min\{(1 + r), X/B\} ,$$

where X is the return to the project, and B is the size of the loan. That is the lender either receives the promised amount, or the firm goes into bankruptcy. They ignored bankruptcy costs, and assumed that the returns in the event of bankruptcy would be divided among the lenders. In Figure 16.3 we plot the return received by the lender as a function of the return on the project, X. It is a concave function. On the other hand, the return to the borrower is

$$\pi = \max\{0, X - (1 + r)B\} .$$

Because of limited liability, the lowest return he obtains is zero (the return function can be modified by collateral as we indicated earlier). This is a convex function. The analysis then has three steps:

(1) Because of the convexity of the firm's profit function, borrowers whose

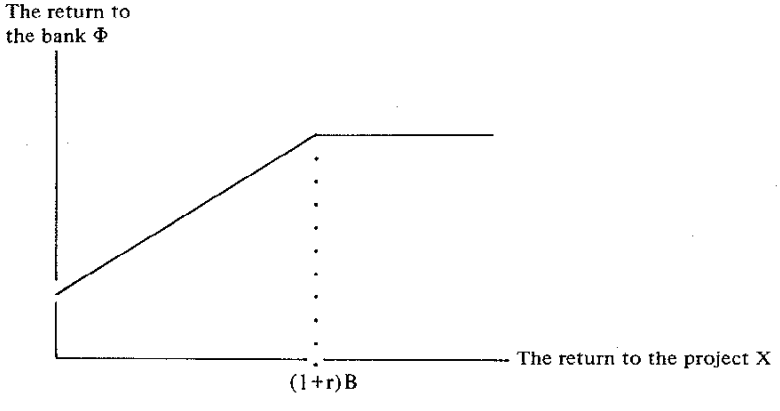

Figure 16.3. The return to the bank is a concave function of the return on the project.

[21] We will later remove both of these assumptions.

return is riskier (in the mean-preserving sense) have a higher expected profit. We denote the riskiness of a project (firm) by θ, with higher θ representing greater riskiness. If (risk-neutral) borrowers have to put up a fixed amount of equity of their own, e_0, then a project will be undertaken if

$$E\pi > e_0(1+\delta)\,.$$

Since the expected profit depends on a project's risk, there exists a risk level $\bar{\theta}$ such that firms with $\theta > \bar{\theta}$ undertake the investment, while others do not. We plot $E\pi - (e_0(1+\delta))$ as a function of θ in Figure 16.4.

(2) An increase in the quoted rate r reduces the expected profits for all borrowers. This downward shift in the $E\pi$ curve means that the critical value of θ is higher, so fewer firms will demand loans. Moreover, it is the safest firms – those with the lowest value of θ – which drop out of the market. This is the adverse selection effect.

(3) The negative effect on the lender's expected return can now easily be seen. Because of the concavity of the lender's return function, the expected return to the lender is smaller with higher θ; this follows immediately given our assumption that all projects in the given category have the same expected return. If the expected return to the borrower for high-risk projects is higher, then the expected return to the lender must be lower. Thus, the total expected return – averaged over all applications for loans – may either increase or decrease when the interest rate r is increased. There is a positive direct effect, but a negative adverse selection effect, as the best risks (those with the lowest θ) drop out of the market.

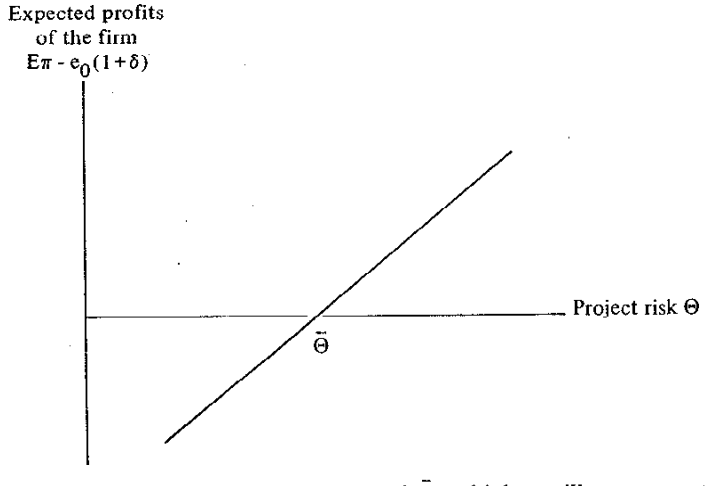

Figure 16.4. Only firms with projects at risk level $\bar{\theta}$ or higher will carry out their projects.

The fact that the adverse selection effect can easily outweigh the direct effect can be seen most easily in an example with just two groups in the population, groups a and b, with each group having two possible outcomes. The unsuccessful outcome for both groups is a return of 0. The successful outcome for the groups are X^a and X^b and the probabilities of success are P^a and P^b, respectively. We further assume that

$$X^a < X^b \quad \text{and} \quad P^a > P^b, \quad \text{with} \quad P^a X^a = P^b X^b,$$

so that the mean returns are equal but group a is safer and group b is riskier. We also set the loan size B equal to 1. Thus, if the good group a represent a proportion Γ of the total population, and all individuals apply for loans, the mean gross return to the lender is

$$(1+r)\bar{P}, \quad \text{where} \quad \bar{P} = \Gamma P^a + (1-\Gamma)P^b,$$

while if only the high-risk individuals apply, the mean gross return is

$$(1+r)P^b.$$

There is a critical interest rate, r^*, at which the safer borrowers stop applying. Thus, the return to the bank declines precipitously at r^*, as illustrated in Figure 16.5.

An adverse selection effect arises because a higher loan rate affects the safer borrowers – who anticipate they will always repay the loan – more than it does the riskier borrowers – who will recognize that the loan rate does not matter in situations where they have to default on the loan. (At the extreme, an individual who was fairly sure he would not pay back the loan fully would be

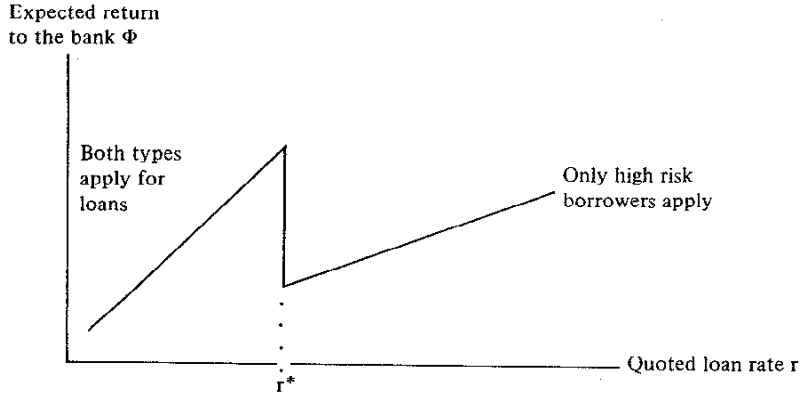

Figure 16.5. The determination of the optimal loan rate.

almost indifferent to the promised rate of interest.) Thus, raising the loan rate r adversely affects safer borrowers more than riskier borrowers.

The argument that a higher loan rate creates an adverse selection effect may become even more cogent in a competitive setting, in which loan applicants apply to several different banks. If one bank then raises its quoted loan rate, it knows that only those borrowers who have been refused loans at all other banks will accept its loans. If the bank is not confident about its judgment of the riskiness of the loan applicant, the fact that other banks have rejected the given applicant conveys a lot of information. When the given bank is quoting precisely the same rate as all other banks, then the same information is not conveyed when a borrowers accepts a loan.[22]

3.2. *Adverse incentive effects*

As the interest rate is increased, applicants undertake riskier projects. We call this the *adverse incentive effect*. Of course, lenders could try to control directly the actions of borrowers, but unfortunately, monitoring is costly and never perfect. Thus, lenders must resort to *indirect control* mechanisms. That is, lenders know that the behavior of a borrower is affected by the terms of the contract, including the interest rate. This is the basis of a key result of Stiglitz and Weiss that we will now demonstrate – that the risk-taking of borrowers rises as the interest rate they are charged rises.

This is seen most simply in the case of a firm with two techniques, a and b, which are described exactly as were the two projects in the previous subsection, the only difference being that they now reside within a single firm. The net expected return to the firm from undertaking project i(= a or b) is $P^i(X^i - (1+r)B)$, which declines with r.

We plot the return in Figure 16.6, where the slope of the expected return function is $-P^iB$. The return on the safer project a decreases more with an increase in the interest rate because the safer project is more likely to have to pay the promised rate. The firm undertakes the project with the highest expected return; from the figure, it is apparent that for $r < r^*$, the firm undertakes the safer project; for $r > r^*$, the riskier one. [The gross return to the bank if the firm undertakes project i is $(1+r)P^i - B$, with the safer project

[22]This argument is weaker, at least for small changes in interest rates charged, in the context of the customer markets discussed in earlier sections. On the other hand, a bank which suddenly charged a rate in excess of that charged by other banks would suffer a loss of reputation, and accordingly might find it more difficult to recruit borrowers.

A bank may deal with this problem by conditioning the extension of its loan to the provision of matching credit by some other bank. This is another illustration of the public good aspect of loan markets.

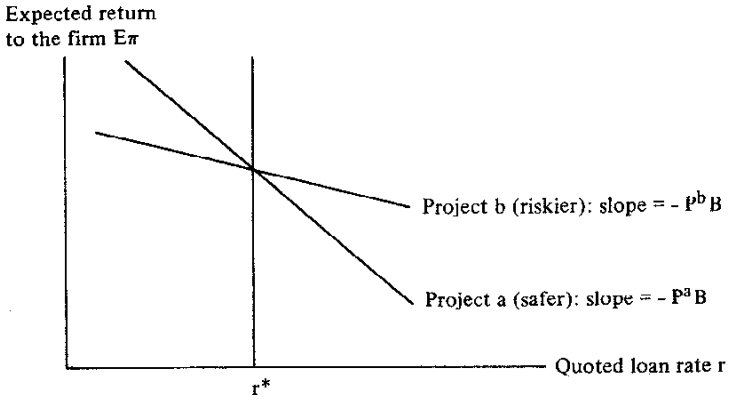

Figure 16.6. The safer project is chosen at loan rates below r^*, the riskier project at loan rates above r^*.

undertaken if $r < r^*$. Thus, there will be a precipitous decline in the bank's return at $r = r^*$, similar to that illustrated in Figure 16.5.]

3.3. Credit rationing with many groups

When there are many groups in the population (distinguished in whatever manner), quoted rates will be set for each group to make the expected return on loans in each group equal to the deposit rate. In competitive equilibrium, all loans must have the same expected return, this rate representing the cost of deposits. Thus, we can divide the groups into three types, as illustrated in Figure 16.7.

Type 1 borrowers are completely denied credit – they are "redlined" (credit

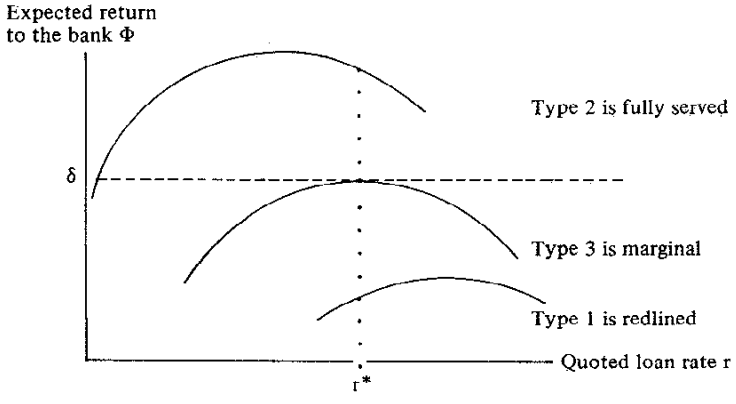

Figure 16.7. Credit rationing status of different borrower groups.

rationing definition 3) because there is no interest rate at which the lender's expected return reaches the required return.

Type 2 borrowers are fully served because banks actively compete to make them loans. That is, the expected return on their loans (which equals the deposit rate) is less than the maximum expected return a bank could earn with a higher quoted rate.

Type 3 borrowers are the *marginal group*. They are rationed in the strongest sense of the term (credit rationing definition 4): some members of this group received credit, while other, apparently identical members (in terms of observable characteristics), are denied credit. Banks obtain the required return from members of this critical, marginal group by charging them the interest rate which maximizes the expected return.

Reduced credit availability always has its first impact on the marginal group: more of these borrowers become rationed, while the interest rate charged borrowers in this group may not change at all (the expected return is already maximized). Moreover, a sufficiently large reduction in credit availability will be reflected as a change in the marginal group. In this case, the interest rate will be adjusted, the old marginal group will be totally excluded from loans, and the new marginal group will be partially excluded from loans.

Riley (1987) has suggested that the credit rationing of the marginal group is significant only when the number of groups is small. His point is that, as the number of groups increases, the number of borrowers in the marginal group falls, so the extent of this credit rationing falls. In the limit, the marginal group would consist of just one borrower.

Stiglitz and Weiss (1987b) have responded that redlining (credit rationing definition 3) and pure credit rationing (credit rationing definition 4) may be nearly indistinguishable when there is a continuum of groups. This happens because there are groups just above the marginal group who are not rationed and groups just below the marginal group who are redlined. The characteristics of these two groups will converge when there is a continuum of groups. Consequently, the situation is effectively one of pure credit rationing, namely that among groups of (nearly) indistinguishable borrowers some are credit rationed and some are not. The extent of this kind of "nearly" pure rationing may not diminish as the number of types increases.[23]

3.4. *Some comparative statics of credit rationing*

Changes in uncertainty have an ambiguous effect on the quoted loan rate. For example, as the economy goes into a recession, it is plausible that the expected

[23]Stiglitz and Weiss (1987b) also point out that there are many natural extensions of their basic model in which credit rationing occurs at several, or even all, contracts. An example of such a model with collateral is discussed in Subsection 4.3 below.

return falls, given the quoted interest rate; but there is no a priori reason to believe that the quoted interest rate at which the expected return is maximized will either increase or decrease, as illustrated in Figure 16.8.

Consider first the incentives model. The curve relating a bank's expected return to its quoted interest rate can be derived from a more fundamental curve, which relates the probability of default to the quoted interest rate. It is more convenient to depict the bankruptcy probability as a function of $1/1 + r$; for the slope of this curve is just $P/(1/1 + r) = P(1 + r)$, the expected return. Hence, the bank's optimal interest rate is that interest rate at which the slope of a line from the origin to the curve is maximized. An increase in uncertainty (associated with a move into a recession) may be thought of as shifting this curve upwards; at each r there is a higher probability of bankruptcy. But there is no easy way of seeing whether the interest rate at which the slope is maximized is likely to increase or decrease.

We illustrate this with the case where there are only two types of activities, the safer (a) and the riskier (b). The critical interest rate, where the expected return to the borrower is the same if he undertakes either project a or b, is

$$1 + r^* = [P^a X^a - P^b X^b]/[P^a - P^b]. \tag{3.1}$$

If as the economy goes into a recession, the probability of success of both safer and riskier projects is reduced proportionately, then there is no change in the quoted rate of interest, in spite of the reduction in the expected return to loans. All of the adjustments must occur then through loan availability. On the other hand, if, as the economy goes into a recession, risky projects have their success probabilities reduced more than proportionately, then the quoted rate of interest will increase in a recession,[24] in spite of the fact that the demand for

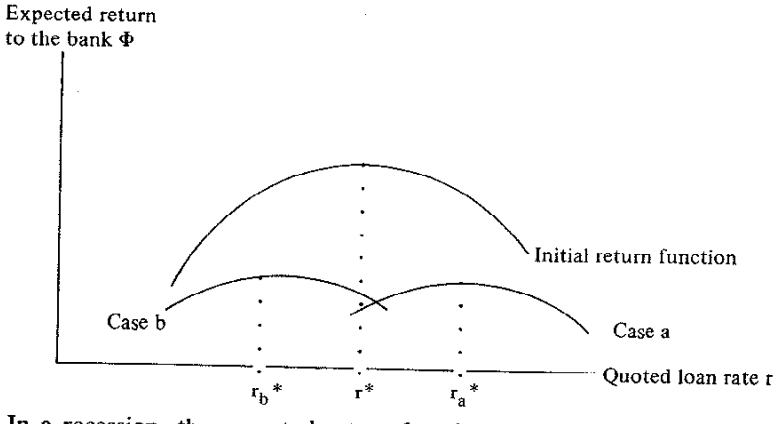

Figure 16.8. In a recession, the expected return function shifts down, but the optimal loan rate may increase (case a) or decrease (case b).

[24]Define $\tau = P^a/P^b$. Then we can rewrite equation (3.1) as $1 + r^* = [\tau X^a - X^b]/[\tau - 1]$. Differentiating with respect to τ, we obtain $dr^*/d\tau = -[X^a - X^b]/[\tau - 1]^2 > 0$.

loans has decreased: it is easier to discourage borrowers from undertaking riskier loans when the threat of bankruptcy is greater.[25]

Similar results obtain when adverse selection effects are the reason for credit rationing. Again, consider the two-group case. The critical interest rate at which the safe borrowers drop out may increase or decrease in a recession. The greater uncertainty associated with any project means that, at a fixed expected return for the project, the expected return to the firm has increased; but the expected return to any project is also likely to decrease in a recession.

3.5. *A consumer loan model*

Jaffee and Russell (1976) developed a model of credit rationing that applies many of these same concepts to a *consumer* loan market. The basic structure is a simple two-period model in which each consumer receives current income Y_1 and future income Y_2, and has current consumption C_1 and future consumption C_2. A loan B is taken out to increase current consumption and is repaid with interest (at the rate r) from the income received during the future period. The resulting consumption pattern is then

$$C_1 = Y_1 + B\,,$$
$$C_2 = Y_2 - (1+r)B\,.$$

The basic model assumes that all consumers have the same income and consumption preferences. Consequently, all consumers have the same loan demand, which is assumed to be negatively related to the interest rate.

A "moral hazard" is introduced by the fact that consumer i will default on his loan if his cost of default Z_i is less than the loan repayment $(1+r)B$. The cost of default is interpreted broadly to include the lost access to further credit, the social stigma, and similar factors. The cost of default is assumed to vary over the population: some consumers have high Z_i values, so they tend to repay their loans (they are "honest" borrowers); while other consumers have lower Z_i values, so they may intend to default. Banks, however, cannot identify the consumers who are likely to default. In fact, consumers who intend to default will act exactly as their honest counterparts so as not to identify their true character.

Loans are made through a competitive banking industry with access to deposits at the constant rate δ. If a bank knows that Γ percent of its borrowers

[25]All of these results extend to the more general model, described below, where there is collateral, and multiple forms of loan contracts offered by firms [Stiglitz and Weiss (1987a)].

will repay their loans, then its profit function is

$$\Phi = \Gamma(1+r)B - (1+\delta)B\,.$$

Given that competition forces bank profits to be zero, the equilibrium value for the loan rate r^* will be such that

$$1 + r^* = (1+\delta)/\Gamma\,.$$

This shows that the loan rate factor $(1+r)$ exceeds the cost of funds factor $(1+\delta)$ by an amount $1/\Gamma$ that compensates the bank for the borrowers that default. Loans are made in the size demanded by honest borrowers at the loan rate r^*. This is a "pooling" contract since all borrowers are offered the same, single contract.

The honest borrowers have an incentive to create a separate loan pool because they are subsidizing the dishonest borrowers by the amount that the contract rate r^* exceeds the cost of deposits δ. However, the dishonest borrowers always mimic the actions of the honest borrowers. Therefore, the best the honest borrowers can do is to adopt a pooling contract that has a smaller size than their loan demand at r^*. Even though this contract still pools honest and dishonest borrowers, fewer borrowers default, so the loan rate is lower. It is easily demonstrated that the honest borrowers are better off in this case.[26]

4. Extensions of the basic theory

In the preceding section we explained why an increase in the interest rate might have adverse selection and incentive effects, so that lenders might choose not to increase the interest rate charged, even when there is an excess demand for credit. The basic theory has been extended in a number of different directions to respond to criticism of the simpler versions of the theory and to apply the basic theory in different institutional settings.

4.1. Enforcement problems

In some important contexts – international lending – legal recourse in the event of a default is limited. In other contexts, legal recourse simply has very high

[26]If the market allows only a single contract, then this pooling contract represents an equilibrium. Otherwise, the concept of equilibrium depends on whether an informed or uninformed agent has to act first.

costs. In these situations, a debt contract – a promise to pay in the future – is enforced only if the borrower faces costs of default that exceed the benefits of default. Eaton and Gersovitz (1981) have focused on the fact that borrowers lose their reputation for repaying if they default.[27] Access to the capital market has a value, say M, because borrowing can be used to smooth consumption; in the absence of borrowing and lending an individual (or country) must adopt more expensive ways to smooth consumption. The benefit of repudiating a debt is D when the debt has a value of D (assuming the debt is a perpetuity which promises to pay \$1 a year, and the interest rate is r and is expected to remain there). Thus, repudiation will occur if $D > M$. Since lenders know this, they will restrict loans to M, i.e. there will be credit rationing. If there is uncertainty about the future rate of interest or the value of M, then the initial level of lending will be set so that there is some probability of default. An increase in the degree of variability should lead to a reduction in the maximum amount that lenders will be willing to lend.[28]

In other contexts, a default simply results in a period during which the borrower must search out a new source of lending. Then the penalty for default is, of course, much smaller [Allen (1983)].

4.2. Enforcement problems in multiple period models

While the meaning of default is clear in simple two-period models, it is not clear in multi-period models. That is, the lender may have an incentive to postpone a default by extending additional credit to the borrower. Thus, for a default to occur there must in effect be complicity between the lender and the borrower: the lender must refuse to continue to extend further credit on terms which the borrower finds acceptable. Indeed, given that real costs are associated with default (the costs of bankruptcy or corporate reorganizations), there should be mutually agreeable arrangements that avoid default [Eaton, Gersovitz, and Stiglitz (1986)]. On this basis, it is remarkable that the number of defaults is so high.

Two explanations suggest themselves. First, an effective threat of cutting off credit may have important incentive effects on borrower behavior, causing borrowers to undertake less risky projects, thus reducing the likelihood that

[27]They construct a simple model in which the by now familiar perfect equilibrium entails the firm repaying the loan.

[28]This analysis implies that loans to less developed countries (LDCs) may not be viable (in the absence of trade or similar sanctions). In principle, an LDC should borrow funds when the marginal productivity of its capital is high, and repay the funds to the developed economy later. But the LDC may not have incentive at the future date to repay its loan: access to future credit, by assumption, is no longer important. If lenders anticipate this, they may not lend initially.

ıe economic circumstances will occur under which default is contemplated tiglitz and Weiss (1983)]. But how can the threat of cutting off credit be ade convincing? And even if one bank cuts off credit, why would not other ınks provide the credit? There are two possible explanations. Stiglitz and eiss provide a model in which banks earn profits on their initial loans; they ke a loss on the continuation of the loan contract, but they do so because the ntractual arrangement with the borrower allows them to cut off credit when ıe default circumstances occur. As a result, when credit has been terminated one lender, no other lender would be willing to lend to the individual. eniority provisions in debt contracts, as well as the information-theoretic ncerns discussed earlier in this chapter, reinforce the conclusion that there ay be high costs imposed on the borrower by the termination of his lationship with his lender.

Second, reputation models provide a different set of explanations. Reputaons affect firm behavior in two ways. First, they provide the rationale for the ıforcement of implicit contracts, such as the continuation of the customer lationship between a bank and a borrower. Secondly, they provide an planation for why, given that there is imperfect information, a bank may metimes force bankruptcy on a borrower who is technically in default, even ough a renegotiated agreement might appear to be a Pareto improvement. ıe bank knows that if customers come to believe that such renegotiations will cur, they will undertake riskier actions, making it necessary to undertake ese renegotiations, and thus the banks' expected profits will be lowered.[29] aton (1986) has addressed the question of how bank reputations can be aintained in circumstances in which the owner-managers of banks are finitely ed. He argues that an asset is created which can be transferred to the next neration. The firm's current owner has an incentive to maintain this asset, e firm's reputation.]

However, the possibility of mutually agreeable renegotiations which avoid organization/bankruptcy costs must be taken into account. For as Stiglitz 972) pointed out, there is always a conflict of interest in the presence of ınkruptcy between the interests of debtors and of shareholders. So long as ntrol remains vested in the shareholders, they may take actions which,

[29]The Eaton–Gersovitz model is effectively a reputation model in which a borrower repays his n to protect his reputation. Indeed, to our knowledge their paper provided one of the first oretical models of reputation (in which maintaining a reputation constituted a perfect equilibm). Subsequent more formal developments in reputation models have surprisingly failed to cite ir pioneering work.

Shapiro (1983) has provided an alternative theory of reputations in which reputations are based simple extrapolations of past behavior. In the context of highly complex environments, in which characteristics of the agents vary greatly and are hard to ascertain and there may not be mmon knowledge concerning the "game" which the agents are supposed to be playing, Shapiro's havioristic model may provide more insights into the nature of the reputation mechanism than game theoretic models.

though increasing the value of their shares, decrease the value of debt. The amount of this activity may increase the "closer" the firm is to bankruptcy; this explains loan contract provisions which enable control of the firm to switch to debtors when events occur that significantly increase the probability of the firm being unable to meet its debt obligations, even though it currently is meeting them. (Eastern Airlines went technically into default when it failed to obtain wage concessions from its unions.)

4.3. *Collateral, loan size, and non-price rationing*

A continuing criticism leveled against credit rationing theories is that it may be possible to adjust other terms of the loan contract to eliminate the credit rationing. Two contract terms in particular – collateral and loan size – deserve attention.

4.3.1. *Collateral*

Several articles have suggested that credit rationing disappears when a bank can set collateral requirements and interest rates simultaneously. The argument is that the bank could offer a set of self-selecting contracts [Rothschild and Stiglitz (1971)] that would fully reveal the risk character of each borrower; in this case, credit rationing would not occur. For example, if the market consisted of just two types of borrowers – good risks and bad risks – then the good risks might choose a contract with a lower interest rate and higher collateral requirement (because it is unlikely they will default and lose their collateral), while the bad risks might choose a contract with a higher interest rate and a lower collateral requirement (because there is a higher probability they will default and lose their collateral). As a result, if the *only* informational imperfection concerned which borrowers were good risks and which bad, then the bank could design contracts that reveal this information, and credit rationing would not occur.

The fact that banks never have perfect information concerning the characteristics of their borrowers suggests what is wrong (or irrelevant) about this argument: the conclusion holds only if individuals differ in just one dimension (say wealth), so that a simple set of contracts can completely separate and identify the different groups.[30] but if the groups differ in two dimensions (risk aversion and wealth), then a perfect separation cannot be made with {interest

[30]Even then there may exist problems when there are a large number of groups. Under monopoly, there may be partial pooling [see Mirrlees (1971), Stiglitz (1977), and a large subsequent literature analyzing conditions under which the relevant functions are differentiable], while under competition, there never exists an equilibrium.

rate, collateral} contracts. Of course, if individuals differ in just two dimensions, then it might still be possible to find a more complicated contract that would perfectly identify the different groups. But so long as the dimensionality of the space of borrower characteristics is larger than the dimensionality of the space of contracts, it seems unlikely that perfect information can be obtained.[31]

Stiglitz and Weiss (1981) showed that while increasing collateral requirements have a positive incentive effect, they could have a negative selection effect. They argued that even if all individuals in society had the same utility functions, wealthier individuals will, in general, be willing to take greater risks (based on decreasing absolute risk aversion). Moreover, among those with large amounts of wealth, there is likely to be a larger proportion of risk-takers: individuals who gambled, and by chance won. Thus, as a result of such adverse selection effects, it may not be desirable to require collateral to the point where credit rationing is eliminated.

Stiglitz and Weiss (1986, 1987b) have also examined a model in which adverse selection and incentive effects are both present, and in which interest rates and collateral requirements are both used. They find that the equilibrium may take on different forms:

(1) There may be a pooling equilibrium with credit rationing in which both types of borrowers (high-risk and low-risk) adopt the same contract; collateral is not increased, since doing so would have adverse selection effects; interest rates are not increased, since doing so would have adverse incentive effects.

(2) Alternatively, equilibrium may be characterized by multiple contracts, with credit rationing on each one. Some rich individuals who undertake risky projects may have to accept low collateral, high interest rate contracts because they do not receive high collateral, low interest rate contracts. The fraction of those of each type at the low collateral contract is determined endogenously in such a way to ensure that the expected return on a low collateral contract exactly equals the expected return on a high collateral contract.

Since a loan application has no cost in the model, the extent of credit rationing on different contracts does not serve as a screening device. However, the role of rationing as a screening device can be examined using straightforward adaptations of similar models in the context of labor markets [Nalebuff and Stiglitz (1983)].

[31]Some of the papers that attempted to show that collateral requirements can eliminate credit rationing did so by developing examples in which credit rationing does not occur. However, Stiglitz and Weiss (1981) had pointed out earlier that credit rationing would occur *only if* the adverse selection effect outweighed the direct effect of an increase in the interest rate. Thus, creating an example to show that credit rationing does not occur is an exercise directed at an irrelevant question; they would have to show that credit rationing does not arise in any "plausible" model. See, for instance, Bestor (1985).

4.3.2. Smaller loans

It has also been suggested that banks can substitute smaller loans for credit rationing. To the extent that there are projects of fixed (or optimal) investment scale, reducing loan size simply forces borrowers to put up more of their own equity, and the effects of this are analogous to those just described for collateral.[32]

But even when there are no non-concavities in the production technology, the nature of the credit relationship may cause banks to avoid making loans that are "too small". Loan size is an attribute of the loan contract which affects borrower behavior; by reducing loan size, borrowers may take actions which actually reduce the expected return to the lender (when appropriate account of further "forced loans" are taken into account) [see Stiglitz and Weiss (1981)]. For example, in a multi-period context, borrowers always are in a position to return to the lender to ask for further funds; a refusal to lend further funds may then jeopardize the amounts already lent out.[33]

4.4. Issues of efficiency and welfare

There are several basic results regarding the welfare aspects of equilibrium with credit rationing:

(a) A market equilibrium with credit rationing (as in other cases in which markets are characterized by imperfect information and incomplete markets) is not Pareto efficient in general, even when account is taken of the costs of information.[34]

(b) Pareto efficiency may well entail credit rationing (in other words, market clearing is not, in general, an attribute of efficient markets in the presence of imperfect information).

(c) When credit rationing occurs in markets, there are systematic biases *against* undertaking projects which maximize expected returns.

Although our analysis has focused on competitive markets, informational costs are likely to result in imperfect competition among banks (particularly ex post, after the customer relations have been initiated). Credit rationing may (will) characterize imperfectly competitive lending markets as well as competitive lending markets.

[32]Indeed, in some simple versions of the credit rationing model, increasing equity requirements and increasing collateral requirements are equivalent.

[33]This is the point we have emphasized earlier in our discussion of lending with enforcement problems. It was originally noted in an important paper by Hellwig (1977) and in Stiglitz and Weiss (1981).

[34]They are, to use the fashionable phrase, not constrained Pareto efficient. See Greenwald and Stiglitz (1986a) and Stiglitz and Weiss (1981, 1983).

5. Macroeconomic aspects of credit rationing

The macroeconomic ramifications of credit rationing have been a focus of attention at least since the development of the Availability Doctrine at the end of World War II. At that time, there was pessimism regarding the effectiveness of monetary policy for two reasons:

(a) real expenditures were thought to be relatively unresponsive to interest rates; and

(b) the Federal Reserve was under pressure to maintain stable (and low) interest rates.[35]

In this context, Roosa (1951) and others at the Federal Reserve developed the Availability Doctrine, according to which monetary policy could still affect real expenditures through a credit rationing channel. The Availability Doctrine relied on three steps.

(1) Federal Reserve open market sales of Treasury securities would cause banks to reallocate their portfolios from loans to Treasury securities.[36]

(2) Banks would tend to reduce the quantity of loans through credit rationing, not by raising loan interest rates.

(3) As credit rationing rose, rationed firms would face a rising shadow price for credit, causing their investment activity to fall, even though market interest rates were quite stable.[37]

We have seen in the previous sections how a theory of credit rationing has developed that is consistent with the first two steps. We will now look at research that has focused on step 3 – the macroeconomic effects of credit rationing, particularly with regard to the fixed-capital investment of firms and the housing investment and consumption expenditures of households.

5.1. *Market interest rates and the shadow price of credit*

The connection between credit rationing and capital investment is illustrated in Figure 16.9. The economy is initially at point E_0, where the quantity of loans Q_0 is supplied by the banks (based on their supply curve S_0) at the loan interest rate r_0. There is credit rationing here because the demand for loans (based on

[35]An important record of these views is provided in testimony provided by economists and the Federal Reserve before the Joint Economic Committee (1952), the Patman Hearings.

[36]Lindbeck's (1962) survey of the Availability Doctrine discusses a variety of factors that cause this shift.

[37]Modigliani (1963) particularly emphasized the shadow price of credit as the mechanism that transmitted the impact of credit rationing from the loan markets to the real markets. The idea that monetary policy was asymmetrical in its effect – you cannot push on a string – also was emphasized in the Availability Doctrine.

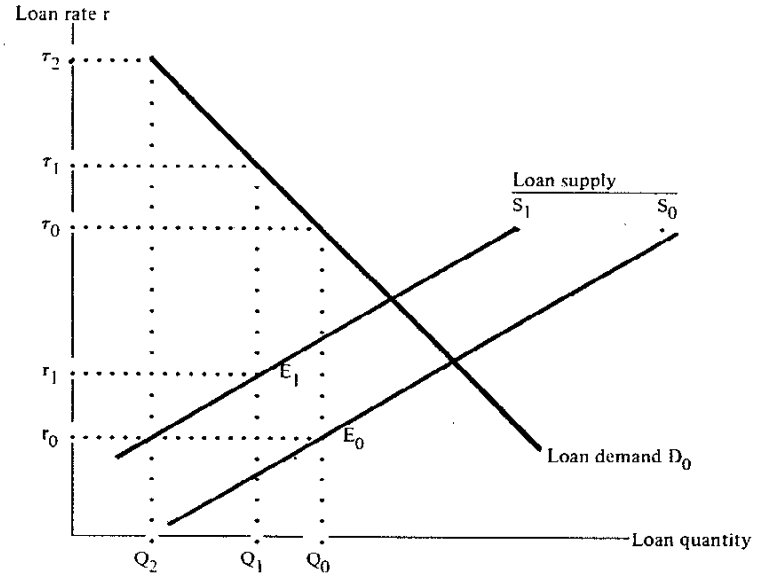

Figure 16.9. A leftward shift in the loan supply curve raises the shadow price of loans.

demand curve D_0) exceeds Q_0. The shadow price of credit, τ_0, is determined on the demand curve D_0 by the loan quantity Q_0.

Now suppose that Federal Reserve action causes the supply curve of loans to shift to the left, to curve S_1. This establishes a new equilibrium at a point such as E_1, with a lower loan quantity Q_1, a higher loan interest rate r_1, and a higher shadow price of credit τ_1. Moreover, the *less* the loan rate rises, the *more* the shadow price of credit rises. For example, if the loan rate were to remain unchanged at the level r_0 – which the credit rationing theory in Section 3 indicates is quite possible – then the loan quantity falls to Q_2 and the shadow price of credit rises to τ_2.

The actual pattern of real interest rates in the U.S. economy since 1952 is shown in Figure 16.10. The real interest rate is measured by the 6 to 9 month commercial paper rate minus the inflation rate for the Consumer Price Index. Three distinct periods are evident.

(1) From 1952 to the early 1970s the real interest remained in a narrow band centered on 2 percent. (William McChesney Martin was Chairman of the Fed for most of this period.)

(2) During most of the 1970s the real interest was negative, usually about −1 percent. (Arthur Burns was Chairman of the Fed.)

(3) During most of the 1980s the real interest rate was positive, sometimes above 5 percent. (Paul Volcker was Chairman of the Fed.)

In the absence of credit rationing, the (before-tax) cost of capital to firms is determined by the real interest rate. The cost of capital for a new capital

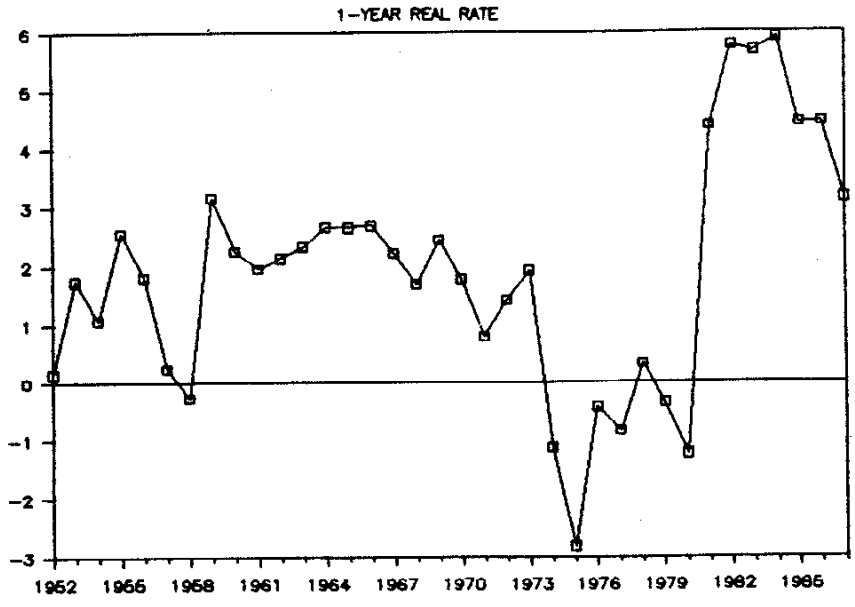

Figure 16.10. The real interest rate: 1952–87.

investment that is initiated each year and that provides a return of an equal amount of output at the end of each of the following 5 years is illustrated in Figure 16.11.[38] The cost of capital smooths out the year-to-year fluctuations in the real interest rate, so that over the 20-year period ending in the early 1970s, the cost of capital was virtually constant at 2 percent. After that, the cost of capital first fell and then rose in a smooth fashion.

The variations in the cost of capital can be contrasted with the variations in real, fixed, non-residential capital investment that occurred over the same period of time, as illustrated in Figure 16.12. This figure shows that the annual percentage change in the amount of real investment was often in the range between −2 and +10 percent. The amount of variation in capital investment appears to be about the same in the period prior to the early 1970s and the period after that time.

The implication of Figures 16.11 and 16.12 is that variations in the cost of capital appear prima facie to be implausible as a major source of the observed fluctuations in capital investment.[39] That is, a theory of capital investment cannot be based on a constant – which the cost of capital roughly represented

[38]For example, the capital investment in 1952 provides 1 unit of output at the end of each year from 1952 to 1956. The cost of capital is the constant annual rate that creates the same present value for this investment as the actual real rates shown in Figure 16.10.

[39]The point would be made even stronger by using an *after-tax* cost of capital to the extent that the tax rates applicable to capital investment are reduced when capital investment is low.

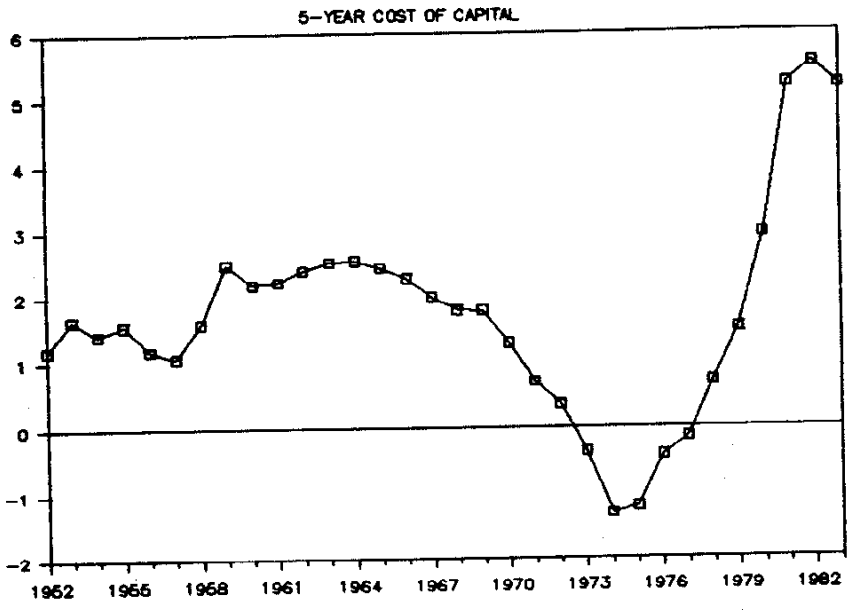

Figure 16.11. The cost of capital on 5-year investments.

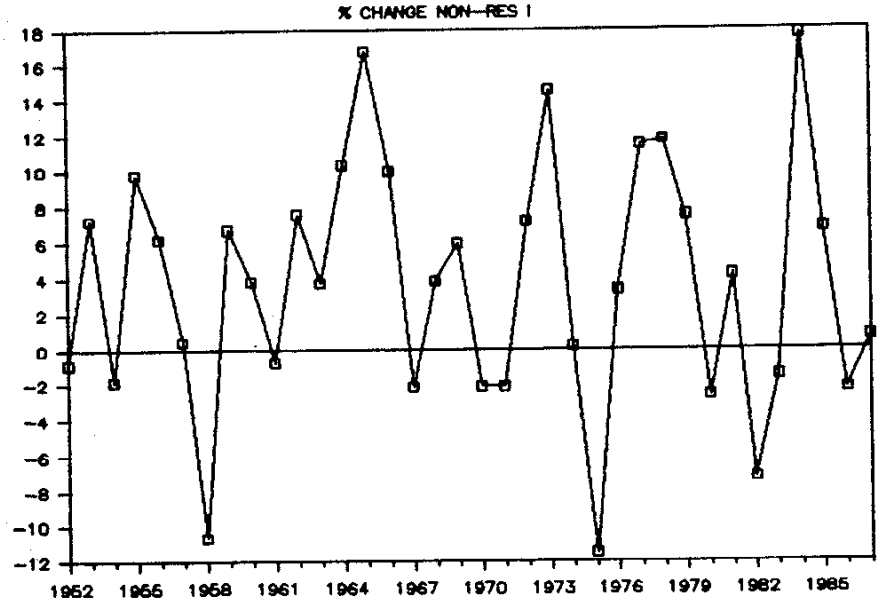

Figure 16.12. Annual percentage change in fixed non-residential investment.

ughout the 1950s and 1960s. Other factors, including credit rationing, must efore account for the observed range of variation in capital investment. We now evaluate credit rationing as a factor that may affect capital investment.

Cyclical changes in credit rationing

ur earlier discussion we analyzed the comparative statics of the credit ning model, with a particular focus on how interest rates would be affected hanges in mean returns, uncertainty, and the availability of credit. The ysis was, however, static, and a full cyclical analysis requires a more icitly dynamic model, yet to be formulated. Here, we offer three observa-

e began by discussing why the conventional "auction-market" analysis for rs and tables is inappropriate for the market for loans. An analogy may be ul. Some might find it appealing for American universities to auction the e in each incoming class to the highest bidders. After all, the individuals presumably well informed concerning their own abilities – they *know* how they had to work to obtain the A – and might be the best judges of the cted value added of, say, a Harvard education. Also, the losses created by judgments would be borne by the individuals who over (or under) bid. dard efficiency arguments would thus seem to call for such auctions.[40]
owever, none of the major private universities uses an auction system. umably it is *not* believed that individuals are good judges of their own ty. One reason might be that an auction system would have a systematic ; individuals who are over-confident (individuals that many of us as hers find particularly objectionable to instruct) would be over-represented. onal expectations arguments might well counter that, were these individuo live the 9 lives of a cat, but with memory of only the *return* to learning, the learning itself, crossing over from life to life, they would not make e mistakes. However, modern Western ideology has cast skepticism on 's of repeated reincarnations, which makes a theory of resource allocation d on that premise particularly problematical. Accordingly, it is not surpristhat non-price rationing systems have persisted at all of the major private ersities, in spite of the eminence of the economists on their faculty and the ly availability of advice on how to improve the efficiency of resource cations.
milar arguments hold for credit markets, with particular force in changing ronments. We argued earlier that credit is used when there is a discrepancy veen the availability of current resources and judgments concerning the

[40] Problems caused by lack of resources could presumably be rectified by loan programs.

returns on potential uses of resources. But are individual judgments to be trusted? Assume that interest rates were the only dimension of loan contracts that individuals cared about. In undertaking projects, individuals compare the expected returns with the expected interest payments. An individual who, when confronted with a high current (short-term) interest rate, believes that future interest rates are going to go down, may be willing to undertake a project; while another individual, with an equally good project, who believes that future interest rates are going to remain the same, will not. The bank does not want to select among alternative borrowers on the basis of their projections of future interest rates; it wishes to discriminate on the basis of the quality of the project. But willingness to borrow (at any interest rate) may be affected as much by the borrowers' optimism concerning future interest rates, prices, and wages as it is by the "real" characteristics of the project. The price system would work no better in allocating capital resources than it would in allocating scarce places in our major private universities.

The second observation is that the response of real expenditures to credit rationing can follow a variety of dynamic patterns.

(1) Expenditures may respond with variable lags depending on the initial liquidity of the spending units and on their willingness to use this liquidity.

(2) The anticipation of future credit rationing may have current effects, even when there is no credit rationing at present. Thus, the impact of credit rationing cannot be assessed just by looking at those periods in which there is direct evidence for its presence.

(3) There will be further multiplier effects of the initial changes in spending induced by credit rationing.

The third observation is that the loan interest rate is not necessarily a good measure of monetary tightness. For example, as we showed in the discussion of the comparative statics of credit rationing in Subsection 3.4, the quoted loan rate and the expected return on loans may even change in opposite directions.

5.3. The measurement of credit rationing

A major pitfall in evaluating the effect of credit rationing on capital investment is that the amount of credit rationing in the economy at a given time is not readily measured. In principle, the amount of credit rationing could be measured as the demand for credit minus the supply of credit. However, we generally only observe the quantity of credit that is transacted (or that is outstanding), not the amount that is demanded or supplied. This is illustrated in Figure 16.13 for the interest rate r_0, at which the quantity that is transacted might possibly correspond to the supply curve (at Q_s), to the demand curve (at Q_d), or to any quantity in between, depending on how the difference between

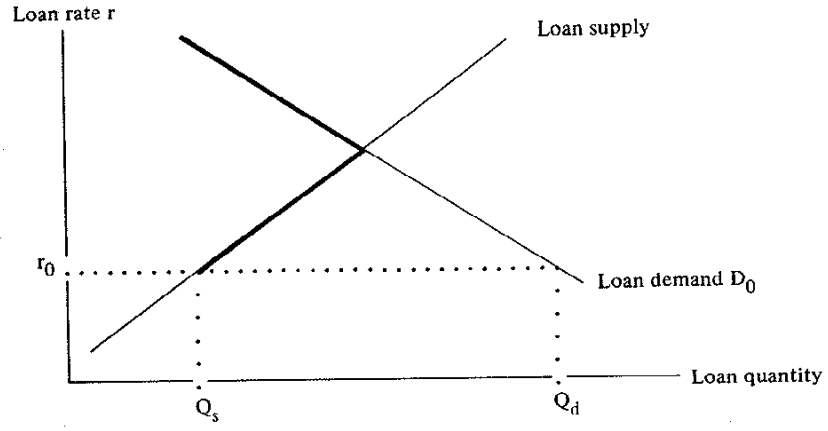

Figure 16.13. The observed loan quantity is the minimum of loan demand and loan supply.

lemand and supply is allocated. Whatever the specific case, if demand and upply are not directly observed, then the amount of credit rationing is not lirectly observed.

Nevertheless, Fair and Jaffee (1972) developed a basic technique for estimat- ıg the demand and supply curves for a market that may be in disequilibrium. 'hey assumed that transactions are voluntary, in the sense that the quantity ransacted Q_t must be the minimum of demand and supply:

$$Q_t = \min\{Q_d, Q_s\} .$$

n this case, only the darkened portions of the demand and supply curves in 'igure 16.13 would actually be observed. But it is still possible to obtain naximum likelihood estimates of the demand and supply curves, and therefore ıf the amount of credit rationing. Indeed, a large literature now exists for stimating markets in disequilibrium, including applications to loan markets.[41]

There have also been attempts to measure credit rationing with proxy ariables and survey techniques: Jaffee and Modigliani (1969) developed a ıroxy measure of bank credit rationing based on the percentage of banks loan hat are granted to low-risk firms; and the Federal Reserve carries out a uarterly survey of the terms of bank lending that refers to availability of credit see Harris (1974) and Jaffee (1971)]. Although disequilibrium estimation, ıroxy variables, and surveys all generally confirm that banks use non-price ationing, these techniques do not directly provide evidence of the impact of

[41]The theory of disequilibrium estimation is developed in Maddala (1983) and Goldfeld and)uandt (1975). Specific applications to loan markets are discussed by Bowden (1978), Laffont and ;arcia (1977), and Sealey (1979).

credit rationing on real expenditures. We will now consider the evidence regarding different classes of investment and consumption spending.

5.4. *Fixed capital investment of business firms*

The neoclassical theory of capital investment focuses on changes in the cost of capital as a key variable determining changes in investment demand [Hall and Jorgenson (1967), Eisner and Nadiri (1968), Bischoff (1971), and Clark (1979)]. Consistent with the Modigliani–Miller theory, the theory assumes that firms can borrow whatever funds they need to carry out their desired capital investment. In contrast, if credit rationing limits a firm's access to external finance, then the firm's liquidity and internally generated cash flow may determine how much of its investment demand is realized as actual capital investment [Meyer and Kuh (1957)]. Furthermore, credit rationing would have a larger impact on firms that have a higher ratio of investment demand to internally generated cash flow.

The relationship of capital investment to internal cash flow is the focus of recent research by Fazzari, Hubbard and Petersen (F-H-P) (1988). They extend a q theory of investment to include imperfections in loan and equity markets that may cause firms to be credit constrained. Their empirical analysis compares the investment behavior of classes of firms that vary in the extent of their need for, and access to, external finance, based on panel data (from the Value Line database) for individual manufacturing firms.

The F-H-P analysis shows that the investment expenditures of certain firms display "excess sensitivity" to variations in their cash flow. In response to lower interest rates or other factors that raise investment demand, the increase in the investment expenditures of these firms is closely tied to the amount of their internally generated cash flow. By implication, these firms do not have substantial and continuing access to external financing.

F-H-P identify the firms that are hampered by inadequate access to external finance as firms that retain most of their earnings – they pay little or no dividends. Although the earnings retention rate is an endogenous variable for firms, and therefore it is not an ideal basis for classifying them, the F-H-P data indicate that these firms are also distinctive as being fast growing, relatively small, and highly profitable.

All of the firms studied by F-H-P are relatively large – even their group of small firms had an average capital stock of $347 million in 1984 (in 1982 prices). This means that about 80 percent of all manufacturing firms in the United State are smaller than the F-H-P group of small firms. Since the sensitivity to internal cashflow is presumably greater for smaller firms, this reinforces the F-H-P conclusion that the investment expenditures of many firms may be limited by the amount of their cash flow.

On the other hand, the firms studied by F-H-P also represent about 85 percent of the total assets held by manufacturing firms. This highly skewed distribution of firms by size suggests that the contribution of smaller firms to aggregate investment may be limited. That is, even though credit rationing may have a significant impact on the investment spending of smaller firms, these firms might account for only a small part of the fluctuations in aggregate investment. Additionally, if the large firms that dominate the statistics for aggregate investment are rationed by banks, they might still have access to non-bank capital markets for equity and debt or to other sources of funds. We will now consider some of the reasons that raising funds in the capital markets may not substitute for bank credit.

5.5. Credit substitutes for bank loans

For credit rationing to be effective in reducing investment, firms must be unable to raise capital in other ways, or the (marginal) cost of raising capital in other ways must be higher than the cost of borrowing. Equity capital represents an obvious alternative to bank loans for this purpose. Also, trade credit – loans from one firm to another – may provide firms with an alternative source of working capital. We will now look at these in turn.

5.5.1. Equity capital as a substitute for bank credit

For (the manager of) a firm, equity has the distinct advantage that since there is no fixed commitment to repay, there is no bankruptcy risk. Equity has, however, three problems:

(a) *Monitoring*. Equities represent promises to pay shareholders a given fraction of the firm's profits. But it may be difficult for shareholders to monitor what the profits are. Or the firm's managers may divert a large fraction of the firm's returns to their own uses. Alternative control mechanisms (voting, takeovers) have only limited efficacy, partially because of free-rider problems and the costliness of information. (The benefits associated with monitoring accrue to all shareholders.)

(b) *Signalling* (adverse selection effects). Issuing equities may provide an adverse signal to the market. If firms were risk neutral (and there were no costs of bankruptcy), the owners of the firm would only be willing to sell a share of a firm whose actuarial value is say, $\$X$, for a price which equalled or exceeded $\$X$: so there would not exist a market for equities.[42] With bankruptcy costs/manager risk aversion, there are gains from the issue of equities, but

[42]This is an application of the standard Akerlof (1970) lemons model to equities.

there will be a significant signalling effect, with only the worst firms (within any category of firms) issuing equity.[43,44]

(c) *Agency* (adverse incentive effects). The costs of monitoring managers' activities imply that managers may have a wide discretion. This discretion is limited by a large supply of outstanding debt in two ways. First, if managers wish to avoid bankruptcy, then the necessity of meeting these fixed obligations alters their actions. Second, and perhaps more importantly, banks (lenders) monitor the actions of the firm directly, paying particular attention to actions which adversely impact the likelihood that the loan will be repaid. They have an effective threat – cutting off credit and demanding the repayment of outstanding loans – not available to those who supply equity funds. This means that effective control of managers is exercised as much by lenders as it is by shareholders.[45]

As a result of these factors, firms may be reluctant to raise capital by issuing new equities, even (or particularly) when they are credit constrained. Greenwald and Stiglitz (1986a, 1986b) refer to this as an equity constrained firm; although firms have the option of issuing equity, the cost of doing so is so high that they act as if they cannot do so. (Clearly, for large enough perturbations to their environment, the constraint will no longer be binding.)

For many purposes the whole set of financial constraints is relevant; that is, as a result of informational asymmetries, funds inside the firm are less expensive than outside funds, whether obtained in the form of equity or in the form of debt. Raising funds provides a signal, and outsiders' judgments, at least in some cases, are likely to be more pessimistic concerning the firm's prospects than insiders' judgments (or, in any case, less confident). Thus, what the outsider expects to get may be less than the insider thinks he has promised to give.[46] (Even in rational expectations models with risk neutrality, where those who pay more than the market expects them to pay are exactly offset by those who pay less, the informational asymmetries have real effects not only on

[43]This is demonstrated in the theoretical models of Stiglitz (1982), Greenwald, Stiglitz and Weiss (1984) and Myers and Majluf (1984). Empirical confirmation is provided by Asquith and Mullins (1986).

An important aspect of the issue of equities is that they tend not to be issued continuously, but rather in discrete amounts. With few exceptions, firms that enter the equity market do so only infrequently. A dynamic model of equity issue which explains this is provided by Gale and Stiglitz (forthcoming).

[44]Earlier models focused on the incentive of the original owners of the firm to sell their shares. The willingness to do so had an adverse selection effect [Stiglitz (1974, 1982) and Leland and Pyle (1977)]. Ross (1977) has argued that a firm's willingness to issue debt, and thus to incur bankruptcy costs, has a positive signalling effect. In each of these instances, one needs to ask whether there are alternative ways in which the given information can be credibly disclosed without the costs (bankruptcy, lack of diversification, etc.) associated with the choice of financial structure.

[45]This is an old view. For a more modern rendition of the argument, explaining why the free-rider problems which limit the effectiveness of shareholder control do not apply with equal force to lenders, see Stiglitz (1985).

[46]This point was emphasized in Stiglitz (1972).

e allocation of capital, but also on the magnitude of investment; the increase investment by those who underpay for credit may be less than the decrease investment by those who overpay.)

5.2. Trade credit

ade credit – loans between firms that are used to finance the purchase of aterials and goods in process – represents a way of redistributing credit nong firms, which could also serve as a substitute for bank loans [Meltzer 960), Jaffee (1971), and Duca (1986)]. The idea is that large firms, which are ıt rationed by banks (or which use debt and equity capital markets), can ake loans to smaller firms that cannot obtain bank loans. Trade credit is a ajor element in the U.S. credit system: trade credit outstanding is almost as rge as bank loans to business firms and as corporate bonds.[47]

The price charged for trade credit by a lending firm is generally very high, ually translating to an annual interest rate in excess of 24 percent.[48] This ıplies that firms that borrow through trade credit have faced credit rationing th respect to bank loans. In addition, most lending firms rarely change their ade credit interest rate, so trade credit outstanding is basically determined by e demand for the credit. (Of course, firms with very low credit ratings may : denied access to trade credit.)

The existence of this trade credit system raises two basic questions:

(1) Why do lending firms extend trade credit, given that the borrowing firms e likely to have been denied credit by banks?

(2) Why are lending firms willing to extend more trade credit when bank edit rationing rises?

Earlier research tried to answer these questions by analyzing trade credit as a les expense (like advertising) of firms operating in imperfectly competitive arkets [Nadiri (1969) and Schwartz and Whitcomb (1980)]. However, a more teresting and complete answer is provided by analyzing trade credit with the me model we used in Section 3 to analyze the lending decisions of banks [see uca (1986)].

The key point is that trade credit allows for an efficient diffusion of formation in the form of risk-sharing arrangements that eliminates elements moral hazard. The idea is that firms which are selling goods to other firms e likely to have better information about the profit prospects of the buyers an would a bank lending to the same buyers. Trade credit can thus serve as a sk-sharing arrangement between buying and selling firms.

[47]According to the Flow of Funds accounts, the outstanding debts of non-financial business firms the end of 1987 included trade debt of $546 billion, bank loans of $618 billion, and corporate nds of $790.

[48]For example, a firm may offer a 2 percent discount from its list price if payment is made mediately (within 5 days); otherwise the list price must be paid within 30 days.

The result is that trade credit contracts and bank loan contracts can represent two parts of a *separating equilibrium*: all borrowers first apply for bank loans, and those who do not receive bank loans (due to redlining or to pure credit rationing) then apply for trade credit. Firms that extend trade credit will thus anticipate that their borrowers will have above average credit risk, and therefore they would charge an above average interest rate. Moreover, since the trade credit interest rate mainly represents a premium for the high risk of default, it would not be highly sensitive to the market interest rate.

5.6. *Housing investment*

Between World War II and 1980, housing investment was often the most volatile component of aggregate expenditures. During most business cycles, housing investment fell during the recession and rose during the boom by more than 50 percent relative to its average level. At the same time, nominal mortgage interest rates tended to be more stable than comparable bond interest rates. Under these circumstances, credit rationing was considered to be a major source of the observed fluctuations in housing investment.[49] Both the risk of default and government regulations were possible sources of this credit rationing.

5.6.1. *The risk of default and mortgage credit*

Most mortgage lenders try to control the risk of default on mortgages by using two key ratios as their lending criteria.

(1) The *equity ratio* equals the borrower's equity investment in a real estate property divided by the appraised value of the property. Typical equity ratios range from 5 to 25 percent. Lenders charge lower interest rates on loans with higher equity ratios because there is a greater likelihood that the housing collateral will cover the loan amount should the borrower default.

(2) The *income ratio* equals the carrying cost of the property (mortgage interest, property taxes, etc.) divided by the borrower's income. Typical income ratios range from 25 to 35 percent. To satisfy the income ratio criterion, a borrower may have to buy a smaller house or make a larger downpayment. Lenders use an income ratio to supplement the equity ratio because real estate values can fluctuate and the transactions costs of selling a property are substantial.

Credit rationing in the mortgage market is a good example of a situation where the redlining form of rationing merges into pure credit rationing.

[49]Jaffee and Rosen (1979) review the earlier housing investment cycles and the research that pointed to credit rationing as a source of these cycles.

pecifically, young, first-time homebuyers often do not have the equity or the ncome to satisfy even the minimum requirements for the equity and income atios. Although this appears to be redlining, it occurs because lenders adopt a mall number of equity and income ratio categories. If transaction and nformation costs were lower, then lenders would adopt a larger number of ategories, and the rationing would take the form of pure credit rationing, not edlining.[50]

5.6.2. *Government regulations and mortgage credit*

Jntil 1980, two sets of government regulations – usury ceilings on mortgage nterest rates and Regulation Q ceilings on bank deposit rates – created an dditional source of credit rationing in the mortgage market. The Regulation Q eilings – which set limits on the deposit rates of commercial banks and thrift nstitutions – created *disintermediation* – an outflow of deposit funds – vhenever market interest rates rose above the ceilings. This happened with ome frequency during the 1960s and 1970s, with the result that the total mount of lending by banks and thrifts had to be reduced. Credit rationing rises under these circumstances to the extent that lending rates are constrained by the considerations of adverse selection and moral hazard discussed n Section 3.

There were also reasons to expect disintermediation to have a particularly trong impact on the mortgage market, one aspect of which could be credit ationing.

(1) About half of all mortgage lending in the United States is carried out by hrift institutions – savings and loan associations and savings banks. By regulaion, these institutions raised most of their funds through deposits that were ubject to Regulation Q ceilings and invested most of these funds in mortgages. As a result, an outflow of deposits due to disintermediation had a particularly harp impact on mortgage lending.

(2) Although large commercial banks had access to sources of funds that vere not affected by Regulation Q ceilings, they did not expand their share of he mortgage market significantly. One factor was that most mortgage loans vere fixed-rate, long-term contracts, so if these loans were made on the basis of short-term deposits, a loss would result if interest rates rose. Most large anks tried to balance the maturities of their assets and liabilities rather losely, and this limited the amount of their mortgage lending (wisely so, as

[50]The amount of mortgage market credit rationing is also offset by the government's FHA and /A mortgage programs. Evidence of credit rationing based on default risk is provided in recent tudies by Rosenthal, Duca and Gabriel (1987) and Duca and Rosenthal (1988). The studies ndicate that borrowers use more costly or cumbersome VA and FHA mortgages when they are redit constrained in conventional mortgage markets.

evidenced by the huge losses suffered by thrift institutions when interest rates soared in the early 1980s).

(2) Many states had laws – usury ceilings – which set maximum limits on mortgage interest rates. When binding usury ceilings kept mortgage interest rates below the level of rates on other loans or securities, lenders simply stopped making mortgage loans. Furthermore, state legislatures were usually slow to raise the usury ceilings, so the amount of credit rationing tended to rise as market interest rates rose during the 1960s and 1970s.[51]

The situation changed significantly beginning in 1980 when Congressional actions (1) removed the state usury ceilings and (2) phased out all Regulation Q ceilings over a 5-year period. These actions basically eliminated disintermediation and usury ceilings as a source of mortgage market credit rationing.[52] Other related changes in the mortgage market during the 1980s have also tended to reduce the amount of credit rationing:

(a) The facilities for secondary market trading of seasoned mortgages have improved, allowing lenders to separate the activity of making mortgage loans from the activity of holding mortgage loans.

(b) A variety of mortgage pass-through securities (such as GNMAs) and mortgage-backed securities now allow portfolios of mortgages to be packaged for investors in a form comparable to other capital market securities.

(c) Adjustable-rate mortgages have been developed to allow investors with short-term funds to hold mortgages without facing a severe maturity mismatch.

(d) Non-banking firms have entered the mortgage market – for example, General Motors Acceptance Corporation (GMAC) is now one of the largest mortgage lenders in the United States.

5.7. *Consumption expenditures*

It has been long debated in macroeconomics whether consumption depends on current income – the simple Keynesian theory – or on "wealth" (or the discounted value of future income) – the permanent income and life cycle theories [Tobin and Dolde (1971)]. The existence of credit rationing – called liquidity constraints in the consumption literature – is the factor that distinguishes these

[51]As market interest rates rose, banks would first ration more risky borrowers (those with lower equity ratios and therefore higher loan rates). However, there were cases in which the usury ceilings were below even the interest rates that lenders required on very safe mortgage loans.

[52]Congress allowed the states a period in which they could reinstate their usury ceilings by passing new legislation, but no state took this action. Comparable usury ceilings still exist in many states on consumer loans and credit card loans, but the states now tend to change these ceilings more promptly when market interest rates change.

theories. The permanent income/life cycle (PI/LC) theory assumes that consumers face no borrowing constraints and adopt optimal consumption plans based on their current and future income, implying that current income will have only a small effect on current consumption. In contrast, if consumers face borrowing constraints, then consumption expenditures would show "excess sensitivity" with respect to current income (relative to the PI/LC theories).

Empirical testing of these theories has been especially active in recent years, following the lead of Hall (1978) who introduced tests based on the Euler equations (the first-order conditions for the optimal consumption plan). Many issues – concerning specification, econometric methods, and data sources – arise in carrying out these tests. Nevertheless, most studies reject the PI/LC theories – for example, it is estimated that from 15 to 50 percent of consumption expenditures are determined by current income rather than by permanent income.[53] Since it seems that most consumers do face borrowing limits, the failure of the PI/LC theories is often attributed to liquidity constraints.[54]

Liquidity constraints have important implications for macroeconomic policy. For one thing, changes in average tax rates affect consumption spending when there are liquidity constraints, in contrast to the traditional case where marginal tax rates matter. This is relevant because recent tax law changes have focused on marginal rates. For another thing, liquidity constraints may cause Ricardian Equivalence not to hold.

The impact of liquidity constraints on consumption expenditures was vividly illustrated in March 1980 when the Federal Reserve (on the urgent request of President Carter) instituted emergency credit controls that required banks and lenders to limit the amount of new loans, especially to consumers (including credit card loans). As a result, during the second quarter of 1980, consumption expenditures experienced one of the largest quarterly declines on record. Indeed, the effect was so powerful that the Fed rapidly reversed its policy, dismantling the controls by the summer of 1980.[55]

5.8. *The role of credit for monetary policy*

Credit has been considered to be an important transmission channel for the effects of monetary policy by various economists over most of this century.

[53]Recent studies that focus on liquidity constraints include Flavin (1981), Hall and Mishkin (1982), Hayashi (1985a, 1985b), Hubbard and Judd (1986), and Campbell and Mankiw (1987).

[54]See, especially, Hayashi (1985a, 1985b). It is instructive that one of the few firm confirmations of the PI/LC theory – Bernanke (1984) – is based on the demand for automobiles, where credit rationing should not be important because autos provide an exceptionally liquid form of collateral.

[55]For an account of this episode, see Greider (1987), a controversial analysis of Federal Reserve operations, especially for the period beginning in 1979 when Paul Volcker became Chairman of the Board of Governors.

Among others, this "credit" school of monetary policy includes Hawtrey (1919), Roosa (1951), Gurley and Shaw (1960), and Friedman (1981). Their shared view is that variations in the availability of credit can have large effects on real economic activity, both on the aggregate level and on its distribution among sectors and even individual projects. In addition, most would argue that monetary policy should be carried out, or at least measured and evaluated, with regard to its effect on the availability of credit.

The "credit" school is often compared with the "money" or Monetarist school. The two schools differ most fundamentally over the modus operandi of monetary policy – whether it is based on the amount of the money supply, or on the availability of credit. This basic conceptual difference leads to different views regarding the implementation of monetary policy: how it should be measured, when and how it should be used, and what it might accomplish.

However, it is important to recognize that within the structure of the U.S. banking and financial system, the *monetary aggregates* of the respective schools – the money supply versus the credit level – are likely to be highly collinear. That is, a Federal Reserve policy that increases the reserves of the banking system is likely to raise the money supply and the credit level in roughly the same proportion. This occurs because bank assets (consisting mainly of loans and other credit instruments) equal bank liabilities (consisting mainly of deposits that are part of the money supply).

The credit school has had a resurgence in recent years as the result of a number of developments:

(1) As developed in our discussion, there now exists a rigorous theory of credit rationing based on the risk of default when there is imperfect information. This theory explains both why credit availability is likely to be important and why the institutions (banks) and the instruments (loan contracts) are structured as they are. (The Monetarist school, in contrast, assumes basically that capital markets are perfect – and also that government policy can control money substitutes.)

(2) Evidence is accumulating that large changes in the availability of credit certainly create correspondingly large changes in the level of economic activity:

- Bernanke (1983) points to the breakdown of the economy's credit facilities, and not the decline in money, as the monetary source of the Great Depression.
- Wojnilower (1980) argues that the availability of credit, not the cost of money, has been the source of most large changes in the level of real economic activity since World War II.
- Nakamura (1984) discusses the key role of banks in determining whether to force a borrowing firm into bankruptcy.
- The Federal Reserve created a deep recession during 1981, yet the growth rate of the money supply fell very little.

(3) Deregulation and other innovations in the financial system in recent

years have created large and unpredictable changes in the demand for money. A key result is that since 1987, the Federal Reserve has not used the M1 money supply as an operating target for monetary policy. At the same time, Friedman (1981) has shown that a broad measure of credit stands at least on par with money as an instrument that (a) the Federal Reserve can control and (b) forecasts future movements in nominal GNP.

References

Akerlof, G. (1970) 'The market for lemons: Qualitative uncertainty and the market mechanism', *Quarterly Journal of Economics*, 84: 488–500.

Allen, F. (1983) 'Credit rationing and payment incentives', *Review of Economic Studies*, 50: 639–646.

Arnott, R. and J. Stiglitz (1985) 'Labor turnover, wage structure, and moral hazard', *Journal of Labor Economics*, 3: 434–462.

Asquith, P. and D. Mullins (1986) 'Equity issues and offering dilution', *Journal of Financial Economics*, 15: 61–89.

Baltensperger, E. (1978) 'Credit rationing: Issues and question', *Journal of Money, Credit and Banking*, 10: 170–183.

Baltensperger, E. and T. Devinney (1985) 'Credit rationing theory: A survey and synthesis', *Zeitschrift Fur Die Gesamte Staatswissenschaft*, 141: 475–502.

Bernanke, B. (1983) 'Nonmonetary effects of the financial collapse in the propagation of the great depression', *American Economic Review*, 73: 257–276.

Bernanke, B. (1984) 'Permanent income, liquidity, and expenditure on automobiles: Evidence from panel data', *Quarterly Journal of Economics*, 99: 587–616.

Bernanke, B. and M. Gertler (1987), 'Financial fragility and economic performance', Princeton University, mimeo.

Bestor, H. (1985), 'Screening versus rationing in credit markets with imperfect information', *American Economic Review*, 75: 850–855.

Bischoff, C. (1971) 'Business investment in the 1970s: A comparison of models', *Brookings Papers on Economic Activity*, 1971-1: 13–58.

Blinder, A. (1987) 'Credit rationing and effective supply failure', *Economic Journal*, 97: 327–352.

Blinder, A. and J. Stiglitz (1983) 'Money, credit constraints, and economic activity', *American Economic Review*, 73: 297–302.

Bowden, R. (1978) *The econometrics of disequilibrium*. Amsterdam: North-Holland.

Calomiris, C., R. Hubbard and J. Stock (1986) 'The farm debt crisis and public policy', *Brookings Papers on Economic Activity*, 1986-2: 441–479.

Campbell, J. and G. Mankiw (1987) 'Permanent income, current income, and consumption', NBER Working Paper 2436.

Clark, P. (1979) 'Investment in the 1970s: Theory, performance, and prediction', *Brookings Papers on Economic Activity*, 1979-1: 73–113.

Clemenz, G. (1986) *Credit markets with asymmetric information*, Lecture Notes in Economics and Mathematical Systems 272. Berlin: Springer-Verlag.

Diamond, D. and P. Dybvig (1983) 'Bank runs, deposit insurance, and liquidity', *Journal of Political Economy*, 91: 401–419.

Duca, J. (1986) 'Trade credit and credit rationing: A theoretical model', Research Papers in Banking and Financial Economics, Board of Governors of the Federal Reserve System.

Duca, J. and S. Rosenthal (1988) 'Mortgage rationing in the post-disintermediation era: Does FHA make a difference?', Economic Activity Working Paper 83, Board of Governors of the Federal Reserve System.

Eaton, J. (1986) 'Lending with costly enforcement of repayment and potential fraud', *Journal of Banking and Finance*, 10: 281–293.

Eaton, J. and M. Gersovitz (1981) 'Debt and potential repudiations', *Review of Economic Studies*, 48: 289–309.

Eaton, J., M. Gersovitz and J. Stiglitz (1986) 'The pure theory of country risk', *European Economic Review*, 30: 481–515.
Eisner, R. and M. Nadiri (1968) 'Investment behavior and neoclassical theory', *Review of Economics and Statistics*, 50: 369–382.
Fair, R. and D. Jaffee (1972) 'Methods of estimations for markets in disequilibrium', *Econometrica*, 40: 497–514.
Fazzari, S., R. Hubbard and B. Petersen (1988) 'Financing constraints and corporate investment', *Brookings Papers on Economic Activity*, 1988-2: 141–195.
Flavin, M. (1981) 'The adjustment of consumption of changing expectations about future income', *Journal of Political Economy*, 89: 974–1009.
Freimer, M. and M. Gordon (1965) 'Why bankers ration credit', *Quarterly Journal of Economics*, 79: 397–410.
Fried, J. and P. Howitt (1980) 'Credit rationing and implicit contract theory', *Journal of Money, Credit and Banking*, 12: 471–487.
Friedman, B. (1981) 'The roles of money and credit in macroeconomic analysis', Working Paper 831, National Bureau of Economic Research.
Gale, I, and J.E. Stiglitz (forthcoming) 'The informational content of initial public offering', *Journal of Finance*.
Goldfeld, S. and R. Quandt (1975) 'Estimation in a disequilibrium model and the value of information', *Journal of Econometrics*, 3: 325–348.
Greenwald, B. and J. Stiglitz (1986a) 'Money, imperfect information, and economic fluctuations', *Symposium on Monetary Theory*, The Institute of Economics, Academia Sinica, Taipei, Taiwan.
Greenwald, B. and J. Stiglitz (1986b) 'Externalities in economies with imperfect information and incomplete markets', *Quarterly Journal of Economics*, 101: 229–264.
Greenwald, B., J. Stiglitz and A. Weiss (1984) 'Informational imperfections in the capital market and macroeconomic fluctuations', *American Economic Review*, 74: 194–199.
Greider, W. (1987) *Secrets of the temple*. New York: Simon and Schuster.
Gurley, J. and E. Shaw (1960) *Money in a theory of finance*. Washington: The Brookings Institution.
Guttentag, J. (1960) 'Credit availability, interest rates, and monetary policy', *Southern Economic Journal*, 26: 219–228.
Hall, R. (1978) 'Stochastic implications of the life cycle–permanent income hypothesis: Theory and evidence', *Journal of Political Economy*, 86: 971–988.
Hall, R. and D. Jorgenson (1967) 'Tax policy and investment behavior', *American Economic Review*, 74: 194–199.
Hall, R. and F. Mishkin (1982) 'The sensitivity of consumption to transitory income: Estimates from panel data on households', *Econometrica*, 50: 461–482.
Harris, D. (1974) 'Credit rationing at commercial banks', *Journal of Money, Credit and Banking*, 6: 227–240.
Hawtrey, R. (1919) *Currency and credit*. New York: Longmans, Green & Co.
Hayashi, F. (1985a) 'The effect of liquidity constraints on consumption: A cross-sectional analysis', *Quarterly Journal of Economics*, 100: 183–206.
Hayashi, F. (1985b) 'Tests for liquidity constraints: A critical survey', NBER Working Paper 1720.
Hellwig, M. (1977) 'A model of borrowing and lending with bankruptcy', *Econometrica*, 45: 1879–1906.
Hodgman, D. (1960) 'Credit risk and credit rationing', *Quarterly Journal of Economics*, 74: 258–278.
Hodgman, D. (1963) *Commercial bank loan and investment policy*. Champaign-Urbana: Bureau of Economic and Business Research, University of Illinois.
Hubbard, R. and K. Judd (1986) 'Liquidity constraints, fiscal policy, and consumption', *Brookings Papers on Economic Activity*, 1986-1: 1–51.
Jaffee, D. (1971) *Credit rationing and the commercial loan market*. New York: Wiley.
Jaffee, D. and F. Modigliani (1969) 'A theory and test of credit rationing', *American Economic Review*, 59: 850–872.
Jaffe, D, and K. Rosen (1979) 'Mortgage credit availability and residential construction activity', *Brookings Papers on Economic Activity*, 1979–2: 333–386.

ffee, D. and T. Russell (1976) 'Imperfect information, uncertainty, and credit rationing', *Quarterly Journal of Economics*, 90: 651–666.
ıne, E. and B. Malkiel (1965) 'Bank portfolio allocation, deposit variability and the availability doctrine', *Quarterly Journal of Economics*, 79: 113–134.
:aton, W. (1979) *Equilibrium credit rationing*. New York: Garland Publishing Company.
:ynes, J.M. (1930) *A treatise on money*. London.
ng, M. (1986) 'Capital market imperfections and the consumption function', *Scandinavian Journal of Economics*, 88: 59–80.
ɔskela, E. (1976) *A study of bank behavior and credit rationing*. Helsinki: Academiae Scientarum Fennicae.
ɔskela, E. (1979) 'On the theory of rationing equilibrium with special reference to credit markets: A survey', *Zeitschrift fur Nationalokonomie*, 39: 63–82.
ıffont, J. and R. Garcia (1977) 'Disequilibrium econometrics for business loans', *Econometrica*, 45: 1187–1204.
:ibenstein, H. (1957) *Economic backwardness and economic growth*. New York: Wiley.
:land, H. and D. Pyle (1977) 'Informational asymmetries, financial structure and financial intermediation', *Journal of Finance*, 32: 371–387.
ndbeck, A. (1962) *The 'new' theory of credit control in the United States*, 2nd edn. Stockholm Economic Studies.
addala, G.S. (1983) *Limited-dependent and qualitative variables in econometrics*. Cambridge: Cambridge University Press.
eltzer, A. (1960), 'Mercantile credit, monetary policy, and the size of firms', *Review of Economics and Statistics*, 42: 429–437.
eyer, J. and E. Kuh (1957) *The investment decision*. Cambridge, Mass.: Harvard University Press.
irrlees, J. (1971) 'An exploration of optimum income taxation', *Review of Economic Studies*, 38: 175–208.
irrlees, J. (1975a) 'The theory of moral hazard and observable behavior: Part 1', Working Paper, Nuffield College.
irrlees, J. (1975b) 'A pure theory of underdeveloped economies', in: L.A. Reynolds, ed., *Agriculture in development theory*. New Haven: Yale University Press, pp. 84–106.
odigliani, F. (1963) 'The monetary mechanism and its interaction with real phenomena: A review of recent developments', *Review of Economics and Statistics*, 45: 79–107.
yers, S. (1977) 'Determinants of corporate borrowing', *Journal of Financial Economics*, 5: 147–175.
yers, S. and N. Majluf (1984) 'Corporate financing decisions when firms have investment information that investors do not have', *Journal of Financial Economics*, 13: 187–220.
ıkamura, L. (1984) 'Bankruptcy and the informational problems of commercial bank lending', Financial Research Center Memorandum 54, Princeton University.
ıdiri, M. (1969) 'The determinants of trade credit in the U.S. total manufacturing sector', *Econometrica*, 37: 408–423.
ılebuff, B. and J. Stiglitz (1983) 'Equilibrium unemployment as a worker selection device', Princeton University mimeo.
tman Hearings (1952) 'Hearings before the Subcommittee on General Credit Control and Debt Management of the Joint Committee on the Economic Report', 82nd Congress, 2nd Session. Washington: Government Printing Office.
ley, J. (1987) 'Credit rationing: A further remark', *American Economic Review*, 77: 224–227.
ɔosa, R. (1951) 'Interest rates and the central bank', in: *Money, trade and economic growth: Essays in honor of John H. Williams*. New York: The Macmillan Company, pp. 270–295.
ɔsenthal, S., J. Duca and S. Gabriel (1987) 'Credit rationing and the demand for owner-occupied housing', Economic Activity Working Paper 79, Board of Governors of the Federal Reserve.
ɔss, S. (1977) 'The determination of financial structure: The incentive signalling approach', *Bell Journal of Economics*, 8: 23–40.
ɔthschild, M. and J. Stiglitz (1971) 'Increasing risk: I. A definition', *Journal of Economic Theory*, 2: 225–243.
hwartz, R. and D. Whitcomb (1980) 'The trade credit decision', in: J. Bicksler, ed., *Handbook of financial economics*. Amsterdam: North-Holland.

Sealey, C. (1979) 'Credit rationing in the commercial loan market: Estimates of a structural model under conditions of disequilibrium', *Journal of Finance*, 34: 689–702.
Shapiro, C. (1983) 'Premiums for high quality products as returns to reputation', *Quarterly Journal of Economics*, 98: 659–679.
Shapiro, C. and J. Stiglitz (1984) 'Equilibrium unemployment as a worker discipline device', *American Economic Review*, 72: 912–927.
Smith, A. (1776) *The wealth of nations*, Modern Library Edition. New York: Random House.
Smith, B. (1983) 'Limited information, credit rationing, and optimal government lending policy', *American Economic Review*, 73: 305–318.
Stigler, G. (1967) 'Imperfections in the capital market', *Journal of Political Economy*, 85: 287–292.
Stiglitz, J. (1970) 'A consumption oriented theory of the demand for financial assets and the term structure of interest rates', *Review of Economic Studies*, 37: 321–351.
Stiglitz, J. (1972), 'Some aspects of the pure theory of corporate finance: Bankruptcies and take-overs', *Bell Journal of Economics and Management Science*, 3: 458–482.
Stiglitz, J. (1974) 'Incentives and risk sharing in sharecropping', *Review of Economic Studies*, 41: 219–255.
Stiglitz, J. (1976a) 'Prices and queues as screening devices in competitive markets', IMSS Technical Report 212, Stanford University.
Stiglitz, J. (1976b) 'The efficiency wage hypothesis, surplus labour and the distribution of income in LDCs', *Oxford Economic Papers*, 28: 185–207.
Stiglitz, J. (1977) 'Monopoly non-linear pricing and imperfect information: The insurance market', *Review of Economic Studies*, 44: 407–430.
Stiglitz, J. (1982) 'Ownership, control and efficient markets: Some paradoxes in the theory of capital markets', in: K. Boyer and W. Shepherd, eds., *Economic regulation: Essays in honor of James R. Nelson*. Ann Arbor: Michigan State Press, pp. 311–341.
Stiglitz, J. (1985) 'Credit markets and the control of capital', *Journal of Money, Credit and Banking*, 17: 133–152.
Stiglitz, J. (1986) 'Theories of wage rigidities', in: J.L. Butkiewicz, K.J. Kotford and J.B. Miller, eds., *Keynes' economic legacy*. New York: Praeger, pp. 153–206.
Stiglitz, J. (1987) 'The causes and consequences of the dependence of quality on price', *Journal of Economic Literature*, 25: 1–48.
Stiglitz, J. and A. Weiss (1981) 'Credit rationing in markets with imperfect information', *American Economic Review*, 71: 393–410.
Stiglitz, J. and A. Weiss (1983) 'Incentive effects of termination: Applications to the credit and labor markets', *American Economic Review*, 73: 912–927.
Stiglitz, J. and A. Weiss (1986) 'Credit rationing and collateral', in: J. Edwards, J. Franks, C. Mayer and S. Schaefer, eds., *Recent developments in corporate finance*. Cambridge: Cambridge University Press, pp. 101–135.
Stiglitz, J. and A. Weiss (1987a) 'Macro-economic equilibrium and credit rationing', Working Paper 2164, National Bureau of Economic Research.
Stiglitz, J. and A. Weiss (1987b) 'Credit rationing with many borrowers', *American Economic Review*, 77: 228–231.
Tobin, J. and W. Dolde (1971) 'Wealth, liquidity, and consumption', Federal Reserve Bank of Boston, Conference Series No 5.
Viner, J. (1937) *Studies in the theory of international trade*. New York: Harper and Brothers.
Wette, H. (1938) 'Collateral in credit rationing in markets with imperfect information: Note', *American Economic Review*, 73: 442–445.
Wojnilower, A. (1980) 'The central role of credit crunches in recent financial history', *Brookings Papers on Economic Activity*, 1980-2: 277–340.
Yellen, J. (1984) 'Efficiency wage model of unemployment', *American Economic Review*, 74: 200–205.