THE ECONOMICS OF CREDIT MARKETS: THEORY AND EVIDENCE

Thesis submitted for the degree of Doctor of Philosophy

by

Muradali Valimamade Ibrahimo

Department of Economics and Related Studies
University of York

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To my Father and Mother

If the legal rate [...] was fixed so high [...], the greater part of the money which was to be lent, would be lent to prodigals and profectors, who alone would be willing to give this higher interest. Sober people, who will give for the use of money no more than a part of what they are likely to make by the use of it, would not venture into the competition [...]. *Adam Smith, Wealth of Nations, 1776.*

So far [...] as bank loans are concerned, lending does not [...] take place according to the principles of a perfect market. There is apt to be an unsatisfied fringe of borrowers, the size of which can be expanded or contracted, so that banks can influence the volume of investments by expanding or contracting the volume of their loans, without there being necessarily any change in the level of bank-rate, in the demand schedule of borrowers, or in the volume of lending otherwise than through banks. This phenomenon is capable, when it exists, of having great practical importance. *J. M. Keynes, A Treatise on Money, 1930.*

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DECLARATION

Chapters 1 and 2, and Sections 5.2 to 5.4 of Chapter 5 are based on works undertaken jointly with Brian Hillier. Chapter 1 and the parts of Chapter 5 referred to use the material written for the forthcoming papers, to be published as 'Asymmetric Information and Models of Credit Rationing' and 'Credit, Money and the Government Budget Constraint', respectively, in the Bulletin of Economic Research. Chapter 2 uses the contents of the forthcoming paper in the Journal of Economic Studies, to be published as 'The Performance of Credit Markets Under Asymmetric Information About Project Means and Variances'.

In those joint works the effort and contribution may be attributed to both the authors in equal parts.

ABSTRACT

Recent years have witnessed an increasing interest in credit markets for a number of reasons: first, credit markets perform important functions in any developed monetary economy, such as the sharing of risk between different individuals, the allocation of financial resources and the transmission of monetary policies; second, several influential theoretical studies have, by taking into consideration the idea of incomplete information, concluded that they operate in a very distinct way compared to most other markets, with equilibria in most cases exhibiting inefficiency; third, the new empirical research has provided support for the importance of the role played by the financial system in the determination of the real economic activity.

This thesis examines the relevant works on credit, evaluates the explanatory power of the theories hitherto advanced and, more importantly, offers new theoretical and empirical studies which provide further insights into the subject.

Part 1 is devoted to the microeconomic studies on credit with incomplete information. Assuming that borrowers are better informed than lenders about the quality of their investment projects, it derives several theoretical propositions which add to the understanding of credit market functioning. Moreover, it provides empirical evidence on the characteristics of random distributions of rates of return associated with industrial corporations.

Part 2 is concerned with macroeconomic studies on credit in the context of the conventional ad-hoc approach with symmetric information. It shows how an explicit credit market may be incorporated in a standard macroeconomic model augmented with wealth effects and government budget constraint in order to allow the examination of issues, such as credit market shocks, that would not otherwise be possible.

The thesis' mode of exposition is eclectic, using alternatively 'literary' reasoning, geometrical demonstrations and analytical proofs depending on the nature of the topics under consideration.

GENERAL INTRODUCTION

GENERAL INTRODUCTION

Credit markets, and financial markets more generally, have been the focus of recent research for three main reasons: first, they perform important functions in any advanced economy, such as the sharing of risk between different individuals, the allocation of financial resources and the transmission of monetary policies; second, a number of influential economists have noted that they operate in a very distinct way compared to most other markets, with non-Walrasian and seemingly non-optimal equilibria being the rule rather than the exception; third, the new empirical research, examining both historical and postwar data, has provided support for the importance of the role played by the financial system in the determination of the real economic activity.

Although the interpretation of the issues associated with credit markets varies from one set of studies to another, the above points have come to constitute a common ground shared by economists of rather different persuasions. In the attempt to provide a sound explanation of the aforementioned phenomena, recent theoretical research on the economic importance of credit markets has branched off into two general directions.

Concerned with capital market imperfections, the first has focused on the effects of asymmetric information between lenders and borrowers. It is well understood that the optimal performance of an economy requires an efficient transfer of resources from wealth owners to firms, which in turn requires the complete availability of information or state contingent contracts to all participants in the market. The collection of information is an activity in which financial intermediaries are supposed to specialise. However, this activity is usually costly and not always effective in eliminating the informational problems which emerge in the market. Financial intermediaries, therefore, cannot always perform their coordination function efficiently, and the problems caused by the existence of asymmetric information between the different categories of economic agents may produce serious misallocations of the amount of resources available to producers. Recent microeconomic studies on credit have demonstrated that those informational problems can have a number of important economic consequences: they can lead to equilibrium credit rationing, they can provide an explanation of the form of financial contracts offered by financial institutions, they can provide a rationale for the existence of financial intermediation, and they can generate non-optimal levels of aggregate investment which may justify government intervention.

Following up the lines of research suggested by the partial equilibrium approach to the credit market, much of modern business cycle theory - developed in the context of the micro-based general equilibrium framework - has also sought to model informational asymmetries so as to provide explicit choice theoretic foundations for macroeconomic phenomena. This recent line of research has yielded interesting insights regarding the important role that credit and financial intermediation may play in explaining macroeconomic relationships, in propagating business cycles and in producing cyclical behaviour in response to shocks.

The second general direction of research on credit markets has used the traditional method in macroeconomics. It is widely recognized that the movements of credit in response to monetary policy interventions are an important channel through which monetary policy affects aggregate demand. Although developed in the context of the conventional ad-hoc approach, some recent macroeconomic studies have been particularly successful in dealing with this issue of monetary transmission mechanism. Moreover, these studies have been quite valuable for the analysis of the effects of government macroeconomic policies when analytical difficulties have precluded the use of the general equilibrium optimizing framework.

This thesis reflects the current level of development in the economics of credit markets. The aim of the thesis is to examine the relevant works on credit, to evaluate the explanatory power of the theories hitherto advanced and, more importantly, to offer new theoretical and empirical studies which provide further insights, thereby adding to the existing literature on the subject.

The thesis is divided in two parts. Part 1, which comprehends Chapters 1 to 4, is mainly devoted to the microeconomic studies on credit with asymmetric information, while Part 2, which only includes Chapter 5, is concerned with the macroeconomic studies on credit in the context of the conventional ad-hoc approach with symmetric information. An outline of the chapters is given next.

Chapter 1 surveys the modern theories of credit that explore the consequences of imperfect information. The topic of credit rationing is one of the central themes under consideration. Recent research into this phenomenon has aimed at answering the question of whether there exist plausible conditions which make rationing compatible with the rational optimizing behaviour of all market participants without resort to some exogenous constraints such as usury laws. Based upon the idea of asymmetric information about the quality of investment projects, the seminal works of Keeton (1979), Stiglitz and Weiss (1981), and Williamson (1986) have advanced sound theoretical explanations for the existence of equilibrium credit rationing. In this literature, three fundamental reasons have been put forward for lenders to ration credit instead of raising the interest rate up to the level where the demand for and supply of loans are equated: adverse selection, moral hazard and monitoring costs. In all these cases, the explanations of credit rationing rely on some form of asymmetry of information as well as on the idea that changes in the rate of interest affect the quality of the loan portfolio of lenders adversely, either in terms of the riskiness of the projects being funded or in terms of the expected monitoring costs. The dependence of the quality of the loan portfolio on the interest rate constitutes the main cause of rationing. In each case the lender may have reasons for wishing to hold the interest rate below the market clearing level in order to affect the quality of the loan portfolio rather than reap the direct gains available from charging a higher rate.

The possibility of rationing also depends on the mode of ranking investment projects in the market. In the Stiglitz and Weiss (1981) model, for instance, the distributions from which project returns are drawn all have a common mean and differ from one another only in terms of their variance. If, instead, as in the de Meza and Webb (1987) model, projects are assumed to differ in expected return but not in terms of variance, then equilibrium requires market clearing. This result clearly suggests that the propositions established in several studies of credit based on asymmetric information are sensitive to changes in model specifications. During the course of the thesis, the importance of this problem will become increasingly clear.

Other issues addressed in Chapter 1 are the form of financial contracts and the non-optimality of equilibria. In models of ex ante asymmetric information (e.g. Jaffee and Russell 1976, Stiglitz and Weiss 1981, and de Meza and Webb 1987), financial intermediation takes place via a standard debt contract with a probability of default. With few exceptions (e.g. de Meza and Webb 1987), debt contracts are not derived endogenously. However, in models of ex post asymmetric information (e.g. Williamson 1986, 1987), debt contract as the optimal form of intermediation is derived from first principles. The basic reason why debt contract is optimal is that under any other financial arrangement the borrower never has an incentive to announce an ex post return in excess of the minimum return necessary to prevent auditing by the lenders; this minimum return corresponds to the no-default payment on the loan rate. Moreover, in ex post asymmetric information models, financial intermediaries arise naturally because, in comparison to direct lending, they economize on monitoring costs when a borrower defaults.

The allocation of financial resources in equilibrium (with and without rationing) is inefficient in a number of studies (e.g. Stiglitz and Weiss 1981, de Meza and Webb 1987, and Mankiw 1986). However, the type of inefficiency differs from one group of models to another. Furthermore, 'the non-optimality of equilibria in the presence of credit rationing is not general: there are examples in which the allocation with credit rationing is that which would be produced by a central planner with the same information as is available to market participants. Thus the allocation in a credit-rationed equilibrium is optimal in the model set up by Williamson (1986) [...]. The point in all of these cases is that credit rationing is an efficient method of preventing overinvestment in risky projects that would otherwise take place because of the lack of information by the lender.' (Blanchard and Fischer 1989, p. 486).

Informational problems and their consequences are also examined within the micro-based general equilibrium frameworks recently developed. This line of research offers two advantages over the partial equilibrium approach. First, it provides a stronger theoretical foundation for welfare policies. Second, it allows the analysis of the importance of financial intermediation in the determination of the macroeconomic activity as well as in the explanation of business cycles.

Several issues, referred to later, remain unresolved in the current literature. The studies developed in other chapters of the thesis attempt to lay the theoretical and empirical foundations for answering part of those outstanding problems.

Chapter 2 develops a microeconomic model of credit with ex ante asymmetry of information about both the mean and variance associated with individual project returns. In the model, both entrepreneurs and financiers are risk-neutral and expected profit maximisers. Debt contract is the form of financial arrangement considered. The novelty of this framework is that investment projects are distinguished in terms of two characteristic parameters of their distribution functions of returns, i.e. in terms of the mean and variance parameters. This contrasts with the models of Stiglitz and Weiss (1981) and de Meza and Webb (1987), in which distributions are distinguished in terms of either the mean or the variance parameters but not both. The more general model thus combines the adverse selection arguments of Stiglitz and Weiss and the favourable selection arguments of de Meza and Webb. As a consequence, two results are derived. First, market equilibrium may exhibit rationing. Second, inefficiencies may involve not merely the volume of investment but also its composition, i.e. market equilibrium may simultaneously display both some projects being funded which would not be funded in the first-best case and some projects not being funded which would be funded in the first-best case, regardless of whether the aggregate level of investment is above, below or equal to the first-best level.

Chapter 3 also considers a partial equilibrium model with informational asymmetries. But this time entrepreneurs' projects only differ in risk and the problem analysed is that of financing them by own equity, debt and outside equity. This framework draws on and synthesises the works of de Meza and Webb (1990) and Stiglitz and Weiss (1981). Entrepreneurs are considered to behave in a risk-averse manner and each of them is endowed with a project at the beginning of the period. The projects, if undertaken, require outside finance from risk-neutral bankers who offer financial contracts to entrepreneurs. All projects are assumed to have the same expected return and there are two outcomes, one with a high probability of securing the successful return and another with a low probability. The quality of an individual entrepreneur's project, that is, the success probability - not known by the financial institutions - is private information. With this model, if negative incentive effects are not taken into account, the financial equilibrium involves pooling equilibrium with both categories of projects being entirely financed through outside equity. With this type of solution there can be no adverse selection and social efficiency is achieved.

However, the assumption that equity contract entails no costs seems unreasonable because of moral hazard problems. Incentive effects may justify an optimal small proportion of outside equity in the capital structure of firms. It is therefore assumed that in all projects the share of equity held by bankers is fixed and relatively small. With this assumption the model exhibits interesting properties. First, if a separating equilibrium exists, it must be the unique equilibrium. Regardless of the values of the parameters of the model, a pooling equilibrium cannot exist; moreover, under quite plausible conditions, equilibrium may not exist. Second, credit rationing in equilibrium is not viable. Third, the competitive equilibrium is not economically efficient, i.e. in separating equilibrium aggregate investment falls short of the first-best level. This result is novel. Fourth, capital structure of firms does matter, i.e. the relative magnitude of outside equity makes a real difference to the quantity of aggregate investment in equilibrium. And finally, the leverage of firm is positively associated with default probability.

The contribution of Chapter 4 is situated at the empirical level. In the literature, the assumptions advanced regarding the mode of ranking investment projects in the market remain an unresolved issue. These assumptions have significant economic implications. For instance, in Stiglitz and Weiss (1981), where the distribution function of returns differs across investment projects only in terms of variance, the market equilibrium involves under-investment relative to the first-best level. On the other hand, in de Meza and Webb (1987), where the underlying distribution of returns differs across projects only in terms of expected return, the market equilibrium exhibits over-investment. Moreover, if investment projects differ from one another in terms of both the means and variances of the distributions from which project returns are drawn (as in Chapter 2), the aggregate investment may be above or below its first-best level. The empirical study in this chapter tests the validity of these assumptions, at the same time contributing to the existing body of empirical evidence on the random distributions of rates of return associated with individual corporations in the United Kingdom. For this purpose, and hence the interpretation of statistical data, the analysis of variance technique, the non-parametric runs and Kruskal-Wallis tests, and the multiple pairwise comparison method are used. The data used refer to UK companies grouped in industries for the years 1980-89.

In general, the findings bear out the assumption that the distributions from which firms' returns are drawn differ (significantly) in terms of both means and variances. However, it must be acknowledged that, from a theoretical viewpoint, it is perfectly legitimate to develop an analysis on the assumption of either identical mean returns and differential risks (as assumed in Stiglitz and Weiss, and Chapter 3), or identical variances and differential expected rates of return (as assumed in de Meza and Webb), although the evidence presented offers provisional support to the assumption made in Chapter 2.

Chapter 5 briefly surveys the literature on macroeconomics of credit based on the conventional approach and also proposes a model along this line of research. In recent years, the method applied in macroeconomics has undergone a radical change. From ad-hoc models of Keynesian or monetarist inspiration most leading macroeconomists have shifted the focus of their research towards general equilibrium models, attempting to place macroeconomics on the theoretically firm grounds of microeconomic theory. However, the micro-based general equilibrium models which establish the important role of financial intermediation in business cycles are not very explicit regarding the way monetary policy, and central bank policy in general, affect aggregate economic activity. This is due to the well known analytical difficulties entailed by the introduction of money in general equilibrium models. As a result, some alternative macroeconomic models allowing roles for both money and credit have recently been developed in the context of the standard IS-LM model (e.g. Bernanke and Blinder 1988, and Brunner and Meltzer 1988). In these models money and credit interact and explain a variety of macroeconomic relationships, such as the variations in aggregate demand stemming from the movements of credit in response to monetary policy interventions.

The study by Bernanke and Blinder (1988) emphasises the interdependence of money and credit. However, interdependence also extends to fiscal policy and therefore coordination of these several policies is an issue that should be considered in any macroeconomic analysis. Indeed, the implications of the government mode of financing its deficits together with wealth effects highlight the interdependence of monetary and fiscal policies (e.g. see Blinder and Solow 1973). Accordingly, the model elaborated in Chapter 5 encompasses credit, money, wealth, government budget and aggregate demand. The study shows how an explicit credit market may be incorporated in a standard macroeconomic model augmented with wealth effects and government budget constraint in order to allow the examination of issues, such as credit market shock, that would not otherwise be possible. As a consequence, it is able to demonstrate, for instance, that a negative credit market shock causes the loan rate to rise and, hence, investment to fall, which in turn triggers off the fall in income, in the transactions demand for money and in the interest rate on bonds. Such an outcome could not have been predicted by the standard IS-LM model, which illustrates the value of introducing an explicit credit market into this framework. In addition, the study demonstrates that the analysis of more conventional policies (e.g. open market purchase of bonds) is enhanced by reinforcing the usual channels of the transmission process with a credit market.

Finally, the concluding remarks offer an assessment of the works presented in the preceding chapters as well as an outlook on possible future research.

PART 1

MICROECONOMIC STUDIES ON CREDIT WITH ASYMMETRIC INFORMATION

CHAPTER 1

ASYMMETRIC INFORMATION AND MODELS OF CREDIT: A SURVEY

1.1. Introduction

The main purpose of the studies in Part 1 of the thesis is to apply the analytical tools and concepts developed in the 'New Information Economics' to credit markets in order to explore the possibility of market failures and their consequences. The New Information Economics - a term coined by one of its leading proponents (Stiglitz 1985) - refers to the attempts, intensified in the last two decades, to incorporate informational problems into economic theory in a rigorous way.

In view of this, the present chapter surveys the recent theoretical literature which explores the consequences of asymmetric information in the credit market.[1] These consequences could potentially add to our understanding of microeconomic, macroeconomic and welfare economic issues.

One of the central themes in the present study is credit rationing. During the 1950s and at the beginning of the 1960s, the proponents of the so-called Availability Doctrine were the first to focus attention on this phenomenon. They argued that monetary policy could be used to change aggregate demand (even if investment were insensitive to the rate of interest) if variations of the money supply were reflected in changes of the availability of loans rather than in changes of the interest rate.

Ever since, continued interest in credit rationing has aimed at answering the following questions: first, whether there exist plausible conditions which make rationing compatible with the optimal behaviour of economic agents without resorting to exogenous constraints such as interest rate regulations; second, whether rationing leads to inefficiency and, if so, what policies should be followed to overcome this problem; and, third, whether credit rationing has any effect on the transmission of monetary policy.

The following sections examine how these issues have been dealt with by economists - of rather different persuasions - concerned with asymmetric information.

In addition to the rational explanation of credit rationing, the research on financial markets based on asymmetric information has yielded appealing explanations of a variety of other economic issues, such as the necessity of financial intermediation, the optimal form of financial contracts and the nature of the inefficient level of aggregate investment.

Many of the results in the literature, including those on credit rationing, are, however, not robust to changes in the model specification. Thus, while Stiglitz notes the importance of credit (and equity) rationing and feels able to conclude that 'an effective stabilization policy of the government should be directed at overcoming the limitations of this rationing' (1988, p.320), Williamson concludes that 'there appears [...] to be no obvious role for *stabilization policy* that arises from the existence of unemployed resources and credit rationing in equilibrium' (1987, p. 1215). These differences notwithstanding, it does seem safe to conclude that the area of research is interesting and that further work, both theoretical and empirical, is likely to prove rewarding.

The remainder of this chapter is organised as follows. Section 1.2 offers a brief review of the views of some earlier writers on the importance of the credit market and financial structure in the determination of economic activity. Section 1.3 outlines the role of asymmetric information in the credit market and then presents an illustrative partial equilibrium model to show how it may lead to rationing. Section 1.4 examines the inferences that have been drawn from such models, whilst Section 1.5 discusses some criticisms and recent developments which both extend and question the analysis. Section 1.6 further extends the analysis by examining the ideas in general equilibrium contexts. Finally, Section 1.7 offers some conclusions and defines the research program for the remaining chapters of the thesis.

1.2. Background

The idea that the credit market and financial structure are important in the determination of economic activity is, of course, not new. Notable economists whose works remain influential include Fisher and Gurley and Shaw. Fisher (e.g. see 1933) in his theory of 'debt-deflation' coupled the collapse of the financial system with the collapse of real economic activity in the Great Depression. According to Fisher, the high level of borrowers' debt built up during the period of prosperity preceding 1929 made the economy vulnerable to the ensuing downturn which led to a wave of bankruptcies which, in turn, enhanced the downturn. Gurley and Shaw (e.g. see 1955) similarly noted the role of financial intermediation in the credit supply process and called attention to the importance of 'financial capacity'. Financial capacity was an aggregate indicator of borrowers' ability to support debt without having to cut back current or future spending in order to avoid default or rescheduling. The role of financial and balance sheet variables on investment and output was thus emphasized.[2]

The literature on asymmetric information and the credit market may be traced back to the Availability Doctrine associated with Rosa.[3] According to Rosa there was a commonly held view amongst economists in the United States of America in the years immediately following World War II that 'central bank control over interest rates was useless as a restraint upon cyclical swings in the American economy' (1951, p. 270). In reaction to this view, Rosa and others (see Scott 1957a,b and Lindbeck 1962) argued that even if investment and saving were insensitive to the rate of interest, monetary policy could still be useful via its effects on lenders and the availability of credit. As Rosa put it, 'in essence, it is not necessarily interest rates as a cost to the borrower, nor as an inducement to the saver, but rather interest rates as a reflection of underlying changes in credit availability, that have an important (though certainly not always a decisive) impact upon the generation of business cycles' (1951, p. 276). He went on to add that '[interest] rate changes brought about by the open market operations of the central bank influence the disposition or the ability of lenders to make funds available to borrowers, either for the continuation of outstanding indebtedness or for incurring new debt' (1951, p. 282).

Rosa's argument focused attention on two important issues: first, the interaction of the central and commercial banks (specifically in the presence of a large public debt across a broad spectrum of terms to maturity) and, second, credit rationing. Stimulated by the Availability Doctrine, the interest in credit rationing led to attempts to provide a sound theoretical explanation for the existence of equilibrium credit rationing; or, in other words, to answer the question as to why an excess demand for loanable funds should not cause the interest rate to rise until demand and supply were equated.

As the term 'equilibrium credit rationing' suggests, the traditional definition of credit rationing which refers only to an excess demand for loans at the ruling loan rate is insufficient. In fact, it is neither surprising that lenders do not grant large loans arbitrarily, regardless of the level of loan rate, nor that borrowers with differences in relevant characteristics get different loan contracts. This point, however, has not always been recognized, and it was only in 1979 that Keeton proposed a neat distinction between different types of credit rationing: Type 1 rationing in which some or all loan applicants get a smaller loan than they desire at the quoted loan rate of interest; and Type 2 rationing in which some loan applicants are denied a loan even though for the lender they are indistinguishable from accepted applicants. For both types of rationing, applicants are required strictly to prefer a loan in the sense that they are ready to accept a higher rate of interest in order to obtain one. At first sight, Type 2 rationing appears to be merely a special case of Type 1 rationing, since getting no loan is one example of a smaller than the desired one. But the requirement of homogeneous applicants, as perceived by the lender, makes Type 2 rationing the more interesting case. While Type 1 rationing was used in most of the older literature referred to next, recent studies have for the most part focused on Type 2 rationing.

A number of authors (e.g. Hodgman 1960, Miller 1962, Freimer and Gordon 1965, Jaffee 1971, Smith 1972, Azzi and Cox 1976, and Jaffee and Modigliani 1969, 1976) attempted to explain credit rationing within a full-information framework. Freimer and Gordon (1965) generated a backward bending supply of credit and based their explanation of rationing upon it. Jaffee and Modigliani (1969), however, rightly pointed out that credit rationing can only be explained with an analysis of the interaction of supply and demand curves and not by looking at the supply of credit alone.

Jaffee and Modigliani attempted to provide an affirmative answer to the question: 'is it rational for commercial banks to ration credit by means other than price?' (1969, p. 850). Their answer, although interesting, was not fully convincing since it relied upon exogenously given loan demand functions and produced rationing as the equilibrium outcome of rational bank behaviour only by imposing the constraint that the bank in their model must offer a uniform interest rate to different borrowers, though that rate may be chosen freely and the loan size may be varied across customers. If the bank were allowed to charge different customers different rates, as it would wish to do in order to maximise profits, then rationing would not appear. Thus, one is left wondering why bank behaviour obeys such a constraint. If the constraint is taken as a legal restriction then it seems that Jaffee and Modigliani have really produced rationing by imposing it from outside the model and, thus, have not offered a wholly satisfactory explanation.

A more convincing explanation of credit rationing may be based upon the idea of asymmetric information. It is this type of explanation which forms the focus of the remainder of this chapter.[4] It is interesting to note, however, that Jaffee and Modigliani hinted at such an explanation when discussing an intermediate scenario between the extremes of perfectly discriminating monopoly and the uniform rate case. They argued that in order to improve profitability a banker might try to classify customers into several different rate classes and pointed out that 'an effort would no doubt be made to choose the criteria for classification so as to minimize the difference between the optimal classification of customers into rate classes and the categories dictated by the objective criteria, but a close approximation might be difficult to achieve' (1969, p. 860). More modern writers might well explain the difficulty to which Jaffee and Modigliani allude by reference to asymmetric information. The next section turns to such explanations.

1.3. Credit Rationing Under Asymmetric Information

1.3.1. An Outline of the Key Ideas

The idea that asymmetric information could cause markets to deviate from the behaviour patterns conventionally analysed became widely recognized following the seminal papers by Arrow (1963, 1968) and Akerlof (1970).

Arrow's contribution focused attention upon the problem of moral hazard. This may occur where one party, known as the principal, enters into a contract with another, known as the agent, who has some degree of autonomy over his consequent actions which cannot be perfectly monitored by the principal. These actions affect the outcome for both the principal and the agent and their preferences differ so that there is some degree of conflict between the two parties. The principal, therefore, wishes to devise a contract which will induce the agent to undertake actions, which the principal cannot fully monitor, desired by the principal. A simple example of this type of problem concerns a contract between an insurance company (the principal) and an insuree (the agent). Suppose that in return for an annual premium the insurance company agrees to indemnify the insuree against the theft of his motor car. As a result of being insured, the insuree may feel that he has less incentive to fit and operate anti-theft devices in his car, thus making theft more likely. In consequence, the insurance company may place restrictions on the observable circumstances under which it will compensate the insuree against theft, or agree to provide only partial compensation in an attempt to induce the insuree to continue to take sensible precautions even after insurance.

The key point is that the behaviour of the agent, which the principal wishes to control, is a function of the terms of the contract between them. Moral hazard is simply the temptation of the agent to undertake actions which the principal finds undesirable; it need not amount to outright dishonesty such as cases of insurance fraud, although these cases may occur.

The application of this idea to the credit market is straightforward. Consider the bank to be the principal and the borrower to be the agent. If the interest rate to be charged on the loan affects the consequent behaviour of the borrower, then the bank may choose to set an interest rate which does not clear the credit market if it chooses the interest rate partly to influence the unobservable behaviour of the borrower and the use made of the loan. For instance, if a higher interest rate encouraged borrowers taking out loans for investment finance to invest in riskier projects, it can be shown that banks may have an incentive to charge a rate below the market clearing rate in order to induce investment in less risky projects.

Akerlof's contribution drew attention to another problem associated with asymmetric information, that of adverse selection. The reasoning here is quite simple. Consider a market in which sellers, who know the quality of their product, offer products of different qualities to buyers who are unable to distinguish between them. Given that they are unable to distinguish between products, buyers will offer a price reflecting the perceived average quality of products, which may force some sellers of high quality goods, with a reservation price above this average price, to withdraw their goods from the market. Hence, the market for high quality goods may fail even though all agents are acting rationally. Clearly, several issues arise from this idea, such as how sellers respond to the incentive to signal the quality of their product if it is above the average, but the basic idea is simple and seems readily applicable to the credit market. Viewing the bank as the buyer of risky promises and borrowers as the sellers of such promises, it is easy to imagine sellers knowing the riskiness of their promises and the bank being less well informed. This asymmetry of information may lead to credit rationing since banks know that their categorization of borrowers into different risk classes is imperfect and fear that setting a market clearing rate may lead to a worsening, in terms of risk characteristics, of the overall quality of borrowers. As Akerlof noted, 'the difficulty of distinguishing good quality from bad is inherent in the business world; this may indeed explain many economic institutions and may in fact be one of the more important aspects of uncertainty.' (1970, p. 500). One difference between the models to be discussed below and the basic Akerlof model is that in the models below banks can choose the interest rate in order to try to affect the quality of projects, whereas in the Akerlof model buyers are price takers.

The ideas of adverse selection and moral hazard were first applied to the credit market in papers by Jaffee and Russell (1976), Keeton (1979) and Stiglitz and Weiss (1981). Apart from the paper by Jaffee and Russell, the literature relates more clearly to the finance of investment projects than to consumer credit, perhaps because in the market for consumer credit the banks can more easily be imagined to segregate borrowers into risk classes or control the use of funds or impose other terms on customers so as to avoid the problems of adverse selection and moral hazard. Although in principle the ideas might be applied to the consumer credit market, the present study follows the literature and assumes that loans are used for investment finance from now on.

The adverse selection and moral hazard problems outlined above may be considered to be problems of ex ante asymmetric information, since the ex post returns associated with a project are assumed to be costlessly observable by both lenders and borrowers. The asymmetry of information in either of these two cases concerns the riskiness of the project for which a loan is used rather than the eventual outcome of the project.

A more recent idea which has also been applied to the credit market (see Williamson 1986, 1987) is that of costly state verification (see Townsend 1979). In this case, lenders know as much as borrowers about the riskiness of the projects being funded but only the borrower is able to observe his project returns costlessly. This ex post asymmetry of information gives rise to a novel kind of moral hazard problem; the borrower has an incentive to declare a project return so low as to make him unable to pay off his debt to the bank even if the return is in fact much higher than would be needed to do so.[5] Banks respond to this incentive by committing themselves to incur costly monitoring of the project returns of any borrowers who declare themselves bankrupt. An underlying premise within this environment is that the higher the interest rate on loans the greater the likelihood for any borrower genuinely to suffer bankruptcy and for any bank to incur monitoring costs. Hence, once again the bank has a reason to choose an interest rate which does not clear the loan market, this time because to do so might entail an unacceptable rise in expected monitoring costs which would more than offset the direct benefits to the bank of the higher interest rate needed to clear the market.

Notice that all of the above explanations of credit rationing rely on a form of asymmetry of information and on the consequence that changes in the rate of interest affect the quality of the loan portfolio of the bank adversely, either in terms of the riskiness of the projects being funded or in terms of the expected monitoring costs. It is this dependence of the quality of the loan portfolio upon the interest rate which leads to credit rationing. In each case the bank may have reasons to wish to hold the interest rate below the market clearing level in order to affect the quality of the loan portfolio rather than reap the direct gains available from charging a higher rate. It will be shown below that if the bank has some other way of affecting the quality of its portfolio then the possibility of credit rationing may disappear.

The remainder of this chapter aims to flesh out some of the above ideas. The next subsection begins this task by examining a simple partial equilibrium model of the credit market under ex ante asymmetric information which exhibits the problem of adverse selection.

1.3.2. A Credit Market Model with Ex Ante Asymmetric Information and Adverse Selection

The role of ex ante asymmetric information and adverse selection may be shown using a simplified version of a model due to Stiglitz and Weiss (1981).[6]

Consider that a bank has identified a group of borrowers, each of whom has a single one period project in which he can invest. Each project requires a fixed amount of investment denoted by K and each borrower must borrow this amount if he is to invest. This assumption rules out any complications provided by the possibility of the borrower investing some of his own wealth in the project or raising finance by other means, such as an equity issue. Such complications will however be discussed in Section 1.5 below.

The return on any project is a random variable. Stiglitz and Weiss introduce the concept of the mean preserving spread.[7] In this case, the distributions from which project returns are drawn all have a common mean and differ from one another only in terms of their variance, with projects whose returns are drawn from distributions with larger variances being said to be riskier projects. The assumption that each project has a common expected payoff or gross return, denoted by $\bar{R}$, is retained, but for simplicity assume that projects either succeed in the period after they are carried out, the ith project yielding the specific return R^s_i with probability p_i, or fail and yield zero. Hence, for all projects the following holds:

$$(1.1) \qquad p_i R^s_i = \bar{R}, \quad \text{for all } i.$$

Project i is said to be riskier than project j if, given that (1.1) is satisfied, $p_i < p_j$.

Banks and borrowers are risk-neutral profit maximisers. Banks are competitive; they compete 'by their choice of a price (interest rate) which maximises their profits' and 'the interest rate received by depositors is determined by the zero-profit condition' (Stiglitz and Weiss 1981, p. 395). The supply of loanable funds to the bank is independent of the interest rate it charges borrowers.

There are two key asymmetries in this model. First, there is an asymmetry of information. Banks are assumed to be ignorant of the probability of success, p_i, and the value of the return if successful, R^s_i, of the ith borrower's project, though they do know the characteristics of the population of borrowers. Borrowers, on the other hand, know the probability of success and the value of the successful outcome associated with their project. Given this asymmetry, if banks do decide to ration credit, they will be unable to do so in a way which discriminates between high-risk and low-risk borrowers. Rationing will therefore be of Type 2 where some borrowers are granted loans of size K to finance their projects, whilst other loan applicants will be denied credit even though the bank is unable to distinguish in any way between loan applicants.[8]

The other key asymmetry is an asymmetry in payoffs introduced by the nature of the debt contract. The contract is assumed to be of a standard form, on which the borrower pays the specified amount (1+r)K in the period after he has borrowed K if the project succeeds, or else pays nothing if the project fails. Banks, therefore, receive either zero or (1+r)K once the project has been carried out, depending on whether it fails or succeeds, whilst borrowers receive either zero or any payoff in excess of (1+r)K, i.e. R^s_i-(1+r)K. The effect of this latter asymmetry is to make risk-neutral banks prefer less risky projects, and risk-neutral borrowers to choose to apply for loans to carry out their projects only if they are - in a way to be described below - sufficiently risky. Thus, for a given interest rate r, investors with riskier projects will be those who choose to borrow and invest, whilst those with less risky projects, which the bank would prefer to see carried out, will choose not to invest.

To show that it is the riskier projects which will be undertaken, consider the expected return net of debt repayment to the bank for the ith borrower:

$$(1.2) \qquad E(\pi_i) = p_i[R^s_i - (1+r)K].$$

Profit maximizing risk-neutral borrowers will certainly wish to borrow and invest in their project if and only if $E(\pi_i)$ exceeds zero, or, in other words, if and only if R^s_i exceeds $(1+r)K$, since p_i must be positive. Therefore, only projects with a high enough R^s_i will be carried out, but from equation (1.1) this can be seen to be the same as saying that only projects with a low enough p_i will be undertaken. Alternatively, this result may be shown by differentiating (1.2) to yield:

$$(1.3) \qquad dE(\pi_i)/dp_i = R^s_i + p_i(dR^s_i/dp_i) - (1+r)K$$

and noting from (1.1) that dR^s_i/dp_i equals $-\bar{R}/p_i^2$ or $-R^s_i/p_i$. Hence (1.3) becomes:

$$(1.4) \qquad dE(\pi_i)/dp_i = -(1+r)K.$$

Thus, the higher p_i is the lower expected net profits are and only for a sufficiently low p_i will (1.2) yield a positive value for expected net profits.

The result that expected net returns to the borrower are higher for riskier projects may be interpreted as stemming from the fact that for such projects 'the expected interest payments are lower because the loan is repaid less often' (English 1986, p. 7). However, this interpretation must be considered carefully. It is only because expected gross returns are held constant that reducing expected interest payments raises expected net profits, $E(\pi_i)$. If, for example, R^s_i were the same for all projects, both expected gross returns and expected net returns would rise with p_i, as can be seen by looking at $p_iR^s_i$ and by setting dR^s_i/dp_i equal to zero in (1.3) for projects where R^s_i exceeds $(1+r)K$, i.e. for projects which borrowers would wish to carry out. Following de Meza and Webb (1987, 1990), the case for projects with a common return if successful and unequal expected returns will later be examined. It will be seen that the arguments presented for projects with equal expected gross returns are not robust to such changes in model specification.

Thus, for a pool of projects with equal gross expected returns the higher the interest rate r the higher R^s_i must be, i.e. the lower p_i must be, in order for a potential borrower to choose to borrow and invest in his project. Hence, as a bank increases the interest rate r which it charges, the pool of loan applicants becomes composed of borrowers with riskier projects. Since banks prefer less risky to more risky projects they will have to balance this effect of increasing the interest rate against the higher debt repayments it produces from successful projects.

To show that banks would prefer to invest in less risky projects, consider the net return to the bank on a loan to the ith borrower:

$$(1.5) \qquad E_b(\pi_i) = p_i(1+r)K - (1+\rho)K$$

where ρ is the cost of funds to the bank.[9] Clearly, the expected return to the bank given by equation (1.5) is increasing in p_i for given r and ρ values.

Let $\bar{p}$ be the cut-off probability of success above which potential borrowers choose not to apply for loans given the interest rate r. The total number of loan applicants from the potential group of borrowers identified by the bank will therefore be given by $_0\int^{\bar{p}} g(p_i)dp_i$, where $g(p_i)$ is the density function characterizing the distribution of p_i across potential borrowers and is known by the bank. Assuming that all these applicants are granted loans, the total expected gross profit to the bank on its loan portfolio is given by:

$$(1.6) \qquad E(\pi_b) = \int_0^{\bar{p}} (1+r)Kp_i g(p_i)dp_i = (1+r)K \int_0^{\bar{p}} p_i g(p_i)dp_i$$

which represents the return the bank receives from successful projects weighted by the expected number of successful projects.

Now consider the expected gross interest factor, λ, earned by the bank per unit of money loaned on this portfolio. This is given by:

(1.7) $$\lambda = [(1+r)K \int_0^{\bar{p}} p_i g(p_i)dp_i] \;/\; [K \int_0^{\bar{p}} g(p_i)dp_i].$$

The numerator in (1.7) is just $E(\pi_b)$ and the denominator is simply the total value of loans granted. Differentiating (1.7) with respect to r it can be seen that the sign of $d\lambda/dr$ depends upon:

(1.8) $$\int_0^{\bar{p}} g(p_i)dp_i \, [\int_0^{\bar{p}} p_i g(p_i)dp_i + (1+r)\bar{p}g(\bar{p})(d\bar{p}/dr)] - (d\bar{p}/dr)g(\bar{p})[(1+r) \int_0^{\bar{p}} p_i g(p_i)dp_i]$$

which is ambiguous. The term after the negative sign in (1.8) is negative and represents the reduction in the denominator of (1.7) as r rises; since it enters (1.8) with a negative sign, however, it would tend to make the whole term positive (i.e. reducing the denominator - which represents the value of loans - in (1.7) would, for a given numerator - which represents gross returns - cause gross profits per dollar loaned to rise). The integral term outside the first set of brackets in (1.8) is positive; it represents the total number of loan applicants. The first term in brackets is also positive; it represents the higher repayments as r rises by those who repay. The product of these latter two terms, therefore, tends to make the whole term in (1.8) positive. Hence, the ambiguity in the sign of the whole term arises from the fact that the second term in the first set of brackets is negative.

This term represents the adverse selection effect, or the deterioration in the quality of the pool of applicants as r rises and $\bar{p}$ falls. If this latter effect outweighs the other effects from an increase in the interest rate, then λ will fall as r rises.

Consequently, the sign of $d\lambda/dr$ depends on the properties of the density function, $g(p_i)$, and the number of relatively safe borrowers driven out of the market for loans as r rises; the possibility of a negative relationship between r and λ, over a certain range, is due to adverse selection.

Notice that this relationship between λ and r will continue to hold even if rationing occurs and not all applicants are granted loans. This is so because loan applicants cannot be distinguished by the bank according to the riskiness of their projects; hence, if loans are rationed, the effect on equation (1.7) would simply be to multiply both numerator and denominator by the same fraction representing the proportion of applicants granted loans.[10]

It is now possible to present a diagrammatic determination of market equilibrium, following Stiglitz and Weiss (1981). The third quadrant of Figure 1.1 shows the relationship between λ and r, assumed to yield a maximum for λ^* at r^*. The fourth quadrant depicts the relationship between the supply of loanable funds (or deposits), D^s, to the bank as an increasing function of the interest factor $(1+\rho)$ paid to depositors. It is assumed that depositors are paid the same return as the bank earns, since the market for deposits is competitive, so that $(1+\rho)$ equals λ, the interest factor earned by banks. Thus, if the bank charges borrowers r^* and earns λ^* it will attract D^s_* deposits and be able to offer D^s_* equal to L^s_* in loans. Hence, it is possible to trace D^s_* from quadrant (iv) through to quadrant (ii) via quadrant (i) - which shows a standard 45° line - and to derive the point (L^s_*, r^*) as a point on the loan supply curve offered by the bank. Other points on this L^s

function may be derived in similar manner.

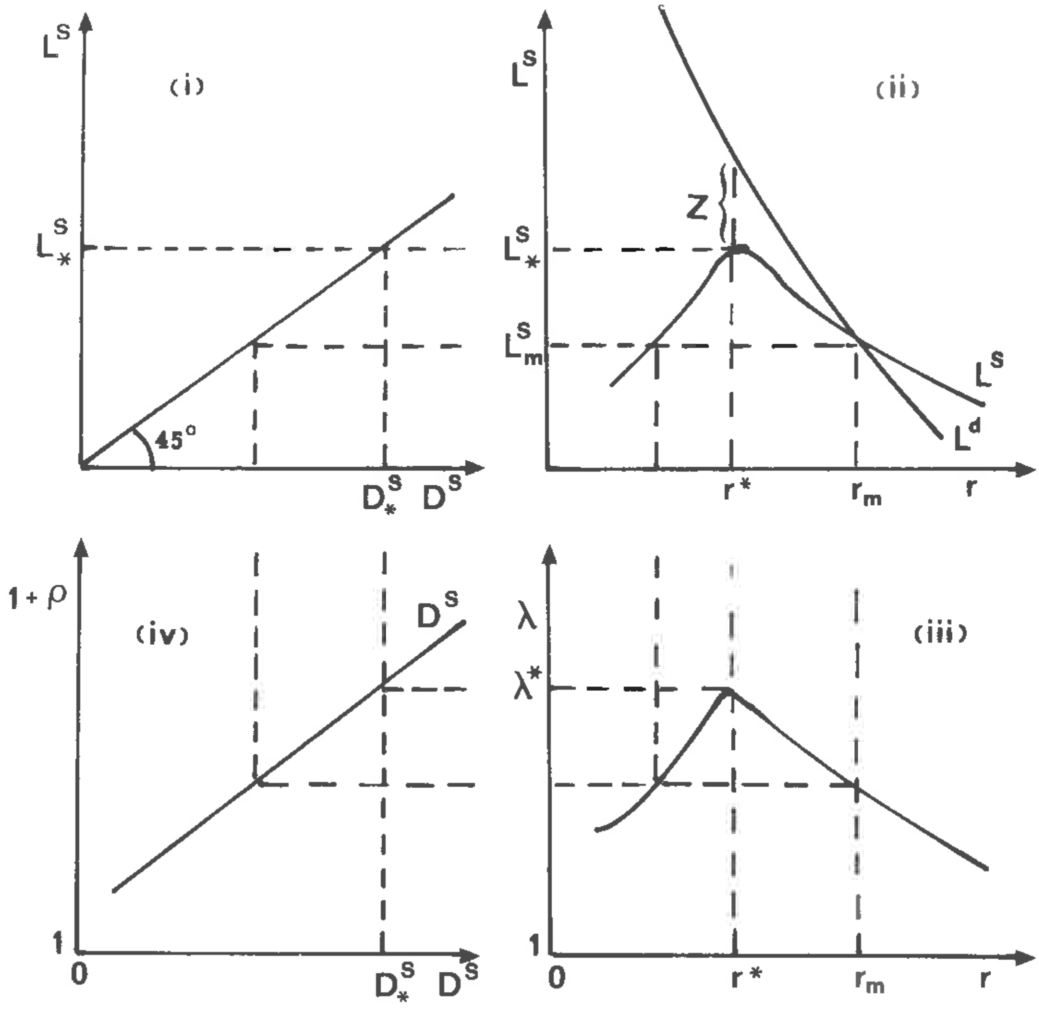

Figure 1.1: Derivation of Equilibrium Credit Rationing

The demand for loans, L^d, is given by:

(1.9) $$L^d = K \int_0^{\bar{p}} g(p_i)dp_i \; .$$

L^d has a negative slope against r since $d\bar{p}/dr$ is negative because as r rises customers with less risky projects choose not to apply for loans. This curve too is shown in the second quadrant of Figure 1.1. Its intersection with the L^s curve at the interest rate r_m shows that there is a point at which the demand for loanable funds equals supply. However, if the bank chose the lower interest rate r^* it would attract more - and relatively safer and more profitable - loan applicants, thus pushing up profits per unit of money loaned, λ. Since banks compete for funds and pay depositors the rate ρ, such that $(1+\rho)$ equals λ, competition will force banks to choose the interest rate r^* in order to pay a higher return to their depositors and attract more funds than would be possible with any other interest rate on loans.[11]

There is credit rationing at r^* in Figure 1.1. The demand for loanable funds exceeds the supply of loanable funds derived from the supply of deposits. Given that the project size is fixed at K, the bank makes a loan of K to some applicants and no loan at all to other applicants (any potential problems caused by K not being a factor of L^s_* are ignored). The excess demand for funds is measured by Z in the second quadrant.

Thus, the approach of Stiglitz and Weiss (1981) provides an explanation of credit rationing. The argument is based upon rational profit maximizing behaviour by all market participants in the presence of asymmetric information. There is no need for recourse to some exogenous constraint on behaviour such as a usury law or the restriction that different borrowers must be charged the same interest rate by the bank, as in Jaffee and Modigliani (1969). The approach does therefore represent a clear improvement upon the earlier work. Notice that asymmetric information might be viewed as offering a reason why the bank charges different borrowers the same rate; the bank cannot tell the difference between them. Also notice that the form of the debt contract is taken as exogenously given and the relaxation of this assumption will be shown - in Section 1.4 below - to have important implications.

It should be pointed out, however, that rationing is not inevitable in the model. If the L^d curve in the second quadrant of Figure 1.1 had cut the L^s curve at r^* or below, then the market would have cleared. Thus, credit rationing requires not only that asymmetric information and the consequent adverse selection produce a non-monotonic relationship between L^s and r, but also that the market clearing, or Walrasian, equilibrium (where supply equals demand) be sub-optimal for lenders compared to some other position, as is the case with the curves drawn in Figure 1.1. Furthermore, it should also be pointed that, rather surprisingly, when rationing does occur, as in Figure 1.1, the rate of interest charged, r^*, is less than the market clearing rate, r_m, and the total value of loans, L^s_*, exceeds the market clearing amount, L^s_m.

The other explanations of credit rationing outlined earlier may be understood in a manner similar to the adverse selection case. In each case, a necessary condition for rationing to occur is the non-monotonic relationship between λ and r of the type shown in quadrant (iii) of Figure 1.1, and the nature of the debt contract is also important. Consider the moral hazard story under ex ante asymmetric information. Assume that all borrowers are truly identical but let each have a choice of projects in which to invest. The bank is assumed to be unable to monitor their choice, but wishes to influence it and encourage investment in relatively safe projects. The difference between this and the adverse selection model is that now banks choose the interest rate to affect the actions of their borrowers, rather than to affect the quality of the pool of borrowers. Otherwise, the story is the same since in each case the bank is trying to channel funds into safer projects. This time if it raises the interest rate too far it will cause borrowers to choose riskier projects, rather than cause borrowers with less risky projects to leave the market. The effect is, however, the same in producing a non-monotonic relationship between λ and r and a consequent possibility of credit rationing. For a more detailed analysis of this case, see Stiglitz and Weiss (1981) or Stiglitz (1987).

Under ex post asymmetric information banks are assumed to know the probability distribution from which the return to any project will be drawn, but are no longer assumed to be able to costlessly observe returns. In this case, it is the positive relationship between the interest rate and expected monitoring costs which produces the non-monotonic relationship between λ and r and creates the possibility of rationing. For a more detailed analysis of this case, see Williamson (1986).

Having seen how asymmetric information may create a non-monotonic relationship between bank profitability per unit of money loaned and the interest rate, and how this may lead to credit rationing, it will now be useful to examine some of the possible implications of this analysis. This task is carried out next in Section 1.4 below. Section 1.5 then discusses some criticisms and recent developments which call into question some of the inferences drawn from the simpler analysis.

1.4. Implications

The above analysis has several interesting implications which are worth being listed and briefly discussed.

(i) Repeal of the Law of Supply and Demand

Clearly, rationing in equilibrium is inconsistent with the 'law of supply and demand' which asserts that in equilibrium supply equals demand and rationing does not occur. Stiglitz and Weiss conclude their 1981 paper by saying that 'the Law of Supply and Demand is not in fact a law, nor should it be viewed as an assumption needed for competitive analysis. It is rather a result generated by the underlying assumptions that prices have neither sorting nor incentive effects. The usual result of economic theorizing: that prices clear markets, is model specific and is not a general property of markets - unemployment and credit rationing are not phantasms.' (p. 409).

(ii) Normal Comparative Static Analysis Breaks Down

A corollary of the possibility of rationing is that the 'normal' comparative static analysis - based on the 'law of supply and demand' - no longer holds. For example, the usual result of a shift in supply, say an increase in supply at every price level, is to cause a reduction in price and an increase in the quantity traded. In terms of the credit market, an increase in supply at every price would usually be interpreted as producing a fall in the interest rate and a rise in the amount of loans. However, if the initial equilibrium is characterized by credit rationing it is quite possible that an increase in the supply of loanable funds may lead to an increase in the volume of loans without a reduction in the interest rate. This may easily be seen by shifting the D^s line downwards in quadrant (iv) of Figure 1.2, which causes the L^s curve to shift upwards in quadrant (ii), resulting in an increase in the volume of loans but no change in the interest rate charged on them. Rationing in quadrant (ii) falls from Z to Z' as the quantity of loans rises to L^s_{*1}, but the interest rate remains at r^*.

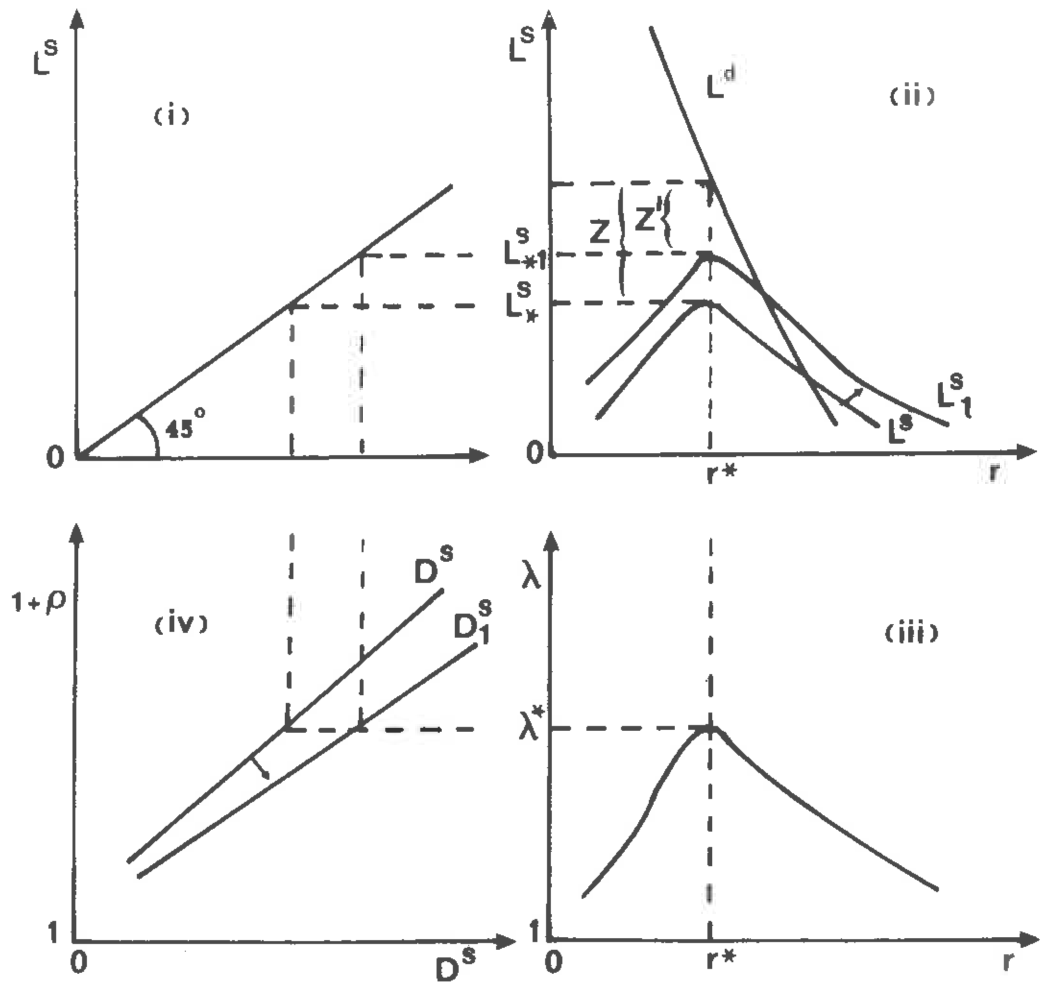

Figure 1.2: Effects of an Increase in Deposits on Optimal Solution

Stiglitz (1988a) argues that this implication offers support for the monetarist view 'that monetary policy may not primarily work through an interest rate mechanism and that interest rates may not provide a good target for monetary policy (except to the extent that interest rates are correlated with inflation rates, through Fisher's law)' (p. 318). On the other hand, he argues that the Keynesians are correct in their view 'that a major channel of monetary policy is through its effects on investment' (p. 318), although the mechanism through which monetary policy works is not by driving down the interest rate but by easing credit rationing. For a further discussion of such macroeconomic issues, see Blinder and Stiglitz (1983) or Blinder (1987, 1989 Chap.4). The macroeconomic issues in the context of general equilibrium models with explicit microeconomic foundations will be discussed in Section 1.5 below.

(iii) Supply and Demand are Interdependent

Notice that in discussing the shift in the supply function in the above comparative static exercise, the demand function was held constant. Indeed most 'normal' comparative static exercises treat supply and demand as independent functions, but Stiglitz (1987) points out that this is not always the case in models of the type under discussion here (where adverse selection and moral hazard play a role). For instance, consider that some supply shock shifted the characteristics of the projects in which borrowers may invest (say making them all more likely to be successful). This would affect the demand for funds and also the banks willingness to supply funds, since both functions partly depend upon the density function ($g(p_i)$ in the earlier example) defining the distribution of project characteristics across potential borrowers.

(iv) Repeal of the Law of the Single Price

According to Stiglitz (1987) 'another central aspect of the traditional paradigm is codified in the Law of the Single Price. This law holds that all objects with the same observable characteristics should sell at the same price.' (1987, p.8). However, it is easy to show that if the function relating λ to r 'has several modes, market equilibrium could either be characterized by a single interest rate at or below the market clearing level, or by two interest rates, with an excess demand for credit at the lower one' (Stiglitz and Weiss 1981, p. 398).

(v) Red-lining

Another implication of the analysis is that when there are several observationally distinguishable classes of borrowers, some classes may be denied credit at any interest rate whilst other classes obtain credit - such a phenomenon is known as 'red-lining'. Figure 1.3 shows the relationship between λ and r for three distinct classes of borrowers : A, B and C. Assume that the bank requires a rate of return of λ^* on all its loans and that members of group A obtain loans at the rate of interest r_A and are unrationed. Competition between banks will prevent banks from charging more than r_A to members of group A even though bank returns would be higher if the rate were higher. Suppose that one bank asked r_B, then another could undercut it and attract away the former's bank customers until the rate r_A were reached. Members of group B may obtain loans at the interest rate r_B, although there may be rationing in this group depending on whether the demand for loans exceeds the supply at r_B. Group C, however, will be 'red-lined' and unable to obtain funds at any interest rate. For a more detailed analysis of this issue, see Stiglitz and Weiss (1981).

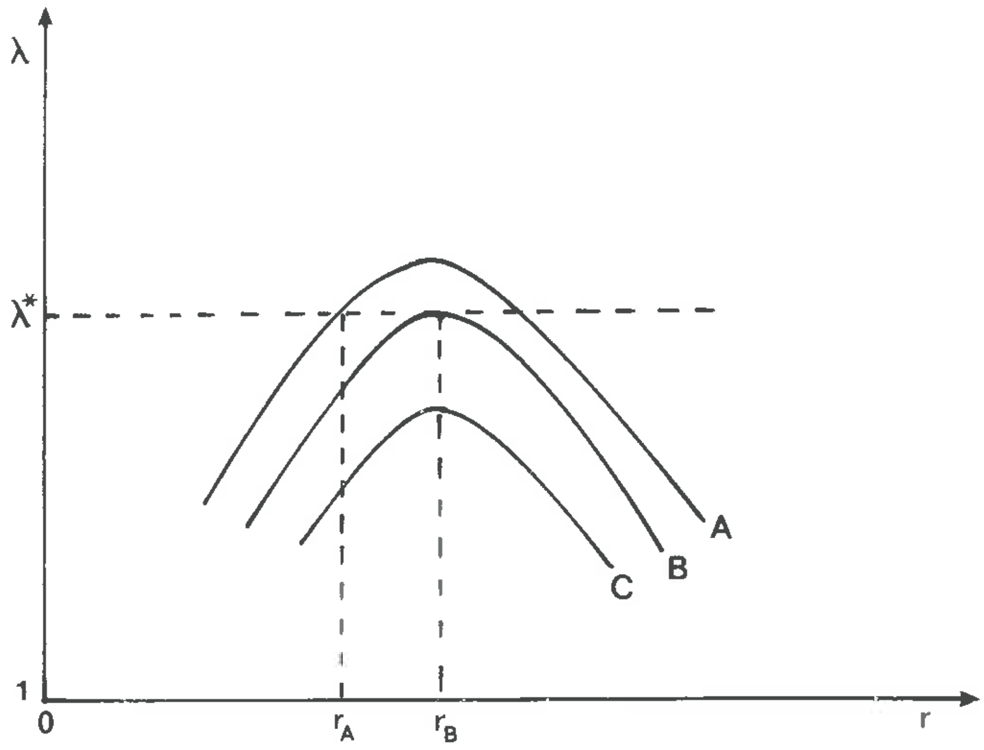

Figure 1.3: Red-lining Phenomenon

(vi) Inefficient Level of Investment

The analysis has the important implication from the point of view of welfare economics and public policy that a decentralized, competitive credit market will not produce a first-best efficient outcome. There may therefore be scope for a government intervention to improve upon the allocation of funds, which would be produced by the competitive credit market with perfect information. Indeed, adapting the analysis of de Meza and Webb (1987), it is possible to show that, in the model presented in Section 1.2 above, there will be under-investment in equilibrium.

To derive the under-investment result, notice that, given the assumed risk-neutrality of banks and borrowers and assuming risk-neutrality of bank depositors, the socially optimal or first-best level of investment may be assumed to require that all projects should be undertaken up to the socially marginal project (denoted by the subscripts SM) in which the following equality holds:

$$(1.10) \qquad p_{SM}R^s_{SM} = (1+\rho)K.$$

But for the marginal project which investors choose to undertake (denoted by the subscript M) it is clear from (1.2) that $E(\pi_M)$ equals zero, or:

$$(1.11) \qquad p_M R^s_M = p_M(1+r)K.$$

Substitution in (1.5) from (1.11) yields the expected net return for the bank from the marginal project chosen as:

$$(1.12) \qquad E_b(\pi_M) = p_M R^s_M - (1+\rho)K.$$

If the marginal project funded by the bank is the socially optimal marginal project, then the expected net return for the bank from this project is zero, as can be seen by using (1.10) in (1.12). But since the marginal project which investors choose to undertake is less risky than all the other projects undertaken, for every non-marginal project j, $E_b(\pi_j)$ would be negative. Thus, if banks fund the socially marginal project and break even on it, then they expect to make losses on all other projects which they fund. Hence, banks cannot, in equilibrium, fund investment up to the first-best level. Instead, since competitive banks are assumed to make zero profit on their portfolio and the marginal project chosen by investors is the project with the highest probability of success which, therefore, yields banks the highest expected profit, the expected profit for the bank on this project must be positive. In other words, marginal and near marginal projects with high success probabilities must subsidize projects with low success probabilities for the banks to break even. Now, summing (1.2) and (1.5) and noting that $E(\pi_M)$ equals zero and $E_b(\pi_M)$ exceeds zero, it follows that at this margin:

$$(1.13) \qquad E(\pi_M) + E_b(\pi_M) = p_M R^s_M - (1+\rho)K > 0.$$

(1.13) and (1.1) show that, as long as the supply of funds to the bank is non-decreasing in the rate of return (i.e. the rate on deposits), the banks only fund projects for which $p_i R^s_i$ exceeds $(1+\rho)K$. Hence, more investment should be undertaken if the first-best level of investment is to be reached.

Notice that this argument does not depend on credit rationing. Indeed, since the supply of funds, if rationing occurs, exceeds the market clearing supply, removing rationing by imposing market clearing on the system would only make matters worse.[12] Instead, as de Meza and Webb (1987) point out, a subsidy on interest income could be used to induce the banks to increase the supply of funds to borrowers and make possible the achievement of the first-best level of investment.

In summary, the model does not exhibit first-best efficiency at the market (clearing or otherwise) equilibrium and generates a role for government intervention. However, it is precarious to make strong policy recommendations on the basis of such a simple model. The next section, therefore, looks at some criticisms and developments which elucidate the statement made earlier that the above results are not robust to changes in the model.

1.5. Criticisms and Further Developments

The above implications stand in stark contrast to those of standard full-information market clearing models. It is necessary, however, to temper one's view of the role of asymmetric information by looking at some recent developments and some criticisms of the simple analysis provided so far. In particular, it is worth looking at the nature of the distributions from which the random project returns are drawn, at the nature of financial intermediation in the models and at the extension to multiperiod analysis.

1.5.1. The Nature of Return Distributions

Perhaps the two most striking results presented so far concern the explanation of credit rationing as an equilibrium outcome and the related result concerning under-investment relative to the first-best level. These results, however, may both be overturned if, following de Meza and Webb (1987), the assumption that projects all have the same mean return is replaced. If, instead, it is assumed that projects differ in expected return, then rationing no longer remains a possibility and the outcome would be over-investment rather than under-investment relative to the first-best.

De Meza and Webb's result is easily illustrated and interpreted. Consider the model of Section 1.3 but now assume that all projects have the same payoff if successful, R^s, although they differ in terms of their probability of success - p_i for the ith project - which is the private information of the potential borrowers and is not known by the bank. As before, unsuccessful projects yield zero. Under these assumptions, projects with a higher probability of success have a higher expected return than those with a lower success probability. Once again, banks prefer to invest in projects with a higher success probability (see equation 1.5 and the earlier discussion), but now as the interest rate is raised it is the projects with the lower success probabilities that are withdrawn from the market. Hence, there is no adverse selection as the interest rate is increased, but instead what is here termed 'favourable selection' occurs as the quality of the pool of loan applicants improves as the weaker projects are driven out. The relationship between the rate of return per unit of money loaned by the bank, λ, and the interest rate, r, is now monotonic: banks gain from both the higher debt repayments on successful projects and the improvement in the pool of loan applicants as r rises. Banks, therefore, no longer have a reason to wish to hold down the interest rate in the presence of excess demand and rationing will not occur.

To demonstrate the favourable selection effect, consider the expected return net of debt repayment to the bank for the ith borrower:

$$(1.14) \qquad E(\pi_i) = p_i[R^s - (1+r)(K-W)]$$

where W is an initial amount of wealth that all borrowers are assumed to have available either for investment in their project or in a safe asset yielding ρ. Clearly, risk-neutral profit maximizing entrepreneurs choose to apply for funds for their projects only if $E(\pi_i)$ is at least equal to $(1+\rho)W$. As the interest rate rises satisfaction of this condition at the margin requires a higher probability of success. Thus, raising the interest rate now leads to favourable selection and rationing no longer occurs.

With favourable rather than adverse selection, the marginal project in the market at any interest rate is the least profitable rather than the most profitable from the bank's point of view and, hence, the arguments supporting under-investment in the previous section all neatly reverse. For the first-best level of investment to occur, the marginal project must yield the bank zero expected profit (equation (1.10) must hold as before), but this would now imply that the bank would be making positive expected profit on all non-marginal projects funded and so positive profit overall. Consequently, the zero-profit condition in equilibrium implies that banks must expect to make losses on the marginal projects and offset these with profits on the non-marginal ones (this is contrary to the adverse selection case where marginal projects subsidize non-marginal ones). Over-investment, therefore, occurs because the marginal projects funded yield banks an expected loss and have an expected rate of return less than the safe rate. Of course, banks would like to be able to avoid financing such projects but they are unable to do so because of the asymmetry of information. Borrowers still wish to go ahead with such projects as long as the project expected net return to them, which includes an element derived from the loan part of the financing of the project, exceeds the safe return available from investing only their own capital, W. Although in a different context, this issue will be re-addressed in Chapter 2.

With over-investment rather than under-investment, the policy prescription switches from a subsidy on interest income to a tax on it to dissuade banks from lending. Clearly, before prescribing any such policy it is important to define the precise nature of the asymmetric information problem.[13] Furthermore, it should be noted that the analysis so far has been cast in a partial equilibrium framework. A more convincing case for a policy intervention would be supported by a general equilibrium analysis. Some general equilibrium models will be examined below.

1.5.2. The Nature of Financial Intermediation

The analysis so far has taken it as given that financial intermediation takes place via a standard debt contract with a probability of default. Borrowers either repay the loan with interest or default and forfeit all of the returns (zero in the simple case above) to the lenders. Banks or lenders optimally adjust the interest rate they charge on loans, but do not adjust any other terms of the contract, whilst borrowers are assumed to provide no collateral and to be unable to tap alternative sources of funds. An interesting extension of the model is to provide banks with instruments, in addition to the interest rate, which they could adjust when faced with the problems of asymmetric information.

An important contribution along these lines was made by Bester (1985), who allowed banks simultaneously to adjust not only interest rates on loans but also collateral requirements. He argued that by offering different combinations of these two instruments banks will be able to induce borrowers to self-select themselves into various categories. Low-risk borrowers are willing to pledge more collateral than high-risk borrowers and self-selection produces a sorting equilibrium free from the problem of credit rationing exhibited in the *pooling* equilibrium produced by models which impose a simple debt contract of the type examined so far. A simple way of understanding Bester's argument is to note that in a world where borrowers are protected by limited liability and pledge no collateral, as in the previous section, they would be willing to take out a loan at almost any interest rate to finance an appropriate gamble at a casino; since they are gambling with the bank's money and not their own they can only win and never really lose in this situation. In such a world, a little collateral may go a long way to discouraging such borrowers, even though - as the earlier analysis showed - raising the interest rate may not. Bester's analysis would obviously break down if loan applicants were unable to pledge collateral in support of their bid for funds, but it shows that banks will, if possible, be tempted to use extra instruments in offering an array of contracts to induce self-selection by loan applicants. Similar arguments and results are also provided by Chan and Kanatas (1985) and Besanko and Thakor (1987a,b).

Stiglitz and Weiss (1981, 1986, 1987a) have, in contrast, developed models in which collateral may be positively associated with riskier borrowers. They produce their results by relaxing the assumption made so far that borrowers are risk-neutral. Borrowers are assumed to be risk-averse, but their degree of risk-aversion depends upon their wealth, which cannot be observed by the bank. Borrowers each may invest in one of a set of projects available to them. This framework allows for both moral hazard effects on the type of project chosen and adverse selection effects on those who acquire loans. Hence, the Stiglitz and Weiss results are still influenced by adverse selection and moral hazard even when banks can offer an array of combinations of interest rates and collateral requirements to potential borrowers; increasing collateral requirements can then have adverse effects on the type of projects funded by the banks and adverse effects on the return to banks similar to those seen to follow from increasing the interest rate. In such circumstances, credit rationing is still possible despite the greater complexity of the debt contract compared to the basic model (see also Clemenz 1986).[14]

A similar objection to the one posed by allowing banks to impose collateral requirements concerns the role of equity. Why do firms that face credit constraints not attempt to raise capital by issuing new equity? The response to this (Stiglitz and Weiss 1981, Greenwald, Stiglitz and Weiss 1984, Greenwald and Stiglitz 1987a,b, 1988a,b, and Stiglitz 1988) is to argue that the problems of asymmetric information, adverse selection and moral hazard are just as pervasive in the equity market as in the credit market. As a result, 'the cost of issuing equity is sufficiently great that most firms act as if they were equity rationed. When they are denied credit, they do not raise capital by issuing new equity, but rather constrain their capital expenditures to retained earnings.' (Stiglitz 1988, p. 313).

Problems arise with the use of equity for similar reasons to those already discussed with relation to credit. Thus, problems of a moral hazard or incentive type occur because, when a firm is equity financed, managers receive only a small fraction of any extra profit, so their incentive to expend effort on making profits is attenuated. On the other hand, since the owners or managers of firms have private information about their firms' expected returns, it may be those with the lowest expected returns who are most willing to sell their shares, hence leading to adverse selection problems.[15] The presence of such problems under either equity or debt finance led Stiglitz and Weiss (1981) to argue that 'we would not expect to see the exclusive use of either method of financing' (1981, p. 408).

Equity finance is also problematic in the literature based on ex post rather than ex ante asymmetric information. In this case, ex post project returns are the private information of the entrepreneurs who carry them out. Ex ante there is no asymmetry of information between entrepreneurs and banks; the distributions from which project returns are drawn are known to all concerned but banks have to incur costs if they wish to observe returns ex post. This framework has a number of advantages over the ex ante asymmetric information framework. It is possible not only to endogenously derive debt as the optimal form of financial intermediation, but also to motivate the existence of financial institutions which 'share several of the important features of intermediaries as we know them; they issue securities which have payoff characteristics which are different from those of the securities they hold, they write debt contracts with borrowers, they hold diversified portfolios, and they process information.' (Williamson 1986, p. 178). Another advantage is that this model is immune to the criticism that can be levelled at the ex ante asymmetric information version, namely that banks and borrowers may have incentives to remove the asymmetry to allow banks to categorize borrowers so that they can charge a market clearing interest rate in each category without fear of adverse selection or moral hazard problems. With ex post asymmetric information and monitoring costs, it seems that even perfect classification of borrowers into risk categories will not remove the possibility of credit rationing in any or all categories.[16]

Financial intermediaries arise naturally in Williamson's model because they economize on monitoring costs when a borrower defaults compared to direct lending (where a borrower has borrowed from several different lenders and monitoring costs would be incurred by each of them in the absence of intermediation). It has already been illustrated in Section 1.2 above how the positive relationship between the interest rate and expected monitoring costs may lead to credit rationing in this model. As for debt contracts, the basic reason why they are optimal is that under any other arrangement the borrower never has an incentive to announce an ex post return in excess of the minimum return necessary to prevent auditing by the lenders; this minimum return corresponds to the no-default payment on the loan contract.

In endogenously deriving the nature of the debt contract - which is important in determining the asymmetry of payoffs to bank and borrower and, hence, the non-monotonic relationship between the interest rate and returns per unit of money loaned by the bank - the ex post asymmetric information framework is clearly useful. However, in the real world it is possible to observe the coexistence within a firm of debt and equity finance, and a useful task for further research would be to motivate this finance mix from first principles; such a motivation might be provided by a model containing a mixture of ex ante and ex post asymmetric information. The study elaborated in Chapter 3 develops an ex ante asymmetric information model based on a mixed form of contract, though this is not explicitly derived from first principles.

1.5.3. Multiperiod Models

Up to now, only single period projects and single period bank-borrower relationships have been considered. Stiglitz and Weiss (1983) extended their model to allow banks and borrowers to develop multiperiod relationships and showed that the market equilibrium in such a model could still entail credit rationing for both old or experienced bank customers and new or inexperienced ones. More recently, Diamond (1989) and Bester (1990) have examined, respectively, the roles of reputation and collateral in multiperiod models.

Diamond's model begins with an observationally equivalent cohort of risk-neutral borrowers of three different types. One type of borrower has access to a safe project with a high expected return, another has access to a risky project with a low expected return but a high maximum payoff, and the third type of borrower has access to both types of project. Banks, therefore, face an adverse selection problem (they wish to encourage investors with safe projects rather than risky ones to proceed) and also a moral hazard problem (they wish to encourage investors who have a choice of projects to invest in the safer one).[17] Furthermore, ex post returns are the private information of the borrowers, so that banks also face a costly state verification. Banks acquire information on borrowers as time proceeds; borrowers who default are those who invested in risky projects and non-defaulters are a more select group with a lower proportion of those with only risky projects. Consequently, the interest rate can be reduced for non-defaulters, thereby providing an incentive for those borrowers with a choice of projects to invest in the safe one in order to maintain their reputation as a safe borrower (even though some may initially have invested in successful risky projects). The value of this good reputation, or conversely the cost of a default, rises over time as the interest rate to non-defaulters declines and borrowers with a choice of projects will choose the safe one.

This model has some interesting implications for empirical work. For instance, it may help to explain why one firm, with a valuable reputation as a safe borrower, may turn down a potentially profitable, but risky, project that another firm, without that reputation to lose, would accept. It may also explain why some firms 'with a long-standing high credit rating will borrow directly in the open market' whilst others 'with short histories will do their reputation acquisition by borrowing from intermediaries' which can, albeit at a cost, help to control and monitor investment decisions (Diamond 1989, p. 859).

Bester (1990) also examines a multiperiod model with ex post asymmetric information (but no ex ante moral hazard or adverse selection problems). He allows for renegotiation as a possible alternative to bankruptcy for borrowers unable to meet their initial contract terms. Renegotiation may allow the avoidance of costly liquidation procedures, but it may also encourage the borrower falsely to claim that he is unable to meet his initial terms. Bester finds that 'this motive for cheating is weakened when collateral has been posted' (1990, p. 2) so that it may help to reduce the dead-weight losses associated with liquidation, even though it increases the total amount of assets liquidated in the case of bankruptcy. This effect is especially relevant for high-risk projects which may therefore be more likely than safer projects to be financed through loans that make use of collateral.[18]

1.6. General Equilibrium, Business Fluctuations and Asymmetric Information

Thus far, partial equilibrium models of credit markets when borrowers and lenders are asymmetrically informed have been reviewed. Despite the differences in assumptions and implications that can be found within this literature, it is clear that modelling asymmetric information and agency problems promises to improve our understanding of the nature and role of financial intermediation based upon explicit microeconomic foundations. Much of modern business cycle theory is also concerned with providing explicit choice theoretic foundations for macroeconomic phenomena. In view of this, work has begun on following up the lines of research suggested by the partial equilibrium approach to the credit market within general equilibrium models of the business cycle.[19]

This recent line of research offers two advantages over the partial equilibrium approach. First, it allows one to trace the effects of any policies designed to alleviate agency problems and to check that the benefits suggested by the partial equilibrium approach are not offset by repercussions elsewhere in the model, i.e. it allows a more careful welfare economic analysis to ensure that attempts to achieve a first-best outcome posited upon the perfect information model concepts of first-best are not counterproductive. Second, it is possible to see that financial intermediation may have an important role to play in explaining macroeconomic relationships, in propagating business cycles and even in producing cyclical behaviour in response to shocks in models which would otherwise fail to exhibit cycles.

Some of the papers in this literature contain an ex post informational asymmetry (e.g. Bernanke and Gertler 1987a, 1989, Farmer 1984, and Williamson 1987) whilst others contain an ex ante informational asymmetry (e.g. Bernanke and Gertler 1987b, and English 1986).

Williamson (1987) contains an ex post asymmetry of information in the credit market which is used - as in Williamson (1986) - to motivate the existence of financial intermediaries who lend to a large number of borrowers and take deposits from a large number of depositors. This credit market is embedded in an overlapping generations model which is subjected to real disturbances in the riskiness of investment projects.[20] In response to these disturbances, the model 'exhibits equilibrium business cycles with the following features: (1) Real output is serially correlated. (2) Intermediary loans and a nominal monetary aggregate lead output, in the sense of Granger causation. (3) Risk premia and real output are negatively correlated. (4) Business failures and real output are negatively correlated. (5) The price level and real output are positively correlated. (6) The difference between the price level and its expectation is positively correlated with real output.' (Williamson 1987, p. 1197). Features (3) and (4) mimic real observations and are difficult to explain without modelling some role for the credit market, thus illustrating the value of models of credit.

Financial intermediation is very important in Williamson's model. Business cycles are propagated in part due to the presence of credit rationing in the model, in the sense that 'some would-be borrowers do not receive loans in equilibrium, in spite of the fact that these agents would be willing to pay higher-than-market interest rates to obtain loans' (Williamson 1987, p. 1198). The amount of this rationing fluctuates throughout the business cycle and, indeed, the model would not produce cycles in the absence of monitoring costs and agency problems. The source of output persistence is a one-period lag in the production of output from investment projects.

Williamson argues that the model 'provides support for real business cycle theory at the expense of monetary theories of the business cycle' since subjecting the model to monetary, rather than real, disturbances 'would produce comovements in aggregate time series that are inconsistent [...] with observations' (1987, p. 1214). He is, however, as noted in the introduction to this chapter, pessimistic about finding a role for stabilization policy in this model, despite the existence of unemployed resources and credit rationing that it exhibits. It is, nevertheless, possible that such a role could be found in a more complicated version of the model allowing for government intervention via different rules for expenditure, taxation and monetary policy.

In Farmer (1984), a change in the riskless interest rate affects loan rates, default rates and the amount of loans, which in turn affects investment, output and the riskless rate. Hence, any government policy which 'generates a higher real rate of interest will reduce output by increasing the frequency of contract failures [... and] a policy that raises the real value of government debt will have exactly this effect. It follows that [...] fiscal policy will be able to permanently alter the steady-state frequency of contract failures.' (1984, p. 927). In a subsequent partial equilibrium model, Farmer (1985) shows how asymmetric information and contracts in the labour market, as well as in the credit market, may explain employment and layoff probabilities, with layoffs in excess of those that would occur if information were perfectly available. He concludes that 'there is potentially a role for government intervention' (1985, p. 438).

The paper by Bernanke and Gertler (1989) is similar to those by Farmer and Williamson in adopting a real business cycle and overlapping generations framework. Its special emphasis is upon the procyclical movements of entrepreneurs' net worth and the associated counter-cyclical movements in agency or monitoring costs. The effect of the 'decline in agency costs in booms and a rise in recessions [...] is sufficient to introduce investment fluctuations and cyclical persistence into an environment which is rigged to exhibit neither of these features when agency costs are not present' (1989, p. 15). The paper also shows that shocks to net worth independent of changes in output can initiate real fluctuations. For example, a fall in the price level can weaken debtors' balance sheets and reduce their ability to finance investment with repercussions on aggregate demand and aggregate supply.

Bernanke and Gertler's earlier paper (1987a) offers a general equilibrium analysis with the emphasis on the role of banks in facilitating credit flows and affecting the equilibrium values of real variables. Again, net worth, this time of the banks rather than their borrowers, is at the centre of the analysis. An increase in the net worth of a bank, by providing it with more collateral to guarantee its liabilities, permits it to obtain more deposits and to allocate a bigger proportion of its funds to risky loans. They go on to argue that monetary policy matters in so far as it affects bank lending (an increase in reserves increasing lending) and, hence, investment and output.

The paper by English (1986) also examines the effects of policy on the steady-state general equilibrium of an overlapping generations model and comes to conclusions similar to Bernanke and Gertler's (1987a), although in an ex ante asymmetric information model. He concludes that 'whereas changes in the required reserve ratio or the rate of growth of the money supply have effects on the interest rate, changes in the level of government debt can have large effects on the steady-state of the economy and yet have no effect at all on interest rates. As a result, policy makers must look directly at the quantity of lending or the quantity of investment in order to assess the effects of policy.' (1986, pp. 22-23).

Bernanke and Gertler (1987b) examine the possibility of a market collapse. They set up a general equilibrium model with ex ante asymmetric information but, unlike English (1986) or Mankiw (1986), they assume that projects differ in their probabilities of success but not in their payoffs if successful; projects do not, in this case, have equal expected gross returns. This sort of assumption has been discussed in a partial equilibrium setting in Section 1.5.1 above. The inclusion of an evaluation stage by Bernanke and Gertler leads to a revision of de Meza and Webb's (1987) argument that when projects differ in this way over-investment follows.

An important theme in the work of Bernanke and Gertler is that the balance sheet positions matter and specifically that agency costs decline with an increase in the borrower's own investment in his project.[21] They express this idea as follows: 'generally, the more a borrower is able to invest in his own *project* [...] the less his interests will diverge from the interests of those who have lent to him. When the borrower has both superior information than the lenders about his project, as well as the ability to take actions that affect the distribution of project returns, a greater compatibility of interests reduces the agency costs associated with the investment process. Thus, if borrowers as a whole have stronger balance sheet positions [...] then, ceteris paribus, the macroeconomic equilibrium is more efficient.' (Bernanke and Gertler 1987b, pp. 1-2).

So, for Bernanke and Gertler, the performance of an economy depends critically on the balance sheet positions of borrowers. The 'investment collapse' which they analyse, therefore, occurs when 'declines in net worth induce a *financially fragile* situation' (Bernanke and Gertler 1987b, p.21). Such a situation occurs when the project payoff and borrower net worth are low and the interest rate on loans is high.

In Bernanke and Gertler's model, unlike that of de Meza and Webb (1987) and Mankiw (1986), 'an investment subsidy [...] does not help when the economy is suffering from underinvestment' (1987b, p.33). The reason is that although such a subsidy would have the beneficial effect of raising the number of project evaluations carried out by entrepreneurs, it would have the harmful effect of making entrepreneurs less selective in their choice of projects with which to proceed. Instead of a subsidy, Bernanke and Gertler suggest a tax on investment with the proceeds used to subsidize entrepreneurs who decide not to proceed with their projects. This policy conclusion, however, only applies to the case where entrepreneurial skill is unobservable by the social planner. If this assumption is changed and entrepreneurial skill is observable, the policy recommendation changes, too. The optimal policy then becomes a lump-sum subsidy to those entrepreneurs who are relatively efficient in evaluating projects.

Although their model is highly stylized, Bernanke and Gertler indicate that they believe it may well yield important insights on real issues. For example, it may be 'that an important cause of the primitive and fragmented state of the LDC financial markets is the generally low wealth level of potential borrowers' (Bernanke and Gertler 1987b, p. 36). Another example they offer is the New Deal 'debt re-adjustments' in the US in the 1930s, which may correspond to their policy of subsidizing debtors under suitable conditions: 'at that time, those in need of help were easily identified; the source of distress was clearly systemic rather than idiosyncratic to individuals; and it could credibly be argued that New Deal *debt re-adjustments* were a one-time-only policy.' (Bernanke and Gertler 1987b, p. 37).

Finally, Bernanke and Gertler make an important point which is probably of general relevance to this whole literature: '[the] mechanism through which financial factors affect real activity need not involve credit rationing. The agency costs of investing could manifest themselves in an increased cost of capital, for example [...]. Whether credit rationing exists is not key to the debate over whether financial factors matter.' (1987b, p. 2, footnote 3).

1.7. Conclusions

The present study has reviewed the literature on credit markets with incomplete information. It may legitimately be concluded that models of the credit market containing ex ante or ex post asymmetric information and the associated problems of adverse selection, moral hazard and monitoring costs offer interesting and important insights for our understanding of several issues, such as credit rationing, financial intermediation and business cycles. However, as discussed earlier, the agency costs associated with imperfect information may arise in various ways and the implications for theory and policy may differ from model to model. It is therefore important cautiously to select between the different models before attempting to draw firm conclusions from the literature. This selection requires further theoretical as well as empirical work.

Several issues remain unresolved. It is worth mentioning some of the outstanding problems which the studies of the next chapters address. The most obvious issue concerns the assumption associated with the ordering of investment projects of different qualities. Projects may be ranked either according to the mean preserving spread criterion (e.g. Stiglitz and Weiss 1981) or in conformity with the first-order stochastic dominance rule (e.g. de Meza and Webb 1987). The results derived in models have been shown to be sensitive to the mode of ranking the investment projects. Thus, the development of a general model encompassing both of the above criteria undoubtedly constitutes a valuable theoretical exercise and contributes to the existing literature. The study in Chapter 2 outlines and develops such a general model.

Choices of models must also depend on the empirical validity of their assumptions and results. Attempting to settle the above issue, the empirical work in Chapter 4 offers some evidence on the distributions of firms' mean rates of return and variances in the UK economy.

The nature of the financial form of contracts between entrepreneurs and financial institutions is another outstanding problem. In the literature, much effort has gone into the study and modelling of pure debt contracts which may well reflect the small firms sector of the economy rather than large publicly quoted firms. In fact, large modern corporations exhibit both debt and equity in their capital structure. Hence, theoretical work can usefully be directed at extending the analysis of financial intermediation to cover large publicly held firms with a mixture of debt and equity. This task is performed in Chapter 3, where, in addition to the hypothesis of mixed form of financial arrangements, entrepreneurs are considered to behave in a risk-averse manner.

Obviously, the present thesis' research program does not exhaust the overall list of interesting and challenging issues arising from the consideration of incomplete information in financial markets. Another issue, for instance, is related to the nature of rationing. In the papers surveyed, rationing typically takes the form of denying loans to some would-be borrowers at any interest rate. It would be interesting to see some work in which rationing takes the form of restricting the size of loan below that which some borrowers would like to take out at the going interest (or above the going interest). It might also be worth reversing the assumption that borrowers know more, ex ante, about the prospects for their projects than do banks. Banks might well know more than would-be borrowers, at least in the case of small or new firms. This may explain why banks limit the loan size or refuse credit to some applicants who then feel they have suffered from rationing.

It would also be interesting to see some empirical work following up testable implications which could be derived from theoretical papers such as Diamond (1989) or Williamson (1987) and possibly some attempt at a direct assessment of the empirical importance of credit rationing and the nature of inefficiency regarding aggregate investment, as well as at the derivation of stylized facts about credit aggregates (see Blinder 1989, or Greenwald and Stiglitz 1988c, for some preliminary empirical work).

Finally, it would be useful to see more theoretical works on micro-based general equilibrium frameworks allowing roles for credit, money and government intervention via different rules for expenditure and taxation. Although situated in the context of a standard ad-hoc macroeconomic model and perfect information, the model developed in Chapter 5 comprises all these economic aspects.

1.8. Notes

1. As underlined in the General Introduction, the study of the implications of asymmetric information in the capital market and economic activity represents a recent advance. It has not yet received much attention in textbooks, although it is briefly mentioned in Dornbusch and Fischer (1990) at the undergraduate level and Blanchard and Fischer (1989) at a more advanced level devote several pages to this phenomenon.

2. See Gertler (1988) for a brief discussion of how the financial considerations highlighted by Fisher and Gurley and Shaw influenced later work, and how other factors - such as the developments based around the Modigliani and Miller theorem on the irrelevance of financial structure - helped to divert attention from financial considerations.

3. For some unknown reason, Rosa is commonly referred to as Roosa by modern writers. Rosa and Roosa did, however, write on similar issues and this may help to explain the confusion.

4. Other approaches worthy of mention here, but not taken any further, are developed in Cukierman (1978) and Fried and Howitt (1980). In the Cukierman model, credit rationing is a consequence of the horizontal integration of the banking firm. Fried and Howitt's contribution assumes implicit contracts in the credit market to derive rationing.

5. This case is sometimes characterized as 'moral hazard with hidden information' and the earlier case of ex ante asymmetric information with moral hazard is sometimes characterized as 'moral hazard with hidden actions'. See Rasmusen (1989, p. 133).

6. Their 1981 paper represents merely a part of a larger research project by Stiglitz and Weiss and others examining the implications of imperfect information for the microfoundations of macroeconomics. See, for example, Stiglitz (1982, 1984, 1987, 1988a), Stiglitz and Weiss (1983, 1986, 1987a,b), Greenwald and Stiglitz (1987a,b,c, 1988a,b,c), and Greenwald, Stiglitz and Weiss (1984).

7. The concept of the mean preserving spread was first introduced by Rothschild and Stiglitz (1970) to measure the risk of investment projects. It is a special case of the second-order stochastic dominance rule which is used to rank the probability distributions of return of projects. Throughout the thesis, for convenience, the latter concept is used in the sense of the former one.

As an alternative to the above criterion for ordering projects, the probability distributions associated with projects may be ranked by the first-order stochastic dominance rule. A special case of this, as will be seen later, is when the distributions from which project returns are drawn all have a common variance and differ from one another only in terms of their expected return. In this case also, the general term is used to refer to the special case.

For a rigorous definition of the above concepts, see for instance Hirshleifer and Riley (1992).

8. As mentioned before, another type of rationing, not exhibited in this model, occurs when some or all loan applicants are not granted a loan as large as they would wish at the prevailing loan rate.

9. Summing (1.2) and (1.5) clearly shows that the total expected returns from a project (net of the cost of funds to the bank) are distributed asymmetrically between bank and borrower, as discussed in the text.

10. Blanchard and Fischer (1989) and de Meza and Webb (1987) also follow Stiglitz and Weiss (1981) in explaining credit rationing. However, reservations must be expressed concerning the fine detail of de Meza and Webb's formula for $E(\pi_b)$ and Blanchard and Fischer's formula for the bank's expected return per unit of money loaned, since both sets of authors omit integral terms representing the number of borrowers from their formulae.

11. A similar argument would even apply if the supply of deposits to the bank were infinitely elastic at a given rate ρ, so long as competition between banks drove $(1+\rho)$ to equality with λ^* and the supply of deposits to the banking industry rose with ρ. However, it will be interesting later to look at general equilibrium models where the supply of deposits is determined endogenously.

12. Notice that in the mean preserving spread case, as in the illustrative model in Section 1.3, all projects have the same mean gross return and, therefore, from a welfare point of view may be deemed to be equally deserving of funds. If the supply of funds at the rate of return offered by such projects were less than the

demand for funds, then rationing would be needed even in the first-best case, although at a greater supply of funds than would be produced by the decentralized decisions of the market.

13. Bernanke and Gertler (1987b) and Black and de Meza (1990) show that even where the distributions of project returns differ in their means, it is possible to restore the under-investment result by making other small changes in the model. De Meza and Webb (1988) show that the introduction of screening costs to the model can destroy the case for an investment subsidy even if investment is below the first-best level.

14. There is some empirical evidence which indicates that collateral is positively associated with riskier projects (see Berger and Udell 1990). This evidence, thus, offers some support for the position taken by Stiglitz and Weiss and against those papers which argue that safer borrowers are more likely to pledge collateral. However, the evidence is interpreted by Berger and Udell as supporting the idea that banks can observe riskiness and impose tougher collateral requirements on observationally riskier borrowers.

15. De Meza and Webb (1987, 1990) show that, in response to such problems, where projects differ in expected returns, the pooling equilibrium mode of financial intermediation would, indeed, be via debt rather than equity. They also show that when expected returns are equal across projects and entrepreneurs are risk-neutral, equity finance would be the equilibrium mode. For an in-depth explanation of these issues, see Chapter 3 of this thesis.

16. Riley (1987) in fact argued that if banks could categorize borrowers into a large number of risk classes then 'only in a single marginal (risk) pool could rationing ever be observed. From this it is concluded that the extent of rationing generated by the [Stiglitz and Weiss] model is not likely to be empirically important.' (1987, p. 224). Riley did recognize that credit rationing may be possible if categorization is difficult and if the mean and spread of returns on projects are negatively correlated, whilst Milde and Riley (1987) examine the use of loan size as a screening device to help banks and borrowers to sort borrowers into different categories. But ex post asymmetric information and monitoring costs would seem to make rationing possible even if perfect classification of borrowers were possible, since in this case rationing may occur even amongst borrowers who are truly identical in an ex ante sense. Furthermore, Stiglitz and Weiss (1983) show that it is possible with ex ante asymmetric information and multiperiod bank-borrower relationships for all risk classes to be rationed.

17. Notice that the different project return distributions allow both mean returns and risk to vary across projects in such a way that banks would clearly prefer to support the safer projects which also are the ones with the higher mean returns. The adverse selection or moral hazard effects, in the present case, are therefore related to both mean and variance (cf. the mean-preserving models or the cases where the higher mean return is associated with the less risky projects discussed earlier in the text; for a multiperiod model where projects differ only in terms of their probability of success, see Webb 1991).

18. There is some empirical evidence which might be interpreted as supporting

this result. See note 14 above.

19. There are also some examples of macroeconomic models with important roles for the credit market not built upon the general equilibrium optimizing framework (e.g. Bernanke and Blinder 1988, Blinder 1987, Brunner and Meltzer 1972, 1976, 1988, and Greenwald and Stiglitz 1986). A brief survey of this literature is offered in Chapter 5 (Part 2 of the thesis), where a model improving upon the previous ones is also proposed. Although developed in the context of a conventional ad-hoc approach, it will be seen that these models are particularly useful when policy aspects (monetary and fiscal policy implications) are considered and when analytical difficulties preclude the use of micro-based general equilibrium models. An important contribution of these conventional macroeconomic studies is the modelling of money and credit in a more symmetric mode.

20. For an introduction to real business cycle models of this type, see Plosser (1989). Mankiw (1989) offers a disparaging New Keynesian perspective on such models, though whether he would be so critical of the literature surveyed here is less clear, since much of it attempts to provide microeconomic foundations for the sorts of market failure which he argues must be explained.

21. This view differs from that expressed by Stiglitz and Weiss (1981, 1986, 1987a) discussed earlier in Section 1.5.

CHAPTER 2

ENTREPRENEURIAL HETEROGENEITY AND THE PERFORMANCE OF CREDIT MARKETS UNDER ASYMMETRIC INFORMATION

2.1. Introduction

Before turning to the aim and structure of the present chapter, it is worth briefly reviewing some of the focal issues associated with credit markets, which this study will address. As noted in Chapter 1, the seminal paper by Stiglitz and Weiss (1981) drew attention to the role of asymmetric information in explaining behaviour in the credit market. In particular, Stiglitz and Weiss showed that ex ante asymmetry concerning the riskiness or variance associated with individual project returns could lead to problems of adverse selection or moral hazard and produce credit rationing as a result of optimizing behaviour by risk-neutral banks and borrowers. With or without rationing, however, it has been shown by de Meza and Webb (1987) that in the model of Stiglitz and Weiss the market equilibrium is consistent with sub-optimal resource allocation and under-investment relative to the first-best level.

Subsequent research, as underlined before, has taken a number of directions. Several authors have considered extending the instrument set available to lenders to include, for example, collateral requirements, equity finance or contingent contracts (e.g. Bernanke and Gertler 1987b, Bester 1985, 1990, and Clemenz 1986), and others have introduced the concept of ex post asymmetry of information and the associated monitoring costs incurred by banks if they wish to observe project returns ex post (e.g. Williamson 1986). Another important contribution was made by de Meza and Webb (1987). They showed that if the ex ante asymmetry in the Stiglitz and Weiss model concerned the mean rather than the variance associated with individual project returns, then adverse selection and credit rationing would no longer arise, whilst market equilibrium would exhibit over-investment rather than under-investment relative to the first-best level.

The present study develops a model containing an ex ante asymmetry of information about both the mean and variance associated with individual project returns. This more general model combines both the adverse selection arguments of Stiglitz and Weiss and the favourable selection arguments of de Meza and Webb, and contains their models as special cases. Market equilibrium may exhibit rationing as in the Stiglitz and Weiss case, whilst aggregate investment may be above or below its first-best level. A novel issue presented here concerns the quality, rather than just quantity, of aggregate investment. Unlike in the special cases already analysed in the literature, market equilibrium may now simultaneously display both some projects being funded which would not be funded in the first-best case and some projects not being funded which would be funded in the first-best case, regardless of whether the aggregate level of investment is above, below or equal to the first-best level.

The study thus casts serious doubt on the relevance of the fundamental theorems of Welfare Economics and on the basic results concerning the efficient decentralization of economies. Provided that a social planner possesses an accurate knowledge of distributions of investment projects in the market, policies to obtain a second-best solution are justifiable.

The remainder of the chapter is organized as follows. Section 2.2 presents the model. Section 2.3 shows how in this model the loan rate charged by banks acts as a selection mechanism for determining those projects for which individuals apply for loans and those for which individuals do not apply for loans. Section 2.4 then shows how the model yields special cases equivalent to those of Stiglitz and Weiss and de Meza and Webb. Section 2.5 presents the market equilibrium in the general model and discusses its properties. Finally, Section 2.6 offers some concluding comments.

2.2. The Model

Consider that a representative bank has identified a group of individual potential loan applicants, each of whom is endowed with a single one period project with given characteristics in which he can invest. Each project requires an equal amount of investment, denoted by K. The ith project, if executed, yields a random return $\tilde{R}_i$ drawn from a uniform distribution $F(R_i)$, that is, one with density function $f(R_i) = 1/(b_i - a_i)$ for $a_i < R_i < b_i$ and zero elsewhere. The limits of the distribution function $F(R_i)$, a_i and b_i, satisfy $0 \leq a_i < \infty$ and are distributed over the set of all projects according to a joint distribution function H(a,b) with joint probability density h(a,b). It is assumed that H(a,b) is known to the bank, but that the characteristic parameters of the ith project, a_i and b_i, are known by the ith individual but not by the bank. This assumption introduces the key asymmetry of information into the model. The ex post return R_i for the ith project once carried out is assumed to be observable without cost to both bank and borrower.

Notice that the distribution function $F(R_i)$ may be defined either in terms of the interval parameters, a_i and b_i, or in terms of the mean, μ_i, and variance, θ_i, where μ_i is given by $(a_i + b_i)/2$ and θ_i is given by $(b_i - a_i)^2/12$. The mean of a uniform distribution is equal to the midpoint of the interval a_i to b_i, and its variance is directly proportional to the square of that interval. In what follows, projects will therefore be distinguished in terms of either the interval parameters, a and b, or the means and variances, μ and θ, as appropriate.

Potential loan applicants are risk-neutral, expected profit maximizers. They each have the same initial wealth, W, which is entirely invested either in their project or in a safe asset yielding the interest rate ρ.[1] However, $W < K$ so that if a project is to be undertaken, additional finance must be raised. This is done by borrowing $B = K - W$ from banks through a standard debt contract, on which the borrower pays in non-bankruptcy states the specified amount $(1 + r)B$, where r is the posted loan rate, or else pays the entire project return R to the bank if $R < (1 + r)B$.[2] The nature of the debt contract introduces another key asymmetry: banks receive all project returns up to the amount $(1 + r)B$ and borrowers receive any payoff in excess of that amount.

Given the nature of the debt contract and the assumption that projects require $K > W$ investment, it follows that any rationing which takes place will be of the type where some loan applicants receive the loan of B for which they apply, whilst other applicants receive no loan whatsoever. Furthermore, the informational asymmetry implies that banks are unable to ration in a way which discriminates between borrowers. Under rationing only loan applicants who are granted a loan become borrowers and the other applicants invest their wealth W at the safe rate of interest, ρ. Given an interest rate on bank loans, potential loan applicants, that is, people with a project for which they may apply for finance, must decide whether or not to apply, as will be explained below.

Banks are assumed to be competitive, risk-neutral expected profit maximizers; they compete 'by their choice of a price (interest rate) which maximizes their profits', and 'the interest rate received by depositors is determined by the zero-profit condition' (Stiglitz and Weiss 1989, p. 395). They pay for each unit of deposit the interest rate ρ; other costs as well as activities of banking are neglected. The supply of loanable funds or deposits to a bank, D^s, is assumed to be a non-decreasing function of the safe rate of interest, ρ. Formally:

$$(2.1) \qquad D^s = D(\rho), \qquad\qquad D' \geq 0$$

Given the partial equilibrium nature of the model, the function D^s is, as in Stiglitz and Weiss and de Meza and Webb, given exogenously and not derived from first principles.

The novelty and advantage of the present framework is that projects must be distinguished in terms of two characteristic parameters of the distribution function of returns associated with each project, either the interval parameters, or the mean and variance parameters. This is in contrast to the models of Stiglitz and Weiss and de Meza and Webb, in which distributions were distinguished in terms of either the mean or the variance parameters but not both.

Stiglitz and Weiss assumed that the underlying distribution of returns differed across projects only in terms of their variance. In this case, as shown in Chapter 1, from the bank's point of view, 'better' projects are those with a lower variance and lower risk. An increase in the interest rate on bank loans, r, leads to adverse selection and a worsening in the quality of the pool of loan applicants, that is, it causes loan applicants with 'better' projects to leave the market and cease to apply for loans. The results on the possibility of credit rationing and the aggregate level of investment falling below the first-best level both stem from this adverse selection mechanism. De Meza and Webb, on the other hand, assumed that the underlying distribution of project returns differed across projects in such a way that 'better' projects could be defined, from either the bank's or the borrower's viewpoint this time, in terms of the level of expected returns. 'Better' projects now being those with higher expected returns. In this case, as shown before, an increase in the interest rate on bank loans, r, leads to an improvement in the quality of the pool of loan applicants by driving out the applicants with the lowest expected project returns and leaving only 'better' ones in the market. This process, which was termed 'favourable selection', lies behind the results that credit rationing will not occur and aggregate investment will exceed the first-best level.

The present framework shows that the Stiglitz and Weiss and de Meza and Webb models should not be viewed as diametrically opposed alternatives, but as special cases of a more general model in which projects may differ in terms of both the mean and variance of the underlying distributions from which their returns are drawn. In this more general framework it is not possible to define one project as 'better' than another simply by looking at either the mean or variance of the return distribution associated with each, but it is necessary to look at both parameters. Holding expected returns constant and letting variances differ allows the derivation of a special case equivalent to the Stiglitz and Weiss analysis, and holding variances constant and letting expected returns differ allows the derivation of a special case equivalent to the de Meza and Webb analysis. It seems more reasonable, however, to let both parameters vary across project return distributions and to specify the quality of a project in terms of both parameters. The next section shows how, in this model, the loan rate acts as a selection mechanism for determining the payoff distribution functions of projects which satisfy the requirement of non-negative expected profits for the individuals endowed with them.

2.3. The Loan Rate as a Selection Mechanism

This section focuses on the role of the loan rate, r, for the determination of marginal projects, that is, those projects for which individuals are indifferent to either undertaking the investment in the project or banking their wealth. Knowledge about marginal projects and their payoff distribution functions will permit the identification of other payoff functions which satisfy the requirement of positive expected profit for the loan applicants and, hence, the identification of the number of loan applicants. The interest rate on loans will be shown to act as a device for the selection of projects in the credit market.

The return to the ith borrower net of debt repayments, g_i, at the end of the period for a given loan contract (B,r) equals:

$$(2.2) \qquad g_i = \max (R - XB; 0)$$

where X is the interest factor 1 + r. The maximum loss the borrower can make on a project is limited to his initial wealth endowment, W.

The borrower's expected net return , $\bar{g}_i$, at the beginning of the period for a given loan contract (B,r) equals:

$$(2.3) \qquad \bar{g}_i = \int_{XB}^{b_i} R_i f(R_i) dR_i - XB \int_{XB}^{b_i} f(R_i) dR_i \qquad \text{if } a_i < XB < b_i$$

$$\text{or} = \int_{a_i}^{b_i} R_i f(R_i) dR_i - XB \qquad \text{if } XB \leq a_i < b_i$$

In both domains of equation (2.3) the expression on the right-hand side has the same interpretation. The first term represents project returns under the condition that $R_i > XB$ weighted by the appropriate probability density, and the second term is the appropriately weighted repayment due to the bank.[3]

After some manipulation and integration by parts, equation (2.3) may be written as follows:

$$\text{(2.3a)} \qquad \bar{g}_i = b_i - \int_{XB}^{b_i} F(R_i)dR_i - XB \qquad \text{if } a_i < XB < b_i$$

$$\text{or} = b_i - \int_{a_i}^{b_i} F(R_i)dR_i - XB \qquad \text{if } XB \leq a_i < b_i$$

The following proposition may now be established.

Proposition 2.1: For a given interest rate on loans, there are critical values of a and b and, hence, a marginal locus in (a,b) space such that firms apply for loans if and only if their payoff distributions are on or above this locus, provided that the constraints of the model are satisfied.

This follows immediately upon observing that firms apply for loans only if the expected net return is greater than or equal to the safe return they could achieve on their wealth, W. Individuals apply for loans only if $\bar{g}_i \geq IW$, where I is the interest factor on the safe asset, i.e. $I = 1 + \rho$. Therefore, for a given r, there exist critical values of a and b and a marginal locus in (a,b) space determined by the equation $\bar{g}_i = IW$, below which firms do not apply for loans.

Letting $\hat{a}$ and $\hat{b}$ be the critical values of a and b along the locus and using (2.3a), the equation for the locus for $a < XB < b$ is given by:

(2.4) $$IW = \hat{b} - \int_{XB}^{\hat{b}} (\hat{b} - \hat{a})^{-1}(R - \hat{a})dR - XB$$

Letting $\hat{a} = Z(\hat{b})$ in (2.4) and manipulation of (2.4) yields:

(2.5) $$\hat{a} = -\hat{b}^2/2IW + (1 + XB/IW)\hat{b} - (XB)^2/2IW = Z(\hat{b})$$

The derivative of $\hat{a}$ with respect to $\hat{b}$ is therefore:

(2.6) $$\partial Z(\hat{b})/\partial \hat{b} = -\hat{b}/IW + (1 + XB/IW)$$

The second derivative is:

(2.7) $$\partial^2 Z(\hat{b})/\partial \hat{b}^2 = -1/IW < 0$$

Thus $Z(\hat{b})$ is a concave function of $\hat{b}$ with global maximum at $\hat{b} = XB + IW$. Note that equation (2.5) defines a parabola in (a,b) space.

For $XB < a < b$, the equation of the marginal locus is given, again using (2.3a), by:

(2.8) $$IW = (\hat{a} + \hat{b})/2 - XB$$

Letting $\hat{a}$ now be $Y(\hat{b})$, equation (2.8) becomes:

(2.9) $$\hat{a} = -\hat{b} + 2XB + 2IW = Y(\hat{b})$$

The interpretation of the negatively sloped line given by equation (2.9) is straightforward. Individuals will only choose to invest in safe or default-free projects if their expected net returns are at least as great as the returns available from investing in the safe asset; for this to be the case, (2.8) shows that the expected gross returns, $(\hat{a} + \hat{b})/2$, must be at least as great as the debt repayment plus the returns from investing in the safe asset, XB + IW.

Figure 2.1 illustrates the marginal locus in (a,b) space. In this space, only a,b combinations below the 45° line need to be considered, since b has been defined to be greater than a. The horizontal line XB is given for an interest rate r and loan of size B. The marginal locus consists of the curve $Z(\hat{b})$ below the XB line and the line $Y(\hat{b})$ above it. The curve $Z(\hat{b})$ and the line $Y(\hat{b})$ both intersect the XB line at the same point (XB, XB + 2IW). Notice that an increase in the loan factor X shifts the marginal locus rightwards in a way which will be discussed in more detail in Section 2.5 below.

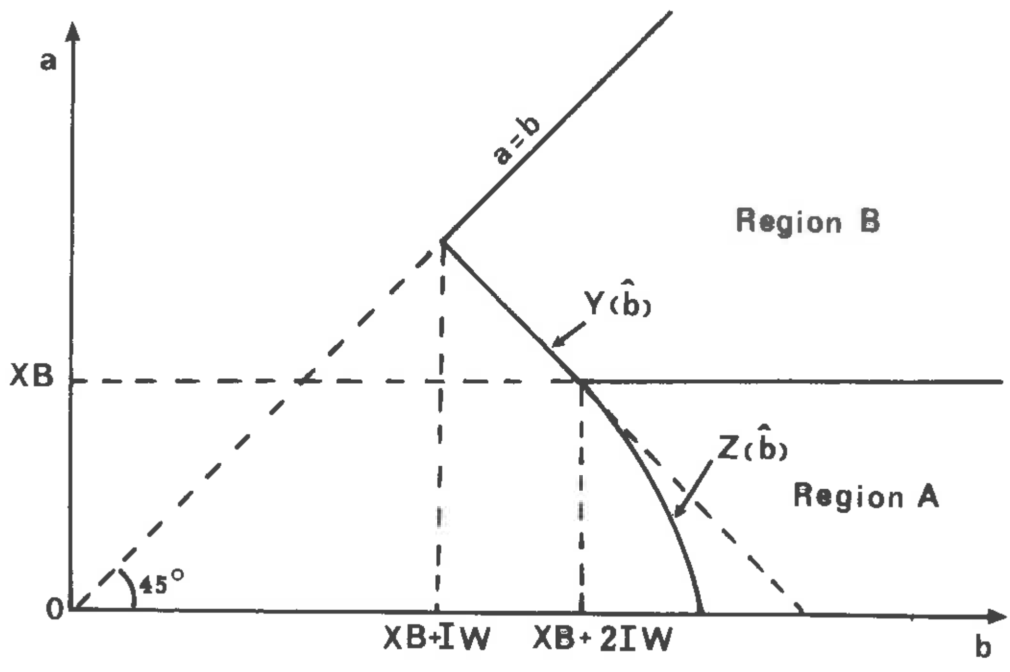

Figure 2.1: The Marginal Locus

Individuals with projects with characteristics on or to the right of the locus choose to apply for loans. Region A, which is to the right of a section of the parabola $Z(\hat{b})$ and below the XB line, represents projects with a non-negative risk of default and an expected net return to loan applicants at least as great as that which could be obtained by investing in the safe asset. Region B, which is bounded by the three lines $Y(\hat{b})$, XB and a = b, represents projects which are default-free and have expected net returns at least as great as those which could be earned by investing in the safe asset.

An interpretation of the shape of the locus is instructive. The straight line segment $Y(\hat{b})$ consists of points representing default-free projects for which the expected gross return equals XB + IW. Moving down the $Y(\hat{b})$ line from the 45° line towards the XB line involves, in terms of the underlying distribution of project returns, a decline in parameter a which is exactly matched by an equal increase in parameter b; this holds the expected gross return constant but increases the variance. Clearly, in the case of default-free projects any project with an expected gross return at least as great as XB + IW is attractive to risk-neutral loan applicants. For default-free projects, the risk to the bank in lending to finance them is zero and cannot be said to increase with variance as in the standard Stiglitz and Weiss analysis, which did not consider risk-free projects. Nor can it be said, as it can for risky projects, that an increase in the variance for a given expected gross return improves the expected net return for the borrower, since expected net returns do not vary as one moves down the $Y(\hat{b})$ line in Region B. Continuation of the line $Y(\hat{b})$ below the XB line, however, lies beyond the marginal locus, since moving down the line into the Region A implies moving to projects with the same expected gross return but a positive risk of default. The risk of default means that expected returns to the bank on such projects are lower than on projects in Region B, thus implying that a larger share of the given expected gross returns must be expected to accrue to the borrower. In other words, if projects on the $Y(\hat{b})$ line above the XB line are just acceptable to borrowers, those on its continuation below the XB line must be more than acceptable. Thus, as one moves down the marginal locus from the risk-free Region B into the risky Region A, it is not necessary to compensate for a reduction in parameter a with an equal increase in parameter b, a smaller increase in parameter b and a reduction in expected gross returns will suffice.

Banks would clearly prefer to grant loans for projects from Region B rather than from Region A; however, they are not able to ascertain the characteristics of individual projects and all loan applicants are treated equally by them. In maximizing profits, therefore, banks are interested to know how the interest rate they charge affects the quality as well as the quantity of loan applicants and to use their knowledge of the joint distribution function H(a,b) and of the marginal locus in evaluating the optimum interest rate to charge. Before examining how such behaviour helps to determine the properties of market equilibrium in the general model, the next section examines - in a setting different to that developed in Chapter 1 - the special cases associated with Stiglitz and Weiss and de Meza and Webb.

2.4. Special Cases

2.4.1. The Stiglitz and Weiss Case of Adverse Selection

The Stiglitz and Weiss case of projects with common expected gross returns may be represented by considering any line for which (a + b)/2 is a constant (i.e. any downward sloping 45° line in (a,b) space) and considering that all possible projects lie along this line. Figure 2.2 shows one such line, μ_1, and two marginal loci, ML_1 and ML_2, drawn for two different loan rate factors, X_1 and X_2, respectively.[4] Given the marginal locus ML_1, individuals with projects lying along the mean preserving spread, or iso-mean, line μ_1, to the right of point A choose to apply for loans; individuals with the smaller variances, and less risk of default, lying along the iso-mean line between A and D choose not to apply. The marginal project (or projects) in this case lies at point A, projects between A and D yielding a lower than marginal expected profit to borrowers, and projects between A and E yielding a higher than marginal expected profit. Banks would, however, prefer to invest in projects lying along D to A, rather than in projects along A to E. Within the set of projects which are funded, low-risk projects subsidize high-risk ones. The following proposition may therefore be stated.

Proposition 2.2 : For a given expected gross return, μ, and interest rate, r, riskier projects yield a higher expected profit for borrowers and a lower one for banks.

Proposition 2.2 implies the corollary that individuals who apply for loans are endowed with riskier projects than those who choose not to apply.

Now consider that the loan interest factor increases from X_1 to X_2. As a consequence, the marginal locus shifts out to ML_2. The effect of this is to make all projects between A and B along the iso-mean line unattractive to the individuals endowed with them, i.e. to reduce the number of loan applicants to only individuals endowed with projects lying along the line B to E. The following proposition, which is really a corollary of Proposition 2.2, may therefore be stated.

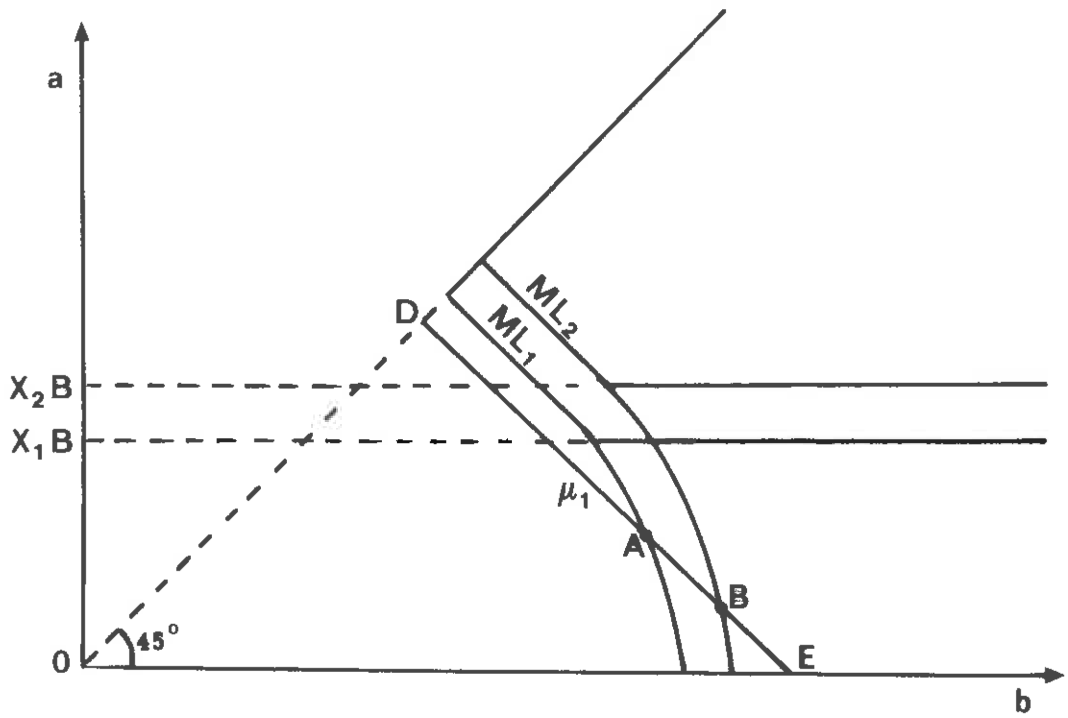

Figure 2.2: The Mean Preserving Spread Case

Proposition 2.3: For a given expected gross return, μ, as the loan interest rate increases, the critical value of the variance, θ, below which individuals do not apply for loans, increases.

Propositions 2.2 and 2.3 are analogous to theorems 2 and 3 in Stiglitz and Weiss (1981) and, as Stiglitz and Weiss showed, they imply that an increase in the loan interest rate leads to the phenomenon of adverse selection upon which the results on credit rationing and under-investment depend. The discussion of credit rationing is deferred until later, but the under-investment result may be discussed now with the aid of Figure 2.3.

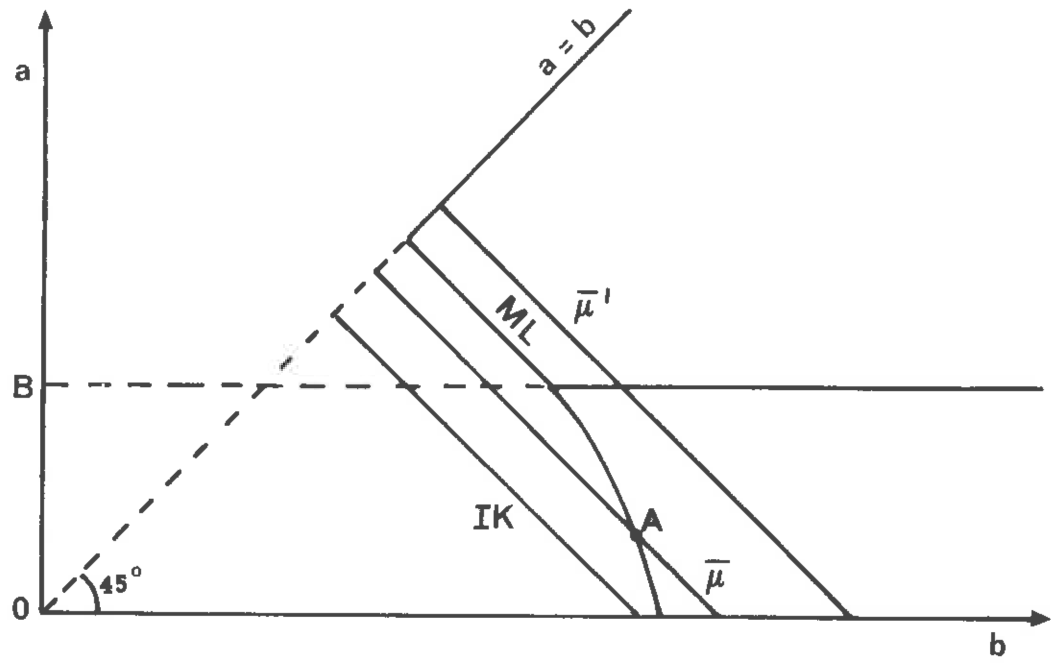

Figure 2.3: Aggregate Investment in the Mean Preserving Spread Case

Figure 2.3 shows a marginal locus, ML, and three iso-mean lines $\bar{\mu}$, $\bar{\mu}'$ and IK. The marginal locus is assumed to be the outcome of competitive, profit-maximizing behaviour by the banks. Following de Meza and Webb, it is assumed that 'social efficiency requires that projects are financed if and only if their expected gross return is at least as high as the safe return' (1987, p. 287), so that the line IK represents the social efficiency locus below which projects should not be financed. The two iso-mean lines represent two possible different sets of underlying projects. The IK line is drawn with an intersection with the 45° below the intersection of the 45° line and the ML line since the zero-profit constraint on banks in equilibrium implies that X must exceed I (or else the banks would be making losses). If the $\bar{\mu}$ line were below the IK line this would also imply loss-making by the banks. This follows since on any project which an individual chose to carry out he must expect to receive net returns greater than IW, which would imply leaving expected returns to the bank of less than IB (since expected gross returns are less than IK or I(B + W)), which is what the bank would need to attract deposits. Two $\bar{\mu}$ lines both lying above IK, one cutting ML and one always above it, are therefore shown.

There seems to be no reason to rule out the line $\bar{\mu}'$ which lies above the ML locus. If the underlying projects all lay along this line, the bank would receive XB on all risk-free projects and some amount less than this on average from risky projects; the bank's average net return on all projects funded would be IB in equilibrium with safe projects subsidizing risky ones. In this case, there could not be credit rationing since all individuals with projects apply for loans while an increase in the interest rate at the margin would not cause adverse selection and so would be used if the bank faced excess demand. All projects would, therefore, receive finance and investment would equal its first-best level. This result contrasts with de Meza and Webb's argument that in the Stiglitz and Weiss case 'investment must be less than the first-best level' (1987, p.288). There would, however, be under-investment if projects lay along the iso-mean line $\bar{\mu}$. In this case, all the projects again should be financed for social efficiency, but only those at or to the right of the point A would actually be financed, with relatively safe projects once more subsidizing relatively risky ones in the loan market. This under-investment result holds if there is no rationing of loans within the set of loan applicants and holds *a fortiori* if the set of applicants is rationed.[5]

Clearly, if under-investment occurs, policies designed to increase investment may improve social efficiency. De Meza and Webb suggest an interest income subsidy be paid to banks. In the present model, this would reduce X and increase I, but would have the desired effect of moving the ML intersection with the $\bar{\mu}$ line in a north-westerly direction. Another policy with similar effects might be to subsidize returns to individuals who carry out their projects.

2.4.2. The de Meza and Webb Case of Favourable Selection

The analysis now turns to the case, analogous to that of de Meza and Webb, of projects with common variances and different expected gross returns.[6] This case may be represented by any line for which $(b - a)^2/12$ is a constant (i.e. any upward sloping 45° line in (a,b) space) and considering that all possible projects lie along this line. Figure 2.4 shows one such iso-variance line, $\bar{\theta}$, and two marginal loci, ML_1 and ML_2, drawn for two different loan rate factors, X_1 and X_2, respectively. Clearly, along the line $\bar{\theta}$, 'better' projects may be defined unambiguously, from the point of view of either the bank or borrower, as those projects further from the intersection of the line and the b-axis; as one moves from the b-axis, expected returns increase and variance remains constant. Given the marginal locus ML_1, individuals with projects lying along the iso-variance line to the right of point A choose to apply for loans; individuals with 'poorer' projects to the left of point A choose not to apply. The marginal project at point A is the worst of all projects in the loan market, as it has the lowest expected return. The following proposition may therefore be stated.

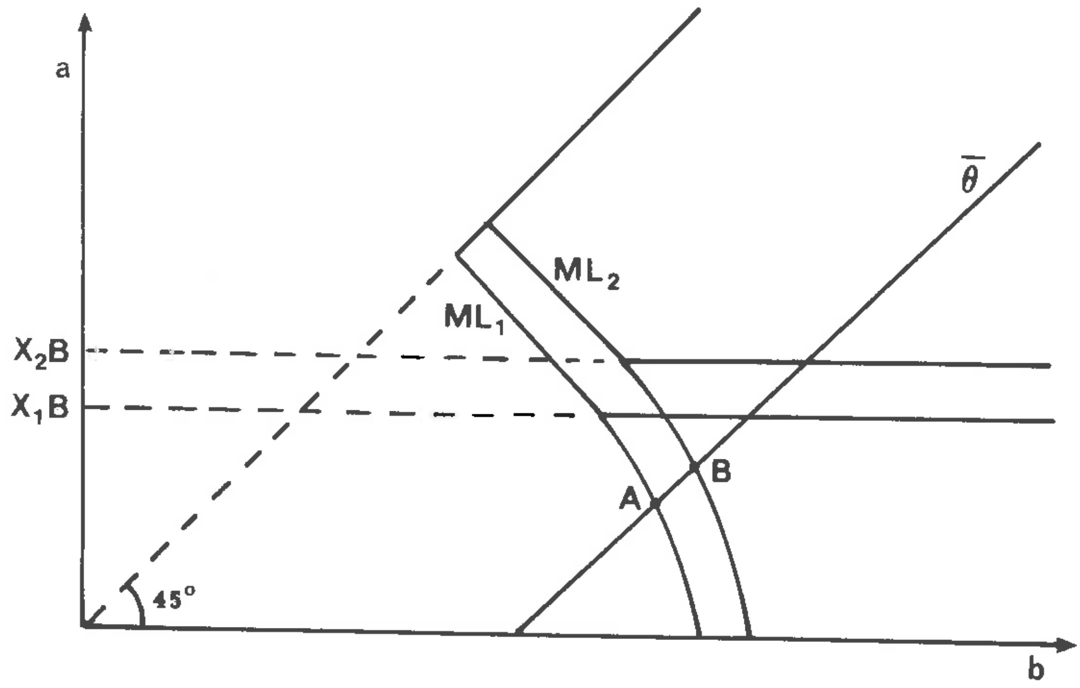

Figure 2.4: The Common Variance Case

Proposition 2.4: For a given variance, $\bar{\theta}$, of the underlying distributions of gross project returns, and interest rate, r, projects with higher expected returns yield higher expected profits for both borrowers and banks (unless, of course, the projects are risk-free for banks, in which case the bank's expected profit is constant).

Proposition 2.4 implies the corollary that individuals who apply for loans are endowed with projects with higher expected returns than those who choose not to apply. It also follows that the marginal project is, from the bank's or the borrower's point of view, the worst project of all those in the loan market, and that high expected-return projects subsidize low expected-return projects in the loan market.

Now consider again that the loan interest factor increases from X_1 to X_2. As a result, the marginal locus shifts out to ML_2. The effect of this is to make all projects between A and B along the iso-variance line unattractive to the individuals endowed with them, that is, to reduce the number of loan applicants to only those endowed with projects to the right of point B on the iso-variance line. The following proposition, which is really a corollary of Proposition 2.4, may therefore be stated.

Proposition 2.5: For a given variance, $\bar{\theta}$, of the underlying distributions of gross project returns, as the loan interest rate increases, the critical value of the expected gross return, μ, below which individuals do not apply for loans, increases.

Propositions 2.4 and 2.5 imply that an increase in the loan interest rate leads to an improvement in the quality of the pool of loan applicants, a phenomenon that has been termed 'favourable selection'. It follows, as de Meza and Webb have shown (see Chapter 1), that in such circumstances the loan market will clear in equilibrium, since if banks were faced with an excess demand for loans they would gain in two ways from increasing the loan rate, they would gain the higher debt-repayments from successful projects and they would improve the quality of the applicant pool by driving out weaker projects with lower expected gross returns, so improving the bank's expected return even from those projects which fail. This mechanism is, obviously, the reverse of that produced under the Stiglitz and Weiss case with adverse selection, and, so long as the D^s function is non-decreasing in the rate of return on deposits, the market equilibrium now leads to over- rather than under-investment.

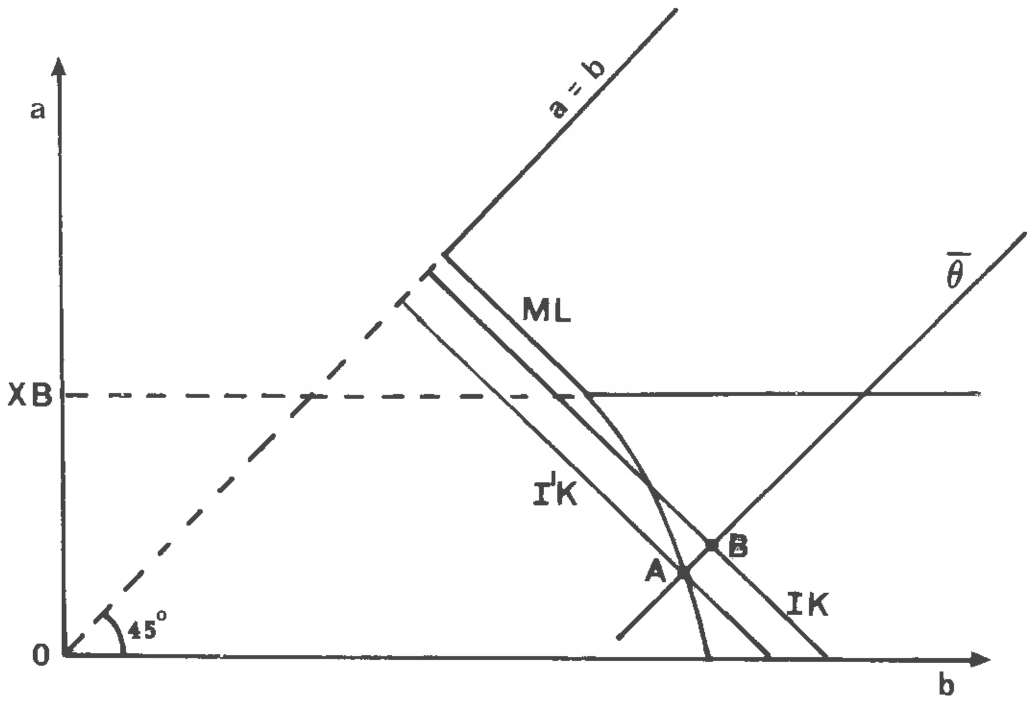

Figure 2.5: Aggregate Investment in the Common Variance Case

Figure 2.5 illustrates the over-investment result. The analysis is (as in Chapter 1) based upon that of de Meza and Webb (1987, pp. 284-285). Consider that projects lie along the line $\bar{\theta}$, and the ML locus is as shown so that all projects at or to the right of point A receive finance. If the safe interest factor were I', then investment would be at its first-best level, but this cannot be the case. If the actually marginal project at point A was the socially marginal project, its expected gross returns would be I'K, divided (in expectation) between the borrower and bank in the amounts I'W and I'B respectively.[7] This would imply that the bank would break even on the marginal project and make super-normal profits on the non-marginal ones carried out. This result is, however, inconsistent with the zero-profit condition on banks in equilibrium. Hence, in competitive equilibrium, banks must pay a higher interest rate factor on deposits, I, and banks must expect to make losses on the marginal project at point A and, indeed, on all projects between A and B, which are offset by profits on projects to the right of point B. In this case, the socially marginal project is at point B and over-investment occurs represented by all projects between A and B which receive finance. Only if by chance the $\bar{\theta}$ line cut the ML line at its intersection with the XB line and X equalled I could investment equal its first-best level and banks break even (on all projects in this case, since no projects applying for funds involve risk to the bank). The zero-profit condition rules out the case where X equals I and the $\bar{\theta}$ line cuts the ML line above the XB line.

If over-investment occurs, an efficiency improving policy would be one designed to reduce investment. De Meza and Webb suggest a tax on interest income to make banks less willing to grant loans at any interest rate to borrowers (1987, p.285).

The present model is capable of allowing projects to differ in terms of both the means and variances of the underlying distributions from which gross returns are drawn. In this case, it is necessary to consider both means and variances in discussing whether one project is more or less attractive to bank or borrower than another project. In this framework, it is possible to have elements of both adverse selection and favourable selection occurring simultaneously, a phenomenon which is here termed 'mixed selection'. Such issues are considered further in the next section which deals with market equilibrium in the general model.

2.5. Market Equilibrium in the General Model

In the general model the distributions from which gross project returns are drawn are allowed to differ in terms of both means and variances. In this case, an increase in the loan interest rate may cause both the means and variances of the underlying marginal project return distributions to increase, thus simultaneously introducing elements of adverse and favourable selection. This is easily seen by considering the effect of the increase in the loan rate to be an approximately horizontal shift of the marginal locus and noting that any point displaced horizontally to the right of another point in (a,b) space implies an increase in both mean and variance.[8] Another way of looking at this would be to note that, in comparing two marginal loci, as the loan rate rises the marginal projects on the new locus must have either a higher mean or higher variance than some point on the old locus to offset the effect on expected profit to borrowers of the increase in the loan rate. It is possible for the higher mean or variance to be coupled with a higher or lower value for the other parameter, variance or mean, but not to find a point on the new locus which has both lower mean and variance, since such a point would represent a reduction in expected borrower profit even at the old loan rate, i.e. it would be below the old locus. It is thus possible, when comparing two marginal loci, to find points on the one drawn for the higher loan rate which compare as follows with some point on the lower locus:

i) The point on the higher locus has a lower mean and a higher variance (of the underlying project distributions); from the bank's point of view both these effects would represent adverse selection.

ii) The point on the higher locus has a higher variance but the same mean; this is the Stiglitz and Weiss case of adverse selection.

iii) The point on the higher locus has a higher mean and a higher variance; whether the bank would prefer this point to the point on the original locus depends upon the relative sizes of the two changes - there may be either adverse or favourable selection in such a case.

iv) The point on the higher locus has a higher mean but the same variance; this is the de Meza and Webb case examined above.

v) The point on the higher locus has a higher mean and a lower variance; from the bank's point of view both these effects would represent favourable selection.

It can now be shown that in the general model it is possible for credit rationing to occur, due to the presence of elements of adverse selection, and for the level of aggregate investment to be above or below the first-best level.

2.5.1. Credit Rationing

In the general model it is necessary to imagine that projects lie over an area in (a,b) space rather than along a line in that space as in the special cases examined above. Clearly, in this case, a rise in the loan interest rate will involve elements of both favourable and adverse selection. For credit rationing to occur, it is necessary that the adverse effects of a rise in the loan rate dominate the favourable effects, so that as the loan rate rises the mean gross return per unit of currency loaned by the bank, λ, declines (λ is defined as total bank receipts, i.e. debt repayments plus the sum of returns from unsuccessful projects, divided by the sum of bank loans). Whether this will be the case or not obviously depends on the joint distribution function H(a,b); but if it is the case, the original demonstration of the possibility of credit rationing provided by Stiglitz and Weiss still holds even though the model is now more complicated than theirs; the difference between the present analysis and that of Stiglitz and Weiss simply being that the favourable effects of a rise in the loan rate now include some elements of favourable selection as well as a rise in the debt repayments of successful projects. The arguments may be illustrated using Figure 2.6, which, while similar to that presented in Chapter 1, is worth being reproduced here since the context is distinct.

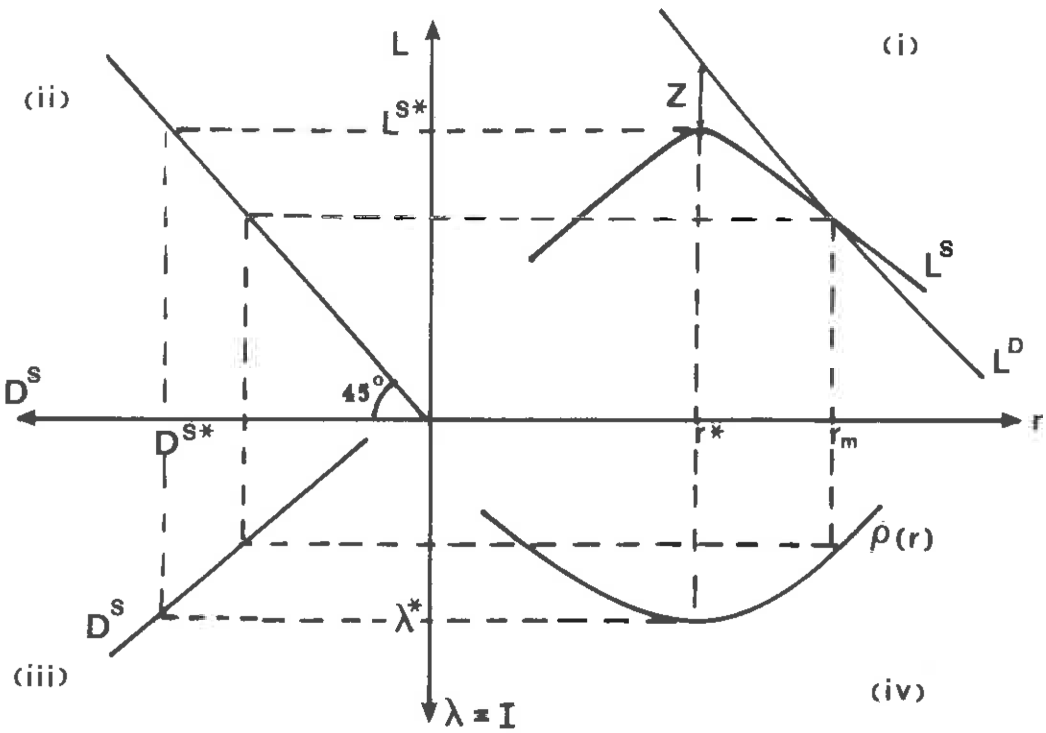

Figure 2.6: Credit Rationing

The fourth quadrant of Figure 2.6 shows the relationship between λ and r, which is assumed to yield a maximum for λ at r^*; for increases in r beyond r^* the adverse selection effects outweigh the effects of favourable selection and the direct effects of higher repayments by successful projects.[9] The third quadrant depicts the supply of loanable funds to the bank, D^s, as an increasing function of the safe loan factor I. The second quadrant simply shows a 45° line used to translate the supply of funds to the bank into a bank supply of loans curve, L^s, in the first quadrant. The first quadrant also shows a demand for loans curve, L^d, which shows the demand for loans declining as the interest rate rises.

The downward slope of the L^d line in Figure 2.6 is easily explained by noting that any increase in the loan rate r moves the ML locus to the right in a diagram in (a,b) space. The shift of the ML locus makes some projects fall below the ML locus rather than lie above it and causes individuals endowed with such projects to cease to apply for loans. The L^s curve in the figure is derived by noting that the zero-profit condition on banks implies that the safe rate factor I offered to depositors by the bank in Figure 2.6 must equal λ, the mean gross return factor received by the bank on its loans. There is, therefore, an implicit relationship between the loan rate charged by the bank and the supply of deposits it attracts and can use to support loans to borrowers. For example, if the bank charges r^* it earns λ^*, as shown in the fourth quadrant, and can attract D^{s*} funds, as shown in the third quadrant; these funds are then translated via the 45° line in the second quadrant to show the supply of loans of L^{s*} at the interest rate r^* in the first quadrant. Other points on the L^s curve may be derived in a similar way.

Figure 2.6 shows credit rationing. A market clearing loan rate of r_m is shown in the diagram but the bank has no incentive to charge this rate, since to do so would not maximize λ and the amount of deposits which the bank can attract. Instead, the bank charges the lower rate r^* and thus maximizes λ and deposits. However, notice that rationing is not inevitable since the non-monotonic relationship between λ and r shown in the figure need not occur if the adverse selection effects are not strong enough and, even if it does occur, rationing only follows (as pointed out in Chapter 1) if the L^s and L^d curves intersect at an interest rate above r^*. If credit rationing does occur in the general model, it does so for the same reason as in the original Stiglitz and Weiss analysis - i.e. when the adverse effect of an increase in the loan rate on the quality, as perceived by the bank, of the pool of loan applicants outweighs the favourable effects of the rise in the loan rate. It is, of course, quite possible that the adverse effect need not outweigh the favourable effects, which now include the effect of improving the mean returns on marginal projects as well as the usual effects of higher debt repayments by successful projects.

2.5.2. Aggregate Investment Relative to the First-Best

The special cases examined earlier led to either under- or over-investment relative to the first-best level. In each case, there was a straightforward relationship between the quality of projects and the sub-optimal level of investment. In the former case, all the projects being carried out deserved support, whilst some other deserving projects did not receive support, in the latter all the projects which did not receive support did not deserve it, but some undeserving projects did receive support. In the general model, there is no such simple relationship between the quality of investment and the difference between the actual and the first-best level of investment. The following proposition summarizes the new results.

Proposition 2.6: Whether or not credit rationing occurs, the aggregate level of investment may exceed, equal or fall below its first-best level, and in any case the quality of the aggregate investment may differ from the first-best in the sense that instances of projects receiving support which would not do so in a first-best world may occur simultaneously with projects failing to receive support which would receive such support in a first-best world.

Proposition 2.6 may be established by examining Figure 2.7. Consider that all possible projects lie within the elliptical shape shown in the diagram and are distributed according to some joint distribution function H(a,b) known to the bank. The bank sets the loan rate factor at X and the safe rate factor is I. In a first-best world, all projects lying on IK or beyond it would be carried out and those below IK would not be carried out. In the present case, however, projects beyond IK but below the marginal locus ML, i.e. those within the shaded Area A, are not carried out since individuals endowed with them do not apply for loans even though they would be carried out in a first-best world. On the other hand, individuals with projects lying within the Area B below the IK line but above the ML locus do apply for loans. Therefore, whether or not there is credit rationing and whether or not the aggregate level of investment differs from the first-best level, it is possible that there may exist projects which are not being carried out which would be carried out in a first-best world, and at the same time projects being carried out which would not be carried out in a first-best world. If there is no credit rationing, the former group of projects will be those in Area A and the latter group will be those in Area B. If there is credit rationing, the former group will be those in Area A plus any projects in the unshaded area of the ellipse beyond IK which do not receive loan support even though individuals endowed with those projects do enter the credit market, and the latter group will be those in Area B which receive loan support.

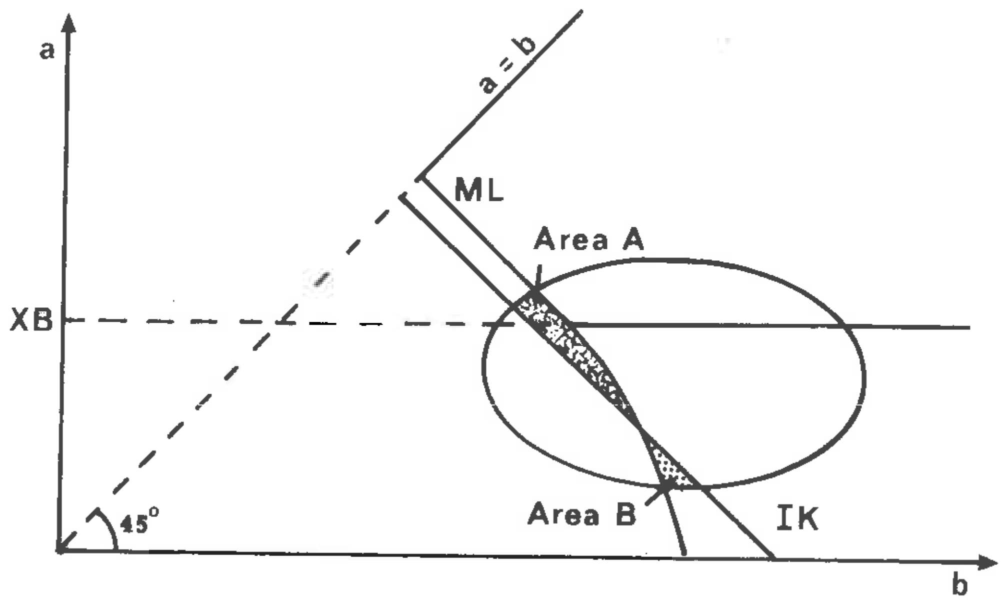

Figure 2.7: Aggregate Investment Relative to the First-Best Case

If there is no credit rationing, whether aggregate investment exceeds, equals or falls below the first-best level will depend upon the number of projects lying within Area A relative to the number lying in Area B. If the number of projects in Area A exceeds (equals, is less than) the number in Area B, then aggregate investment will fall below (equal, exceed) its first-best level. If credit is rationed, the relative comparison becomes the number of projects in Area A plus those in the unshaded area beyond IK which do not receive loan support compared to the number of those in Area B which do receive support.

Projects lying within Area A, plus those in the unshaded area beyond IK which are not carried out under credit rationing, correspond to the under-investment of the Stiglitz and Weiss special case, and projects in Area B, less those which do not receive support under credit rationing, correspond to the over-investment of the de Meza and Webb special case (although, of course, their special case rules out the possibility of credit rationing). The relative sizes of the Areas A and B depend upon the difference between the loan rate factor X and the safe rate factor I. If this difference is zero, Area A ceases to exist and the result is straightforward over-investment, as in de Meza and Webb. On the other hand, Area A grows and Area B shrinks as X grows above I; if Area B shrinks to zero, the result is straightforward under-investment, as in the Stiglitz and Weiss case. But in general Areas A and B can coexist, giving rise to the more complicated outcome with no straightforward relationship between the quantity of investment and the quality of projects receiving or not receiving support.

The general case where Areas A and B coexist implies that an efficiency improving policy could be to encourage more investment if the effect of this in reducing the Area A, and any effects of reducing credit rationing on projects within the unshaded area beyond IK, exceed the harmful effects of increasing the Area B, say by subsidizing loan interest and reducing the loan rate factor X and increasing the safe rate factor I. But whether this is so will depend upon the joint distribution function H(a,b) and it is quite possible that the opposite policy (i.e. a tax on the loan rate) should be followed. It does appear, however, that any such policy must be second-best since such policies would reduce Area A (or B) only at the expense of increasing Area B (or A) and would not simultaneously reduce both areas to zero.

In a different, but related, context, de Meza and Webb (1990) have suggested a simple policy which could achieve the first-best solution in the present model. They suggest a 'true' progressive profit tax with full loss offset approaching 100%. In the limit 'this policy works because the government in effect holds all the equity in all the projects paying a price which is actuarially fair for the project which is just expected to cover its total costs' (de Meza and Webb 1990, p. 212). In other words, only projects whose expected return is at least as high as the safe return will be undertaken. The appeal of this policy is, however, deceptive. The policy only works because the model abstracts from the problems of moral hazard and monitoring costs. It is easily seen that if project returns depend upon the effort expended by entrepreneurs, then the policy may have serious and deleterious effects on incentives. Alternatively, if it is costly to observe project returns, a progressive tax policy, which requires observation of returns, could be excessively costly to implement. Given the complexities of the real world, it is not possible to offer unequivocal support for any policy.

An objection could, however, be raised to the form of debt contract in the model. Indeed, it does seem relevant to mention that a more complex form of contract than the one assumed could help to overcome the complications of the markets characterized by uncertainty and related aspects such as asymmetric information and adverse selection. For example, a social planner (or the bank) could impose a commitment on loan applicants to buy insurance policies designed to keep borrowers' investments safe and to eradicate risk and adverse effects in the loan market. By making the minimum return of any feasible projects at least as great as the amount borrowed plus interests charged by the bank, or by inducing the default probability in projects to become equal to zero, this policy would linearize the parabolic section of the ML locus in a diagram in (a,b) space. Furthermore, to compensate for the increased costs in projects and bring the ML locus to the position of the IK line, the above policy could be complemented by an appropriate subsidy to loan applicants in order to attain the first-best solution if the market is plagued by too little investment.

However, two pertinent arguments could be advanced regarding the above mixed policy. First, it would require a set of insurance markets which would conflict with what is observed in the real world. Competitive markets often entail incomplete insurance due to the problems of the observability of outcomes and possible ex ante asymmetry of information. For example, the policy of insurance requirement could lead - in a manner similar to that arising from the aforementioned policy suggested by de Meza and Webb - to moral hazard problems.[10] In fact, with moral hazard and complete insurance, borrowers would have no incentive to avoid bad outcomes. This is the main reason why competitive markets require incomplete insurance. Second, social costs stemming from the above mixed policy could be higher than those of simple policies of taxing or subsidizing borrowers. This type of issue, of course, calls for a general equilibrium analysis which is beyond the scope of the present chapter.

To conclude, it seems clear that the credit market in which asymmetric information and related phenomena such as risk, adverse selection and moral hazard are present contains numerous forms of potential inefficiencies. The present analysis, therefore, casts serious doubt on the relevance of the fundamental theorems of Welfare Economics and on the basic results concerning the efficient decentralization of economies.

2.6. Conclusions

The study developed in this chapter has generalised some of the existing models of credit markets under asymmetric information. In particular, the present model has accommodated the adverse selection arguments of Stiglitz and Weiss and the favourable selection arguments of de Meza and Webb and has included their models as special cases. The novelty and advantage of this framework has been to distinguish the investment projects in terms of two characteristic parameters of the distribution function of returns associated with each project, i.e. in terms of the mean and variance parameters. This stands in contrast to the models of Stiglitz and Weiss and de Meza and Webb, in which distributions were distinguished in terms of either the mean parameter or the variance parameter but not both.

The possibility of credit rationing in equilibrium still exists in the extended model - just as it does in the well-known special case presented by Stiglitz and Weiss - so long as the adverse selection effect of a rise in the loan rate in leading to an increase in the variance of marginal project returns exceeds the sum of the favourable effects (to the bank) of higher debt repayments from successful projects and the favourable effects upon the mean marginal project returns.

A major contribution of the present analysis has consisted in showing that in equilibrium, with or without rationing, the aggregate level of investment may differ from its first-best level without there existing a straightforward relationship between this difference in levels and the quality of projects receiving or not receiving support. In other words, there are, in general, problems both in relation to projects with an expected gross rate of return in excess of the safe rate which are not carried out - either because individuals endowed with such projects choose not to apply for loans or because they apply but are rationed - and in relation to projects with an expected gross rate of return below the safe rate which are carried out.

Within the context of this model, a progressive profit tax with full loss offset approaching 100%, as suggested by de Meza and Webb (1990), would produce the first-best outcome. However, it must be concluded, along with Black and de Meza, that 'to devise policies for an actual economy with a real chance of improving allocations would be a formidable undertaking' (1990, p. 22). Obviously, reservations on policy issues stem from the recognition of the analysis' limitations. In fact, the issues of moral hazard and ex post asymmetric information which have been noted in the literature (surveyed in Chapter 1) are not present in the above model, nor is there any discussion of the nature of optimal financial intermediation which might reduce or eliminate some of the problems. Thus, further work addressing these issues is warranted. Albeit in a different context, the issue of optimal financial arrangements is dealt with in the next chapter, where a mixed form of financial contracts is taken into consideration.

Finally, it should also be noted that the model is a partial equilibrium one. A general equilibrium analysis would be more conclusive in so far as it would allow tracing the overall effects of any policies designed to produce social efficiency as well as checking that the benefits suggested by the partial equilibrium approach are not vitiated by repercussions elsewhere in the economy.

2.7. Notes

1. For a proof of maximum self-finance see de Meza and Webb (1987).

2. The form of the debt contract is taken as exogenously given as in much of the literature. At this stage, any further discussion of optimal financial intermediation is avoided. Recall that Chapter 1 contains a discussion of this issue. See also Chapter 3 where this issue is re-considered.

3. Note that the distributions in which $b_i < RB$ have been neglected, since in those cases the probability of default equals one and, hence, borrowers have no incentive to apply for loans.

4. Of course the straight-line segments of ML_1 and ML_2 are also parts of iso-mean lines.

5. Although, as Stiglitz and Weiss showed, if rationing exists, then removing it would involve an increase in the loan rate and a reduction in investment. It would not, therefore, improve matters to simply remove credit rationing.

6. The model of de Meza and Webb (1987) assumed that all projects faced common returns R^s if successful and R^f if unsuccessful, they differed only in the probability of success.

7. There may, of course, be more than one such project at point A.

8. A more precise comparison of two ML lines for a common safe interest factor, I, would note:

i) That the two straight line segments are of equal length and that the variances along each of them both range from zero to $1/6(IW)^2$. The variance is obviously zero at the intersection with the a = b line; that it is $1/6(IW)^2$ at the intersection with the XB lines in each case may be derived by replacing XB by $\hat{a}$ (from the equation for the XB line) in equation 2.8 (the equation for the straight line part of the marginal locus) to show that ($\hat{b}$ - $\hat{a}$) always equals 2IW at such intersections. The variance then follows from the formula given earlier. The straight line segments of the marginal loci are therefore parallel iso-mean lines bounded by two common parallel lines, one being the zero iso-variance or a = b line, and the other being the $1/6(IW)^2$ iso-variance line; hence, they are of equal length. The higher iso-mean line obviously has the higher mean.

ii) That the parabolic parts of the marginal loci are of different length, the higher one being the longer and having a higher mean at each of its ends than the lower one. The variance of each at the end which joins the straight line segment is common, at $1/6(IW)^2$, as shown above. The higher curve has a higher variance than the lower curve at the end which intersects the b-axis.

iii) That some projects which used to be default-free and within the set of projects for which individuals apply for loans under the initial ML locus acquire a non-zero risk of default as the loan interest rate rises.

9. Notice that since the bank cannot distinguish between borrowers the average quality of loans depends on the interest rate charged but not on whether or not rationing takes place, and so the bank gains the same return λ at any interest rate r whether or not credit is rationed.

10. See, for instance, Arnott and Stiglitz (1990) where an in-depth analysis of the potential inefficiencies implied by moral hazard in insurance markets is provided.

CHAPTER 3

FINANCIAL INTERMEDIATION, RISK AVERSION AND ASYMMETRIC INFORMATION

3.1. Introduction

A revival of interest in credit issues, both in microeconomics and macroeconomics contexts has already been illustrated in the preceding chapters. As noted, a considerable effort has gone into the study of financial markets under asymmetric information in an attempt to explain the failure of those markets to engender efficient levels of investment.[1] In contrast with the economics of capital structure in modern corporations[2], this literature has paid relatively little attention to the theoretical analysis of the effects stemming from the mixed form of financial arrangement. Optimal contract between two parties assume either the form of debt, as in de Meza and Webb (1987), Gale and Hellwig (1985), and Williamson (1987), or the form of equity, as shown by de Meza and Webb (1987) in Stiglitz and Weiss (1981). And yet modern corporations exhibit in their capital structure both debt and equity (inside and outside). Moreover, on the theoretical level, O. Williamson (1988) shows that an optimal mix of debt and equity, which is termed 'dequity', may supplant both debt and equity. Likewise, Stiglitz notes that 'these forms of financial constraints are but extreme examples, demonstrating clearly that the financial structure of firms can make a difference. Theories of optimal financial structure can be derived, with the optimal structure depending on the nature of the information problems being faced.' (Stiglitz 1988, p.124). Inspired by the works of Leland and Pyle (1977) and de Meza and Webb (1990), the present study seeks to fill this lacuna by analyzing a model in which a mixed form of financial contract between financial institutions and firms is possible.

The structure of information plays a crucial role in the model. The main goal of the present analysis is to examine the effects of incomplete information on the nature of financial equilibrium and on the capital structure of firms. In addition, the study endeavours to show that the results derived in the literature of credit markets are, as mentioned before, not robust to changes in model specifications. This attempt aims at contributing to the advance of the economics of credit markets by offering further insights.

The structure of the model is established in Section 3.2 of the chapter. The context is a simple one-period partial equilibrium model with informational asymmetries. In the model, entrepreneurs are considered to behave in a risk-averse manner and each of them is endowed with a project at the beginning of the period. The projects, if undertaken, require outside finance from risk-neutral bankers, who offer financial contracts to entrepreneurs. All projects are assumed to have the same expected return and are divided into two types: one with a high probability of securing the successful return and a second with a low probability. The quality of an individual entrepreneur's project, that is, the success probability - not known by the financial institutions - is private information. The generalisation of the analysis to continuous categories of entrepreneurs is discussed in the conclusion.

Section 3.3 briefly discusses de Meza and Webb's (1990) contribution, where projects are ranked by the first-order stochastic dominance. In this model, capital market failure involves over-investment if pooling equilibrium prevails.

Section 3.4 develops the model previously established. If negative incentive effects are not considered, the financial equilibrium involves pooling equilibrium with both categories of projects being entirely financed through outside equity. With this type of solution there can be no adverse selection and social efficiency is achieved. Indeed, if the capital structure of firms is wholly absorbed by outside equity, all projects will be equally attractive to risk-neutral financiers.

A special case is investigated in Section 3.5 of the chapter. The assumption that equity contract entails no costs seems unreasonable because of moral hazard problems. Incentive effects may justify an optimal small proportion of outside equity in the capital structure of firms.[3] It is therefore assumed that in all projects the share of equity held by outside investors is fixed and relatively small. With this assumption the model exhibits interesting properties. The first conclusion of this section is that if the equilibrium separating contract is dominant - as defined in the study - in a set of contracts on offer, it will necessarily be the unique equilibrium. Regardless of the values of the parameters of the model, there cannot be a pooling equilibrium. However, under quite plausible conditions equilibrium may not exist, as in Rothschild and Stiglitz (1976).

The second conclusion is that credit rationing, as defined in Stiglitz and Weiss (1981), is not viable. This result is consistent with that of Bester (1985), although in a different setting. The model need not use collateral requirements to induce entrepreneurs to self-select themselves into categories and make rationing impracticable.

The third conclusion refers to welfare properties. The competitive equilibrium is not economically efficient. As in Rothschild and Stiglitz, there is a dissipative externality, i.e. the existence of the high-risk investors produces a negative effect on the low-risk investors. But more importantly, in separating equilibrium aggregate investment falls short of the first-best level and thus a subsidy on bank financing leads to a Pareto improvement.

Finally, capital structure of firms does matter. In disagreement with Modigliani and Miller (1958), the relative magnitude of outside equity makes a real difference to the quantity of aggregate investment in equilibrium. And interestingly, as in Harris and Raviv (1990) and Ross (1977), the leverage of firm is positively associated with default probability.

Section 3.6 offers some concluding comments.

3.2. A Model of Investment Finance and Risk Aversion

The context is a simple one-period partial equilibrium model with informational asymmetries between financial institutions and entrepreneurs. The analysis is intended to decipher the nature of equilibrium and the causes of capital market failures.

The basic assumptions of the model as well as the behaviour and objectives of economic agents are indicated below. Entrepreneurs' projects differ in risk and the problem analysed is that of financing them by own equity, debt and outside equity; this framework draws on and synthesises the works of de Meza and Webb (1990) and Stiglitz and Weiss (1981).[4]

Consider a capital market in which there are two classes of economic agents: potential entrepreneurs who are in need of finance and banks who make it available.

Entrepreneurs are risk-averse, expected utility maximisers, all with identical continuous quasi-concave utility function of end of period wealth, U(.). They each have the same initial wealth, W_0, which can be invested either in an indivisible amount of investment, denoted by K, or in a safe asset yielding the same interest rate ρ. For the sake of simplicity, it is assumed that deposit is the unique safe asset in the market, so if projects are not carried out, W_0 is deposited with banks. The ith project, if executed, yields a random return $\tilde{R}_i$ of R_i^s if it succeeds and R_i^f if it fails. Adaptation of the mean preserving spread criterion of Rothschild and Stiglitz (1970) implies that all projects have a common expected gross return:

(3.1) $$p_i(R_i^s)\, R_i^s + [1 - p_i(R_i^s)]\, R_i^f = \text{a constant}, \quad \text{for all } i,$$

where p_i, defined in [0,1], is the success probability of the ith project. Without any loss of generality, consider that $R_i^f = R^f$ for all i. Projects differ in risk and since p_i depends on R_i^s, they consequently differ in the successful return. In the present analysis it is enough to assume only two categories of entrepreneurs[5]: high-risk individuals with success probability $p_H(R_H^s)$ and low-risk individuals with success probability $p_L(R_L^s) > p_H(R_H^s)$. This condition with (3.1) implies that projects are ranked by the mean preserving spread criterion. In what follows the subscript i will denote the entrepreneur's category.

To cause the need for the outside finance it is assumed that $W_0 < K$, so if a project is to be carried into execution additional finance must be raised. This is done through the issuance of outside equity and/or debt securities. Debt security of current value B pays in the successful state an amount $D = (1 + r)B$, where r is the posted loan rate, or else pays the entire project return to the bank in the event of bankruptcy. Then the return on debt is $\min(D, R^j)$, and the return on equity is $\max(R^j - D, 0)$, where j=s,f. The proportion of inside equity in the project is $0 \leq \alpha \leq 1$, which is held by the entrepreneur, and the remainder - the outside equity - is sold to a bank. For the acquisition of debt security with face value of repayment D and the proportion $(1 - \alpha)$ of the equity, the bank agrees to pay a value F.

Successful states must reward both entrepreneurs and banks. Thus, it makes sense to assume $R_i^s > D$. If a project of category i is successful, the entrepreneur end of period wealth is:

(3.2) $$W_i^s = \alpha\,(R_i^s - D) + (1 + \rho)(F + W_0 - K)$$

and in the low state he obtains[6]:

(3.3) $$W_i^f = W^f = \alpha\,[\max(R^f - D, 0] + (1 + \rho)(F + W_0 - K).$$

From the expected utility theorem, the entrepreneur's preferences for income in the two states of nature are described by the following function[7]:

(3.4) $$EU(W_i) = p_i U(W_i^s) + (1 - p_i)\,U(W^f), \qquad i = H, L.$$

The entrepreneur of category i will execute his project if:

(3.5) $$EU(W_i) \geq U[(1 + \rho)W_0].$$

A group of few large banks supply finance. They are assumed to be competitive, risk-neutral expected profit maximisers. Competition is of Bertrand type in price strategies. Banks pay for each unit of deposit the interest rate ρ; other costs as well as activities of banking are neglected. The supply of funds to a bank is assumed to be non-decreasing in the safe rate of interest, ρ. Given the partial equilibrium nature of the model, this relationship is given exogenously and thus not derived from first principles. It is assumed that banks have knowledge about the proportion of each of the two categories of entrepreneur, $\lambda_i \in [0, 1]$, with $\lambda_L + \lambda_H = 1$. Furthermore, they know the success probability p_i of each type. However, banks cannot distinguish ex ante the characteristics of each entrepreneur's project. This assumption introduces the key asymmetry of information into the model. The ex post return of each project once executed is assumed to be observable without cost to both bank and entrepreneur. When finance is made available, the financial contract specifies its terms F, α and D. With this contract offered to an entrepreneur of category i, in the successful state the bank makes a profit of:

$$(3.6) \qquad \pi^s_{Bi} = D + (1 - \alpha)(R_i^s - D) - (1 + \rho)F, \quad i = H, L,$$

and in the low state:

$$(3.7) \qquad \pi^f_{Bi} = \pi^f_B = \min(D, R^f) + (1 - \alpha)\max(R^f - D, 0) - (1 + \rho)F,$$

where R^f can be greater or smaller than D. Thus, the expected profit to the bank from a project of category i and the above contract is:

$$(3.8) \qquad E(\pi_{Bi}) = p_i \pi^s_{Bi} + (1 - p_i)\, \pi^f_B,$$

where $p_i = p_i(R_i^s)$.

In the present study, coalition between agents is ruled out and each entrepreneur can only carry out one project.

The following definition is now introduced.

Definition 3.1: Equilibrium in the competitive capital market is a set of financial contracts such that all contracts in the equilibrium set yield zero expected profit to banks; and there exists no other contract in the exterior of the equilibrium set which - if offered - generates a non-negative expected profit.

Definition 3.1 implies a Bertrand competition. Each bank expects that the rivals will keep the terms of financial contracts invariable, irrespective of its own decisions.

Before examining the properties of the market equilibrium in the model above described, the next section briefly examines the model developed by de Meza and Webb (1990), where projects reflecting the ability of entrepreneurs differ in terms of mean-return but not in their riskiness.

3.3. The Results of de Meza and Webb: The Model with First-Order Stochastic Dominance

This section briefly reviews the de Meza and Webb model and focuses on the issues which the present study is concerned with. This will allow comparison of the results under their specification and those to be developed below in Sections 3.4 and 3.5. It will become clear that the results depend upon the nature of the assumptions made about the mode of ranking entrepreneurial projects. The essential difference is that in de Meza and Webb projects differ in expected payoff and thus entrepreneurs are categorized by the first-order stochastic dominance relationship regarding their project returns. Assuming the same return in all projects, with $R^s > R^f$, the distinctive characteristic of a category of projects is made dependent only upon the value of the success probability p_i, again with subscript i denoting two categories of projects. Since risk is abstracted, the two categories are now defined in terms of good, g, and bad, b, projects with $1 > p_g > p_b > 0$.

To begin with, the equilibrium in the market is inspected, and thereafter its properties are examined. Definition 3.1 requires that in equilibrium banks make zero expected profit and thus (3.8) must equal zero, for a separating equilibrium with i = b, g, and for a pooling equilibrium if the subscript i refers to an average category of entrepreneurs, as indicated below. From this condition and after some manipulation, the equation for the offer curves of a bank is given by:

$$(3.9) \qquad W_i^s = -[(1-p_i)/p_i]\, W_i^f + R_i^s + (1/p_i)\{(1-p_i)[\min(D,R^f) + \max(R^f-D,0)] + (1+\rho)(W_0-K)\},$$

where the slope of the function is $-(1 - p_i)/p_i$. Three offer curves are shown in Figure 3.1, the straightlines AB, CD and EG with i = b, a, g respectively, where the subscript a denotes an abstract average category in the population of entrepreneurs.[8] The CD line is obtained by considering $p_a = \lambda_g p_g + (1-\lambda_g)p_b$ and is devised for pooling contracts.[9] The 45° line is the certainty line where $W^s = W^f$. At B and G, where this line intersects the offer curves, the bank pays a fair price to each category of entrepreneurs, with $F_g > F_b > K-W_0$, $\alpha_i = 0$ and $D_i = 0$. Note that at these points projects are entirely financed through the use of outside equity which is held by the bank. On any of the offer curves, if $W^f = 0$, then $F = K-W_0$, $D \geq R^f$ and W^s is maximised. Thus payoff at A, for example, is clearly compatible with all debt finance ($\alpha = 1$) and, of course, with many other combinations of α and D. On the interior of each offer curve the terms of contract vary, but $F \geq K-W_0$ must always hold, or else projects cannot be financed.

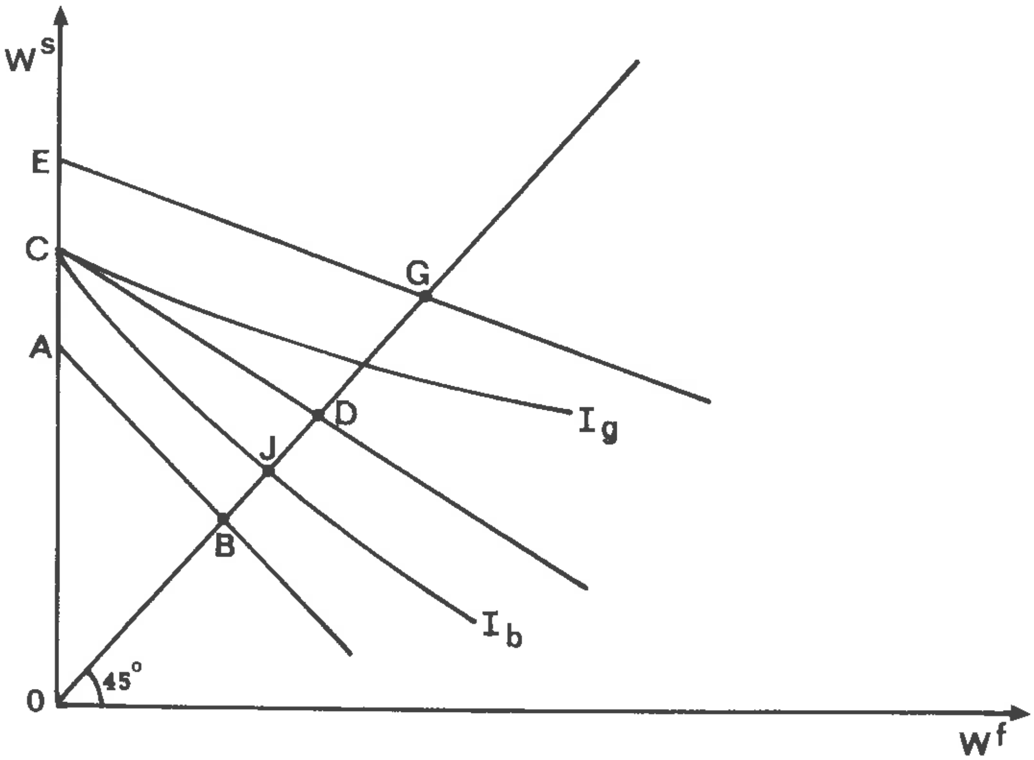

Figure 3.1: Pooling Equilibrium

Indifference curves I_b and I_g for bad and good entrepreneurs in Figure 3.1 are strictly convex because of risk aversion and are derived from (3.4). The slope of an indifference curve for each category of individuals is given by differentiating (3.4):

$$(3.10) \qquad dW_i^s/dW_i^f = -[(1-p_i)U'(W_i^f)] \,/\, p_iU'(W_i^s) < 0.$$

Clearly, a higher p implies a flatter slope, so at any point (W^f,W^s) to the left of the certainty line the indifference curve of the b category is steeper than that of the g category.

With imperfect information all contracts offered have to be incentive compatible. As in all models of this type, there are two obvious possibilities to achieve incentive compatibility in equilibrium: either through a pooling contract or through separating contracts. These two types of equilibrium may occur in de Meza and Webb's model, each type depending upon the values of parameters. However, to save space, the analysis is here mainly devoted to the case of pooling equilibrium. A special configuration of capital market is represented in Figure 3.1. The format and position of curves are contingent on the values of λ_g, p_g, p_b and degree of risk aversion. In this class of model, incentive compatibility requires the pooling equilibrium at C. There are no other contracts which can displace contracts offered at this point. Observe first that a separating equilibrium cannot exist, since the bad category of entrepreneurs prefers to choose any contract along the EG locus to contracts lying on the AB locus. Furthermore, any point on the interior of the CD locus cannot be a pooling equilibrium, as it would only attract category b entrepreneurs and a bank would make losses. Therefore, if the market displays the characteristics indicated in Figure 3.1, the equilibrium point is necessarily determined by pooling contracts involving $W^f = 0$, $F = K - W_0$ and $D \geq R^f$. Recall that one of these financial arrangements is all debt finance, i.e. $\alpha = 1$.

The implications of the model for the point of view of welfare economics is now examined. In de Meza and Webb (1987) it is shown that with a continuum of entrepreneurial types the marginal project is the worst project in the pool of finance applicants. Appropriate adaptation of this proposition to the present discrete case implies that if marginal projects exist they must be defined by the reservation indifference curve of category b entrepreneurs. Suppose then that along the I_b curve in Figure 3.1 category b's are indifferent as regards executing their projects or investing W_0 in the safe asset. It follows that at point J it must be $W^s = W^f = (1 + \rho)W_0$. The pooling equilibrium at C requires that J must lie above B. At this point - where $\alpha = 0$ - the entrepreneur gets an actuarially fair payoff which equals $\mu_b - (1+\rho)K + (1+\rho)W_0$ in both states, where $\mu_b = p_b R^s + (1-p_b)R^f$. But $\mu_b - (1+\rho)K + (1+\rho)W_0 < (1+\rho)W_0$ since the payoff at B is lower than the payoff at J. Hence, the following must hold:

$$(3.11) \qquad \mu_b < (1 + \rho)K.$$

Therefore, the class of model pictured in Figure 3.1 does not exhibit social efficiency, that is, there is too much investment in the market equilibrium, since projects with negative social return are supported. Moreover, in pooling equilibrium at C, entrepreneurs bear too much risk as investments are not shared by a large number of people. Thus, a simple policy to achieve the first-best solution is to charge a profit tax marginally lower than 100% with full loss offset.

As referred to in Chapter 2, 'this policy works because the government in effect holds all the equity in all the projects paying a price which is actuarially fair for the project which is just expected to cover its total cost.' (de Meza and Webb 1990, p.212).

Different configurations of λ_g, p_g, p_b and level of risk aversion to that of Figure 3.1 may lead to a separating equilibrium. For instance, in Figure 3.2 a pooling equilibrium cannot exist since category b entrepreneurs prefer some contracts on the AB line to the pooling contract C. It is easy to see that the pair (H,B) is the only possible equilibrium as it cannot displaced by any other contract on offer. Of these two contracts, the most preferred by the **g** group is at H and, because of Definition 3.1, the b group must choose the contract at B. In this event, the level of aggregate investment is efficient, since the expected return of the worst project equals the safe return $(1+\rho)K$. However, in separating equilibrium there is too little risk spreading as well as a negative externality of bad categories on good categories.

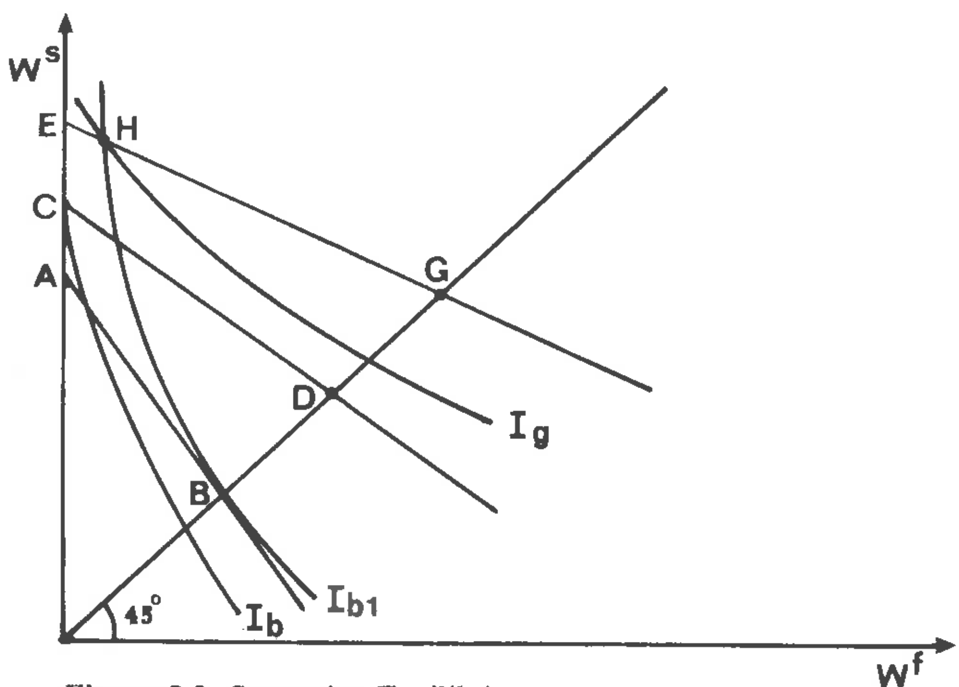

Figure 3.2: Separating Equilibrium

Under plausible conditions, an equilibrium may not exist, a phenomenon that arises when contracts on offer are ineffective in producing incentive compatibility between parties in the market. In other words, an equilibrium will not exist if outside of the possible set of candidates for equilibrium there are contracts that - if offered - yield a positive expected profit to a bank. The non-existence of equilibrium, of course, is a product of bankers' Bertrand behaviour, who fail to take into account the effects of their own actions. Figure 3.3 is an illustration of this case where contracts like γ earn the bank a positive expected profit as they attract both categories of entrepreneurs and are below the pooling offer curve CD.

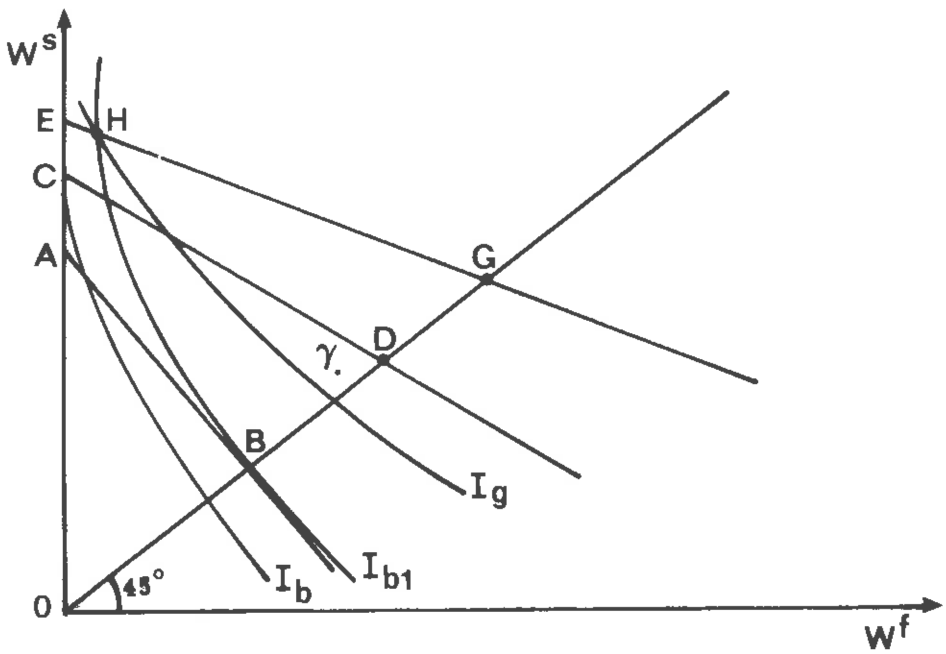

Figure 3.3: Non-Existence of Equilibrium

Having examined the model developed by de Meza and Webb, the next section inspects the properties of equilibrium in the model of Section 3.2, where risk-averse entrepreneurs are grouped in terms of differential risk instead of being categorized by the first-order stochastic dominance relationship concerning their project returns.

3.4. Equilibrium in the Model with Second-Order Stochastic Dominance

Risk as defined in equation (3.1) is now reintroduced with $p_L(R_L^s) > p_H(R_H^s)$. The interpretation of (3.1) is that projects differ according to a mean preserving spread: all projects are assumed to have the same expected value, μ, but riskier projects have a larger variance in returns than less risky ones (see Chapters 1 and 2). This section shows that, under some conditions, the properties of equilibrium in capital markets with asymmetric information may not differ from those of complete information.

Bertrand competition implies that (3.8) must equal zero in a manner corresponding to the explanation given below. This condition yields the following equation for the offer of financial contracts in (W^f,W^s) space:

$$(3.11) \qquad W_i^s = -[(1-p_i)/p_i]\, W_i^f + (1/p_i)[\mu + (1+\rho)(W_0-K)],$$

where p_i depends on R_i^s which is given for each entrepreneurs' category. The slope of an offer curve is given by $-(1-p_i)/p_i$ and, clearly, is steeper for the riskier category. The second term on the right hand side of (3.11) is positive since $\mu > (1+\rho)(K-W_0)$, otherwise projects would not be financed.

Let the subscript A denote an 'abstract' average category of entrepreneurs; and let $p_A = \lambda_L p_L + (1-\lambda_L)p_H$ be the success probability of category A entrepreneurs. Then substituting p_A for p_i in (3.11), an average-risk offer locus is obtained, where a bank earns zero expected profit on average. The average-offer curve can be thought as a benchmark to locate pooling contracts in (W^f,W^s) space.

Figure 3.4 shows the offer lines O_H, O_A and O_L derived from (3.8) with i = H, A, L respectively. The three lines cross the certainty line at the same point, since when $\alpha = 0$ all projects are equally attractive for risk-neutral bankers who are willing to pay to all entrepreneurs the same actuarially fair price in both states. Consider the offer locus O_H. As in de Meza and Webb's case, from (3.2), (3.3) and (3.11), at point E, $\alpha_H = 0$, $D_H = 0$ and $F_H > K-W_0$. W_H^s is maximised if $W_H^f = 0$, which implies $F_H = K-W_0$ and $D_H \geq R^f$. Thus, the payoff at B can be sustained with many combinations of α_H and D_H, one of which is all debt security finance, i.e. $\alpha_H = 1$. On the interior of the locus, α_H, D_H and F_H vary, but F_H must always be greater than or equal to $K-W_0$, otherwise projects cannot be carried out.

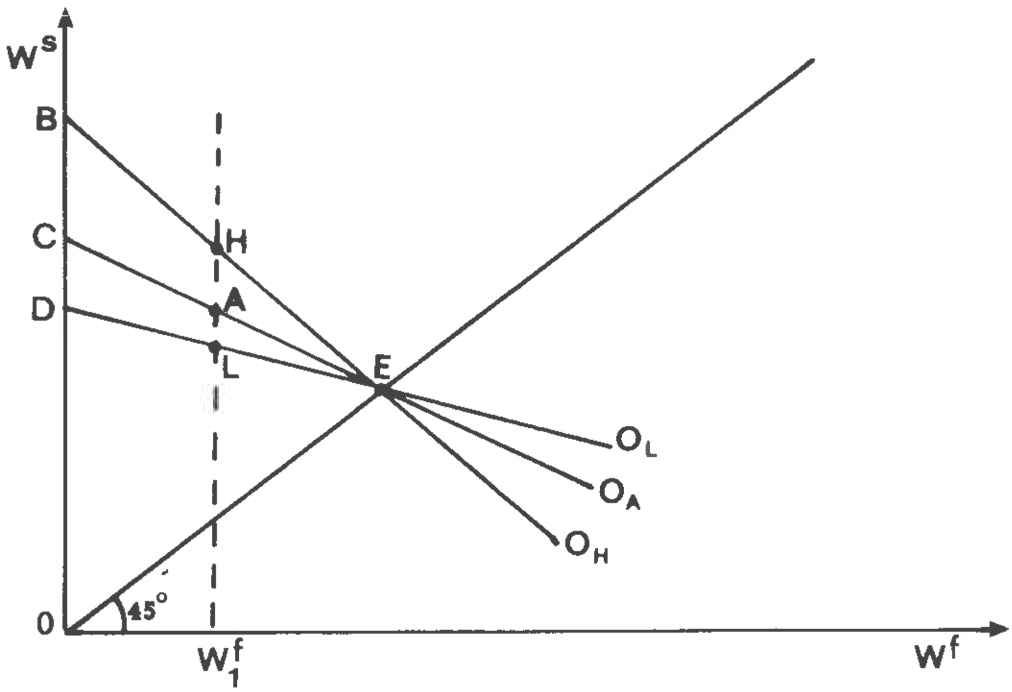

Figure 3.4: Offer Curves of a Bank

Consider now a financial contract, denoted by (F^*,α^*,D^*), on which a bank earns on average zero expected profit. The contract (F^*,α^*,D^*) must then lie on the O_A locus - for instance at A in Figure 3.4 - if offered to a hypothetical average-risk entrepreneur. This contract, however, may or may not yield a non-zero expected profit if offered to either a high- or low-risk entrepreneur. Notice that in (3.2) and (3.3) $R_H^s > R_L^s$ and $R_H^f = R_L^f$. Thus, the contract (F^*,α^*,D^*) lies - on the vertical line through W_1^f as shown in Figure 3.4 - above A if offered to a high-risk entrepreneur and below this point if offered to a low-risk one. Whether or not (F^*,α^*,D^*) lies on the high- and low-risk offer curves will depend upon the value of α^*, as will be shown below.

Suppose that both categories of entrepreneurs choose the contract (F^*,α^*,D^*). Then $W_H^f = W_L^f = W^f$ and from (3.2) it follows that:

$$W_H^s - W_L^s = \alpha^*(R_H^s - R_L^s) = \alpha^*(\mu - R^f)[(p_L - p_H)/p_H p_L] \geq 0. \tag{3.12}$$

But from (3.11), along the offer curves (e.g. comparing H and L in Figure 3.4):

$$W_H^s - W_L^s = [-W^f + \mu + (1+\rho)(W_0 - K)][(p_L - p_H)/p_H p_L] \geq 0 \tag{3.13}$$

where $W^f \leq \mu + (1+\rho)(W_0-K)$. The values of the difference $W_H^s - W_L^s$ in (3.12) and (3.13) need not be equal since the following may hold:

$$\alpha^* \gtreqless [-W^f + \mu + (1+\rho)(W_0 - K)]/(\mu - R^f) \tag{3.14}$$

in which by assumption $R^f < (1+\rho)(K-W_0)$.[10] To simplify the description of (3.14), let $[-W^f + \mu + (1+\rho)(W_0-K)]/(\mu - R^f)$ be φ. As a result of (3.14), three cases may occur. When $\alpha^* = \varphi$, (3.12) equals (3.13) and therefore the contract (F^*,α^*,D^*) which yields on average zero expected profit will also yield zero expected profit with each category. Thus, in this case, a risk-neutral bank looks indifferently at both categories of projects, since from the bank's viewpoint the low risk-projects are as profitable as the high-risk ones. The reason is that the relative amount of outside equity in projects is large enough to overcome the conflict of interests - stemming from the issuance of debt security - between bankers and entrepreneurs. An example of the present case is shown in Figure 3.4, where a given contract (F^*,α^*,D^*) is at H and L for the high- and low-risk groups respectively. But from the earlier discussion, if $\alpha^*= 0$, then $W_i^s= W^f = \mu + (1+\rho)(W_0-K)$ and, therefore, (F^*,α^*,D^*) will be at point E for both groups.

Using similar reasoning, it can easily be shown that if $\alpha^*< \varphi$, (F^*,α^*,D^*) will cause negative expected profit with category L entrepreneurs and positive expected profit with category H's. Thus, given a financial contract in which the proportion of outside equity is relatively large, riskier projects are the more profitable ones for banks. In Figure 3.4, (F^*,α^*,D^*) must be below point H and above point A for the high-risk group, and above L and below A for the low-risk group.

The preferences of banks about projects' categories depend not only upon the nature of intermediation but depend also on the ownership structure of firms. The nature of financial contracts thus provides the rationale for the above results which are in contrast with the Stiglitz and Weiss (1981) theorem that banks prefer less risky projects. This type of behaviour is not, however, ruled out in the present study, since whenever $\alpha^*> \varphi$, riskier projects yield a lower expected profit for a bank. In Figure 3.4, if the value of outside equity is relatively small, (F^*,α^*,D^*) must then lie above point H for the high-risk category and below point L for the low-risk one. Also notice that all debt security finance ($\alpha^*= 1$) is an example of the present case.

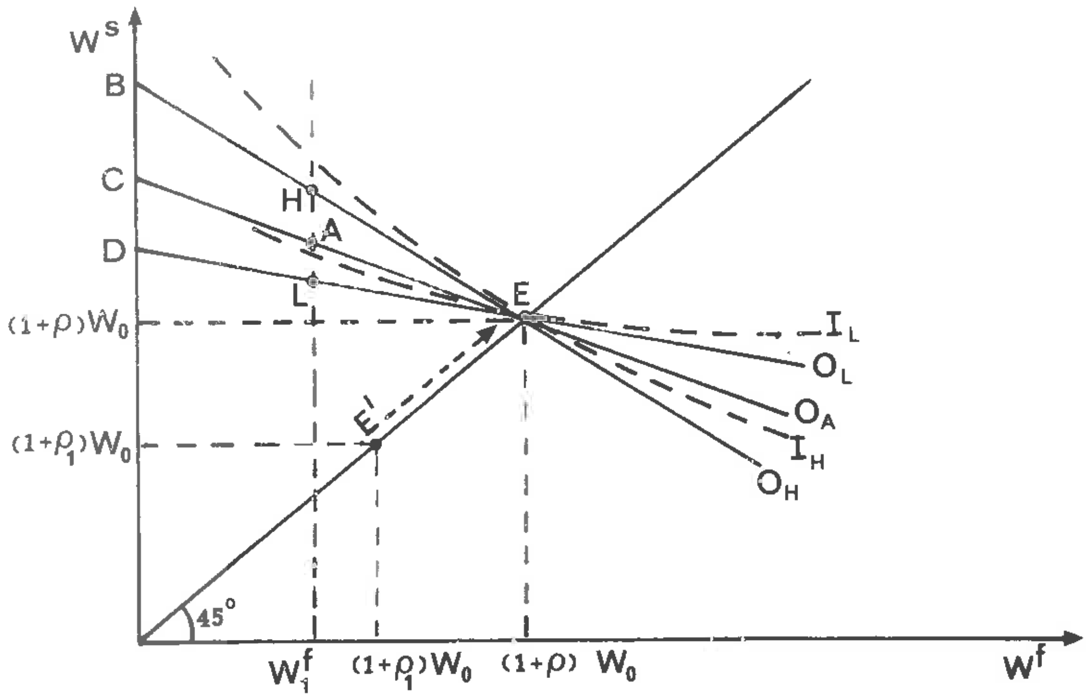

Figure 3.5: Equilibrium in the Market

Indifference curves of risk-averse entrepreneurs are derived from (3.4). The slope of an indifference curve in (W^f,W^s) space is given by:

$$dW_i^s/dW_i^f = -[(1-p_i)U'(W_i^f)]/p_iU'(W_i^s) < 0, \quad i = H,L \tag{3.15}$$

and it is easy to verify that this curve is strictly convex and steeper, at any point to the left of the certainty line, for riskier projects, as shown in Figure 3.5 where I_H and I_L are indifference curves for the high- and low-risk entrepreneurs, respectively. Moreover, indifference curves of each category are steeper than the respective bank's offer curve at any contract (F,α,D) to the left of the certainty line.

If ρ is the equilibrium interest rate on deposits, $(1+\rho)W_0$ sets the reservation level of utilities. Before discussing the reservation indifference curves, the following proposition is established.

Proposition 3.1: Assume that all categories of projects in a capital market have a common expected return but each one has different dispersion of returns. Moreover, assume that banks cannot ascertain the riskiness of a project category. Then there exists a unique equilibrium such that:

(i) a pooling contract is signed with $\alpha^*= 0$, $D^*= 0$ and $F^*= \mu/(1+\rho)$; and

(ii) social efficiency in aggregate investment is achieved.

Proposition 3.1 may be shown by examining Figure 3.5. First note that a separating equilibrium cannot exist, since both high- and low-risk entrepreneurs prefer the contract at E to any of those left on the respective offer curves. Likewise, there is no other pooling contract than contract E which can be a candidate for the equilibrium, since the pooling contract at the crossing point of the offer curves is the most preferable one for both categories when $\alpha^*= \varphi$, and is the most preferable one for category L entrepreneurs (category H entrepreneurs) when outside the certainty line $\alpha^*> \varphi$ ($\alpha^*< \varphi$). Now, from the discussion of the offer curves and from (3.2), (3.3) and (3.11), the equilibrium pooling contract at E specifies $\alpha^*= 0$, $D^*= 0$ and $F^*= \mu/(1+\rho)$. Hence, for any configuration of λ_L, p_L, p_H and degree of risk aversion, there exists a unique pooling equilibrium where an equity contract is signed.

The aggregate level of investment in equilibrium is now compared with that considered optimal from the social viewpoint. It seems reasonable to assume that the society is a risk-neutral macro-agent. Thus, at the social optimum all projects satisfying:

(3.16) $$\mu = p_i R_i^s + (1-p_i)R^f \geq (1+\rho)K$$

should receive financial support. More precisely, in the present case (3.16) must hold as an equality for all categories, since all projects have the same expected return. Note now that with all outside equity finance each entrepreneur receives - in both states - the same actuarially fair payoff which equals $\mu + (1+\rho)(W_0\text{-}K)$. In equilibrium this payoff must be equal to $(1+\rho)W_0$, for if $\mu + (1+\rho)(W_0\text{-}K)$ were greater, more entrepreneurs would enter the market and ρ would increase up to the level where the stationary condition is satisfied. In Figure 3.5, the equilibrium interest rate on deposits, ρ, is at E. Both indifference curves I_H and I_L indicate the reservation utility level for the respective categories as they satisfy the quantity $(1+\rho)W_0$ on the certainty line. Thus, in equilibrium the following must hold:

(3.17) $$\mu + (1+\rho)(W_0\text{-}K) = (1+\rho)W_0$$

which implies:

(3.18) $$\mu = (1+\rho)K$$

for all categories of projects. That is to say, in equilibrium the first-best level of aggregate investment is achieved and all entrepreneurs receive an income equivalent to $(1+\rho)W_0$. The intuitive explanation of the optimality of the equity-based contract is straightforward. When both categories of projects are entirely financed through outside equity their risk characteristic is irrelevant and, hence, they are equally attractive to risk-neutral financiers. As a consequence, in equilibrium there is no adverse selection problem and credit rationing is not viable.

It has been shown that a change in the characterization of projects available to investors in the model, such that projects all have the same expected return but differ in their risk, leads necessarily in pooling equilibrium to all outside equity finance as well as to social efficiency regarding aggregate investment. Not surprisingly, Proposition 3.1 mirrors the results found by de Meza and Webb (1987) in the Stiglitz and Weiss (1981) model, where both entrepreneurs and bankers are risk-neutral. Thus, the possibility of under-investment with all debt finance (which has been noted in Chapters 1 and 2) is ruled out in the present case under efficient equity-based intermediation. However, Stiglitz and Weiss would, of course, refer to moral hazard problems in equity markets and predict a mixed form of finance. Indeed, the conjecture that the outside equity issue does not entail costs sounds illogical because of adverse incentive effects. As a matter of fact, too little effort may be invested by managers in the governance of firms if the share of outside financiers in the capital structure is relatively large. Monitoring of managerial performance could be implemented to reduce the extent to which that inefficiency occurs, but this would itself be costly. Thus, there must exist an optimal proportion of outside equity relative to debt which provides proper incentives for entrepreneurs. The reasons for this will be further discussed in the next section, where, as a consequence, the proportion of inside equity, α, is considered exogenously fixed and relatively large. Thereafter, equilibria in which dequity (mixed form of contract) is the unique feasible financial arrangement are inspected. The assumption imposed on the form of financial contracts is obviously less adequate than if it were derived from the first principles, but, as will be seen, it does provide some interesting insights. Moreover, by considering α relatively large, comparison with the Stiglitz and Weiss (1981) model will make more sense.

3.5. The Model with Dequity as a Financial Instrument

The literature of financial markets with asymmetric information - with few exceptions - treats debt and equity as extreme alternative means of finance. This is so because optimal contracts are derived under very restrictive assumptions. For instance, in the previous section equity is the optimal financial arrangement if the adverse incentive effects arising from the actions of managers are not taken into account. On this matter, it does seem that the theory of the capital structure of modern corporations uses an approach more consistent with the real world. For example, Jensen and Meckling (1976) contend that - in entrepreneurial firms where the resources of entrepreneurs are limited - projects are not in general entirely financed through outside equity, since the entrepreneur's incentives would be diluted, and the answer to the question of why not to support them with debt up to the hilt turns on '(1) the incentive effects associated with highly levered firms, (2) the monitoring costs these effects engender, and (3) bankruptcy costs.'(Jensen and Meckling 1976, p.334). In other words, all debt finance could induce entrepreneurs to take very large ex post risks, knowing that the penalties would not accrue to debtholders in the case of bankruptcy and gains would be captured by entrepreneurs if projects are successful. As perceptive financiers will see through this risk and impose a premium, debt security will become available on progressively worse terms. Thus, an optimal combination of debt and equity can be obtained if the effects of adverse incentives - from issuing new equity - and risk distortions - from issuing debt - are equalised at the margin. It is also for this reason that in O. Williamson (1988) a combined use of debt and equity in the financed investment projects may be optimal. It does, therefore, seem useful to study the effects of dequity in the present framework.[11]

Here a special combination of debt and equity is considered. In all financial contracts, let α be fixed and greater than φ, i.e. $\alpha = \hat{\alpha} > \varphi$. This allows a clearer comparison with the Stiglitz and Weiss model. Thus, as noted before, if $\hat{\alpha} > \varphi$, riskier projects yield a lower expected profit for banks. And let D_{max} be the maximum amount of debt allowed for both categories of entrepreneurs. Then the assumptions of the model imply that, if finance is supplied, $D \leq D_{max} < R_L^s < R_H^s$. Assume also that $0 < R^f < D$. Now, for a given contract $(F, \hat{\alpha}, D)$, equations (3.2) and (3.3) become:

$$(3.19) \qquad W_i^s = \hat{\alpha}(R_i^s\text{-}D) + (1+\rho)(F+W_0\text{-}K),$$

$$(3.20) \qquad W_i^f = W^f = (1+\rho)(F+W_0\text{-}K)$$

and equation (3.6) and (3.7) become:

$$(3.21) \qquad \pi^s_{Bi} = D + (1\text{-}\hat{\alpha})(R_i^s\text{-}D) - (1+\rho)F,$$

$$(3.22) \qquad \pi^f_{Bi} = \pi^f_B = R^f - (1+\rho)F.$$

In equilibrium (3.8) must equal zero, for a separating equilibrium if i = H, L, and for a pooling equilibrium if i = A. Using (3.19), (3.20), (3.21) and (3.22) in the zero expected profit condition, the expression for the offer curves is obtained in (F,D) space:

$$(3.23) \qquad D = [(1+\rho)/p_i\alpha]\ F + R_i^s - \mu/p_i\alpha$$

with slope $(1+\rho)/p_i\alpha$ which clearly is steeper for the riskier category. If $p_i = p_A = \lambda_L p_L + (1-\lambda_L)p_H$ and $R_i^s = R_A^s$, (3.23) will define the pooling offer curve. Figure 3.6 illustrates the lines O_H, O_A and O_L which are the offer curves with i = H, A, L respectively. Consider the line O_H. Contracts on offer lying above (below) this line, if selected by the high-risk entrepreneurs, will cause positive (negative) expected profit for banks.

Substitution of (3.21) and (3.22) for W_i^s and W^f into (3.4) implies the following relationship for indifference curves:

$$(3.24) \qquad p_i\ U(\alpha(R_i^s-D)+(1+\rho)(F+W_0-K)) + (1-p_i)\ U((1+\rho)(F+W_0-K)) = \bar{u}$$

where $\bar{u}$ is a constant and denotes a utility level. The slope of an indifference curve is:

$$(3.25) \qquad dD/dF = [(1+\rho)U'(W^f)]/p_i\alpha U'(W_i^s) > 0$$

and it can easily be shown that this curve is concave and steeper, at any point (F,D), for the riskier project, as shown in Figure 3.6 where I_H and I_L are the indifference curves for the high- and low-risk individuals, respectively. Moreover, indifference curves of each category are steeper, at any contract (F,D), than the respective bank's offer curve.

The equilibrium solution under complete information - which will provide a benchmark against which to measure the effects of asymmetric information - is now derived. This solution follows immediately upon observing that the expected utility of each category increases as its respective indifference curve moves rightwards in Figure 3.6. Equilibrium with no private information is therefore achieved with the pair of separating contracts (A,C), where the contract A is selected by the high-risk group and C by the low-risk one.

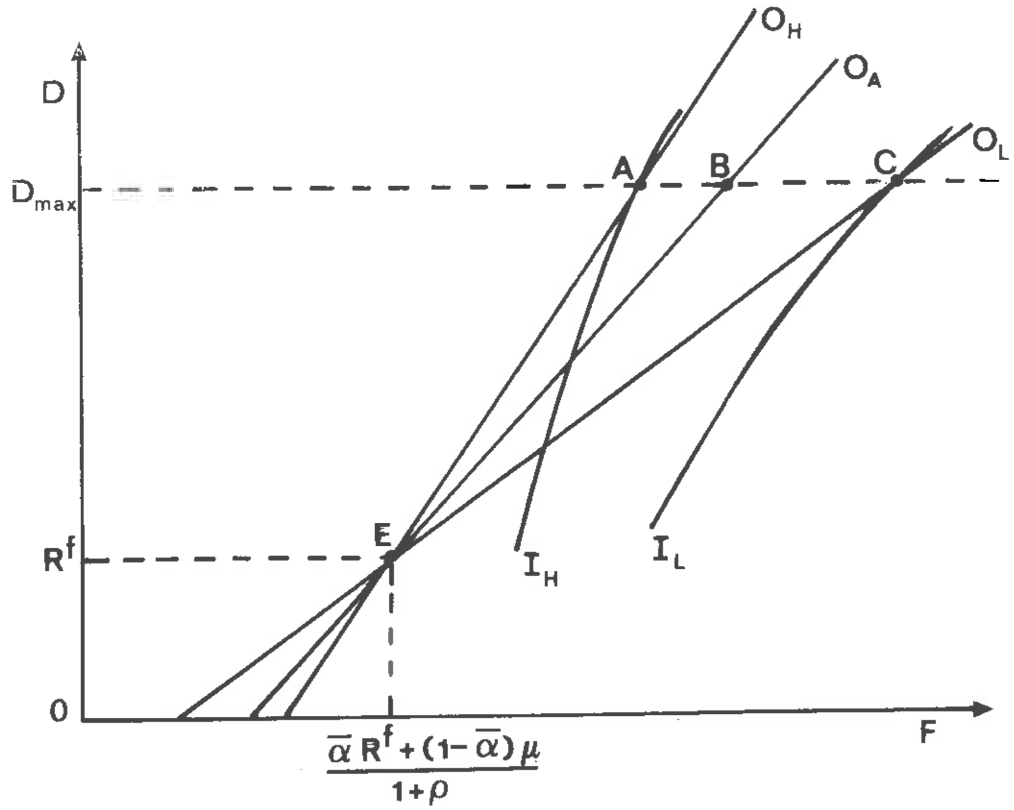

Figure 3.6: Equilibrium With No Private Information

Next, equilibria in the model with incomplete information are discussed. For expositional convenience, the following definition is put forward.

Definition 3.2: Let v_H and v_L be contracts selected by the high- and low-risk entrepreneurs, respectively. If they involve equilibrium and cannot be displaced by any other contract on offer, then v_H and v_L are said to be dominant contracts.

Obviously, Definition 3.2 requires incentive compatibility between banks and entrepreneurs. When $v_L = v_H$ equilibrium will be settled through a pooling contract, and with $v_L \neq v_H$ through separating contracts.

Now a simple argument establishes the following proposition.

Proposition 3.2: Consider the assumptions of the model with $\alpha = \tilde{\alpha} > \varphi$. Then a pooling equilibrium cannot exist.

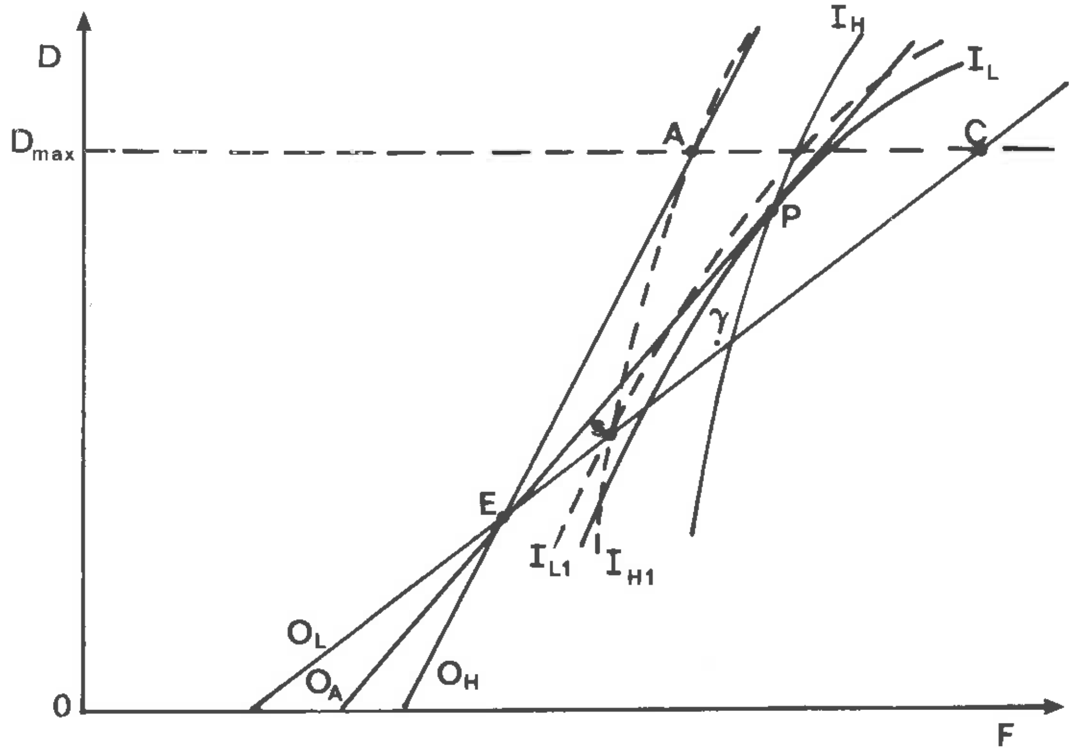

Figure 3.7: Non-Existence of Equilibrium

It is easy to visualise this proposition with the help of Figure 3.7 above. Suppose that P is a pooling equilibrium. Since P lies on the O_A line, the offering bank makes on average zero expected profit. At this point, the slope of the high-risk indifference curve, I_H, is steeper than the low-risk indifference curve, I_L. Thus there is a contract - for instance γ - in the neighbourhood of P which low-risk entrepreneurs prefer to P. Obviously, the high-risk group prefer P to γ. Since the contract γ attracts the less risky group, it earns the offering bank a positive expected profit. The existence of γ contradicts the definition of the equilibrium. Hence, the pooling contract P cannot be an equilibrium. And at all events, a pooling equilibrium contract at any point along the offer curve O_A is impossible because the indifference curve of the high-risk group is steeper than that of the low-risk one at any contract (F,D). As a result of this, a contract such as γ will always exist.[12]

The following proposition, which is really a corollary of Proposition 3.2, may now be advanced.

Proposition 3.3: If an equilibrium exists, then it must be established through a pair of separating contracts.

Consider Figure 3.8. As shown previously, the contract on the O_H most preferred by category H entrepreneurs is at A, which must be part of an equilibrium. On the O_L line the most preferred contract by the L category is at C. However, the pair of contracts A and C cannot be a separating equilibrium because of the nature of incomplete information which makes banks unable to distinguish the characteristics of entrepreneurs. Notice that contract C would attract both high- and low-risk groups and so banks would make negative expected profit. Then an equilibrium contract for the L category must lie on the I_{H1} locus. It is clear that on this curve, of contracts A and S, the one most preferred by the low-risk entrepreneurs is at S. Hence, the pair (A,S) - being dominant in the set of all contracts on offer - is the only possible equilibrium in the market.

and Webb 1990, and implicitly in Bester 1985). However, in contrast with this result, the following proposition is advanced.

Proposition 3.6: Assume $\alpha = \bar{\alpha} > \varphi$ and $\mu_i = \bar{\mu}$ for all i. Then at the competitive separating equilibrium investment is below its respective socially efficient level.

As mentioned before, social efficiency relative to investment requires that projects must be financed if their expected gross return is at least as high as the safe return. In the present case, all projects must satisfy (3.16) with equality. It will be seen below that this condition is not satisfied in equilibrium. For the proof of Proposition 3.6 a large number of entrepreneurial categories is introduced in the model. The distinctive feature of this case is that projects not satisfying condition (3.5) will not be executed. Consider then a countable infinity of entrepreneurs' categories indexed by the non-negative integers, i.e. i = 1, 2, ..., M, ..., N. Let M be the marginal group of entrepreneurs if there is private information, that is, M is the group of projects with the highest success probability among all the projects which are undertaken; and let N be the marginal group under perfect information, in other words, N denotes those projects with the highest success probability among all the projects in the market. Of course, because of (3.1), with no private information all projects deserve financial support. Consider the marginal projects of category N. The bank's expected gross return in each of these projects is:

$$(3.26) \qquad p_N[D_N + (1-\bar{\alpha})(R_N^s - D_N)] + (1-p_N)R^f.$$

Manipulation of (3.26) leads to:

$$(3.27) \qquad p_N R_N^s + (1-p_N)R^f - \alpha p_N(R_N^s - D_N).$$

The zero expected net return condition for the bank implies:

$$(3.28) \qquad p_N R_N^s + (1-p_N)R^f = (1+\rho)F_N + \alpha p_N(R_N^s - D_N)$$

where $\alpha p_N(R_N^s-D_N) > 0$. The first-best solution requires:

$$(3.29) \qquad p_N R_N^s + (1-p_N)R^f = (1+\rho)K.$$

Substitution in (3.28) yields:

$$(3.30) \qquad (1+\rho)K - (1+\rho)W_0 = (1+\rho)F_N + \alpha p_N(R_N^s - D_N) - (1+\rho)W_0$$

where by assumption $F_N \geq (K-W_0)$. But if $F_N = (K-W_0)$, then the following must hold:

$$(3.31) \qquad p_N W_N^s + (1-p_N)W^f = \alpha p_N(R_N^s - D_N) > (1+\rho)W_0$$

or else risk-averse marginal entrepreneurs will not undertake their projects, since a gamble is only indifferent to a certain outcome if it has a mean above this outcome. Then from (3.30) $F_N < K-W_0$ which cannot be. Thus, with complete information there is an F_N such that $F_N > K-W_0$ and $\mu = (1+\rho)K$.

Now with private information, the zero expected profit condition for the bank in a marginal project M implies:

$$(3.32) \qquad \mu = (1+\rho)F_M + \alpha p_M(R_M^s - D_M) \geq (1+\rho)K - (1+\rho)W_0 + \alpha p_M(R_M^s - D_M).$$

If $F_M = K - W_0$, then $\alpha p_M(R_M^s - D_M) > (1+\rho)W_0$ and, hence, in marginal projects $\mu > (1+\rho)K$. If $F_M > K - W_0$ and $\alpha p_M(R_M^s - D_M) \geq (1+\rho)W_0$, then again in the type M projects $\mu > (1+\rho)K$. Suppose now that $F_M > K - W_0$ and $\alpha p_M(R_M - D_M) < (1+\rho)W_0$. Notice first that $\alpha p_M(R_M^s - D_M) > \alpha p_N(R_N - D_N)$ since $p_M < p_N$. Then from (3.28) and (3.32) it follows that $F_M < F_N$ (e.g. compare the equilibrium in Figure 3.6 with that of Figure 3.8). But this condition implies that the equilibrium value of ρ with incomplete information is necessarily lower than that with perfect information. Thus, (3.28), (3.29) and (3.32) imply that in the category M projects $\mu > (1+\rho)K$. Since with asymmetric information the expected return of the marginal projects is greater than their social cost, it follows that the separating equilibrium is characterised by too little investment.

The class of market here considered exhibits in equilibrium another efficiency problem. As in the Rothschild and Stiglitz model, there is a negative externality of high-risk categories on low-risk categories. The externality is purely dissipative, i.e. utilities in social terms are wasted. Comparing with the solution of perfect information, low-risk categories are worse off but high-risk categories are no better off. It is worth mentioning that this type of externality - which is due to the nature of asymmetric information - is the main cause of inefficiency that arises in the quantity of aggregate investment. In reality, the presence of high-risk entrepreneurs in the market induces low-risk entrepreneurs to demand lower amount of debt than they would if information were perfect. Since for each category a lower debt involves a lower value paid by banks in exchange for bonds (e.g. see Figure 3.8), the categories of projects with the highest success probabilities become unprofitable from the point of view of entrepreneurs and hence are not executed. Consequently, in equilibrium the quantity of aggregate investment falls short of the first-best level. Note that this result does not accord with the prediction of de Meza and Webb's (1990) model that separating equilibrium involves the first-best outcome in aggregate investment, despite the existence of negative externalities.

The negative effects of high-risk entrepreneurs on low-risk ones also produce an inefficient risk sharing. If the level of risk borne by individuals in their projects under perfect information is considered optimal, then low-risk entrepreneurs bear too much risk with private information. The process of risk shifting from bankers to entrepreneurs, in the present case, is effected through the quantity of demand for debt. Along the offer curves, the higher the value of debt is the higher the risk borne by the bank in projects will be. Figure 3.8 may be used to illustrate this mechanism of risk transfer. When a project is carried out, the portfolio of assets of the entrepreneur is composed of an amount of deposit and his share α in the project. The value of deposit is F_i+W_0-K and the value of endowment invested in the project is $W_0-(F_i+W_0-K) = K-F_i$. Let F_{LC} be the value paid to a low-risk entrepreneur in equilibrium if there is complete information; and let F_{LS} be the value of F_L in equilibrium with incomplete information. In Figure 3.8, points C and S define these values, respectively. Thus, with complete information $W_0 = (F_{LC}+W_0-K) + (K-F_{LC})$ and with incomplete information $W_0 = (F_{LS}+W_0-K) + (K-F_{LS})$. However, it is clear that $F_{LC}+W_0-K > F_{LS}+W_0-K$ and $K-F_{LC} < K-F_{LS}$ since, as shown before, $F_{LC} > F_{LS}$. These relationships reflect that with private information low-risk entrepreneurs will deposit less and invest more in projects of their initial endowment W_0 than they would with complete information. Hence, low-risk entrepreneurs bear too much risk in equilibrium with private information. And note that the risk shifting to low-risk individuals is a result of the lower quantity of demand for debt as F_L increases with D_L along the contract curve O_L.[15]

The under-investment result suggests that an efficiency improving policy could aim at encouraging more investment which could be achieved by a subsidy on bank financing. It does appear, however, that such a policy must be second-best since it would not dispose of negative externality on low-risk individuals. Implementation of policies leading to reduction of asymmetric information in the market does seem very promising. But social benefits arising from such policies must be compared with social costs. This type of analysis is, however, beyond the scope of the present partial equilibrium one.

A basic message of the present section is that real economic decisions are not independent of financial structure. Against the conclusions resulting from the Modigliani-Miller proposition, it has been shown that capital structure of firms does matter. Clearly, the relative value of outside equity in the capital structure of firms produces a real difference in the level of aggregate investment in equilibrium.

Finally, as in Harris and Raviv (1990) and Ross (1977), the model of this section predicts a positive correlation between leverage and default probability, as shown in Figure 3.8. Firms with less risky returns will have lower debt levels. Signalling produces welfare costs by inducing low-risk entrepreneurs to take lower debt positions in their firms than they would if information could be directly transmitted.

3.6. Conclusions

A shortcoming of previous studies on financial markets under asymmetric information - exceptions being Leland and Pyle (1977) and de Meza and Webb (1990) - is that financial arrangements either take the form of debt or equity. Contrary to this view, the literature on capital structure of modern corporations (e.g. Jensen and Meckling, 1976, and O. Williamson, 1988) considers that there may be an optimal combination of debt and outside equity in the capital structure of firms. Thus, the present study has developed a model of financial market in which dequity is the financial arrangement between financiers and entrepreneurs. If the proportion of inside equity is relatively large, an equilibrium - if it exists - is unique and entails separating contracts. Equilibrium credit rationing is not viable. A novel result is that separating equilibrium involves too little investment. A subsidy on bank financing could therefore be Pareto-improving. However, because of negative externalities due to the presence of high-risk individuals, it seems that the best a policymaker could hope for would be to achieve a second-best allocation.

In the model of second-order stochastic dominance, letting all the terms of contract vary, but without any consideration of moral hazard problems, in the unique pooling equilibrium the capital structure of firms is entirely absorbed by the outside financiers and the first-best solution is achieved. Adverse incentive effects may, however, prevent the achievement of social efficiency.

If projects' returns are ranked by the first-order stochastic dominance, the de Meza and Webb (1990) model is obtained and hence the over-investment result may follow, in which case a 'true profit tax' almost equal to 100% with full loss offset would be the appropriate policy.

The analysis was restricted to only two entrepreneurial categories. It may be shown, however, that the propositions derived are perfectly valid in the case of a continuum of entrepreneurial types. The only qualification is that projects not satisfying Definition 3.1 would not be carried out. The boundary line below which projects are not financed would thus be derived endogenously.

Various extensions of the present analysis are possible. A natural extension would be to consider the multi-period analogue of the model, i.e. allow entrepreneurs to invest more than once and to keep continuing relationships with intermediaries. The purpose of doing this is to see if long-term financier-entrepreneur relationships would eliminate or reduce the welfare costs. Another direction of research could be to incorporate the present analysis in a general equilibrium framework which would undoubtedly offer a stronger theoretical foundation for welfare policies. However, the next chapter will proceed with an empirical examination rather than further theoretical work. The aim is to examine firms' outcomes to see whether it is possible to argue that they are better characterized by the first-order stochastic dominance rule, or by the mean preserving spread criterion, or by a mixed case.

3.7. Notes

1. Many economists have, as underlined in Chapter 1, studied the effects of asymmetric information in capital markets. The present study is particularly influenced by the works of de Meza and Webb (1987, 1988, 1990), Leland and Pyle (1977) and Stiglitz and Weiss (1981).

2. For a survey of the literature on capital structure of modern corporations, see Harris and Raviv (1991).

3. An interesting rationale for an optimal level of outside equity in the capital structure of firms is provided by Jensen and Meckling (1976, pp. 349-350).

4. The model is similar to that used by de Meza and Webb (1990). A significant distinction is that in their case investment projects differ in ability, whilst in the present case they differ in risk, as in Stiglitz and Weiss (1981).

5. The terms entrepreneur and project are used interchangeably.

6. For a given contract note that $W_i^f = W^f$, for all i, since $R_i^f = R^f$.

7. Utilities are assumed not to be state-dependent.

8. Figures 1, 2 and 3 are taken from de Meza and Webb (1990).

9. As the terms indicate, a pooling contract implies that all entrepreneurs choose the same contract, whereas separating contracts involve each category of individuals buying a different contract. In the literature of asymmetric information, separating contracts are often identified with signalling contracts (e.g. see Boadway and Bruce, 1984).

10. This assumption makes sense because projects involve risk. With this condition, in bankruptcy states the bank collects an amount which falls short of the value needed to compensate for the total cost of outside finance required in a project.

11. Historical examples justifying the model of this section can also be advanced. For instance, in the past, in certain countries such as Germany and Japan, large banks played an important role in the provision of not only loan finance but also of equity finance to firms for the purpose of industrial expansion. In this context, it is interesting to quote Hellwig: 'During certain periods, especially prior to 1873, German companies obtained substantial amounts of equity finance. However, the shares [were] held by banks or by clients [...] acting on the banks' advice, so in many respects, banks were as much involved in equity finance as in loan finance. While share markets [in Germany] were organized, they were certainly not anonymous and free for all as the theoretical models would have it.' (1990, p. 41).

12. Since $F > K-W_0$, $\varphi R^f+(1-\varphi)\mu > (1+\rho)(K-W_0)$ and so there is an interval of value of $\hat{\alpha}$ near φ such that γ will exist at any such $\hat{\alpha}$. But if $\hat{\alpha}$ is close enough

to 1, $\alpha R^f+(1-\alpha)\mu < (1+\rho)(K-W_0)$ and γ may not exist.

13. It is worth mentioning that a sufficient condition for the domination of contract P over contracts (A,S) is that the low-risk category must prefer P to S. Indeed, it is possible to have another different configuration of curves such that the high-risk entrepreneurs prefer A to P but the less risky ones prefer P to S. However, it could easily be shown that in this case Proposition 3.3 is still valid.

14. Since it has been assumed that $\alpha > \varphi$, riskier projects will always yield a lower expected profit for risk-neutral banks. However, riskier projects will only produce higher expected utility gains for entrepreneurs if the high- and low-risk reservation indifference curves do not intersect in the feasible region of (F,D) space.

15. Throughout the analysis it has been assumed that $W_0 < K$. However, the relaxation of this assumption may not change the results of the model, since the demand for outside finance (debt plus outside equity) implies risk sharing. Suppose that $W_0 \geq K$. If both categories of projects are executed and no outside finance is demanded, then each entrepreneur will deposit W_0-K and the value of endowment invested in each project will be K. But again, if outside finance is demanded, then the entrepreneur will deposit the amount F_i+W_0-K and will invest in his project the value $K-F_i$. Clearly, $F_i+W_0-K > W_0-K$ and $K-F_i < K$. Hence, risk-averse entrepreneurs may consider it beneficial to devolve part of risk to banks through the demand for outside finance.

CHAPTER 4

INTRA-INDUSTRY RATES OF RETURN AND RISK DIFFERENCES IN UK MANUFACTURING 1980-1989

4.1. Introduction

The preceding chapters have discussed and further developed theoretical studies on credit markets in which the selection of investment projects is based on stochastic dominance rules. It has been shown that the nature of this selection mechanism has significant macroeconomic implications. In theoretical models of credit with ex ante asymmetric information, (i) if the probability distributions of firms' returns differ in the sense of mean-preserving spread[1] (Stiglitz and Weiss 1981, and the preceding chapter), the market equilibrium is consistent with sub-optimal resource allocation and under-investment relative to the first-best level; (ii) if firms' returns have common variance but are ranked by first-order stochastic dominance (de Meza and Webb 1987, 1990), the market equilibrium exhibits over-investment; and (iii) if firms differ from one another in terms of both the means and variances of the distributions from which firm returns are drawn (as in Chapter 2), the aggregate investment may be above or below its first-best level.

Most often, in empirical economic research the non-relevance principle about the assumptions of models promoted by Friedman (1953) has been considered a rule. Arguably, however, a theory must be 'tested not by a selected set of its predictions, but by all of its predictions. Among the testable parts of a theory are those assumptions which are themselves directly testable [...]. We count it a virtue, not a vice, if the assumptions of the model are themselves plausible; if the micro-foundations underlying the theory are themselves testable - and tested.' (Stiglitz 1992, p.276). Accordingly, this chapter endeavours to remedy the existing imbalance by testing the validity of the assumptions relative to the *order* of stochastic dominance in the above mentioned models as well as to contribute to the existing body of empirical evidence on the random distributions of rates of return associated with industrial corporations in the United Kingdom. Thus, the aim of the present study is to expose the significance of statistical differences in mean rates of return and in risks associated with companies in each of the industries selected through the use of the analysis of variance (ANOVA) technique complemented with a test based on distribution-free theory. Whenever the requirements for the application of these techniques were not satisfied, the multiple pairwise comparison method of mean rates of return (by establishing a joint confidence interval) was applied.

Empirical evidence as to whether the rate of return on investment and other financial ratios are normally distributed is mixed . From a statistical standpoint, however, this is not a particularly relevant question. In fact, numerous non-parametric statistical techniques are available in the event that financial ratios are conclusively determined to be non-normally distributed. Moreover, the assumption of normality can be relaxed a little since the conclusions drawn in the analysis of variance are still approximately true for reasonable departures from normality. Hence, the statistical tests chosen in this study are particularly appropriate for dealing with differences in mean-returns and risks.

The plan for the remaining part of the chapter is as follows. Section 4.2 offers an overview of the existing empirical literature on the distribution of financial ratios. Section 4.3 addresses the research method and the principle governing the selection of data. Section 4.4 comprises a discussion of the empirical results related to the statistical significance of the differences of mean-returns and risks across companies. Section 4.5 forms the conclusion.

4.2. Existing Empirical Evidence on the Distribution of Financial Ratios

The return on total assets constitutes the random variable in the empirical analysis which was developed and is presented in the following sections. It is a financial ratio and measures the effectiveness with which a firm has employed its total resources. Its mathematical form is EBIT/Total Assets, where EBIT denotes earnings before interest and tax. The rationale for the choice of this ratio is provided in the next section.

Choices of appropriate statistical tests which are used for the analysis of a random variable (such as a ratio) depend on the theoretical distribution which best approximates the underlying distribution of that variable. It is well-understood that continuous random variables may assume any of a number of distributional forms: e.g. the rectangular, the gamma, the chi-square, and the normal. Nonetheless, the normal distribution is the most widely used by researchers. Keller, Warrack and Bartel argue that 'this distribution provides a useful approximation to many other distributions, including discrete ones such as the binomial distribution. [Moreover] the normal distribution is the cornerstone distribution of statistical inference, representing the distribution of the possible estimates of a population parameter that may arise from different samples.' (1990. p. 183). It is therefore hardly surprising that in general researchers tend to disregard the possibility of non-normality in their analysis of the distribution of financial ratios.

There are a number of empirical studies which examine the distribution of financial ratios in various countries. Table 4.1 - which is taken from Ezzamel and Mar-Molinero (1990) - contains a summary of those studies.[2] The table clearly

Table 4.1: Summary of the Distributional Evidence of Financial Ratios

Study	No.of Ratios	Period Covered	Sample Size	Null Hypoth.: Distrib. is Normal
Horrigan (1965), USA	17	1948-57	50	Not rejected
O'Conner (1973), USA	10	1950-66	127	Not rejected
Bird & McHugh (1977), Australia	5	1967,69,71	68	Mixed
Deakin (1976), USA	11	1955-73	454-1114	Rejected
Bougen & Drury (1980), UK	7	1975	700	Rejected
Frecka & Hopwood (1983), USA	11	1950-79	346-1243	Rejected
McDonald & Morris (1984;1985), USA	4	1979	239	Mixed
Lee (1985), USA	5	1961,65,70, 75 & 80	348-606	Mixed
Buijink & Jegers (1986), Belgium	11	1977-81	Varied	Mixed
McLeay (1986a,b), UK & Ireland	3	1981/82	1634	Rejected
Ezzamel, Mar-Molinero and Beecher (1987), UK	5	1980/81	131	Mixed
So (1987), USA	11	1970-79	490	Mixed
Karels & Prakash (1987), USA	50	1972-76	50	Rejected

indicates that the results of the statistical tests of normality with regard to financial ratios are mixed. Two main conclusions follow from these works: (i) positive skewness is frequent in ratios; and (ii) non-normal distributions of ratios exhibit extreme outliers. In general, two methods for dealing with these problems have been considered. The first method advocates the transformation of the raw data and the deletion of outliers to improve approximation to normality (e.g. Bougen and Drury 1980; Deakin 1976; Bird and McHugh 1976; O'Conner 1973; and Frecka and Hopwood 1983). The second method determines theoretical distributions which provide a better fit for non-normally distributed ratios without having to transform or trim raw data (Buckmaster and Saniga 1984; and McLeay 1986a and 1986b).

Both methods have advantages and limitations. The first approach allows the user to choose among the various statistical tests derived from normal distributions. Barnes, however, argues that 'the usual transformation methods such as square roots or natural logarithms as suggested by Deakin (1976) merely confuse the data further. Transformation in fact may change the interrelationships among the variables and may also affect the relative positions of the observations of the group.' (1982, p. 57). The second approach sidesteps these problems by maintaining data in their original form. But 'different distributional forms are fitted to different classes of ratio and, hence, it is not strictly clear which statistical tests should be employed when ratios belonging to several classes are being simultaneously examined' (Ezzamel and Mar-Molinero 1990, pp. 2-3).

From a statistical viewpoint, the issue of normality is not a particularly important question, since there are numerous non-parametric statistical techniques which are available in the event that financial ratios are conclusively determined to be non-normally distributed. The only problem with a non-parametric test is the probability of a Type II error associated with it. When the conditions for a parametric test to be performed are satisfied, the probability of a Type II error is smaller for this type of test than for a non-parametric test. This is so because the ranks assigned to observations in a sample entail the loss of information about their actual values. It is clear that 'whenever we are restricted to using less information than the full amount available, our decision (in general) becomes less authoritative' (Keller, Warrack and Bartel 1990, p.625). Since the probability of a Type I error is fixed at some value α, the poorer decision is reflected by a higher probability of a Type II error. Consequently, when a parametric technique can be used, it should be, so as to reduce the probability of incorrectly accepting a false hypothesis. In particular, for the comparison of the mean-values of several populations, an alternative and also a complement to some specific non-parametric models is the usual analysis of variance technique, whose statistical-test conclusions are robust to reasonable departures from normality (Green and Margerison 1978).

To complete the discussion on this point it is worth mentioning Ezzamel and Mar-Molinero (1990)'s conclusion that for the UK companies in the case of ratio EBIT/Total Assets in most instances normality was not rejected for the complete original data, when individual groups were examined.[3] Moreover, Horrigan (1983) mentions the study by Ricketts and Stover (1978), which concentrated on a single industry and could not reject the null hypothesis of normality for financial ratios. These results, in particular the former one, are encouraging for some of the statistical models presented in the following sections.

The statistical definition of risk is also a point at issue in the present study. Among the many definitions of risk in the economic literature, a useful one is that considered by Fisher and Hall (1969) who consider the concept of risk differentials in corporate earnings and propose a model for measuring them for the USA large companies. Risk is defined 'as the inability to predict the outcome of a forthcoming event with complete certainty. [Thus] entrepreneurs are viewed as making decisions in the face of uncertainty on the basis of probabilistic expectations about future outcomes. If certainty is a situation where the entrepreneur's anticipation will assuredly be fulfilled, then uncertainty can be measured by the likelihood that the actual outcome will differ from the anticipated outcome.' (Fisher and Hall 1969, p. 80).

The foregoing definition involves studying risk by examining distributions of corporate rates of return. Specifically, this approach suggests - as will be elaborated in the next section - that it can be analyzed statistically in terms of the second moment of the distribution. Thus, risk is here defined broadly and not in the more restrictive sense of Rothschild and Stiglitz (1970).

4.3. Research Method

This section is devoted to the specification of concepts and hypotheses' tests, the discussion of statistical techniques and samples selected for the empirical analyses referred to in Section 4.1.

4.3.1. Concepts and Tests of Hypotheses

In this study, the accounting earnings before interest and tax are the proxy for the returns of firms as defined in Stiglitz and Weiss (1981) and de Meza and Webb (1987).[4] To adjust for differences in firm size, earnings are expressed as a percentage of total assets, as in Winn (1977) and many other studies. Ratios in empirical analysis are commonly used as a method of reducing variables to similar scale.[5] This method is particularly suitable for the comparison of firms of different sizes. For instance, Whittington argues that 'the denominator [in a ratio] acts as a size deflator, to remove the effects of scale from the comparison' (1980, p.226). However, it must be acknowledged that 'an additional *real* size effect may still be present even after regular accounting data are converted into financial ratios. Large firms, for example, may exhibit relatively higher liquidity levels [...] than small firms. In this type of situation, size itself might be a variable of interest. Financial ratios cannot be expected to control real size effects, and it would seem pointless to adjust them further for that purpose.' (Horrigan 1983, p.684).

To test the significance of the expected rate of return differences and the risk differences among companies, it is necessary to translate the theoretical definition of expected rate of return and risk into statistical and workable terms. This can be done by assuming that entrepreneurs' anticipations, on average, are correct, thereby permitting the observed mean rate of return in a time-period to be used as a proxy for the expected rate of return. Risk exposure, as defined in theoretical models, can be measured by the second moment of the distribution of earnings. That is, the expected rate of return is measured by:

$$(4.1) \qquad r^*_i = (\sum_{t=1}^{n_i} r_{it})/n_i$$

and the risk is measured by:

$$(4.2) \qquad s^2_i = [\sum_{t=1}^{n_i}(r_{it}-r^*_i)^2]/(n_i-1)$$

where r_{it} is the observed rate of return for firm i in year t; r^*_i the (estimated) average rate of return on total assets for firm i; s^2_i the (estimated) variance of rates of return about mean for firm i; and n_i the number of years included in the ith sample.

The aforementioned issue of the significance of expected rate of return differentials and risk differentials entails the following sets of null and alternative hypotheses:

(i) H_0: There is no difference between the variances of firms' rates of return;

H_1: not H_0, i.e. the variances of firms' rates of return are not all equal.

(ii) H_0: There is no difference between the mean rates of return of firms;

H_1: not H_0, i.e. at least two of the means are not equal.

The assumptions of the theoretical models dealt with in the preceding chapters are condensed in these hypotheses' tests. Note that the combination of H_0 in (i) and H_1 in (ii) forms part of the assumptions established in de Meza and Webb (1987, 1990); the combination of H_1 in (i) and H_0 in (ii) is associated with part of the assumptions in Stiglitz and Weiss (1981); and the combination of H_1 in (i) and H_1 in (ii) is consistent with part of the assumptions in the model of Chapter 2.

4.3.2. Statistical Techniques

To begin with, randomness of the time series of rates of return for any firm samples is a required condition for the statistical tests here performed. In this study, the non-parametric runs test was employed to detect departures in randomness of sequences of quantitative measurements over time, caused by trends or periodicities. In a sample of observations, by replacing each measurement in the order in which they are collected with a *plus* symbol if it falls above the mean value, with a *minus* symbol if it falls below the mean value, and omitting all measurements that are exactly equal to the mean value, a sequence of runs (i.e. subsequences of identical symbols) is generated. The total number of runs appearing in an arrangement of this kind is a good indication of a possible lack of randomness. If there are too few runs, a definite grouping or clustering, or perhaps a trend may be suspected; if there are too many runs, some sort of repeated alternating pattern may be suspected. The test of the null hypothesis of randomness and the appropriate table for critical values are provided in several textbooks on statistics (e.g. Freund and Walpole 1987, and Mood and Graybill 1963). Through the use of this method, the non-random time-series of rate of return on investment associated with some firms were identified. These non-random time-series were eliminated from the samples rather than adjusted.

For the statistical analyses of the hypotheses described in Subsection 4.3.1, the following methods were used: the analysis of variance technique, the Levene's S test, the non-parametric Kruskal-Wallis test and the multiple pairwise comparison method of mean rates of return. One of the required conditions for the validity of these statistics is that the random samples (for the different firms considered here) drawn from a population must be independent. Throughout the analysis this condition was taken as an assumption.[6] Despite the possibility of similar industry effects on companies, it seems reasonable to assume that the random samples (time-series) of rates of return are independent since there are a number of characteristics - such as capital structure, technology, managerial ability and investment policy - which differ across the companies.

The null hypothesis tested by the analysis of variance technique is that the population means are equal. Correspondingly, the alternative hypothesis is that the population means are not equal. Basically, what this technique does is to compare two different estimates of the variance of the observations, using an F test. One estimator is based upon the variation between the means of the data corresponding to a number of different samples, the other is based upon the variation within samples about the sample means. The mathematical expression of the test statistic is:

$$(4.3) \qquad F = MSTr/MSE = [(1/k-1).\sum_{i=1}^{k} n_i(r^*_i - R^*)^2] \;/\; [(1/n-k).\sum_{i=1}^{k}\sum_{t=1}^{n_i}(r_{it} - r^*_i)^2]$$

where MSTr is the mean square for treatments;[7] MSE the mean square for error; k the number of samples; $n = n_1 + n_2 + ... + n_k$; n_i the size of the ith sample; r_{it} and independent because each value is derived using the same sample mean. However, it could be shown that 'this departure from the proper conditions for one-way analysis of variance causes only a very small disturbance unless the number of observations in the various sets is very small.' (Green and Margerison 1978, p. 169).

The normality condition has often been referred to. Despite the relative robustness of ANOVA to the violation of this condition, if non-normality in the distribution of observed values is *too pronounced*, the conclusions derived from the F-test may be invalid. When this is the case, the non-parametric Kruskal-Wallis H test for the completely randomized design is an adequate method to follow. Here the problem objective is to test whether the population distributions are identical. This means that the Kruskal-Wallis statistic not only tests for identical means (more precisely, locations) but for identical spreads (dispersions) and shapes as well. Unfortunately, by implication the rejection of the null hypothesis may not necessarily signify that there are differences in population means. The rejection of H_0 may be due instead to differences in distribution shapes and/or spreads. To circumvent this difficulty, it may be assumed that probability distributions are identical except with respect to means, which then become the sole focus of the analysis.

To perform the Kruskal-Wallis H test, the data of independent samples are ranked *jointly* from low to high, as though they constituted one sample. Then, letting T_i be the sum of the ranks of the values of the ith sample, the test is based on the statistic:

$$(4.6) \qquad H = \{[12/n(n+1)].\sum_{i=1}^{k}(T_i^2/n_i)\} - 3(n+1)$$

where n, n_i and k remain as specified previously. Since the H statistic is proportional to a weighted mean of the squared differences $[T_i/n_i - (n+1)/2]^2$, where T_i/n_i is the mean rank of the values of the ith sample and (n+1)/2 is the mean rank of all the data, it follows that the null hypothesis must be rejected for large values of H. For $n_i \geq 5$, the sampling distribution of H can be approximated closely to a chi-square distribution with k-1 degrees of freedom.[9]

Thus far the arguments have been conducted in support of the ANOVA and Kruskal-Wallis tests. From the foregoing discussion, however, it clearly emerges that when the variances are found to be significantly different, those tests are not the most appropriate ones for testing the homogeneity of population means. To overcome this problem, a series of separate two-sided t-tests on combinations of pairs of population means may be performed to determine which ones are significantly different. It is obvious that any significant pairwise difference implies overall significance, i.e. rejection of overall H_0. But it can readily be seen that with k(k-1)/2 (total number of combinations) pairwise t-tests applied separately each at level α, the probability of concluding overall significance, when in fact H_0 is true, can be well in excess of α and will be close to one for sufficiently large k. Thus, with multiple t-tests, spurious overall and detailed (pairwise) significant rejections are obtained more frequently than is indicated by the per-comparison level α. This essentially is the import of the multiplicity effect. One way to sidestep this problem is to use the significance level of the joint probability distribution of all pairwise differences to determine the right significance level for each pairwise t-test. It could be shown that if the sample distributions are independent and α is the significance level of the joint probability distribution, the significance level for each of t-tests on all combinations of pairs of population means must be equal to $1-(1-\alpha)^{1/m}$, where $m = k(k-1)/2$.[10] This result ensures that the overall significance level equals α. Thus, the rejection of any particular H_0 by the corresponding t-test with level $1-(1-\alpha)^{1/m}$ implies the rejection of overall H_0 with significance level α.[11]

The analytical form of the pairwise t-test which was employed is:

$$(4.7) \qquad t = [(r^*_i - r^*_j) - (\mu_i - \mu_j)] \;/\; [(s_i^2/n_i) + (s_j^2/n_j)]^{1/2}$$

where μ_i and μ_j are the means of the ith and jth populations, respectively; the other variables are as defined before.[12] This statistic does not usually have a t-distribution when the populations are non-normal. Nevertheless, probabilities given in the usual t-table are nearly correct if the populations are not far from normal or if the sample sizes are large. Thus, as the test in (4.3), the test in (4.7) is fairly robust with respect to the assumption of population normality.[13]

The statistical and regression analyses were performed using the computer package MINITAB.

4.3.3. Data

The study is based on 93 UK manufacturing companies of 4 industries (Contracting and Construction, Breweries, General Food Manufacturing, and Packaging and Paper) which were selected randomly and taken from the EXSTAT data base for the years 1980-89. To control for variations in the conditions of different industries, the empirical analyses were conducted separately by industry.

The samples, in the form of panel data, were restricted to only those companies with complete observations for ten years.[14] But no stratification by financial year end was employed, i.e. manufacturing companies were included in the samples irrespective of their financial year end. The arguments that may be advanced here are not straightforward. For instance, it can be argued that by including companies with differing financial year ends the samples become less homogeneous. In contrast, it can also be argued that restricting the samples to companies with the same year end would be selective since such companies may share some characteristics that differ from those companies with different financial year ends. Both approaches have been used in the literature, e.g. Gonedes (1973) ignored differences in financial year ends whereas Brown and Ball (1967) restricted their sample to firms with the same year end.

The annual Balance Sheets and the annual Profit and Loss Statements of companies reproduced in the EXSTAT data base supplied data on variables previously referred to, such as earnings before tax, total interests and total assets. From those observations, the expected rate of return for each firm was computed by taking the arithmetic average of each firm's annual rates of return over the period 1980-89. Computing moments about the mean, however, may overstate the firm's true risk exposure if its rates of return exhibit trend and/or are serially correlated. Applying the non-parametric runs test to each firm's time series indicated twenty seven firms with non-random samples. Rather than attempting to adjust for these temporal observations it was decided to remove these firms from the samples. The risk variable for each of the remaining 93 firms was then computed from the rates of return about the mean. Tables 4.2, 4.3, 4.4 and 4.5 below show the values of the mean rate of return and risk of firms grouped by industries.

The accounting data which were used are not immune to criticisms. The most obvious shortcoming of the accounting rate of return is that it may provide an inadequate measure for the internal (economic) rate of return (Benston 1985, Fisher and McGowan 1983, and Harcourt 1965).[15] From a practical point of view, however, it is not possible to correct this accounting bias, since individual firms cannot be tracked over their complete life-time up to the present in the published data (Schmalensee 1989). Moreover, even if it were possible, it is not at all clear what the relevance of a number that shows the performance of a company over a very prolonged period of time (e.g. hundred or more years) would be. Indeed, 'what we are interested in is the performance of a [company] this year, last year, during the 1970's etc. Those are not questions that an internal rate of return can answer and the comparisons that Harcourt, and Fisher and McGowan have made are therefore of little practical relevance.' (Mayer 1988, p.4).[16]

Another difficulty is related to the *nature* of the accounting data. The accounting conventions remain firmly embedded in historic cost principles and thus inflation-adjustments of firm's indicators are often required in order to correct the accounting measurement errors. However, Bhargava (1991) in a recent study on profitability of UK firms concludes that the estimates of the regression models, one using the inflation-adjusted value of the rate of return on capital and the other the unadjusted (book) value, are broadly similar. It therefore seems reasonable to suspect that the use of inflation-adjusted rates of return on investment would not alter the basic results of the present study.

Table 4.2: Mean Rate of Return and Risk in the Contracting and Construction Industry

Company/Issuer Code in EXSTAT	Mean Rate of Return (estimated)	Variance (estimated)
ARADU E	0.104042	0.0036725
BAADZ P	0.099177	0.0055913
BAAQE N	0.122053	0.0006833
BEABISN	0.109847	0.0009779
BEAFC 3	0.138367	0.0008635
BEAKW T	0.072786	0.0007281
BLAAU 8	0.076112	0.0020320
BOACR B	0.044371	0.0025213
BOACUSK	0.046722	0.0010994
BRAHB 1	0.060881	0.0027028
CAAAAOH	0.171121	0.0016151
COAZV J	0.107164	0.0005326
COBAO A	0.164461	0.0025054
COBBG T	0.097895	0.0002195
CRADD 2	0.141715	0.0004725
CRAGE*N	0.056602	0.0129637
DOAED H	0.046520	0.0005898
EAAAAOS	0.106996	0.0009711
GAACM 4	0.100405	0.0004232
HEAFPSF	0.117940	0.0030918
HOAIPMD	0.149121	0.0016962
LIABUMA	0.061824	0.0187569
MAAZB*V	0.087249	0.0008242
MAAZQIM	0.082809	0.0008572
MOAKK Y	0.091452	0.0002590
NAAASKD	0.037514	0.0169477

NEAHX X	0.058655	0.0003098
NOAFG L	0.062990	0.0023261
POAAA 1	0.084538	0.0009591
RAACL C	0.074449	0.0005695
TAAGX 4	0.074458	0.0000743
TUABL U	0.078521	0.0010667
VIAFF B	0.125366	0.0027426
WAAEI K	0.157117	0.0013428
WIAAU R	0.099371	0.0061687
Notes: Industrial Classification in EXSTAT - 18; Years - 1980-89; Firms with time trends were dropped.		

Table 4.3: Mean Rate of Return and Risk in the Brewery Industry

Company/Issuer Code in EXSTAT	Mean Rate of Return (estimated)	Variance (estimated)
ALAGQMX	0.102104	0.0001348
BAARX Z	0.108723	0.0001830
BUACA X	0.148294	0.0012921
DEAHR X	0.066990	0.0005651
ELAAV 3	0.071534	0.0004475
EVAAQ J	0.043505	0.0001960
GRABN 4	0.110254	0.0001074
GRAGMMC	0.080859	0.0000772
HAAGY 9	0.122285	0.0008210
HEAAU 7	0.066949	0.0000827
MAAUA K	0.105091	0.0002283
MEAFE 2	0.148074	0.0016598
MOAGM B	0.074221	0.0004055
SCAGI 3	0.101632	0.0000618
TAAGN**	0.153386	0.0004441

WHAAW W	0.087621	0.0001094
YOABG 9	0.052703	0.0002360
Notes: Industrial Classification in EXSTAT - 45; Years - 1980-89; Firms with time trend were dropped.		

Table 4.4: Mean Rate of Return and Risk in the General Food Manufacturing Industry

Company/Issuer Code in EXSTAT	Mean Rate of Return (estimated)	Variance (estimated)
ACAAAHZ	0.119768	0.0015278
ASACU 8	0.118591	0.0001986
BAAQA Z	0.122188	0.0004554
BAASAMI	0.064971	0.0008765
BEAHR M	0.104703	0.0001811
BIAAV*3	0.093280	0.0003376
BOAGDMQ	0.051857	0.0056091
BRAJOMJ	0.139747	0.0005485
CAACM J	0.076657	0.0026131
CAASRJY	0.088573	0.0002041
CLACPMU	0.098871	0.0001467
DEAAI*N	0.089366	0.0074494
FAAES*S	0.077114	0.0006586
FIAJN 2	0.109135	0.0009188
HAAKK*X	0.160046	0.0043826
HEABU 2	0.170879	0.0006429
HIACYMB	0.093520	0.0009446
LEACG O	0.105430	0.0008056
NIAAU X	0.283342	0.0010790
PRACP*Q	0.106424	0.0013279
TAAGF L	0.113676	0.0002261

TAAGQ P	0.056955	0.0007250
UNABI T	0.135379	0.0002878
UNADC 0	0.079392	0.0010184
URAAKT0	0.065339	0.0005419
WEABC 9	0.142623	0.0027941
WEAJD*5	0.113062	0.0002021
Notes: Industrial Classification in EXSTAT - 49; Years - 1980-89; Firms with time trends were dropped.		

Table 4.5: Mean Rate of Return and Risk in the Packaging and Paper Industry

Company/Issuer Code in EXSTAT	Mean Rate of Return (estimated)	Variance (estimated)
ASADY S	0.111885	0.0011984
BOAFPTI	0.102216	0.0005581
BUACN V	0.114311	0.0002143
CAABT*5	0.117950	0.0005212
CHABO F	0.065245	0.0014302
CRAEJ G	0.084681	0.0005959
DEADIM*	0.085451	0.0009188
FEACC 3	0.105598	0.0007884
LOAIQMW	0.103136	0.0005248
MAACVAR	0.066024	0.0017397
MAAEU 3	0.136973	0.0006776
POACA S	0.114026	0.0009358
SOADT 1	0.067033	0.0009358
WEADDMQ	0.071989	0.00020468
Notes: Industrial Classification in EXSTAT - 54; Years - 1980-89; Firms with time trends were dropped.		

4.4. Empirical Results

This section reports the empirical results of the statistical tests - discussed in Section 4.3 - on the significance of the mean rate of return differentials and risk differentials in the UK industries.

In the first place, initial data analysis was performed on the data sets in order to gain as much insight as possible into the distributional properties of the ratio examined here. Initial data analysis involved investigating the randomness of samples and the histograms of the ratio associated with firms and industries. As noted earlier, through the runs tests it was possible to select 93 firms (grouped in 4 industries) whose time series data exhibited random behaviour. Thus, in total, 97 histograms (total of companies and industries) were examined. In general, the histograms of the rate of return appeared to be approximately bell-shaped and fairly symmetric, particularly (as illustrated in Figures 4.1, 4.2, 4.3 and 4.4) for the large samples which aggregated the manufacturing companies in accordance with the industrial classification. These results are consistent with some of the previous studies (e.g. Ezzamel and Mar-Molinero 1990, and Ezzamel, Mar-Molinero and Beecher 1987). Such a configuration of histograms permitted the use of the tests mentioned before.

In the second stage of the analysis, the significance of the differences in the variances of firms' rates of return was tested. For each firm, the quantities y_{it} were obtained as defined in equation (4.5). The Levene's S test and the Kruskal-Wallis H test were subsequently employed on the values of y. The results are condensed in Table 4.6 - which is self-explanatory - for each industry. The observed F value

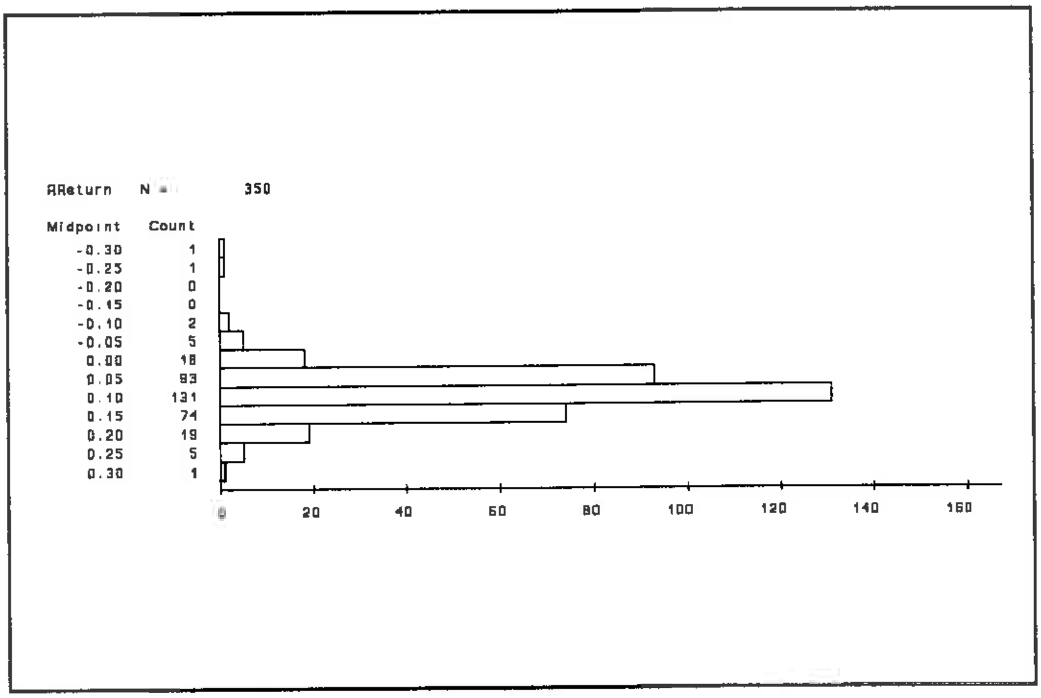

Figure 4.1: Distribution of Rates of Return in the Contracting and Construction Industry

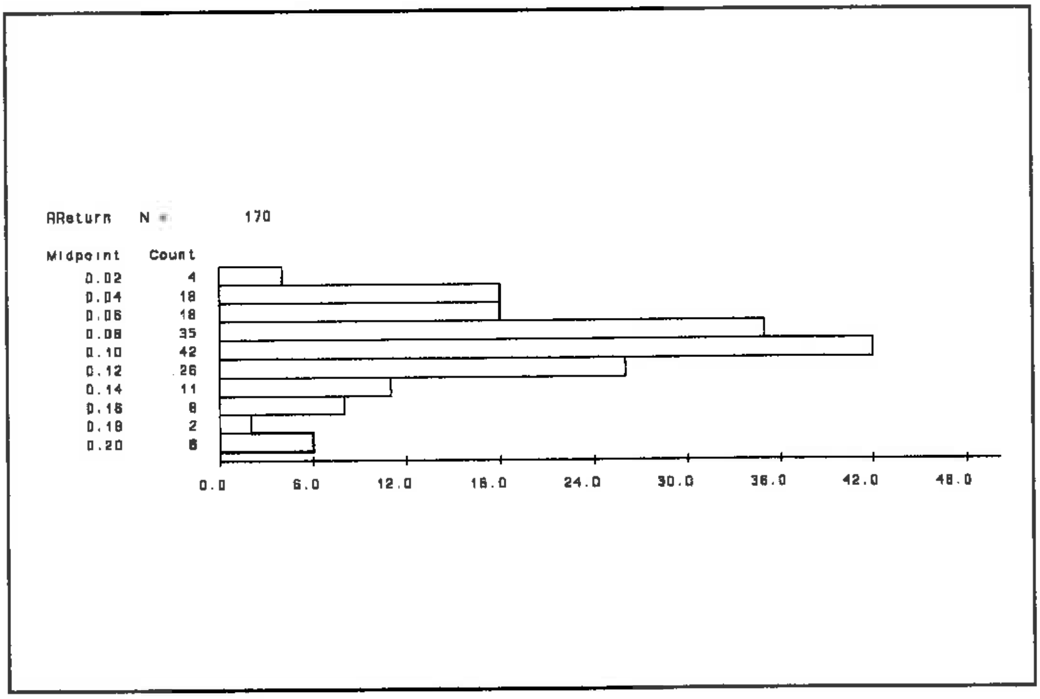

Figure 4.2: Distribution of Rates of Return in the Brewery Industry

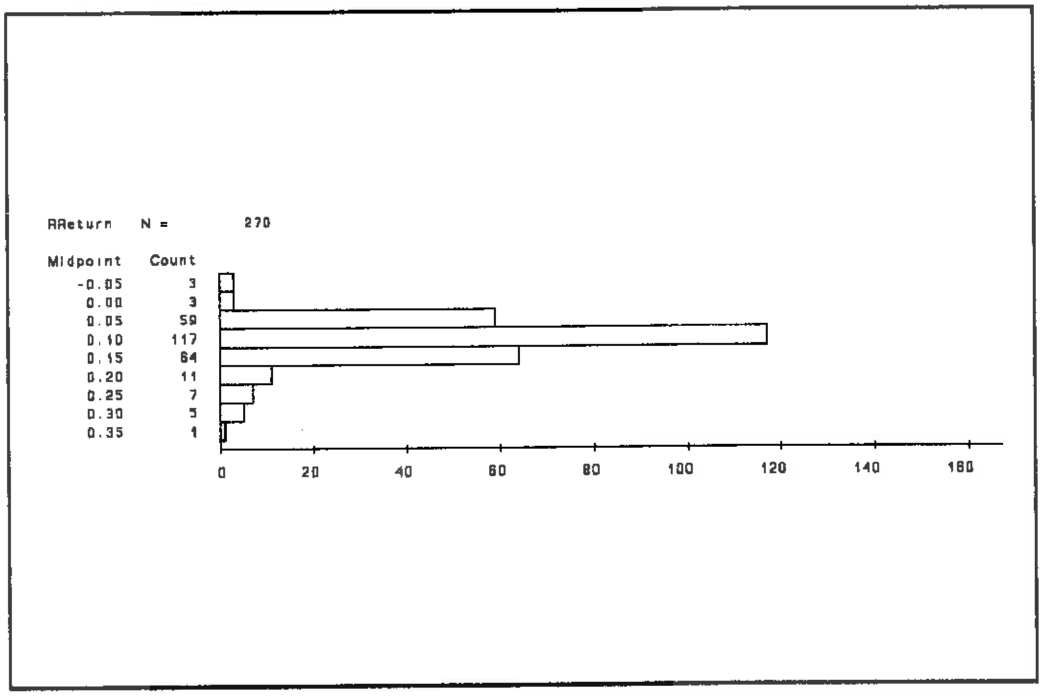

Figure 4.3: Distribution of Rates of Return in the General Food Manufacturing Industry

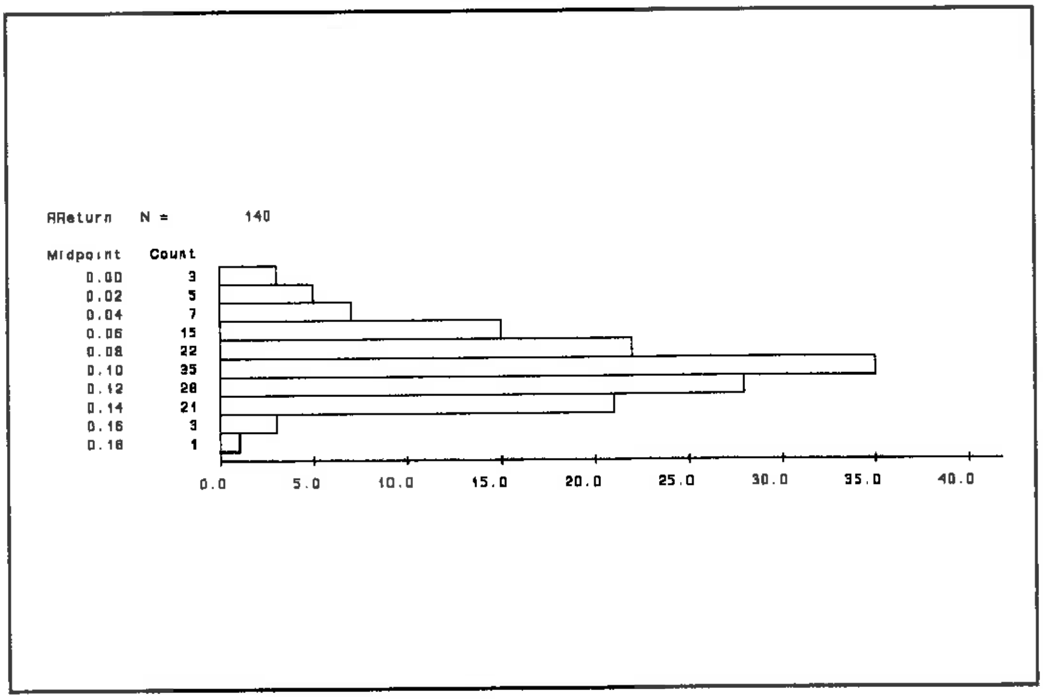

Figure 4.4: Distribution of Rates of return in the Packaging and Paper Industry

in the second column for the Packaging and Paper industry is not significant at the 0.01 and 0.05 significance levels, respectively. Moreover, the Kruskal-Wallis test clearly corroborates this result since the p-value of 0.208 is too high. In this case, it is safe to state that the variances of the firms' rates of return are likely to be homogeneous. But note that in all other three industries (Construction, Breweries

Table 4.6: Tests on the Significance of Risk Differences

Industry Group	Levene's S test on y's	Kruskal-Wallis H test on ranked y's
Contracting & Construction (35 companies)	$F = 1.66$ $v_1 = 34$, $v_2 = 315$ $F_{0.05} = 1.425$ $F_{0.01} = 1.65$	$H = 90.68$ d.f. = 34 p-value = 0
Breweries (17 companies)	$F = 2.81$ $v_1 = 16$, $v_2 = 153$ $F_{0.05} = 1.65$ $F_{0.01} = 2.008$	$H = 33.04$ d.f. = 16 p-value = 0.008
General Food Manufacturing (27 companies)	$F = 3.15$ $v_1 = 26$, $v_2 = 243$ $F_{0.05} = 1.50$ $F_{0.01} = 1.76$	$H = 70.33$ d.f. = 26 p-value = 0
Packaging & Paper (14 companies)	$F = 1.67$ $v_1 = 13$, $v_2 = 126$ $F_{0.05} = 1.72$ $F_{0.01} = 2.13$	$H = 16.87$ d.f. = 13 p-value = 0.208

Notes: The y values are defined as in equation (4.5); F and H are the observed values of the tests (4.3) and (4.6), respectively; d.f. denotes degree of freedom; v_1=k-1 and v_2=n-k; F_α is the F theoretical value at the α level of significance; and the p-value is the smallest value of α that would lead to rejection of the null hypothesis.

and Food Manufacturing) the observed values of F are significant at both 0.05 and 0.01 levels. And note also that in these cases the high values of H and low p-values (equal to zero or close to zero) in the third column reinforce the conclusion derived from the Levene's S test which rejects the null hypothesis of equal variances. Thus, in general the empirical evidence lends support to the idea that risk is more likely to vary significantly across companies in a particular industry.

The statistical methods for testing the significance of the mean rates of return differences among companies were chosen according to whether or not the variances of firms' rates of return were homogeneous. As mentioned before, for the cases where this condition (i.e. homogeneity) was not satisfied, a multiple pairwise comparison procedure was employed. Where this condition was met, the usual ANOVA and Kruskal-Wallis techniques were used. Table 4.7 illustrates the results of these statistical tests. In all cases, the evidence negates the hypothesis of identical mean rates of return across companies in a given industry. In the Packaging and Paper industry - where variances are homogeneous - the F value of 5.83 is highly significant since the p-value equals zero, i.e. at any level α the differences between several mean rates of return are clearly significant. This conclusion is reconfirmed by the Kruskal-Wallis test, where the value of H is 50.96 with p-value again equal to zero. In the other remaining industries - where variances are non-homogeneous - it was possible to find several pairwise t-tests exhibiting zero p-value. For instance, for the Contracting and Construction industry, 217 t-tests out of 595 possible combinations of pairs of mean rates of return were performed, with a 95% confidence interval for the joint probability distribution on all pairwise combinations. The appropriate significance level for each t-test was found to be $1-(0.95)^{1/595} = 0.000086$. Out of 217 t-tests performed, 10 t-tests with p-value of zero were determined, i.e. the null hypothesis of equal means had to be rejected. Similar results emerged in the other two industries, Breweries and General Food Manufacturing. Thus, the evidence clearly suggests that the expected rate of return varies significantly across companies in a given industry.

Table 4.7: Tests on the Significance of Mean Rate of Return Differences

Industry	ANOVA test	Kruskal-Wallis test	No. of pairwise t-tests performed	No. of pairwise t-tests with p-value = 0
Cont. & Const.(35)			217 (m = 595) α^*=0.000086	10
Breweries (17)			16 (m = 136) α^* = 0.00037	4
G. Food Man.(27)			120 (m = 351) α^* = 0.00014	14
Pack. & Paper(14)	F = 5.83 v_1= 13 v_2= 126 p-value = 0	H = 50.96 d.f.= 13 p-value = 0		
Notes: m is the total number of possible t-tests and α^* denotes the appropriate significance level for each pairwise t-test.				

To summarise, in general the findings bear out the assumption that the distributions from which firms' returns are drawn differ in terms of both means and variances. Obviously, this contention is based on the principle that the exception proves the rule, the exception being the case (Packaging and Paper) that accords with the de Meza and Webb assumption. However, it must be acknowledged that from a theoretical (abstract) viewpoint, it is perfectly legitimate to develop an analysis built on the hypothesis of either identical mean returns and differential risks (as assumed in Stiglitz and Weiss 1981, and Chapter 3), or identical variances and differential expected rates of return (as assumed in de Meza and Webb 1987, 1990), although the evidence presented here offers provisional support to the assumption that firms differ from one another in terms of both the means and variances of their returns (as assumed in the model elaborated in Chapter 2).

4.5. Conclusions

In the economic literature on credit markets with ex ante asymmetric information, the assumptions advanced regarding the order of stochastic dominance as a method of financial decision making remain an unresolved issue. The main contribution of the present empirical study has been to shed some light on the accuracy of these basic assumptions in the aforementioned models of credit. For this purpose, and thus for the interpretation of the statistical data, the analysis of variance technique, the non-parametric runs and Kruskal-Wallis tests, and the multiple pairwise comparison method were used. The data on the UK companies grouped in industries were extracted from the EXSTAT data base for the years 1980-89.

The results of the statistical tests revealed that the expected rate of return differences and the risk differences among companies are in general significant. Thus, the evidence lends support to the assumption that both risk and average earnings vary across firms, as argued in Chapter 2. Although the samples were restricted to four industries, the indication is that the results found would not significantly alter with a larger number of samples. Nevertheless, from a theoretical (abstract) standpoint and as a first approximation to reality, it must be acknowledged that both the Stiglitz and Weiss (1981) and de Meza and Webb (1987, 1990) hypotheses are tenable.

Although many deficiencies remain, the study offers a method for extending the present empirical analysis to a larger number of samples as well as to the study of many other economies (e.g. USA and other EEC countries) in order to enhance the knowledge on the distributional arrangements of the mean rate of return and risk in industries.

The research agenda has focused on the performance of credit markets under asymmetric information. In models of credit, many unsettled issues, such as the debate on the existence of credit rationing and on under- or over-investment, remain. The empirical research on these topics also appears very promising. While the discussion of these issues lies beyond the scope of this study, it is worth mentioning that they are directly connected to the assumptions tested here.

4.6. Notes

1. Recall that the mean-preserving spread criterion requires that firms' probability distribution of returns with common expected return are ranked by the second-order stochastic dominance. See Chapter 1.

2. A number of financial ratios are examined in those studies. Here some of them are listed: (1) Earnings Before Interest and Tax/Total Assets; (2) Working Capital/Total Assets; (3) Total Debt/Total Assets; (4) Quick Assets/Total Assets; (5) Total Debt/Net Worth; (6) Net Profit/Sales; (7) Cash/Sales; (8) Sales/Working Capital; (9) Debtors/Inventory.

3. Recall that this ratio is the object of the present empirical study.

4. This study follows McLeay (1986b) who defines 'profit' as the return before tax attributable to shareholders' funds and 'earnings' as the return to total funds before tax and interest.

5. For an extensive analysis of the problems associated with ratios as size deflators, see Lev and Sunder (1979). They assert that financial ratios are merely the products of 'tradition' and 'convenience' and that their *major* role is to control for size effects. However, no evidence is offered to corroborate those assertions.

6. Note, however, that in the present case the independence hypothesis about

the random samples associated with firms could be tested by using the simple regression technique, i.e. by regressing the sample values of the rate of return of a firm on the sample values of the rate of return of another firm it would be possible to determine the degree of the relationship between these two samples. For k samples it would be necessary to perform k(k-1)/2 regressions and thus F-tests which would clearly imply a large number of statistics for a large value of k.

7. Treatments are here used in the sense of sources (samples). The practice of referring to sources as treatments is due to the fact that many analysis of variance techniques were originally developed in connection with agricultural experiments.

8. A proof for this result as well as a systematic explanation of the ANOVA test can be found in Berry and Lindgren (1990).

9. Proofs concerning the sampling distribution of H when $n_i \geq 5$ are provided in several textbooks on non-parametric statistics (e.g. Lehmann 1975 and Noether 1976).

10. A proof for this result can be found in Mood and Graybill (1963, pp. 267-8).

11. Alternatively, the significance level for each t-test could be equal to $2\alpha/k(k-1)$. This method, referred to as the *least significance difference (LSD) method*, satisfies also the condition that the overall significance level does not exceed α. See Keller, Warrack and Bartel (1990). See also Hochberg and Tamhane (1987)

for the most in-depth study on multiple comparison procedures.

12. Note that (4.7) requires that the ith and jth samples of firms be independent.

13. See Berry and Lindgren (1990) for a more detailed discussion.

14. Recall that the Levene's S test requires equal sample sizes, on account of which it shows to be robust to the violation of the normality condition in distributions.

15. The internal rate of return is, in general, defined as that rate of interest which, when used to discount the cash flows associated with an investment project of a firm, reduces its net present value to zero. Hence, it gives a measure of the 'break-even' rate of return of an investment, since it shows the highest rate of interest at which the investment makes neither a profit nor a loss. When the internal rate of return is greater than the rate of interest which has to be paid, the investment is profitable; and conversely when it is smaller. Alongside the drawback indicated in the main text, the internal rate of return as a measure of investment (or firm) profitability suffers from two important defects: (i) a given investment may have more than one interest rate which discounts its cash flows to zero, and so the method may not yield a clear-cut answer (this can happen when cash inflows within the lifetime of the investment are followed by cash outflows); and (ii) the method may give incorrect rankings of investments in that the actual profitability of one investment may be greater than that of another even though its internal rate of return is lower. The internal rate of return is also known

in the economic literature as the marginal efficiency of capital.

16. These points by Mayer notwithstanding, economists should not make uncritical use of accounting data.

PART 2

MACROECONOMIC STUDIES ON CREDIT - THE CONVENTIONAL APPROACH

CHAPTER 5

ECONOMIC ACTIVITY, CREDIT, MONEY AND GOVERNMENT FINANCE

5.1. Introduction and Overview of the Literature

Over the past twenty years, the methodological approach in macroeconomics has undergone a radical change. From ad-hoc models of Keynesian or monetarist inspiration most leading macroeconomists have shifted the focus of their research towards general equilibrium models, attempting to place macroeconomics on the theoretically firm grounds of traditional microeconomic theory. The search for the microfoundation of macroeconomics constitutes both a very ambitious program and a promising field for research since it might eventually yield a comprehensive framework of analysis for applied economists and policy makers. As underlined in Chapter 1, general equilibrium models in which the allocation of credit plays a crucial role have been proposed by a variety of authors (e.g. Bernanke and Gertler 1989, Greenwald and Stiglitz 1988a, and Williamson 1987) who have demonstrated how financial market imperfections[1] can amplify the effects of shocks and introduce new transmission mechanisms into the economy. The essential idea is straightforward. 'The smaller the extent of self-finance or the higher the probability of bankruptcy, the more important are credit market imperfections. Shocks that act initially to reduce output (or to redistribute wealth from borrowers to lenders) thus cause credit markets to function less well, which [in turn] leads to further declines in output.[2] Even more strikingly, Mankiw (1986) and Bernanke and Gertler (1987b) show how disturbances that would have only mild effects with Walrasian credit markets can cause discontinuous change (financial collapse) in the presence of credit market imperfections.' (Mankiw and Romer 1991, p. 13).

The aforementioned general equilibrium models which establish the important role of capital market imperfections in business cycles are not, however, very explicit regarding the way monetary policy and central bank policy in general affect aggregate economic activity. Nevertheless the money-output relationship continues to be a central issue in macroeconomics. While the breakdown of this relationship - continuous since 1982 and well documented (empirically) by B. Friedman (1988a, 1988b) and Bernanke (1983) - remains an unresolved puzzle, the ability of central banks to cause a recession when appropriate restrictive monetary policies are implemented is widely recognised. Thus money non-neutrality constitutes an important empirical regularity which is still calling for an appropriate theoretical explanation.

Despite many notable attempts to address this problem at the formal level by economists who emphasize the importance of asymmetric information in credit markets (see, for instance, Blinder and Stiglitz 1983, Greenwald and Stiglitz 1987c and Stiglitz and Weiss 1988 who suggest that the existence of capital market imperfections due to asymmetric information may play an important role in transmitting monetary shocks to the economy), it is useful to deal with it in a more standard macroeconomic model. This task is performed in the present chapter.

It is well known that the traditional IS-LM model of aggregate demand is unable to describe adequately the monetary transmission mechanism, a fact stressed many years ago by Patinkin (1956), Gurley and Shaw (1955), Brainard and Tobin (1963), and by the 'availability doctrine' theorists.

Patinkin, for instance, proposed a static macroeconomic model in which both the money market and the credit market are included, while the labour market is assumed to be always in equilibrium and, hence, excluded from the analysis. The model was used by Patinkin to show that it is impossible to determine the effect of a change on the money market without at the same time making assumptions about the behaviour of other markets. A change in the supply of money, for example, will require corresponding changes in the credit flows. If, for some reason, the credit market does not adjust to the changed conditions of the money market, monetary policy will not have the standard effects usually derived in the IS-LM model.

As noted in Chapter 1, the work of Gurley and Shaw represents a major contribution to the study of the relation between financial markets and aggregate economic activity. They stressed the close relationship that exists between economic development and the evolution of the financial structure of the economy. Relatively undeveloped economies are characterised by very simplified markets where the dominating asset is money while more advanced economies are characterised by a more complex financial structure. The sophistication of the financial structure of the economy is not only a result of growth but also constitutes an active element of the development process. Improvements in the financial structure of the economy accelerate economic growth by facilitating the transfer of funds from households to the most efficient firms.

Thus, when an economy with a complex financial structure is under consideration, money becomes only one of the many assets that enter individual portfolios and a whole set of other financial institutions compete with the banking system. According to Gurley and Shaw, in an economy characterised by a rudimentary financial structure the control of the money stock is sufficient to control aggregate economic activity. When the financial structure is more complex, however, the link between money and economic activity weakens because of the substitutability between money and other financial assets.

The above considerations alongside those of other studies (see Chapter 1) suggest that the movements of credit in response to monetary policy interventions are an important channel through which monetary policy affects aggregate demand. Recently, Brunner and Meltzer (1988)[3], and Bernanke and Blinder (1988) have studied the consequences of explicitly introducing a loan market in the IS-LM model. Although proposed in the context of an ad-hoc 'textbook' model, the studies are particularly useful when policy issues are considered and when analytical difficulties preclude the use of micro-based general equilibrium models.

The argument put forward by Bernanke and Blinder is that the IS-LM model places too much emphasis on banks' liabilities while neglecting banks' loans which are lumped together with other financial instruments and then conveniently eliminated through the Walras' Law.[4] Allowing roles for both money and credit, their extended model differs from the standard IS-LM in three important respects. First, an exogenous increase in bank reserves has an ambiguous effect on the bond interest rate by causing an increase in both the credit and money supplies. The expansionary effect on income is greater than the one that would have appeared in the standard IS-LM model. This is so because the response of the credit market amplifies the effects on income and reduces the effects on the bond interest rate. Second, shocks to the supply of credit stemming, for example, from the increased riskiness of firms' enterprises and banks' liquidity problems and the consequent possibility of runs, will have important effects on output. Third, the traditional results concerning what is the appropriate target for monetary policy are no longer valid. In the Bernanke and Blinder model, a strategy of interest rate targeting does not protect the economy against monetary shocks as it would in the IS-LM model. Apart from inducing changes in the money quantity, monetary shocks induce changes in the level of credit, so that fixed interest rates will not result in a stable level of output at the targeted level. Moreover, when monetary shocks are important, it may be better to use credit as a target instead of money. To illustrate this, suppose for example that a positive shock in the demand for money occurs. In this case the upward sloping LM curve (in the income-interest rate space) would shift leftward and would send a contractionary impulse to income. If the central bank's objective were the stabilisation of a monetary aggregate it would contract reserves which in turn would further destabilise income. However, if the central bank's objective were the stabilisation of credit it would expand reserves as a response to the monetary shocks which implies that a credit target would be superior.

The main message of the Bernanke and Blinder paper is that 'a more symmetric treatment of money and credit is feasible and appears warranted.' (1988, p. 439). But monetary and financial policies in general are not independent of fiscal policy and, therefore, coordination of these policies is an issue that should also be taken into consideration in any macroeconomic analysis. Indeed, the implications of the 'government budget constraint' together with 'wealth effects' highlight the interdependence of monetary and fiscal policies. Wealth, defined as total assets minus total liabilities of private sector, is an important determinant of both consumption spending (Pigou 1943 and Patinkin 1956) and the demand for money (Silber 1970). The government budget constraint denotes an accounting relationship which states that government outlays on goods and services, plus interest payments on outstanding government bonds and non-interest transfer payments to private sector, must be financed either through tax revenues or by printing new money or by issuing bonds (or a mixture of these three sources of government funds).[5] A necessary requirement for this relationship to hold is that at least one policy variable be determined endogenously in order to accommodate the values of the other policy variables. Accordingly, policies are interconnected.

In addition to the issue of policy interdependence, the recognition of government budget constraint and wealth effects also permits the introduction of dynamic analysis into the otherwise static IS-LM model. In fact, the weakness of the traditional IS-LM framework for the long-term analysis of fiscal and monetary policies is that it fails to incorporate the consequences of government budget surpluses or deficits. A government budget deficit, for example, necessitates a continuing acquisition of government liabilities (i.e. wealth) by the private sector. By implication, the economy can only be at rest when the budget is balanced. In this context, 'an analysis of the effectiveness of fiscal and monetary policy has to cover both the comparative-static multiplier for bond-financed or money-financed government spending and [the dynamic together with] the stability of the process touched off by an unbalanced government budget.' (Blinder and Solow 1973, p. 14).

The IS-LM analysis was, of course, never intended to extend to the long-run since it assumed a period short enough for the asset stock variables (money, bonds and capital stock) to be treated as fixed. Nevertheless, it is useful to consider the long-run effects within this framework of the asset stock changes required to finance the government budget.

The first explicit analyses of the implications of the government financing requirement with, in general, the inclusion of wealth effects in both goods and money markets came with the work of Ott and Ott (1965), Christ (1968, without wealth effects) and Silber (1970). The analyses have since been developed to include the effects of alternative financing methods (Blinder and Solow 1973), to allow for the effects of variations in the rate of inflation (Pyle and Turnovsky 1976), to incorporate growth and variations in the capital stock (Buiter 1977), to examine an open economy (Turnovsky 1976), and to reconsider certain policy questions in the light of these analyses (Buiter and Tobin 1976, and G. Smith 1979).[6]

Four main conclusions follow from these works. First, fiscal policy can be expected to have significant and lasting effects on the level of demand and income, irrespective of the method of financing the government budget deficits. Second, the economy is more likely to be stable under money financing of budget deficits than under bond financing. Third, if the economy remains stable under bond financing, the long-run impact of fiscal policy on aggregate demand is greater under bond financing than under money financing. Fourth, if however the economy is unstable under bond financing, the long-run effects of fiscal policy on income may well be perverse, leading in practice to a reversal or modification of policy.

In summary, this section has at some length attempted to highlight the importance of the following concepts in the macroeconomic analysis: credit, money, wealth, government budget and aggregate demand. The development of a model encompassing all these economic dimensions is a worthwhile exercise and undoubtedly contributes to the existing literature. Therefore, Section 5.2 of the present chapter takes the approach of Bernanke and Blinder a step further by incorporating an explicit credit market into another tool of standard analysis, the IS-LM model augmented with an explicit government budget constraint and with wealth effects explicitly included in the demand for money, credit and consumption. Section 5.3 examines how, as a result, the model is able to address issues such as credit market shocks that it would be impossible to analyse in conventional models without a credit market. Moreover, the implications of more standard policies and shocks are examined. And, finally, Section 5.4 draws some conclusions.

5.2. The Model

The model presented in this section adds a credit market to a standard linear fixed-price IS-LM model with a government budget constraint and wealth effects. The model has three assets - money, government bonds and private sector loans (from banks to firms) - and one commodity. As in the usual conventional macroeconomic model, the bond market may be suppressed using Walras' Law, leaving three markets to be analysed, i.e. the markets for goods, money and private sector loans, or credit.

The goods market is described by the following equations:

(5.1) $C = c_0 + c_1(Y+r_BB-T) + c_2W,$

(5.2) $I = i_0 - i_1r_L - i_2r_B,$

(5.3) $T = t_0 + t_1(Y+r_BB),$

(5.4) $Y = C + I + G.$

Following Blinder and Solow (1973), consumption, C, is assumed to depend upon disposable income and wealth. Disposable income consists of output, Y, plus interest payments on the national debt, r_BB, less taxes, T. The national debt consists of capital-certain securities upon which the variable interest rate r_B is paid. Investment, I, varies inversely with the interest rates on loans, r_L, and bonds, r_B.[7] Taxes are levied upon income inclusive of interest payments on government debt. G is real government expenditure on goods and services. Wealth, W, consists of the sum of reserves of high-powered money, R, plus the national debt, B, as follows:

$$(5.5) \qquad W = R + B.$$

Manipulation of equations (5.1) to (5.4) yields the following IS relationship:

$$(5.6) \qquad Y = [c_0+i_0-c_1t_0+c_1(1-t_1)r_BB-i_1r_L-i_2r_B+c_2W+G] \;/\; [1-c_1(1-t_1)].$$

The introduction of interest payments on government debt in the consumption function results in an ambiguity about the slope of the IS curve in (Y,r_B) space. The slope coefficient is given by $[c_1(1-t_1)B-i_2]/[1-c_1(1-t_1)]$. The denominator of this term is positive since both c_1 and t_1 are positive and lower than one. In order to generate a downward sloping IS curve it is assumed that as r_B rises the negative effect on investment demand outweighs the positive effect on consumption, due to higher interest payments raising disposable income, so that the numerator is negative.[8]

The money market is described by the following equations:

$$(5.7) \qquad D^D = d_0 - d_1r_B + d_2Y + d_3W,$$

$$(5.8) \qquad D^S = l_0 + l_1r_B + l_2R,$$

$$(5.9) \qquad D^D = D^S,$$

where D^D and D^S are the non-bank private sector's demand for deposits and the banking sector's supply of deposits respectively. Following Bernanke and Blinder, neither D^D nor D^S are considered to depend upon the interest rate on loans, r_L, although they could both be made to do so.[9]

Manipulation of equations (5.5) and (5.7) to (5.9) yields the following LM relationship:

(5.10) $$Y = [l_0-d_0+(d_1+l_1)r_B+(l_2-d_3)R-d_3B] / d_2.$$

Equation (5.10) has the usual positive slope in (Y,r_B) space. Notice that the coefficient on R in the LM curve is $(l_2-d_3)/d_2$. When the supply of deposits is considered to rise faster than the demand for deposits following an increase in reserves (i.e. when l_2 exceeds d_3), the implication is a shift of the LM curve to the right in response to an increase in reserves. This shift is less than it would be in the absence of the wealth effects on money demand, in which case the coefficient on R would be l_2/d_2. The reason is that the wealth effects cause an increase in the demand for money which partly absorbs the increase in supply, thus lessening the impact on the position of the LM curve. Furthermore, notice the inclusion of the B term in the LM equation which also arises from the introduction of wealth effects into the demand for deposits equation.

The credit market is described by the following equations:

(5.11) $$L^D = a_0 - a_1r_L + a_2r_B + a_3Y + a_4W,$$

(5.12) $$L^S = b_0 + b_1r_L - b_2r_B + b_3D,$$

(5.13) $$L^D = L^S.$$

Following Bernanke and Blinder, the demand for and supply of loans, L^D and L^S respectively, are assumed to depend upon the interest rates on both bonds and loans. The demand for loans varies inversely with r_L, positively with r_B, and also positively with income and wealth. For obvious reasons the signs attached to r_B and r_L in the supply of credit equation are opposite to those in the demand for credit equation. Loan supply varies positively with deposits, D.

Equations (5.5), (5.8) and (5.11) to (5.13) may be manipulated to yield the following relationship, which is termed the LL curve:

$$(5.14) \qquad Y = [b_0+b_3l_0-a_0+(b_3l_1-a_2-b_2)r_B+(a_1+b_1)r_L+(b_3l_2-a_4)R-a_4B] \ / \ a_3.$$

The LL curve shows the necessary relationship between Y, r_B and r_L for equilibrium to hold in the credit or loan market for given values of R and B. Note that b_2 is the bond-interest sensitivity of supply of loans and l_1 the bond-interest sensitivity of supply of money. It seems reasonable to assume that the values of these coefficients are approximately equal and lower than one, so that the coefficient of r_B is likely to be negative, i.e. $(b_3l_1-a_2-b_2) < 0$. Note also that a_4 is the wealth sensitivity of demand for loans. According to Brunner and Meltzer (1976), for the public, buying securities is an alternative to repaying loans and selling securities is an alternative to borrowing from banks. Since changes in wealth affect the public's desired borrowing and the excess supply of securities offered to banks in opposite ways, the wealth sensitivity of demand for loans is likely to be small. Thus, in what follows it is assumed that the value of a_4 is relatively small and the coefficient of R in (5.14) is positive, i.e. $(b_3l_2-a_4) > 0$.

Combining the IS and LL equations yields the following relationship, termed the CC curve[10]:

$$(5.15) \qquad Y = [(a_1+b_1)(c_0+i_0-c_1t_0)+i_1(b_0+b_3l_0-a_0)+(\beta B-\lambda)r_B+\gamma R+\theta B$$
$$+(a_1+b_1)G] / \alpha$$

where $\alpha = (a_1+b_1)[1-c_1(1-t_1)]+i_1a_3 > 0,$

$\beta = c_1(1-t_1)(a_1+b_1) > 0,$

$\lambda = i_2(a_1+b_1)-i_1(b_3l_1-a_2-b_2) > 0,$

$\gamma = c_2(a_1+b_1)+i_1(b_3l_2-a_4) > 0$ and

$\theta = c_2(a_1+b_1)-i_1a_4 > 0.$

The assumptions about the signs of these parameters all follow from the discussion above.

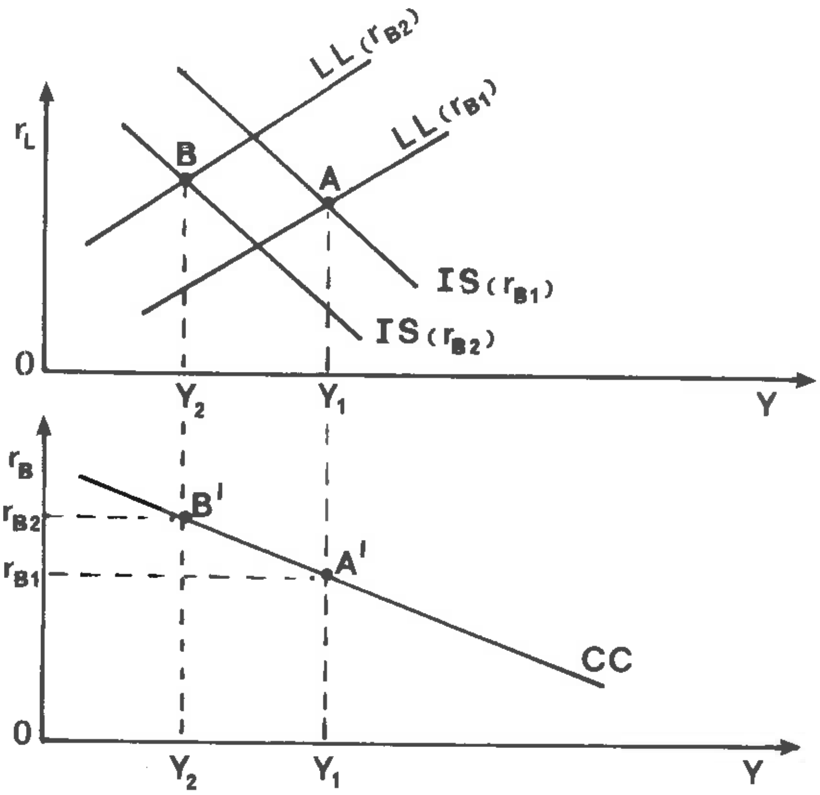

Figure 5.1: Derivation of the CC curve

The derivation of the CC curve may be illustrated by plotting the IS and LL curves in (Y, r_L) space for different values of r_B to find the combinations of r_B and Y consistent with equilibrium in the credit and commodity markets as shown in Figure 5.1.

The upper part of the figure shows two IS and LL curves in (Y, r_L) space; one each for r_{B1} and r_{B2}, where r_{B2} is greater than r_{B1}. Under the assumptions of the model the IS curve slopes downwards and moves nearer the origin as r_B rises. The LL curve slopes upwards and under the assumptions referred to it moves upwards as r_B rises. The points A and B show r_B and Y combinations consistent with equilibrium in the credit and commodity markets; these combinations are transferred to the points A' and B' on the CC curve in the lower part of the diagram. Deriving other such points would yield the CC curve shown for given R, B and G values.

Finally, the model is completed by adding the following government budget constraint:

$$(5.16) \qquad G + r_B B = T + \dot{B} + \dot{R}$$

where $\dot{B}$ and $\dot{R}$ represent the time derivatives of the stocks of bonds and high-powered money respectively.

5.3. Policy Analysis

The model may be used to examine the effects of some typical policies or shocks to the system. The examples considered here are an open market purchase of bonds and a credit supply shock. These two cases are chosen since they illustrate well the properties of the model. In the case of the open market purchase, it will be seen that the results are similar to those that would be found in the well-known IS-LM-wealth effects government budget constraint model (as found, for example, in Blinder and Solow 1973). Indeed, in general, the results derived from the model for standard policy actions of this type are closer to those that would be found using the well-known model than to those that would be found using the Bernanke and Blinder model (which contained a credit market but excluded wealth effects and the government budget constraint). In other words, the lessons of the well-known augmented IS-LM models are quite robust to the inclusion of an explicit credit market. Incorporating the credit market, however, allows a more detailed examination of familiar topics and introduces some issues, such as the analysis of a shock to the credit supply function, which clearly elude the more standard models.

5.3.1. An Open Market Purchase

Consider that the government carries out an open market purchase of bonds in exchange for high-powered money. In the standard IS-LM analysis this policy is seen to shift the LM curve rightwards down the IS curve causing income to rise and the interest rate to fall. The picture in the short-run is similar in the model developed here, as may be seen by examining Figure 5.2.

The upper part of the figure shows the CC and LM curves in (Y, r_B) space. Starting from point A in the figure, the policy will cause the LM curve to shift rightwards to LM_1. The LM shift in response to the policy is, in fact, entirely standard since the change in B is equal and opposite to the change in R, so that W remains unchanged and the shift in the LM curve is the same as in the conventional analysis.

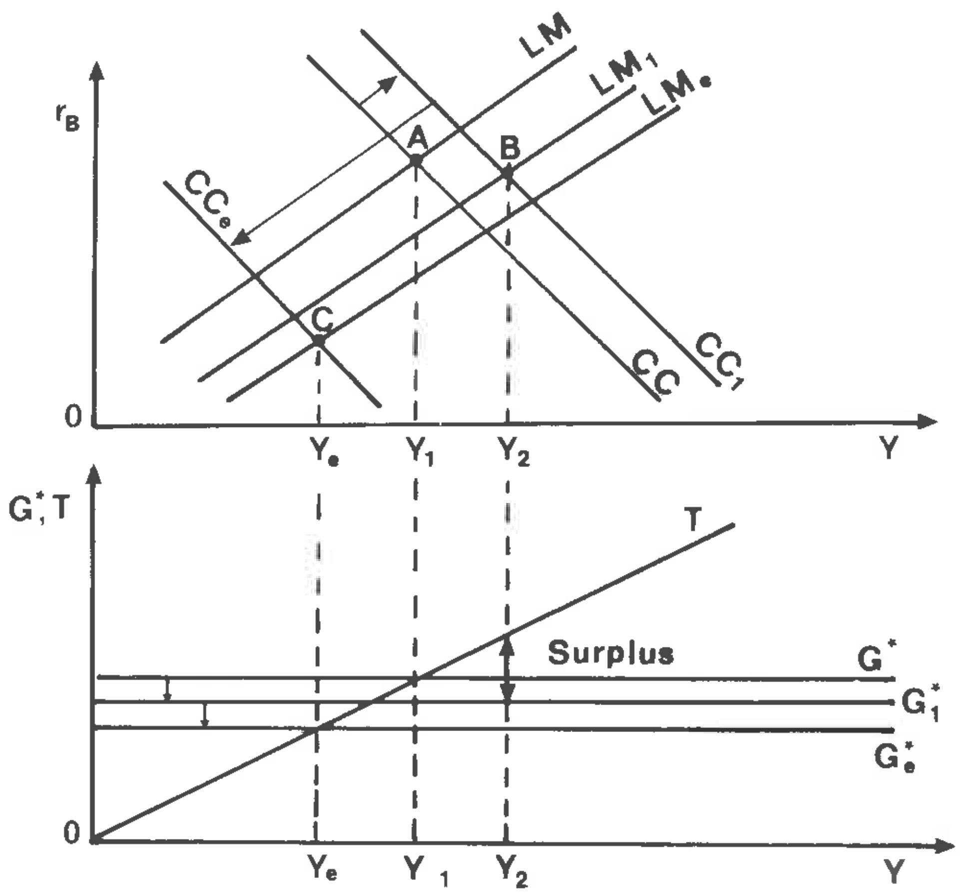

Figure 5.2: An Open Market Purchase

Consider now the CC curve, which is affected in a number of ways by the policy. Notice from equation (5.15) that both R and B are multiplied by the same terms involving wealth effect coefficients, $[c_2(a_1+b_1)-i_1a_4]$, and, therefore, the effects of the equal and opposite changes in B and R via these terms cancel out. This leaves the effect of the increase in R on deposits, hence on the credit market and on investment (via the $i_1b_3l_2$ term), to impart a rightward impetus to the CC curve. In other words, the increase in deposits increases the supply of loans in the credit market, reduces the loan rate and boosts investment causing the CC curve to shift rightwards. This shift enhances the impact of the policy in boosting income but lessens its impact in reducing the interest rate on government bonds. Bernanke and Blinder explain this as follows: 'economically, the credit channel makes the monetary policy more expansionary than in IS-LM and therefore raises the transaction demand for money by more than in the conventional model.'(1988, p.437).

However, the effect of the reduction in the supply of bonds must also be considered. This reduces disposable income causing consumption to fall and pulling the CC curve to the left via the r_BB term in equation (5.15). If the CC curve is pulled back beyond its original position the net effect of the policy on income becomes ambiguous. The ambiguity of the CC shift would be removed if net interest from bonds were excluded from disposable income. This exclusion might be justified on the grounds that including bonds in wealth and the income from bonds in disposable income is double counting. Following Blinder and Solow (1973), the interest term in disposable income is included, but it will be assumed from now on that the CC curve moves rightwards in response to the policy, thus making the policy unambiguously expansionary regarding income in the short-run. The short-run change in income, denoted $(dY)_{SR}$, may be found by totally differentiating the CC and LM relationships about the equilibrium values of B_0 and

r_{B0}. Noting that dR and dB are equal and opposite and that dG is zero under this policy, the differentiation yields:

$$(5.17) \qquad (dY)_{SR} = [(d_1+l_1)(\alpha-\beta r_{B0}-\theta)-l_2(\beta B_0-\lambda)]dR \;/\; [\alpha(d_1+l_1)-d_2(\beta B_0-\lambda)]$$

where dR is the increase in reserves brought about by the policy in the short-run. Excluding (net-of-tax) interest payments from disposable income would have the effect of removing the r_{B0} and B_0 terms from the above expression and rendering it unambiguously positive.

The effects of the policy are illustrated in Figure 5.2. The short-run effect is to move the CC-LM intersection from A to B in the upper part of the figure. The short-run analysis must be complemented by examining the dynamic and long-run consequences of the policy. The lower part of Figure 5.2 shows income taxes, T, and government expenditure inclusive of net interest payments, G plus $(1-t_1)r_BB$, denoted by G^* on the vertical axis, against income, Y, on the horizontal axis. Consider that prior to the open market purchase the government budget was balanced with income taxes equal to G^* at the initial level of income Y_1. The government budget constraint, represented in the lower part of Figure 5.2, indicates that the government budget moves into a surplus after the introduction of the policy and the movement of income to the new higher level of Y_2. This surplus is due to the increase in income taxes and also the fall in net interest payments as a result of the government purchase of its bonds, shown by the downward movement of the G^* line to G^*_1, which depends upon the assumption that the fall in B has a greater effect on interest payments than any possible accompanying rise in r_B. The government must either remove this surplus, by increasing its expenditure on goods and services or cutting taxes or increasing transfer payments, or allow it to affect asset stocks in the economy, by using it to withdraw high-powered money from circulation or to redeem yet more bonds. Each of these possibilities, or some combination of them, will have effects on the economy and cause income to move away from Y_2. Undoubtedly, recognition of the government budget constraint introduces (intrinsic) dynamic issues into an otherwise static model.

Long-run equilibrium requires a balanced government budget, so that no changes in asset stocks are brought about in response to imbalances, and no changes to taxing or spending policies are forced on the government. Consider that in the short-run the government uses the surplus to redeem bonds. It is well-known that such a policy may lead to instability. In mathematical terms this can be shown as follows. The assumption that budget imbalances are met by buying or selling government bonds implies that $\dot{R}$ is set equal to zero in (5.16) and the dynamics of the system is given by the LM, CC and government budget constraint, i.e. equations (5.10), (5.15) and (5.16). Taking linear approximations it is possible to determine a first-order linear differential equation in B, i.e. $\dot{B} = f(B)$. For the system to be stable, the derivative of $\dot{B}$ with regard to B must be negative, i.e. $(d\dot{B}/dB) < 0$. From this, the following stability condition is derived:

$$(5.18) \qquad \{(1-t_1)[r_{B0}(d_1\alpha+l_1\alpha+d_2\lambda)+B_0(d_3\alpha+d_2\theta)]-t_1[(d_1+l_1)(\beta r_{B0}+\theta) +d_3(\beta B_0-\lambda)]\} \,/\, [(d_1+l_1)\alpha-d_2(\beta B_0-\lambda)] < 0$$

where B_0 and r_{B0} are the equilibrium values about which the linear approximations were taken. Clearly, condition (5.18) is not necessarily satisfied; stability of the system depends upon the values attached to the parameters of the model. The possibility of instability may be explained with reference to Figure 5.2.

Assuming that the effect of the redemption of bonds on interest payments is greater than any effect from a possible rise in the interest rate on them as the economy moves from A to B, the effect will be to cause the G^* line to continue to move downwards in the lower part of the figure. As the G^* line moves down the T line, the level of income consistent with a balanced government budget and full stock-flow equilibrium at the intersection of these two lines continues to move to the left and below the initial equilibrium of Y_1. Thus the policy reduces interest payments by the government, making any new equilibrium level of income (one consistent with a balanced government budget) less than the level before the introduction of the policy - so that the reduction in interest payments may be matched by a reduction in income tax receipts.

The changes in the quantity of bonds to satisfy the government budget constraint also affect the CC and LM curves. Examination of equation (5.10) shows that the LM curve moves rightwards as B falls. This is explained by the fall in B causing wealth and the wealth-induced demand for money to fall, which with the supply of reserves held constant (bonds are redeemed out of excess taxes now with no change in reserves being needed) means that, ceteris paribus, more money is available for transactions purposes and so the LM curve moves outwards as shown. Examination of equation (5.15) indicates that the shift of the CC curve as B falls depends upon the sign of the term $[c_1(1-t_1)(a_1+b_1)r_B+c_2(a_1+b_1)-i_1a_4]$; if this term is negative CC will move rightwards as B falls and if is positive it will move leftwards as B falls. In other words, the effect of the fall in B on wealth and disposable income causes consumption to fall, whilst at the same time causing the demand for credit to fall and, hence, the credit loan rate to fall and investment to rise. The changes in consumption and investment have offsetting effects on the CC curve which can, therefore, move leftwards or rightwards in response to the changes in B.

Under the assumption made about the sign of θ the CC curve will move leftwards as B falls, but consider first the alternative possibility. Clearly, if as B falls both the CC and LM curves move to the right, the level of income at which they intersect will rise, and if G^* is falling then the government budget surplus will go on rising over time in an unstable way. In such a case, to stabilize the system the government will need to change its policy. Alternatively, if, as assumed, as B falls the CC curve moves to the left, there is a possibility that income will fall; if this happens and also income taxes fall faster than G^* then the system will eventually stabilize at some income level to the left of Y_1. Figure 5.2 depicts a new stable equilibrium at a level of income of Y_e consistent with the CC_e, LM_e and G^*_e lines shown.

In short, if the system is stable the long-run effect on income, denoted by $(dY)_{LR}$, will be negative despite the expansionary effect in the short-run.[11] This result is not surprising and is in fact similar to what would have been predicted by an IS-LM model augmented with wealth effects and the government budget constraint (see, for example, Blinder and Solow 1973, 1976).

5.3.2. A Credit Supply Shock

Now consider a negative shock to the supply of credit, which is modeled by imagining that the constant term in equation (5.12) changes by some negative amount db_0. This shock may be imagined to be policy induced, say by a tightening of credit market controls, or to be a result of private actions, say due to more pessimistic expectations by suppliers in the credit market. From equations (5.10) and (5.15) it is easy to see that the shock shifts the CC curve leftwards to CC_1 and leaves the LM curve unchanged. This is shown in the upper part of Figure 5.3 by the CC-LM intersection moving from A to B, with both income and the interest rate on bonds falling.

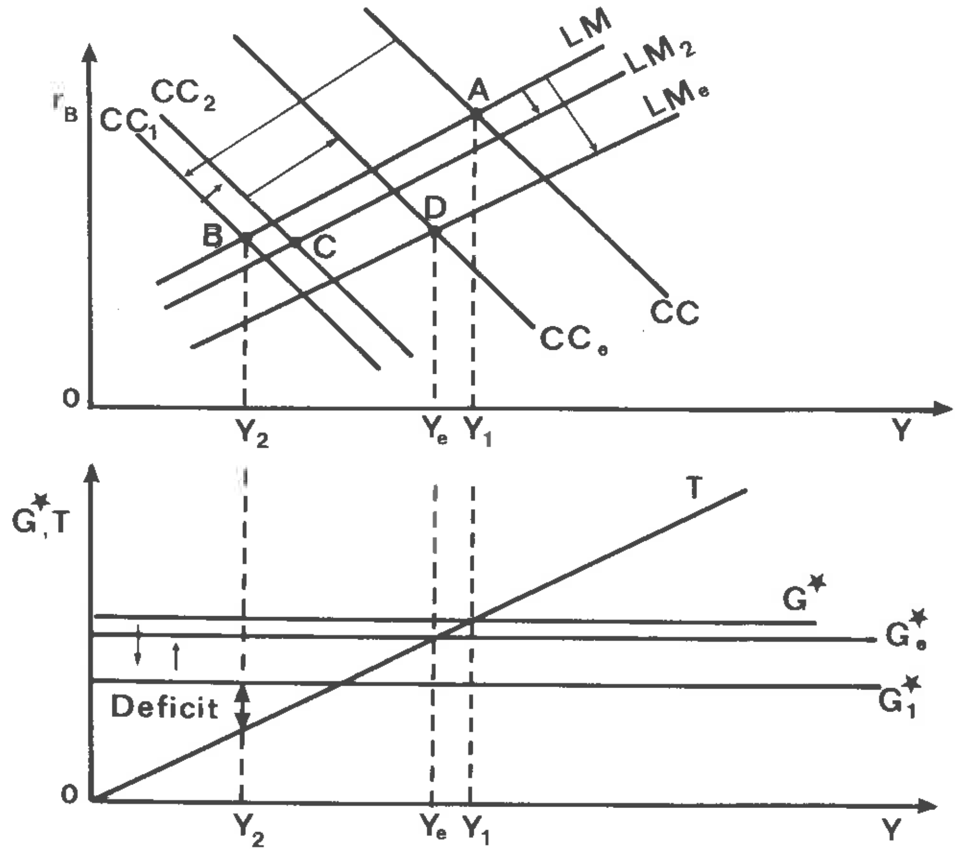

Figure 5.3: A Credit Supply Shock

The intuition is straightforward. The credit market shock causes the loan rate to rise and, hence, investment to fall, causing the CC curve to move leftwards, whilst the fall in income and the transactions demand for money cause the interest rate on bonds to fall as the CC curve moves down the LM curve. Thus, it is quite possible for the loan rate to rise as a result of the credit market shock at the same time as the rate on government bond falls. Such a result could not have been predicted by the standard IS-LM framework and illustrates the value of introducing an explicit credit market.

The above short-run result is not, however, the end of the story. Examination of the lower part of Figure 5.3 shows that if the government budget had been in balance before the credit shock, then it will be in deficit at the new lower level of income of Y_2, assuming that the fall in the position of the G^* line to G^*_1 brought about by the fall in r_B is not enough to offset the fall in taxes as a result of lower income and interest payments. Assume that the government responds to the deficit by holding the supply of bonds constant and financing the deficit by increasing the supply of high-powered money. The increase in the quantity of high-powered money causes the LM curve to move to the right (by less than it would in the standard model without wealth effects). Further, it increases wealth and causes consumption to rise, and it also increases both supply and demand on the credit market.[12] Assuming that the effect on the credit market is to reduce the loan rate, investment will rise and along with the rise in consumption this will shift the CC curve to the right.

Both the LM and CC shifts are expansionary with respect to income which, therefore, tends to rise as long as the deficit exists and is money-financed in this way. The upper part of the diagram shows a new temporary equilibrium at point C in response to CC and LM shifts to CC_2 and LM_2 respectively. As income rises the deficit shrinks and the system, therefore, tends to be stable under this policy. The diagram shows a new long-run equilibrium with a balanced government budget at the income level Y_e generated by the intersection of the CC_e and LM_e lines at point D in the upper part of the figure. Notice that the new equilibrium bond rate is below the rate before the shock to the credit market; the final G^* line, G^*_e, is therefore below the original G^* line and so the new equilibrium level of income consistent with a balanced budget must be below the initial level of income. The policy response to the initial credit market shock, therefore, tends to partially offset the short-run negative impact on income.

The stability of the system may be checked in this case by setting $\dot{B}$ equal to zero in equation (5.16) and by manipulating (5.10), (5.15) and (5.16) after linearization to yield a first-order differential equation in R with the stability condition $(d\dot{R}/dR) < 0$ implying:

$$(5.19) \qquad [t_1(\beta B_0-\lambda)(l_2-d_2)-\gamma t_1(d_1+l_1)-\alpha(1-t_1)(l_2-d_3)B_0+\gamma d_2(1-t_1)B_0]/[\alpha(d_1+l_1) -d_2(\beta B_0-\lambda)] < 0.$$

Condition (5.19) will be satisfied under the assumptions of the model as long as the term $(\beta B_0-\lambda)$ is negative, i.e. as long as the value of debt which the system is linearized is sufficiently small. This then confirms the argument that the system is likely to be stable under the policy of money-financing budget imbalances.

Since the stability conditions under different means of financing budget imbalances are independent of the initial causes of the imbalances, comparison of conditions (5.18) and (5.19) indicates that stability is more easily satisfied under money-financing of budget imbalances than under bond-financing. This result is equivalent to that found by Christ (1978) in a similar model without a credit market.

5.4. Conclusions

The main contribution of the present study consisted in showing how an explicit credit market may be incorporated in a dynamic standard macroeconomic model augmented with wealth effects and government budget constraint in order to allow the examination of issues, such as a credit market shock, that would not otherwise be possible.

It has been shown, for instance, that a negative credit market shock causes the loan rate to rise and, hence, investment to fall, which in turn triggers off the fall in income, the transactions demand for money and the interest rate on bonds. Therefore, it is possible to argue that, as result of the credit market shock, the loan rate rises and the rate on government bonds falls. Such an outcome could not have been predicted by the standard IS-LM model and illustrates the value of introducing an explicit credit market into this framework.

Moreover, the study has also demonstrated that the analysis of more conventional shocks or policies (e.g. open market purchase of bonds) is enhanced by supplementing the usual (money market) channels of the transmission process with a credit market.

Further work on examining targeting policies using a Poole-type (1970) analysis in the framework proposed here would be useful, as would extending the analysis to deal with an open economy. In this framework, it would also be interesting to examine the implications of credit rationing. Such an exercise may prove to be a valuable complement to the literature examined and discussed in Part 1 of the thesis, which uses asymmetric information to explain the microfoundations of credit market behaviour.

At this stage of the analysis, it is possible to conclude that a symmetric treatment of money and credit is feasible and, at the same time, defines a very promising research agenda in both micro and macroeconomics.

5.5. Notes

1. In this literature, financial market imperfections are equated with incomplete and costly information. As underlined in Part 1 of the thesis, these information related problems both shape capital market institutions and debt instruments, and produce, for instance, a non-conventional pattern of credit supply function (which may imply credit rationing or borrowing constraints) and agency costs.

2. 'Thus credit market imperfections serve to raise the cost of capital in downturns and thereby reduce firms' incentives to cut their prices and expand output. This strengthens the ability of small frictions in price setting to lead to price rigidity and real effects of nominal shocks.' (Mankiw and Romer 1991, p. 17).

3. Brunner and Meltzer have also in a series of other papers (e.g. 1972 and 1976) stressed the importance of the distinction, and interaction, between money and credit.

4. Implicitly the IS-LM model considers three markets: output, money and bonds. Since the Walras Law asserts that equilibrium in any two of these markets will necessarily imply equilibrium in the third, in the model the bond market is excluded. For an in-depth discussion of this issue, see Hansen (1970) and Stevenson, Muscatelli and Gregory (1988).

5. Note that according to the above definition (outside) money and bonds are both wealth of private sector.

6. A comprehensive survey of this literature is in Currie (1978).

7. It is assumed throughout that coefficients are positive; thus negative signs are used to indicate inverse relationships between variables.

8. If bonds had been considered to be of the fixed-interest-payment, variable-value type, then as r_B rose interest payments would not rise, but the value of bonds and, hence, wealth and consumption would fall. In this case, C and I would both fall as r_B rose and the IS curve would unambiguously slope downwards.

9. Introducing an r_L term into either or both of the D^D and D^S functions would result in an r_L term in the LM curve too, thus preventing the drawing of the CC-LM diagram in (Y,r_B) space below. The LL curve (derived below for the credit market) could however be used with the LM curve to eliminate r_L and derive a CM curve (for 'commodities and money'). The CM curve could be drawn in (Y,r_B) space alongside the CC curve (which is derived below in similar manner) to produce a CC-CM model instead of the CC-LM model presented by Bernanke and Blinder. The CC-LM model is therefore just a special case of the CC-CM model under the assumption that neither D^D nor D^S depends upon r_L. Although it would be easy to relax this assumption, the Bernanke and Blinder suggestion is followed so that the results of the present model may more easily be compared with theirs.

10. CC is Bernanke and Blinder's mnemonic for 'commodities and credit', although it should be remembered that the money market equation (5.8) has also been used in deriving the CC curve.

11. $(dY)_{LR}$ differs from $(dY)_{SR}$ by allowing for all the changes in B stemming from the effects of the policy over time and not just the initial change in B.

12. The supply of credit rises as a result of the increase in deposits brought about by the policy, whilst the increase in wealth due to the increase in the supply of high-powered money causes the demand for credit to rise.

CONCLUDING REMARKS AND BIBLIOGRAPHY

CONCLUDING REMARKS

The preceding chapters have demonstrated at length the importance of credit, and financial intermediation in general, in any advanced monetary economy. Part 1 of the thesis has mainly addressed the issues concerning credit markets at the microeconomic level, while Part 2 has focused on macroeconomic aspects of credit markets. Now it is time briefly to assess the analyses developed as well as to identify areas of future research.

As stated at the beginning of Chapter 1, the analyses in Part 1 are in accordance with the principles of the New Information Economics, a branch of economics that has been attempting to model informational problems in a rigorous mode. In so far as the studies in Part 1 may be considered to exemplify the strengths and weaknesses of the New Information Economics, a few words on this subject seem appropriate in the present context.

The major deficiency of this field of economics is that it has not yet produced a general theory analogous to the traditional general equilibrium theory of the Arrow-Debreu type. Indeed, in the New Information Economics 'there seems to be a myriad of special cases and few general principles' (Stiglitz 1985, p. 21). This state of affairs is hardly surprising given that there are a number of ways in which information may be incomplete, while there is just one way of being perfectly informed. At the same time, it may easily be understood that the informational assumptions of the traditional Arrow-Debreu type models do not adequately describe the real world features. In this sense, the New Information Economics have contributed to the advance of economic science by challenging the validity of several propositions derived from those models. As the thesis illustrates, they did so by offering compelling counterexamples based on sound theoretical explanations, as for instance in models where equilibria may be non-Walrasian and inefficient, or where equilibria may not exist.

A related issue to the above criticism is the usual arbitrariness of assumptions in the models of credit with incomplete information. For instance, in the capital market, the characteristics defining the quality of investment projects as well as the form of informational asymmetries assumed vary from one set of studies to another depending on the way in which researchers perceive the phenomena under consideration. As a consequence, the theoretical results and the policies derived in these studies are particularly sensitive to model specifications. This point substantiates what has been alluded to earlier, namely that at this stage of development any model of credit based on asymmetric information can only 'show that certain phenomena *may* occur under *some* plausible conditions, but not that they *must* occur under *all* plausible (let alone imaginable) circumstances' (Clemenz 1986, p. 200). It is therefore important cautiously to select between the different models before attempting to draw firm conclusions from the recent literature on credit developed along the lines of New Information Economics. This caveat also applies, of course, to the new models proposed in the present thesis. Further theoretical as well as empirical work in this field of economic science is therefore required to broaden the spectrum of choices, thereby enabling a prudent selection of studies.

In dealing with the issues of credit movements and monetary transmission mechanism, the studies in Part 2 of the thesis adopt the conventional ad-hoc macroeconomic approach. This method of analysis of macroeconomic relationships is especially useful when analytical difficulties exclude the option of the general equilibrium optimizing frameworks. The main deficiency of the models using this traditional approach is that their behaviourial equations (in the case of the macroeconomic model developed in Chapter 5, for instance, the investment demand, the money and credit supply and demand functions) are not derived from first principles. Nevertheless, it can legitimately be argued that 'good science need not always be built up from solid microfoundations. Thermodynamics and chemistry, for example, have done pretty well without much micro theory. Boyle's Law applies directly to aggregates, much like the marginal propensity to consume. And the microfoundations of medicine are often very poor; yet much of it works. Empirical regularities that are formulated and tested directly at the macro level *do* have a place in science.' (Blinder 1989, Ch. 8, p. 124). This point notwithstanding, it must be acknowledged that, whenever possible, macroeconomists should build their theories up logically from the optimizing behaviour of economic agents, a rule that defines the method of first principles in economic science.

The above considerations regarding the methods applied in the examination of the phenomena associated with credit markets raise the question of the direction future research on these issues should take. Several areas for prospective research have been identified in the concluding section of each of the preceding chapters. At this point it may be worth indicating in very general terms the various dimensions of future research.

First, since general results have to be produced, the type of analyses advanced in the preceding chapters needs to be extended. In this context, a synthesis of the models elaborated in Chapter 2 (where investment projects are distinguished in terms of both mean and variance parameters) and Chapter 3 (where a mixed form of financial contracts is considered) would be a valuable theoretical exercise. Further research should also aim at devising models in which the mixed form of financial contracts could be derived from first principles; this could possibly be done by considering a framework containing a mixture of ex ante and ex post asymmetric information. A good example of a theoretical study combining these forms of informational asymmetries in a single structure is the multiperiod model proposed by Diamond (1989), where adverse selection, moral hazard and costly state verification problems are simultaneously examined. This kind of structure, if embedded in a general equilibrium framework, could probably yield more general results.

Second, and this point follows from the first, it seems also worth focusing theoretical research onto new methodological approaches capable of generating a unified framework integrating micro and macro analysis of credit issues. This is, of course, a difficult task and it will probably remain an open question for some time to come.

Third, empirical tests relating to a number of contradictory theoretical results derived from different studies are called for. This could settle the dispute over which theoretical views are closer to the real world features, while at the same time promoting effective advances in the theory of credit. The type of study elaborated in Chapter 4 is particularly useful in this context. Furthermore, attempts should also be made to produce a direct assessment of the empirical importance of credit rationing and the nature of inefficiency concerning aggregate investment, as well as the derivation of stylized facts about credit aggregates.

To conclude, the area of research here chosen is undoubtedly challenging and offers plenty of room for further work, both at the theoretical and empirical levels.

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