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Ai miei genitori, a mia sorella, a Francesca

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CONTENTS

INTRODUCTION

This thesis focuses on the relationship between credit rationing and collateral value. The thesis is divided into three chapters.

In Chapter 1, I make an overview on credit rationing. I emphasize that economists have linked credit rationing to problems of imperfect information, which arise when borrowers have better information than lenders. In fact, only the borrower knows the risks that he takes or the effort that he puts into his firm. The lender can only try to evaluate the behavior or the characteristic of the borrower. In this situation, the lender must take account of the effects of the credit contract on the mix of loan applicants or their behavior. So the lender cannot raise interest rates even though he has the bargaining power. The two seminal works on this subject are Jaffee and Russell (1976), which demonstrates how credit rationing arises as a market response to adverse selection, and Stiglitz and Weiss (1981), which shows that credit rationing can be an equilibrium phenomenon if either the lender is imperfectly informed about the borrowers, or the lender is unable to directly control the borrowers' behavior. In fact, when the interest rate affects the nature of the transaction, it may not clear the market. So it may not be profitable to raise the interest rate when banks have an excess demand for credit. The interest rate is not the only term in debt contracts, and several papers have also investigated the role of collateral in solving credit rationing. In this theoretical framework, I discuss the paper by Bester (1985) that shows that credit rationing does not occur when certain conditions hold. Recently some papers have contributed to developing a theory of collateral linked to the value of the assets. This theory is another possible explanation of credit rationing. There are two main papers on this. The first is by Williamson (1988) in which he shows that redeployable assets also have high liquidation value because they are good candidates for debt finance. Williamson does not address the problem of specialized assets. The second is by Shleifer and Vishny (1992) where they show that a firm in financial distress sells its assets at prices below value in best use. In this chapter I consider papers, including Jaffee and Russell (1976) and Stiglitz and Weiss (1981), which analyze credit rationing in relation to adverse selection problems. I then focus on papers that study the role of collateral requirement in the model with adverse selection and I discuss papers that show how the collateral value is linked to the liquidation price of assets, focusing, in particular, on the paper by Shleifer and Vishny (1992). Finally, I review some empirical works.

In Chapter 2, I investigate the effect of real assets as collateral on the economy. I construct a model that combines a credit rationing model with the idea that firms' debt capacity and investments are linked to the value of assets in cases of distress. The model builds on Stiglitz and Weiss (1981) and Shleifer and Vishny (1992) to show that there exists a link between firms' debt capacities and asset values in case of distress and the classical credit rationing model. My work investigates the role of real assets in diminishing asymmetric information. When loans are collateralized and firms are credit constrained, the amount borrowed is determined by the value of collateral. The main contribution of the paper is to show how each *good* firm derives positive externalities from the existence of *bad* firms. Indeed, the optimal leverage of firms depends on the possibility of repurchasing the assets. The liquidated assets may or may not be under priced, and this depends on the quantity of *bad* firms. In this way I endogenize the price of assets because it depends on whether there are firms that repurchase the assets. In fact, the price is linked to the number of *bad* firms in the economy as well as to the liquidity of *good* firms. This implies that it is possible to have a separating equilibrium in the model only if there exists a number of *bad* firms that go bankrupt and if there exists a number of *good* firms with sufficient liquidity. My model differs from other papers in the literature in that debt overhang originates from the absence of initial cash and not from an agency problem. I investigate what happens if small firms have to invest without initial cash. In this case, the debt overhang is a consequence of investment and does not depend on decision of investors who would like to keep firms from undertaking a negative net present value project. I consider only projects with a positive net present value.

In Chapter 3, I investigate empirically the role of real assets in credit rationing. The analysis is based on the idea that asset tangibility is inversely related to the probability that a firm will be credit constrained. Indeed, several works show that firms with more tangible assets have higher debt levels.

This is particularly true when capital markets are imperfect because, when loans are collateralized, the amount borrowed is determined by the value of collateral. This happens because, in a context of asymmetric information banks use real assets as a guarantee in case of project default. Consequently, a reduction in collateral values reduces investments and borrowing capacity. Although many papers have explained the relationships between the debt level and the value of real assets, empirical evidence is mainly based on large "listed firms". The question as to the whether these arguments are valid for smaller firms has received limited attention. One reason is that good data on smaller non-listed firms has not been available until very recently. Moreover, many papers focus on the credit rationing of high-tech firms because they have difficulty in borrowing long term and borrow at high spreads. Indeed, if a high tech project fails, there is no collateral to protect creditors. Many papers also show that specialized assets should fetch a low resale price. This suggests that a high resale price corresponds to a highly redeployable asset and that the reduction in resale value aggravates credit rationing, so that investment declines.

My purpose is to show empirically how the value of real assets is inversely linked to credit rationing of Italian small and medium firms. It is interesting to analyze small and medium firms which, because of their ownership structure and size, have fewer financial options. Large firms can obtain credit on the public markets while small firms depend on financial intermediaries. This implies that their main source of funds is banks. These firms are more likely to face credit rationing or very high cost of non collateralized debt because banks resolve asymmetric information by charging higher interest rates or collateral requirement on small firms. Although my work is close to other papers on capital structure, I analyze the problem from another point of view. I consider the relation between credit rationing and firms' capital structure, rather than the relation between debt ratio and firms' capital structure. In this Chapter, I also focus on the propensity score matching model, introduced by Rosenbaum and Rubin (1983), to investigate a causal link between public incentives and firms' rationing. The propensity score is used to select the most comparable counterpart from the control group . The methodology I use was developed by Becker and Ichino (2002). The method is based on the computation of the propensity score using a standard probit model.

1. CREDIT RATIONING, ADVERSE SELECTION, AND LIQUIDATION VALUE: AN OVERVIEW

1.1 Introduction

Credit rationing exists because lenders fix an interest rate on loans and then they supply a smaller loan size than demanded by the borrowers. In normal markets such excess demand tends to raise the interest rate. If there is credit rationing, some borrowers are constrained by fixed lines of credit which they must not exceed under any circumstance, others are refused loans altogether. Economists have linked credit rationing to problems of imperfect information. Such problems arise when borrowers have better information than lenders. In fact, only the borrower knows the risks that he takes or the effort that he puts into his firm. The lender can only try to evaluate the behavior or the characteristic of the borrower. In this situation, the lender must take account of the effects of the credit contract on the mix of loan applicants or their behavior. So the lender cannot raise the interest rates even though he has the bargaining power. Many studies showed that asymmetries may generate credit rationing. The two seminal works on this subject are Jaffee and Russell (1976), which demonstrates how credit rationing arises as a means of market response to adverse selection, and Stiglitz and Weiss (1981), which shows that credit rationing can be an equilibrium phenomenon if either the lender is imperfectly informed about the borrowers, or the lender is unable to directly control the borrower's behavior. In fact, when the interest rate affects the nature of the transaction, it may not clear the market. So, it may not be profitable to raise the interest rate when banks have an excess demand for credit.

The interest rate is not the only term in debt contracts and several papers have also investigated the role of collateral in solving credit rationing (Bester (1985, 1987), Chan and Kanatas (1985), Clemenz (1986)).

In recent years, many papers (Jensen (1986), Williamson (1988), Hart and Moore (1989), Stulz (1990), Shleifer and Vishny (1992)) have contributed to developing a theory of collateral linked to the value of the assets.

Within this theoretical framework two main papers are discussed. The first is by Williamson (1988) in which he argues that redeployable assets have high liquidation value because they are good candidates for debt finance. Williamson, however, does not address the problem of specialized assets. The second is by Shleifer and Vishny (1992) where they show that are also the "general equilibrium" factors that determine which assets are liquid and have the higher debt capacity, and not only the characteristics of individual assets, such as tangibility.

The remainder of the paper is organized as follows. In Section 2, I consider papers, including Jaffee and Russell (1976) and Stiglitz and Weiss (1981), which analyze credit rationing in relation to adverse selection problems. In Section 3, I focus on the papers that study the role of collateral requirement in the model with adverse selection. In Section 4, I discuss papers that show how the collateral value is linked to the liquidation price of assets, focusing, in particular, on the paper by Shleifer and Vishny (1992). In Section 5, I review some empirical work, and in Section 6, I draw conclusions.

1.2 Credit Rationing and Adverse Selection

In this Section, I consider papers that emphasize that credit rationing can be explained by the principle of adverse selection. In the traditional models, adverse selection comes from the fact that, as interest rates increase, some of the best borrowers switch to another project.

Jaffee and Russell (1976) explain how unobserved differences in borrower quality can induce credit rationing. They demonstrate that it arises as a means of market response to adverse selection. In their model there are "good" and "bad" borrowers. *Good* borrowers repay debt, *bad* borrowers default on loans whenever the cost of default is sufficiently low. In the model, borrower default probabilities increase with loan size (L). Moreover, for any given loan size, default probabilities differ across borrowers because they are indistinguishable *ex ante*. Indeed, lenders are unable to distinguish between the two types of individuals. Jaffee and Russell used a two period consumption model where each good borrower has a utility function $U[C_1, C_2]$ and each individual has an exogenous income stream Y_1, Y_2. Budget constraints for borrowers are:

$$C_1 = L + Y_1 \tag{1.1}$$

$$C_2 = Y_2 - L(1 + r) \tag{1.2}$$

where L is the loan and $1+r$ is the interest rate factor. They restate the problem by substituting the budget constraints in the utility function $U[L+Y_1, Y_2 - L(1+r)]$. The first order condition for the solution is:

$$\frac{\partial U}{\partial L} = U_1 - U_2(1+r) = 0 \tag{1.3}$$

This will lead to a loan demand function:

$$L^* = L^*[(1+r)] \tag{1.4}$$

They assume that $\partial L^*/\partial(1+r)$ is negative, that L^* is zero at some finite $(1+r)$, and that L^* approaches infinity as $(1+r)$ approaches zero. *Bad* borrowers are identical to *good* borrowers except that they can default. There are two conditions:

1) the *bad* borrowers' demand for loans must be equal to *good* borrowers', otherwise lenders can distinguish individuals;

2) There is a cost of defaulting measured by δ.

This cost may be interpreted as a reduction in the earning capabilities of *bad* individuals, following their revealed default. *Bad* borrowers have to decide whether to continue or to default. In the first case, they maximize the utility function $U[C_1, C_2]$ by:

$$C_1 = Y_1 + L^* \tag{1.5}$$

$$C_2 = Y_2 - L^*(1+r) \tag{1.6}$$

and in the second case by:

$$C_1 = Y_1 + L^* \tag{1.7}$$

$$C_2 = Y_2 - \delta \tag{1.8}$$

In both cases, C_1 consumption reflects L^* demand. *Bad* borrowers choose default whenever $\delta < L^*(1+r)$. In this framework all *bad* borrowers default over the same range of contracts.

Making the model more realistic, Jaffee and Russell allow the cost of default to vary among individuals, so that the default range of contract size also varies. Let δ_{max} be such that individuals never default and δ_{min} is the value over which default behavior is observed. With δ continuous, is possible to determine a function $\lambda[L(1+r)]$, where λ is the proportion of individuals who do not default when offered a contract size $L(1+r)$.

$\lambda[L(1+r)] = 1$ for $L(1+r) \leq \delta_{min}$, $\lambda[L(1+r)]$ is continuous with $\lambda'[L(1+r)] < 0$ for $L(1+r) > \delta_{min}$. On this basis Jaffee and Russell determine market equilibrium with competitive conditions on the loan market. Lenders maximize the expected value of their profits (ρ), assuming that they obtain their funds in a perfect capital market at the constant one-period interest rate i :

$$\rho = L(1+r)\lambda[L(1+r)] - L(1+i) \tag{1.9}$$

In a competitive loan market, a zero profit condition holds:

$$(1 + r)\lambda[L(1 + r)] = (1 + i) \tag{1.10}$$

The single contract, no-rationing equilibrium occurs when the interest rate factor $(1 + r)_s$ exceeds the marginal cost of funds $(1 + i)$. $(1 + r)$ exceeds $(1 + i)$ by exactly the amount necessary to compensate for default rate λ. *Good* borrowers pay more to support *bad* borrowers.

Jaffee and Russell also show another equilibrium, the single contract rationing equilibrium. They consider the set of zero profit contracts in which the contract does not exceed the demand function. The condition is: $L \leq L^*[(1 + r)]$.

Contracts below S, the equilibrium point $((1 + r)_s, L_s)$, are preferred to the no-rationing equilibrium. Borrowers who are *good* at contract S prefer the equilibrium with rationing, because fewer individuals default on the smaller loan size and this generates a gain for them. The Jaffee and Russell model predicts the absence of multiple-contract equilibrium; in their model the market may in fact reach a stable equilibrium in which individuals are all rationed in the amount they can borrow. Alternatively, the market may oscillate in an unstable fashion.

Stiglitz and Weiss (1981) base their model on two main assumptions, that lenders cannot distinguish between borrowers of different degree of risk, and that loan contracts are subject to limited liability. The analysis is restricted to involuntary default. The presence of limited liability implies that lenders bear all the downside risk, while all returns above the loan repayment obligation accrue to borrowers. Raising interest rates affects the probability of low risk borrowers disproportionally, causing them to drop out of the applicant pool. At very high interest rates, the only applicants are borrowers who can generate very high return but with small probability. Consequently lenders hold interest rates at levels below market clearing, and ration borrowers in order to achieve a better composition. The excess demand in the credit market may persist even in the face of competition and flexible rates. There are three main characteristics in the Stiglitz and Weiss model: first, borrowers are risk neutral, second, if there is involuntary default, borrowers repay loans when they have the means to do so, and third, there is limited liability so that if project returns are less than debt obligations, the borrowers bear no responsibility to pay.

Stiglitz and Weiss explain credit rationing through the riskiness of borrowers' projects. For a given loan rate, lenders earn a lower expected return on loans to bad quality projects than to good. They show that, given their assumptions, the loan supply curve can bend backwards and that credit rationing can emerge as a consequence. A rise in the interest rate lowers the average borrower quality because safe projects are the first to drop out. Further increases in the interest rate may lower lenders' expected return, making the loan supply curve bend backwards. The quantity of loans offered is the maximum the supply curve permits. The excess demand for loans persists because adjustments in the interest rate cannot equilibrate the market. Further increases in the interest rate only lower the supply of loans offered.

Stiglitz and Weiss support the existence of rationing equilibrium and underinvestment with two arguments. The first is based on adverse selection effects of the interest rate on the pool of borrowers and the second is based on the possibility that an interest rate increase could induce borrowers to increase the riskiness of their projects. In both cases, the per-loan return to the bank can reach a maximum for some interest rates on loans and non-market equilibrium may occur. If prices do their job, rationing should not exist. However, credit rationing does exist.

Stiglitz and Weiss show that in equilibrium a loan market may be characterized by credit rationing. When the interest rate affects the nature of the transaction, it may not also clear the market. The expected return of the banks depends on the probability of repayment, but it is difficult to identify "good" borrowers. The interest rate helps to screen the borrowers. Borrowers who are willing to pay high interest rates have a lower probability of repaying the loan. They show that higher interest rates induce firms to undertake projects with lower probabilities of success but higher payoff. Because the bank is not able to control borrowers' behavior, it formulates a contract to select low risk borrowers. In the presence of excess demand for loans, unsatisfied borrowers may offer to pay a higher interest rate, but banks do not lend to an individual who offers to pay more. In the model, θ is a probability distribution of returns of the project Y. A higher θ corresponds to greater risk. Stiglitz and Weiss define the net return to the borrower as:

$$\pi(Y, R) = Y - R \tag{1.11}$$

and the return to the bank as:

$$\rho(Y, R) = min(Y, R) \tag{1.12}$$

with $R = (1 + r)L$, where r is the interest rate and L is the loan.

Stiglitz and Weiss demonstrate that whether the interest rate increases, the critical value of the number of borrowers below which borrowers do not apply for loans increases. So, in addition to the usual direct effect of increasing the interest rate, there is an indirect effect, acting in the opposite direction, that may outweigh the direct effect. The second way in which the interest rate affects the bank's expected return from a loan is by changing the behavior of the borrower. Stiglitz and Weiss consider two investment projects, "a" and "b", with $Y^a > Y^b$ and the probability of success $p^a < p^b$.

Increasing the rate of interest increases the relative attractiveness of riskier projects. Indeed, because:

$$[Y^a - (1 + r)L]p^a \leq [Y^b - (1 + r)L]p^b \tag{1.13}$$

from which:

$$(1 + r)L \leq \frac{p^b Y^b - p^a Y^a}{p^b - p^a} \equiv (1 + r^*)L \tag{1.14}$$

if the bank raises r above r^*, borrowers switch from project b to project a. The maximum expected return to a bank occurs when the bank charges r^*

if and only if:

$$p^aY^a < \frac{p^b(p^bY^b - p^aY^a)}{p^b - p^a} \tag{1.15}$$

De Meza and Webb (1987) build a model that demonstrates that when projects differ in their expected return, the return of the bank always increases in the interest rate because it is the worst borrowers who drop out first, so rationing cannot occur. This is a different scenario from Stiglitz and Weiss (1981). De Meza and Webb show that some sub-optimal investment projects are financed.

In their paper, they show that inability of banks to discover the characteristics of entrepreneurs' projects leads to more investment than is socially efficient. In their model, asymmetric information causes good projects to draw in bad, so that, in contrast with the traditional underinvestment result, there is too much investment.

In the model, all projects require the same initial investment, I. All projects have returns Y^s if successful and Y^f if a failure, with $Y^s > Y^f > 0$. Entrepreneurs have liquid funds to invest but can offer no collateral, unlike from Stiglitz and Weiss (1981). The probability of success is $p_i(Y^s) \in [0, 1]$. All entrepreneurs have initial endowment $A < I$, so additional finance must be raised. The value of default is $\delta = I - A$. The standard debt contract is $R_i = (1 + r_i)L$ when r_i is the interest rate. They assume:

$$Y^s > R_i > Y^f \tag{1.16}$$

The firm wants to maximize the expected profit:

$$E(\pi_i) = p_i(Y^s)(Y^s - R_i) \tag{1.17}$$

and it undertakes the project if

$$E(\pi_i) - (1+\gamma)A \geq 0 \tag{1.18}$$

where γ is the safe rate of interest. Banks are identically competitive and they have no information about firms' characteristics, but they know the distribution of the population of firms. For social efficiency, all projects which satisfy:

$$p_i(Y^s)Y^s + (1 - p_i(Y^s))Y^f \geq (1+\gamma)I \tag{1.19}$$

should be undertaken. All projects which have expected returns at least as high the safe return should be undertaken.

De Meza and Webb propose a simple policy that achieves a first best allocation, a tax on interest income. Banks in fact expect to break even on the marginal project, which is the least profitable. Their expected profits are positive at the social optimum. A tax on interest income will raise γ that banks must pay. The main difference with the Stiglitz and Weiss model is that the expected returns differ between projects. Moreover, in the De Meza-Webb model, the marginal project financed has the lowest success probability of those financed, while in the Stiglitz-Weiss model it has the highest.

1.2.1 Policy Indications

In their paper De Meza and Webb propose a tax on loans as a policy intervention to solve credit rationing. This is one of the few ways of increasing efficiency.

Ordover and Weiss (1981) analyze legal restriction on the terms of contracts and show the effect on allocative efficiency with reference to credit rationing. They also investigate what happens if a government prevents banks from denying loans to an entire class of borrowers. The problem is that banks may refuse to lend to a class of borrowers at any interest rate because their profit does not increase even if the interest rate increases. There are two reasons why bank profits may not rise. First, borrowers choose projects with higher probability of default. This is because the interest rate is not paid in very bad states of the world. This is the incentive effect of the interest rate. Second, borrowers who are deterred from borrowing by the high cost of capital may be better borrowers. Ordover and Weiss argue that if borrowers are risk neutral, the marginal borrowers are those who would have invested in safe projects, the most profitable loans for the bank. The expected profit of a borrower is an increasing function of the riskiness of his project, which is the opposite for a bank. Higher interest rates discourage safe borrowers and this sorting effect reinforces the incentive effect.

Collateral requirement also has similar adverse selection effects. Ordover and Weiss show a case in which the total returns on a loan are higher for an excluded than a financed group. This may happen because there is less information about the excluded group or because the higher return represents riskier projects. In this case, forcing banks to lend to all borrowers at same interest rate would increase the expected total returns per dollar loaned.

Mankiw (1986) argues that small rise in the riskless interest rate can lead to a large reduction in lending. This is because the increase in the free-risk rate forces up the loan rate, which reduces the average quality of borrowers. He demonstrates that government intervention enhances market efficiency, even if the government has no information about lenders.

In Mankiw's model, the project has future payment Y, p is the probability of repayment. A bank can invest in a safe asset and obtain γ, alternatively it can lend at the interest rate r. If the borrower defaults, the bank receives no payment. η is the average probability of repayment, the average of p. The expected return to the bank is ηr. The first equilibrium condition is $\eta r = \gamma$. A borrower borrows if $Y > pr$. If r increases, the borrowers driven out by the increase are those with high repayment probabilities. The market allocation is not fully efficient because there is information asymmetry over p.

Mankiw shows that a small credit subsidy has two effects. First, it increases the number of "good" borrowers who are persuaded to borrow. Second, it also increases the number of bad borrowers at an interest rate equal to the risk free rate, $r = \gamma$, which means that all socially productive investments are undertaken. But it is possible that the extra investment generated is not undertaken because it requires that $\eta r < \gamma$. This difference is made up by the government, and if it uses distortionary taxes to finance the program, the deadweight losses are an additional cost. The optimal rate r^* is never below the risk free return γ and it is generally strictly above the risk free rate. In the Mankiw model, the more heterogeneous the borrowers, the greater the positive effects of government intervention.

In a recent paper, Minelli and Modica (2003) show that the interest rate policy is more efficient than investment subsidy and it is optimal for all policies which the government can implement without using borrowers' private information.

1.3 Collateral Requirement

As we have seen, asymmetric information explains the existence of imperfections in credit markets. But asymmetric information is also a good justification for the use of collateral. In particular, collateral helps to solve the problems caused by asymmetries.

Stiglitz and Weiss (1981) also analyze the role of collateral. They show that when there is an excess demand for funds, the bank does not necessarily increase its collateral requirement. Indeed, an increase in the collateral requirement could increase the riskiness of the loans. They show that even if individuals have the same utility function, the sorting effect of collateral requirement could work in the same way as the interest rate. Stiglitz and Weiss assume that wealthier individuals are likely to be less risk averse. They are willing to take the greatest risks, and this effect is so strong that increasing collateral may lower the bank's return. They also assume that all borrowers are risk averse with the same utility function $U(A)$, with $U' > 0$ and $U'' < 0$, but they differ with respect to their initial wealth A_0. There exist two critical values of A_0 such that all individuals with $\widehat{A} < A_0 < A_0^*$ apply for loan. Each project that borrowers can undertake has a probability of success $p(Y)$, where Y is the return if successful. Each borrower has an alternative safe investment opportunity yielding the return γ^*. Stiglitz and Weiss normalize this so that the cost of all projects is 1. The individual borrows if and only if:

$$V_B(A_0) \geq V_0(A_0) \tag{1.20}$$

where $V_B(A_0)$ is the utility level from borrowing and $V_0(A_0)$ is the maximum between $U(A_0\gamma^*)$, the utility if the borrower does not borrow, and $\widehat{V}(A_0)$, the utility if borrower finances the entire project by himself. The main point is that with decreasing absolute risk aversion, wealthier individuals undertake riskier projects:

$$\frac{\partial Y_0}{\partial A_0} > 0 \tag{1.21}$$

The paper shows that collateral increases the bank's returns because:

$$\frac{\partial p(Y)}{\partial C} > 0 \tag{1.22}$$

but there is also an adverse selection effect from increasing collateral. Indeed, both the average and the marginal borrowers are riskier:

$$\frac{\partial \widehat{A_0}}{\partial C} > 0 \tag{1.23}$$

This adverse selection effect may more than offset the positive direct effect. But the adverse selection effect in the Stiglitz and Weiss model is limited to the cases where borrowers are risk averse.

Wette (1983) finds that increases in collateral requirements can result in

adverse selection even if borrowers are risk neutral. In order to show this, he considers the part of Stiglitz and Weiss's paper analyzing the adverse selection effect of increasing the interest rate. In this case, borrowers are risk neutral, no individuals have sufficient wealth to self-finance projects, and each borrower is allowed to undertake only one project. Wette's model differs from Stiglitz and Weiss (1981) because collateral C, rather than the interest rate r, is allowed to vary. Wette demonstrates that:
1) for given collateral C there is a critical value $\widetilde{\theta}$, where greater θ denotes greater risk, such that an individual borrows from the bank if and only if $\theta \geq \widetilde{\theta}$;
2) as the collateral requirement increases, the critical value of θ below which individuals do not apply for loans increases.
This implies that an increase in collateral unambiguously increases the cost and decreases the profit to the borrower. It means that some profitable projects at the initial level C, become unprofitable at the new, higher level of C. Wette demonstrates that the lender may not be willing to use collateral as a rationing device even when borrowers are risk neutral.

On the other hand, Bester (1985, 1987), shows that whether banks compete by choosing collateral and interest rate simultaneously rather than separately, no credit rationing occurs in equilibrium. This implies that different contracts are used as a self-selection mechanism. When borrowers are denied credit, they can apply for the contracts that are for less risky borrowers, and a credit rationing equilibrium pools *good* and *bad* borrowers. But if pooling occurs, there still exists a contract that attracts only *good* borrowers. In equilibrium, borrowers with high probability of default choose a contract with a higher interest rate and a lower collateral than borrowers with low probability of default.

In Bester's model, the cost of the investment I is fixed, so it cannot be used to obtain information. The return of the project is a random variable Y with distribution function $F(Y)$. Borrowers have the initial endowment $A < I$ and they borrow $L = I - A$. A credit contract $c = (r, C)$ is specified by the rate of interest, r, and the collateral, C. The collateralization is costly. The cost is a factor $k > 0$. The expected profit of borrowers is:

$$\pi_i(c) = E\left\{max[\widetilde{Y} - (1+r)L - kC, -(1+k)C]\right\} \quad (1.24)$$

The expected rate of return for the bank is $\rho_i(c)$, so, if i is the interest rate paid on deposits, the bank's net profit is $(\rho_i(c) - i)L$. The bank is unable to distinguish between borrowers, it can only offer a pair of different credit contracts, (c_α, c_β). Banks act as perfect competitors and they take i as given. Borrowers invest only if they receive a contract c such that:

$$\pi_i(c) \geq (1+i)A \quad (1.25)$$

Bester assumes that borrowers who want to invest first apply for their preferred contract, but if they do not obtain it, they may apply for the other contracts. Bester defines as λ_i, where $0 < \lambda_i \leq 1$, the fraction of firms that receive credit under c_j. In this model, credit rationing exists if a borrower faces a positive probability of being rejected at a contract c_j^* which maximizes his expected profit and at the same time $\pi_i(c_j) \geq (1+i*)A$.

Bester demonstrates that if $\left\{(c_\alpha^*, c_\beta^*), (\lambda_\alpha^*, \lambda_\beta^*), i^*\right\}$ is a market equilibrium and both contracts are demanded, then there is no rationing and both contracts are incentive compatible. Moreover, $i^* = \rho_a(c^*_\alpha) = \rho_b(c^*_\beta)$. If $k > 0$, ten $C^*_\alpha > C^*_\beta = 0$. Banks may use collateral requirement as a self selection mechanism if collateral has a cost. Indeed, if collateral does not have a cost, banks could raise r and C simultaneously along $C = (1+r)L$ and rationing disappears in equilibrium. In Bester's model collateral serves to reveal information about borrower risk levels.

A work similar to Bester (1985) is Besanko and Thakor (1987), but while Bester assumes that sufficient collateral is always available to achieve perfect sorting, Besanko and Thakor find that if borrower's endowment imposes a binding on collateral, $C_2 = A$, where C_2 is collateral requirement for high-risk borrowers, credit rationing may exist even with collateral. Indeed, they demonstrate that if collateral needed for self-selection exceeds A, it is insufficient to deter bad borrowers from choosing the low risk contract. This happens because the probability of being financed is no longer $p_2 = 1$ but $0 < p_2 < 1$. So Besanko and Thakor also find, like Bester, that when $C_2 < A$, collateral requirement leads to a sorting equilibrium without credit rationing. This result implies that when endowments are sufficiently large, credit rationing is eliminated.

Although it is not strictly related to credit rationing literature, the paper by Barro (1976) is interesting because it concerns the relation between transaction cost and collateral.

In Barro's model, collateral provides incentives to repay the debt and default implies that the property right to collateral is transferred to the lender. But the lender's evaluation differs from the borrower's evaluation because of cost of collection and other transaction costs.

Chan and Kanatas (1985) also focus on the different valuation of the borrowers' creditworthiness. They explore the role of collateral in a framework without moral hazard and adverse selection, in which borrowers are unable to take action that will alter the return to the lender. They show that if different valuations originate from asymmetric information, collateral has a signaling role. Chan and Kanatas also show that the amount of collateral requirement is an increasing function of the discrepancy between borrower and lender beliefs. If the lender's valuation is at least as high as that of the borrower and there exist collateral costs δ, collateral plays no role, but when the lender's valuation is lower than that of the borrower, collateral may play a role. This happens only if collateral costs are $0 < \delta < \widehat{\delta}$, where $\widehat{\delta}$ is the maximum level over which no collateral will be offered.

The original contribution of this work is that Chan and Kanatas link the equilibrium level of collateral with the difference in borrower-lender expectations. This means that the less "optimistic" the lender, the higher the collateral and the lower the loan rate. Since collateral costs are paid by borrowers in this model, borrowers are forced to reveal their information truthfully, so that borrowers with better quality projects offer more collateral.

1.4 Collateral Value

Several works have contributed to developing a theory of collateral tied to the value of the assets. This theory is another possible explanation for credit rationing.

Williamson (1988) develop a model that predicts that assets which are redeployable also have high liquidation value because they are good candidates for debt finance. When they are managed improperly, the manager will be unable to pay the debt, and then creditors will take the assets away from him and redeploy them. Williamson demonstrates that redeployability is an important determinant of liquidation value and debt capacity, and he shows that if asset specificity becomes high, then asset redeployability becomes low. He shows that since the value of collateral decreases as the degree of asset specificity increases, the firm may sacrifice more specialized investment in favor of greater redeployability. Williamson does not address the problem of specialized assets because he concentrates his attention on the choice between debt or equity structure.

Shleifer and Vishny (1992) analyze the price of non-redeployable assets in liquidation relative to their value in best use. Shleifer and Vishny find that a firm in financial distress sells its assets at prices below value in best use. In particular, they analyze what prices non-redeployable assets fetch in liquidations relative to their value in best use. They call this difference between price and value in best use "asset illiquidity". The main point of Shleifer and Vishny model is that when firms have trouble in repaying their debts, the highest valuation buyers of distressed assets are not other firms in the industry which have problems themselves, but outsiders with high costs of running the assets. So when industry buyers cannot buy the assets, and industry outsiders are faced with the high cost of managing them, assets in liquidation fetch below value in best use.

The Shleifer and Vishny approach implies that liquidated assets are under priced in recession. The novelty of their model is that no other researchers have focused on the "general equilibrium" factors that determine which assets are liquid.

In the model there are two firms, and two future states of the world, prosperity "p", and depression "d". In prosperity, each firm has a negative net present value (NPV) project to undertake. Investors do not want firms to undertake the negative NPV and they create a debt overhang with a combination of short and long term debts. But the debt that keeps firms from investing in prosperity also keeps them from buying the assets of the liquidating firms in the recession. There are three periods, 0, 1, and 2. Capital structure is determined in period 0, and uncertainty about the state of the world is resolved in period 1. In period 2, additional cash flows are received. Shleifer and Vishny assume that in prosperity the firms are completely symmetrical, but in depression one firm is hit harder than the other with a low cash flow. Moreover, they assume that insider firms have higher cash flows from assets than outsider firms, while outsiders have no debt overhang.

Considering the capital structure of the selling firm, if R is the future payoff from the investment, I is the cost of investment, and Y is cash flow from existing assets, they assume:

$$R^p < I^p \tag{1.26}$$

This represents the agency problem. Without it there is no need to use debt in the model.

$$Y_1^d < Y_1^p - I^p \tag{1.27}$$

$$Y_1^p + Y_2^p + R^p - I^p > Y_2^d + Y_1^d \tag{1.28}$$

The last two equations say that prosperity is always better than depression. Since the debt overhang is used to keep firms from investing, the debt level has to be:

$$I^p > Y_1^p - D_1 \tag{1.29}$$

$$I^p - Y_1^p + D_1 > Y_2^p + R^p - D_2 \tag{1.30}$$

So the debt levels which keep firms from making the negative NPV investment are:

$$D_1 = Y_1^p - I^p + \epsilon \tag{1.31}$$

$$D_2 = Y_2^p + R^p + \delta \tag{1.32}$$

The need to go to capital markets in prosperity implies the inability to pay debt in depression:

$$Y_1^d < D_1 \tag{1.33}$$

$$D_1 - Y_1^d > D_2 - Y_2^d \tag{1.34}$$

From these conditions it is possible to determine the price at which the firm is liquidated in depression:

$$L_d = Y_2^d - \frac{P^p}{P^d}(I^p - R^p) \tag{1.35}$$

where P^p and P^d are the probability of prosperity and depression. The liquidation value is below the cash flow of the second period because of the debt overhang.

The buyer's analysis is parallel to the seller's but it changes in the assumption:

$$0 < y_1^d - y_1^p + i^p < C_{out} < C_{ins} \tag{1.36}$$

where C_{out} and C_{ins} are future cash flows that are generated by, industry outsiders and insiders respectively.

The key condition of the model is:

$$l^d < (y_1^d + y_2^d) - (y_1^p + y_2^p + r^p - i^p) + C_{ins} \tag{1.37}$$

This implies that the maximum price that the buyer can pay to the seller is strictly lower than the cash flow, and i depends on debt overhang. The buyer can buy the liquidating firm only if the price is below l^d. When l^d is below C_{out}, the firm is sold to the outsider with a lower valuation but without credit constraints.

The Shleifer and Vishny model predicts that cyclical and growth assets are therefore poor candidates for debt finance, unless they are readily understood by deep pocket investors outside the industry.

Kiyotaki and Moore (1997) emphasize how shock to technology or income distribution can generate persistent fluctuation in output and asset prices. In their model, unlike Shleifer and Vishny (1992), assets are perfectly redeployable. In Kiyotaki and Moore, credit constraints arise because lenders cannot force borrowers to repay their debts unless the debts are secured by collateral. The collateral is a proportion of the future returns from present investment. In this framework, durable assets are not only factors of production, but they also serve as collateral for loans. Kiyotaki and Moore show that the credit limits of productive agents are determined by the value of collateralized fixed assets. At the same time, the asset price is affected by the size of the credit limit. The idea is that bad times for the economy will also be times when the liquidation value of collateral is low, since potential buyers of these assets will be constrained. This leads to low debt capacity in bad times, which further reinforces the bad times, causing collateral values to fall, and so on. Kiyotaki and Moore describe this as a collateral amplification mechanism. When the forward-looking agents expect that the temporary productivity shock will persistently reduce the aggregate output, the investment and marginal product of the fixed asset in future, the present asset price falls significantly. Thus, the share of investment of productive agents, aggregate productivity and aggregate investment fall even further, and take time to recover. Through the value of the fixed asset, therefore, persistence and amplification reinforce each other. It is interesting to note that uncertainty about the demand for assets plays no role.

While in Shleifer and Vishny financial intermediaries play no explicit role, Araujo and Minetti (2003) propose a theory of financial intermediaries as internal market for corporate assets. Their theory shows that intermediaries can mediate not only between savers and firms at the investment stage, but also among firms at the restructuring stage, acting as efficient redeployers of their capital. But intermediaries can perform their role as internal markets for assets only if they have written debt contracts with firms that allow them to repossess assets if firm defaults. Indeed, information acquisition on assets is attractive for intermediaries only if they have the right to repossess assets. However, debt has a cost in capital reallocation because distressed firms are the best users of assets. Collateral is typically used to secure business loans. When this collateral is a productive input for business, aggregate conditions have a direct effect on collateral values and therefore on the debt capacity of individual.

Collateral value is linked to the problem of the creditor protection. Because the collateral can be seen as an instrument for disciplining the behavior of the debtors, the stronger the protection that creditors obtain via collateral, the more abundant and cheaper credit for entrepreneurs. The perceived cost of the sanctions does not depend only on the lender's willingness to inflict them, but on the entire set of institutional arrangements governing the credit market. The papers by La Porta, Lopez de Silanes, Shleifer and Vishny (1998) , Manove, Padilla, and Pagano (2001) and Jappelli, Pagano and Bianco (2005), among others, explore the impact of the judicial enforcement of debt contracts on credit market.

Krishnamurthy (2003) suggests that an important limitation to hedging is the credibility of insurance suppliers. Under the constraint that insurance suppliers must also post collateral to guarantee any obligations, the depth of insurance markets is constrained by the value of collateral. Krishnamurthy's main finding is that amplification effects are preserved even in the presence of insurance markets, but the relevant collateral constraint shifts from borrowers to insurance suppliers.

1.5 Empirical Evidence

The empirical literature on the role of collateral in reducing credit rationing shows that leverage increases with fixed assets (Rajan and Zingales (1994), Johnson (1997) and Cassar and Holmes (2003)).

Several papers investigate empirically the role of real assets as collateral with reference to their degree of tangibility. In fact, the more tangible and generic the assets are, the easier the access to finance (Titman (1984), Titman and Wessels (1988), Harris and Raviv (1991), Storey (1994), Berger and Udell (1998)).

To explain the effect of real assets as collateral in the economy, many papers (Suzuki and Wright, (1985), Hoshi, Kashyap and Scharfstein, (1991), Chirinko and Schaller, (2001)), focus on the role of land as collateral. They are mainly from Japan, because land is the main form of guarantee for Japanese corporate borrowing.

Ogawa and Suzuki (1998) use a panel data set of Japanese firms to compare the role of land as collateral between firms in industrial groups and independent firms. They investigate empirically whether land as collateral is more effective at reducing agency costs for firms which are not in a group. They find that credit conditions are affected by the value of land assets and that borrowing is less constrained for the firms in the groups. However, the marginal contribution of land to mitigating borrowing constraints is not statistically different between the two types of firms.

Moving on from the Kiyotaki and Moore model, Gan (2003) estimates the effect of real assets as collateral on the economy. He shows what happens if there is a shock to the collateral value. In fact, commercial and industrial loans are largely made on secured bases and most of the collateral, like machinery and land, are also inputs into the production process. When the capital market is imperfect and when loans are collateralized, the amount borrowed is determined by the value of the collateral, and a decrease in the price of productive assets will also have a negative impact on investment. According to Kiyotaki and Moore, this effect is cumulative. Gan underlines that there are two main difficulties in empirically testing the relationship between collateral and firm investments. First, the value of collateral often is not observable due to the lack of active secondary markets for collateralized assets. Second, collateral is endogenous. Gan shows how the collapse in land prices in Japan in the 1990s affected subsequent corporate investments. He thus solves the problem of observability, because there is an active market, and the problem of endogeneity, because he focuses on a source of variation in collateral that is exogenous. In addition to the investment analysis, Gan investigates whether collateral losses also lead to reduced borrowing capacity.

He finds that collateral affects Japanese firm investments in two important ways. The first is a collateral-damage effect: losses in collateral value reduce a firm's borrowing capacity and the firm responds by cutting back on its investments. The second is an indirect internal-liquidity effect: with reduced borrowing capacity, the firm has to rely more upon internally generated cash to finance its investments. Firms with larger land holdings become financially more constrained and have to rely more on internally generated cash. Thus, land-holding companies should have higher investment sensitivities to internal liquidity. According to Kiyotaki and Moore (1997), reduced collateral value leads firms to underinvestment.

In contrast, Jensen (1986) and others have argued that if managers prefer growth over profitability, they may invest free cash flow in negative net-present-value projects. According to this view, land holding companies may have taken advantage of the price run-up in the 1980s and borrowed excessively to finance projects.
As evidence of the importance of the collateral effects, he finds that they affect both major and ordinary investments. Using matched firm-bank data and hence controlling for the unobservable heterogeneity of the loan supply, he finds that banks tend to lend less to those who suffer greater collateral losses.

Another paper which studies the links between asset prices and investment is by Goyal and Yamada (2004) in which they examine how asset price shocks influence investment and the cost of external financing. A common view is that when stocks are overpriced, it becomes less costly for firms to access external capital markets, which increases investment spending, even though. Empirical evidence shows however, that this effect is not unambiguous. Goyal and Yamada find that investment of firms that rely more on bank financing and hold large amounts of marketable collateral responds more significantly to market valuations. They suggest that asset price shocks have more pronounced effects on bank-dependent firms with large collateralizable assets than on those that rely on equity and equity-linked debt markets. Another important result is that cash-flow sensitivity responds significantly to asset price shocks and changes in monetary policy. Bank-dependent firms that face severe erosion in their collateral values show the largest increase in cash-flow sensitivity.

Maksinovic and Phillips (1998) prove empirically that the decision to sell and close plants depends on industry demand and capacity utilization, which determine the opportunity cost of the assets. The value of reorganizing is highest when industry growth is highest. Their approach differs from Shleifer and Vishny because the optimal distribution of assets changes with demand. They find that the proportion of plants is more than three times higher in declining industries than in high-growth industries. However, the productivity of plants in declining industries does not significantly decrease relative to their industry counterparts. Thus, Maksinovic and Phillips find no evidence of any bankruptcy costs in these industries.

These empirical results show that assets are more likely to be sold when the economy is undergoing positive demand shocks, when the assets are less productive than their industry benchmark, when the selling division is less productive and when the selling firm has more productive divisions in other industries.

Maksinovic and Phillips also analyze the factors that are associated with the probability that assets transfer ownership. In particular, the probability that assets are sold is higher for peripheral divisions. The probability is also higher when the selling firm is less productive and there is a positive demand shock in the industry. They also find that the probability that a firm is a buyer of additional assets increases with its efficiency and size. Much of the empirical literature in fact indicates that firm characteristics can influence credit rationing. These characteristics include age (Diamond (1989), Leeth and Scott (1989)), size (Gertler and Gilchrist (1994)), and the type and the length of the relationships with the bank (Boot and Thakor (1994), Berger and Udell (1995), Fazzari et al. (1987), Petersen and Rajan (1994)).

Menkhoff, Neuberger, and Suwanaporn (2006) analyze the case of Thailand. They consider as loan contract variable the collateral value, which is defined as the collateralized percentage of the line of credit granted, by using the internal evaluation of the collateral liquidation value on which banks base their lending decisions, and the total credit line volume. The line of credit includes all forms of credit that a bank grants to its customers. They analyze the factors that influence collateral decisions of Thai banks. They find that 72% of the loans are made on a secured basis, and the mean collateral value is 52.95%. The incidence of collateralization tends to decrease with firm size. Thai banks demand collateral more often and to a higher degree than their counterparts in developed markets. Menkhoff, Neuberger, and Suwanaporn find that housebanks require significantly more collateral than other banks. Their finding for developed markets that collateralization depends on relationship variables, especially bank status, is also confirmed for the Thai banking sample. The collateralization of Thai bank loans is mainly affected by the age and size of the firm and by the incidence of relationship lending, while the direct risk variables are of less importance. They also find that the role of collateral in reducing credit risk is higher in smaller firms, and relationship lending with high collateral requirements of house-banks plays a larger role for the financing of small firms. Larger firms are more likely to obtain uncollateralized loans, because they have higher bargaining power towards each bank because they borrow from several banks.

There are also papers that investigate collateral value with regard to High-Tech (H-T) firms. In H-T sorting out good and bad projects is more difficult than in more traditional sectors. This is because H-T firms have no incentive to communicate information on their innovative projects (Bhattacharya and Ritter (1983)), and because the intermediaries prefer to secure their loans with physical assets.

Guiso (1998) finds that for Italian small and medium enterprises there is evidence that banks cut credit to the most innovative firms, although this does not appear to depend on the amount of collateralizable assets.

Carpenter and Petersen (2002) investigate the effects of capital market imperfections on US firms in H-T industries. They find that small and medium sized enterprises make little use of debt finance, and one reason for this is that high-tech investments have limited collateral value. In fact, *R&D* investment has low salvage value in the event of failure.

1.6 Conclusions

This paper considers credit rationing with regard to adverse selection problems, reviewing some classical papers on this topic. As these papers emphasize, adverse selection derives from the fact that, as interest rates increase, better borrowers often switch to riskier projects, which reduces the expected lender profit.

Developing this theme, the paper focuses on those works that investigate the role of collateral in reducing asymmetric information between borrowers and lenders.

It emphasized that credit rationing can be reduced by the use of collateral, and surveys works on the value of collateral and its link to the liquidation price of assets.

Finally, the paper presents some empirical works.

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2. CREDIT RATIONING AND ASSET VALUE

2.1 Introduction

This paper discusses credit rationing which exists when lenders fix an interest rate on loans and then supply a smaller loan size than that demanded by borrowers. It means that some borrowers are constrained by fixed lines of credit which they must not exceed under any circumstance, while others are refused loans altogether.

In recent years a large and growing number of theories have been proposed to explain credit rationing. Many economists have linked it to problems of imperfect information, and my paper thus investigates the role of real assets in diminishing asymmetric information.

When loans are collateralized and firms are credit constrained, the amount borrowed is determined by the value of collateral.

I combine a credit rationing model with the idea that firms' debt capacity and investments are linked to the value of assets in case of distress.

In my model the extent of credit rationing is linked to the value of distressed assets, and is thus mitigated by the existence of *bad* firms.

My main contribution is to show how each *good* firm derives positive externalities from the existence of *bad* firms. This is because the optimal leverage of firms depends on the possibility of repurchasing the assets. The liquidated assets may or may not be under priced, and this depends on the quantity of *bad* firms.

In my work, I endogenize the price of assets, which depends on whether there are firms to repurchase them. This is linked to the number of *bad* firms in the economy as well as to the liquidity of *good* firms. This implies that it is possible to have a separating equilibrium in the model only if there exists a number of *bad* firms that go bankrupt and if there exists a number of *good* firms with sufficient liquidity.

My model differs from other papers in the literature, discussed in the next section, because debt overhang originates from the absence of initial cash and not from an agency problem. I investigate what happens if a small firm has to invest without initial cash. The debt overhang here is a consequence of investment and does not depend on decisions of investors who would like to keep the firm from undertaking a negative net present value project.

I consider only projects with a positive net present value, and I assume that assets have value only for other firms in the industry.

Finally, my model also includes financial intermediaries, acting as sellers of the assets of failed firms.

The paper is organized as follows: Section 2 presents a brief review of the literature, Section 3 describes the model, Section 4 shows the effects of policy interventions on the equilibria, and the last Section concludes.

2.2 Related Literature

The two seminal works on this subject are Jaffee and Russell (1976), which demonstrates how credit rationing arises as a means of market response to adverse selection, and Stiglitz and Weiss (1981), which shows that credit rationing can be an equilibrium phenomenon if either the lender is imperfectly informed about the borrowers, or the lender is unable to directly control the borrowers' behavior. In fact, when the interest rate affects the nature of the transaction, it may not clear the market.

Stiglitz and Weiss show that higher interest rates lead firms to undertake projects with lower probabilities of success but higher payoffs when successful. So higher interest rates do not necessarily lead to higher profits when banks have an excess demand for credit.

The interest rate is not the only term in debt contracts.

Bester (1985, 1987) shows that no credit rationing will occur in equilibrium if banks compete by choosing collateral requirements and the rate of interest to screen investors' riskiness. Banks may use contracts with different collateral requirements as a self-selection mechanism.

Other works have developed a theory of collateral linked to the value of assets. There are two main papers. The first is by Williamson (1988) in which he shows that redeployable assets also have high liquidation value because they are good candidates for debt finance. When assets are managed improperly, the manager will be unable to pay the debt, and creditors will take the assets away from him and redeploy them. Williamson demonstrates that redeployability is an important determinant of liquidation value and debt capacity. He also shows that if asset specificity becomes high, then asset redeployability becomes low. Williamson does not address the problem of specialized assets.

The second main paper is by Shleifer and Vishny (1992), in which they analyze the price of non-redeployable assets in liquidation relative to their value in best use. They show that a firm in financial distress tends to sell its assets at prices below value in best use. Shleifer and Vishny call this difference between price and value in best use, "asset illiquidity". The main reason for asset illiquidity is the general equilibrium aspect of asset sales. When firms cannot repay the debt and sell assets, the highest valuation potential buyers are likely to be other firms in the industry. But where these firms are in difficulty themselves, they are unlikely to be able to raise funds to buy the distressed assets. When industry buyers cannot buy the assets and industry outsiders face significant costs of acquiring and managing the assets, assets in liquidation fetch prices below value in best use.

In Kiyotaki and Moore (1995), durable assets also serve as collateral for loans. Kiyotaki and Moore show that borrowers' credit limits are affected by the prices of the collateralized assets, and these prices are affected by the size of the credit limits in turn. The idea is that bad times for the economy are times when the liquidation value of collateral is low, since potential buyers of these assets are constrained. This leads to low debt capacity, which further reinforces the bad times, causing collateral values to fall, and so on. Kiyotaki and Moore describe this as a collateral amplification mechanism.

Araujo and Minetti (2003) propose a theory in which financial intermediaries operate as an internal market for corporate assets. But intermediaries can perform their role as internal markets for assets only if they have written debt contracts that allow them to repossess assets if a firm defaults. Debt, however, has a cost in capital reallocation, because distressed firms are the best users of assets.

2.3 Model

The model has three periods, 0, 1 and 2. There are banks and firms. Each firm is one of two types, *good* or *bad*, which are represented in the economy in proportions $(1 - q)$ and q.

There are two possible states of the world, prosperity p with probability $0 < s < 1$ and depression d with probability *(1-s)*, and uncertainty about the state is resolved in period 1.

At initial date 0, firms want to invest a fixed amount I in a project that generates future cash flow y in each of the two subsequent periods. No firm has liquid funds, but each firm owns an amount A of collateralizable wealth, where A cannot be used to finance investment directly because it consists of illiquid assets. Hence, the firm must borrow the entire amount I by issuing debt in period 0. This generates the *debt overhang* for firms in period 1.

The cash flows from the investment are y^i_{tj}, where t=*1,2;i=p,d;j=G,B*. The subscripts t and j indicate the period and the type of firm (*Good* or *Bad*), the superscript i indicates the state of the world, p (prosperity), and d (depression). I assume that the cash flow is constant across periods:

$$y^i_{1j} = y^i_{2j} \tag{2.1}$$

and that

$$y^d_{tG} = y^p_{tG} = y^p_{tB} = y > y^d_{1B} = 0 \tag{2.2}$$

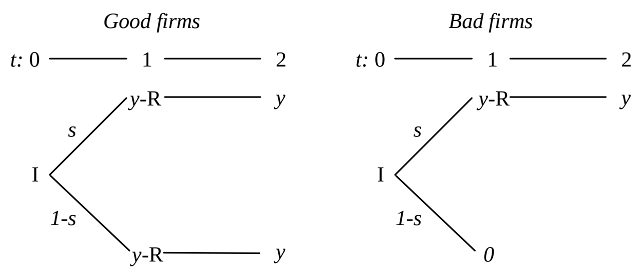
which means that *good* firms are always able to generate y from the investment, whereas *bad* firms can do this only in prosperity.

All firms have access to the same technology. The only difference between the two types is that they have different levels of "capability" to generate revenue in depression.

I assume that the Net Present Value of the project is positive even for bad firms:

$$sy - I \geq 0 \tag{2.3}$$

The diagrams below summarize the payoff structure:



The financial sector consists of many intermediaries that are in competition, like firms. Lenders decide the contract terms at date 0. Entrepreneurs borrow I at date 0 and promise to repay R at date 1.

In period 1 each firm has to repay its debt, which is a necessary condition to reach period 2. R can be seen as a cost that the entrepreneur pays to move into period 2.

I assume that in prosperity all firms can pay R, whereas in depression only *good* firms can. All firms are the same size but they have different levels of "capability". In the model, q are *bad* firms because they do not repay debt in depression:

$$y^d_{1B} = 0 \tag{2.4}$$

and $(1 - q)$ are *good* firms and have a positive cash flow even in depression:

$$y > 0 \tag{2.5}$$

The ability to pay debt is a signal for banks, because although they have no opportunity to observe capabilities, they can observe which firms fail. They can thus decide if assets have to be liquidated or not. The liquidated assets are resold on the market and are bought by firms with sufficient liquidity. *Good* firms expect an additional cash flow $y_j = y^i_{tj} = y$ if they purchase the distressed assets. So, if the asset value is pA, the condition for firms to be willing to purchase assets is:

$$y - pA \geq 0 \tag{2.6}$$

from which we obtain the equilibrium price of assets if there is competition between firms:

$$p^c = \frac{y}{A} \tag{2.7}$$

For lenders, the return on the loan depends on different firms' capability. Their expected return is:

$$E(b) = s\,[qR + (1-q)R] + (1-s)(1-q)R \tag{2.8}$$

if $R \leq y$

Indeed, in prosperity, banks will obtain the payment of the debt from all firms:

$$[qR + (1-q)R] = R \tag{2.9}$$

In depression, the amount will depend on distribution of abilities, so only *good* firms repay debt:

$$(1-q)R \tag{2.10}$$

The assets of failed firms are resold on the market. The value of these assets depends on whether there are other firms in the industry standing by to repurchase the assets in case of distress. In my model I consider industry-wide shocks, but some firms are hit harder than others and it depends on capabilities. So the asset value depends on liquidity of *good* firms in period 1.

Following Shleifer and Vishny (1992), I do not allow renegotiation of the firm's debt contract once the state of the world is revealed and the purchase opportunity becomes available. This assumption implies that good firms cannot obtain new loans in period 1 to buy distressed assets.

Debt overhang precludes the firm from raising capital, so the necessary condition in order for firms to be able to purchase the distressed assets is:

$$y - R \geq pA \tag{2.11}$$

The price above which there is no market is thus:

$$\bar{p} = \frac{y - R}{A} \tag{2.12}$$

Remark if there is a perfectly efficient market, $pA = y$ and *(2.11)* is never satisfied.

The overall liquidity surplus will be:

$$(1 - q)(y - R) \tag{2.13}$$

so, the quantity of demanded assets will be:

$$A^D = \begin{cases} \frac{(1-q)(y-R)}{p} & \text{if } p \leq \frac{y-R}{A} \\ 0 & \text{if } p > \frac{y-R}{A} \end{cases}$$

and the quantity of sold assets will be:

$$A^S = qA \tag{2.14}$$

which depends not on price, but on the number of failed firms. So, in equilibrium we have:

$$\frac{(1-q)(y-R)}{p} = qA \tag{2.15}$$

from which:

$$\hat{p} = \frac{(1-q)(y-R)}{qA} \tag{2.16}$$

If $\hat{p} > \bar{p}$, *good* firms do not buy distressed assets because the cost is too high. Thus we have a market if and only if:

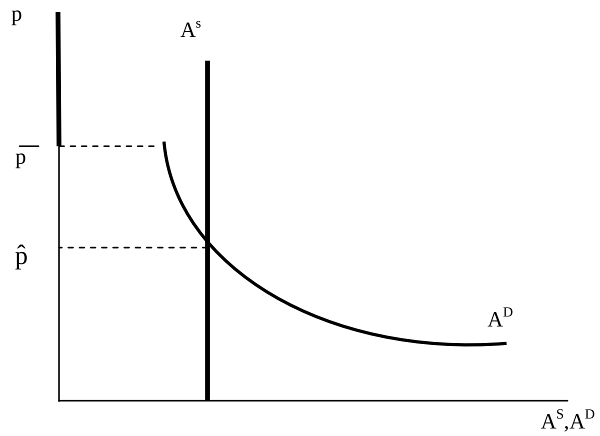
$$y - R \geq \hat{p}A \tag{2.17}$$

From which, we can obtain $q*$, the proportion of *bad* firms under which there is no assets market:

$$q* = \frac{1}{2} \tag{2.18}$$

Graphically:

Fig. 2.1:



At the level $\hat{p}$ the quantity of demanded assets is:

$$A^D = (1 - q)A \qquad (2.19)$$

When $q < \frac{1}{2}$ there is no equilibrium in the market because $A^D > A^S$

2.3.1 Without collateral

In this framework of adverse selection, I analyze two different cases. The first is where contracts do not require a collateral, and the second is where they do. This section discusses the benchmark case, where contracts do not require collateral.

The firm will pay R if the investment return is positive, *0* otherwise. In depression, when firms fail, they can resell their assets in bankruptcy, but they incur a private cost $0 \leq \delta < 1$. The idea is that if *bad* firms resell their assets on the market directly, they do not obtain the whole value, because they sustain costs. The smaller δ is, the greater costs are.

Given our assumptions, the overall cash flow from the project is:

$$Y = 2y \tag{2.20}$$

In fact, I hypothesize that the cash flows from period 1 and period 2 are the same. In depression, the probability that R will be paid depends on distribution of abilities between firms. It is now possible to determine the payoff structure of the firms.

The expected payoff of *bad* firms will be:

$$u_B = s(Y - R) + (1 - s)\delta p_e A \tag{2.21}$$

The expected payoff of *good* firms will be:

$$u_G = s(Y - R) + (1 - s)(Y - R + y - p_e A) \tag{2.22}$$

if there exists a market for the assets, $p_e \leq \bar{p}$. In fact, y is the additional cash flow that derives from buying distressed assets, and $p_e A$ is their cost.

If the bank knows the type of firm, it can ask for two different levels of R, the amount of debt in case of success of the investment. These different levels result from the number of firms of the different types and from the probability of depression. For *bad* firms, because the probability that R will be paid is lower and this depends on the probability of prosperity, we have:

$$R_B = \frac{I}{s} \tag{2.23}$$

For *good* firms, R will be:

$$R_G = I \tag{2.24}$$

So, $R_G \leq R_B$.

But lenders cannot distinguish the type of firm that benefit from loan. They only know that there are $(1-q)$ solvent firms and q insolvent firms, so they offer only one contract that provides a single R, and they decide whether to finance all or nothing. They will finance all firms if:

$$[sq + s(1-q) + (1-s)(1-q)]R \geq I \tag{2.25}$$

But perfect competition in loans market drives the interest rate down, so that condition 2.25 holds with equality in equilibrium:

$$[sq + s(1-q) + (1-s)(1-q)]R = I \tag{2.26}$$

from which we can calculate R^{NC},(no collateral):

$$R^{NC} = \frac{I}{[s + (1-s)(1-q)]} \tag{2.27}$$

2.3.2 With collateral

In this section I suppose that banks require some type of collateral on loans. The target is to lead the *good* firms to signal their quality. The lender may request initial assets as collateral, and if a firm does not repay R, the bank can resell these assets on the market. The collateral thus consists of the assets of the firm at date 0, when they apply for a loan. The firm loses A when it goes bankrupt and offers collateral to the bank, but if it does not sign the contract with collateral requirement, it can sell its assets on the market, although it pays costs δ. *Good* firms will supply collateral, because their failure probability is 0. The bank expected payoff from financing a *good* firm is the same as without collateral:

$$sR + (1-s)R \tag{2.28}$$

The expected payoff of *good* firms is not the same because they can now buy distressed assets either directly from failed firms or from banks. I suppose that the acquiring firm is indifferent between buying assets directly or from the bank. *Bad* firms have an incentive to obtain a contract aimed at *good* firms in cases where the payoff for bad firms is greater, even though they have to provide collateral. I suppose that banks offer two distinct contracts, (R_G, pA) and $(R_B, 0)$, trying to separate types. This pair of contracts has to satisfy these incentive compatibility and individual rationality constraints:

$$s(Y - R_G) + (1-s)(Y - R_G + y - pA) \\ \geq s(Y - R_B) + (1-s)(Y - R_B + y - pA) \tag{IC.G}$$

$$sR_G + (1-s)R_G \geq I \tag{IR.G}$$

$$s(Y - R_G) - (1-s)pA \leq s(Y - R_B) + (1-s)\delta pA \tag{IC.B}$$

$$sR_B \geq I \tag{IR.B}$$

$IR.G$ and $IR.B$ are satisfied with equality in the hypothesis of perfect competition on credit market. $IC.B$ is also satisfied with equality. But assume $IC.B$ is not satisfied with equality. The bank can clearly increase returns to *good* firms by reducing R_G. The original situation was thus not profit maximizing.

This system has solutions:

$$R_G = I \tag{2.29}$$

$$R_B = \frac{I}{s} \tag{2.30}$$

$$pA = \frac{I}{(1+\delta)} \tag{2.31}$$

pA is the minimum value of the collateral in order for it to be effective, but because it is determined endogenously, we have to calculate the minimum price under which the collateral does not work. This price is:

$$p* = \frac{I}{(1+\delta)A} \tag{2.32}$$

The higher is the ratio I/A, the greater is $p*$ because it increases risk for the lender. Moreover, $p*$ depends on the private cost that firms incur in selling assets. If δ rises, the *bad* firms have more opportunity to pretend to be good. $p*$ is the lower bound of the separating equilibrium area. If:

$$\hat{p} < p* = \frac{I}{(1+\delta)A} \tag{2.33}$$

this means that the price in the assets market is below the lower bound, so collateral requirement is not sufficient to separate the types and *bad* firms have an incentive to pretend. Under all the same conditions, the price $\hat{p}$ will decrease if the number of *bad* firms increase. So, the greater q is, the greater the probability is that *bad* firms pretend.

Proposition 1: If the asset price is too low, no separating equilibrium exists.

Proof. Suppose yes, so the lender offers two contracts, $C_1 = (R_G, \hat{p}A)$ and $C_2 = (R_B, 0)$, but because $\hat{p} < p*$, *bad* firms also want C_1. In this case, $IC.B$ is not satisfied and all firms sign C_1.

If the assets value is so low that does not offset the advantage of pretending, the requirement for collateral is not sufficient to have a separating equilibrium.

It is not possible to have the separating equilibrium even if:

$$\hat{p} > \bar{p} = \frac{y-R}{A} \tag{2.34}$$

In fact, because $\bar{p}$ is the upper bound of the separating equilibrium area, if $\hat{p} > \bar{p}$, $A^D(p) = 0$. So, the requirement of collateral is not sufficient to produce a separating equilibrium.

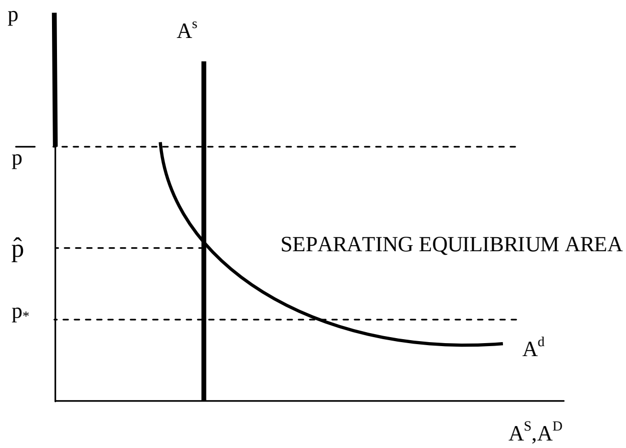
Proposition 2: if the asset price is too high, the separating equilibrium exists only for $pA = \bar{p}A$

Proof. If the lender offers two contracts, $C_1 = (R_G, pA)$ and $C_2 = (R_B, 0)$, because $\hat{p} > \bar{p}$, the assets market does not exist and $C_1 = C_2$.

But because at $\hat{p} = \bar{p}$ we have $A^D > A^S$, the lender can always sell the assets at $\bar{p}$. So, it offers two contracts $C_1 = (R_G, \bar{p}A)$ and $C_2 = (R_B, 0)$

The necessary condition to have the separating equilibrium is that $p* < \hat{p} \leq \bar{p}$

Fig. 2.2:



When the collateral is not sufficient to achieve the separating equilibrium, banks offer only one contract without collateral, such that:

$$sR + (1 - s)(1 - q)R = I \tag{2.35}$$

from which:

$$R = R^{NC} = \frac{I}{[s + (1 - s)(1 - q)]} \tag{2.36}$$

Good firms pay more with this contract if:

$$R > R_G \tag{2.37}$$

that is:

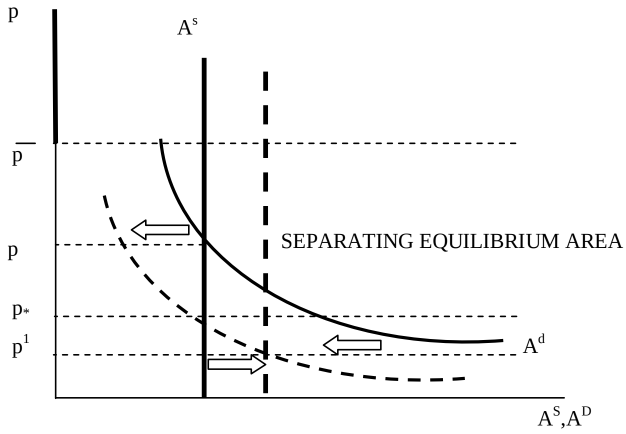
$$\frac{I}{[s + (1 - s)(1 - q)]} > I \tag{2.38}$$

which is $\forall q > 0$

This shows that *good* firms always pay more if banks do not separate. But with this contract, *bad* firms pay less and *good* firms pay more than with two different contracts. As in the original Jaffee and Russell (1976), and Stiglitz and Weiss (1981) papers, *good* firms subsidize *bad* firms.

If the number of *bad* firms compared to the number of *good* firms increases, this reduces the liquidity of the system and increases the supply of assets. The combination of these two effects reduces the asset price. If $\hat{p}$ is less than $\bar{p}$, the existence of a market for distressed assets is guaranteed, but there is no guarantee that the demand for collateral is effective. In fact, if q increases so much that the price falls below p *, the collateral is useless.

Fig. 2.3:



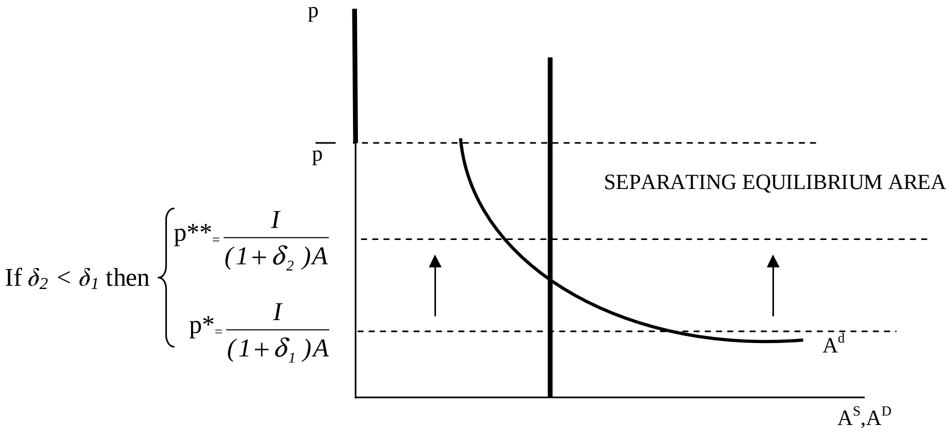
In order for there to exist a separating equilibrium, there must be a number of *bad* firms in the system. The existence of inefficient firms has positive externalities because helps to create the assets market and to create a more efficient equilibrium.

If δ decreases, the cost that *bad* firms must pay in order to resell their assets if they go bankrupt increases. So *bad* firms have more incentive to demand the same contract as *good* firms. If $\hat{p}$ is smaller than p *, the price is not sufficient to compensate *bad* firms for choosing their contract. If private costs are high, it is more likely that the separating equilibrium does not exist.

2.4 Government Intervention

De Meza and Webb (1987) examine the effects of asymmetric information on aggregate investment and the financial structure of firms and they show that imperfect information leads to more investment than is socially effi-

Fig. 2.4:



cient. This result conflicts with the traditional underinvestment noted by Stiglitz and Weiss. While Stiglitz and Weiss propose a usury law to solve market failures, De Meza and Webb suggest a tax. But De Meza and Webb move from a different scenario in which the expected returns differ between projects. Moreover, in their model, the marginal project financed has the lowest success probability of those financed, while in the Stiglitz-Weiss model it has the highest. Beyond these, there are few works that indicate policy interventions to correct market failure.

Minelli and Modica (2003) show that, where the banking sector is not competitive, the interest rate policy is better than investment subsidy. It is also optimal in the class of all policies which the government can implement without using borrowers' private information. Minelli and Modica propose an alternative model in which the government places collateral to guarantee the bank in a separate fund. The bank obtains the collateral only if the firm fails, otherwise the funds go to the firm.

In this section I want to show the effect of government intervention on my simple model. I consider the two most widely used policy instruments, the interest rate and investment subsidies. I first suppose the government wants to finance a fraction of investment, and secondly that it wants to fix the interest rate.

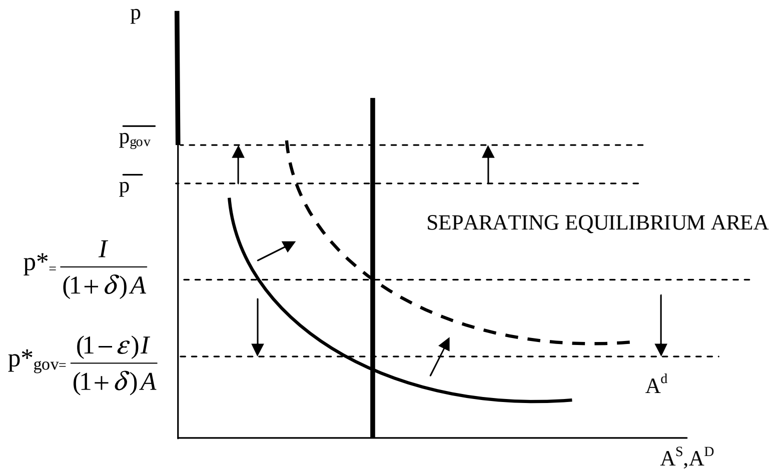
I suppose the investment cost is $(1-\epsilon)I$ where ϵI represents public subsidy, with $0 \leq \epsilon < 1$.

In cases where collateral is required, the solutions are: $R_G = (1-\epsilon)I$, $R_B = (1-\epsilon)I/s$ and $p^*_{gov} = (1-\epsilon)I/(1+\delta)A$, where p^*_{gov} is the new lower bound to have separating equilibrium. *Ceteris paribus*, $p^*_{gov} < p*$. Moreover, public subsidy affects the upper bound $\bar{p}$. Indeed, it increases the liquidity of *good* firms because it reduces the bank's requirement. So public intervention enlarges the *separating area* because it affects the bounds. But because it increases liquidity, it also increases the demand for assets. We therefore have a new price p_{gov}, greater than $\hat{p}$, the price without public intervention. From this, we can see that incentives are efficient if there is no separating equilibrium. Indeed, if $\hat{p} < p*$, government intervention may improve efficiency because it generates a shift from the pooling equilibrium to more efficient separating equilibrium.

But if there exists a separating equilibrium, subsidy is not efficient because it increases the equilibrium price.

Interest rate policy gives better results than investment subsidies. I suppose that government fixes the interest rate, and in order to do this, has to subsidize banks. If the government target is to allow all firms to borrow at the

Fig. 2.5:



minimum price, it fixes $\bar{R} = R_G$ and it transfers an amount C to the bank. So, the expected payoff of the bank is:

$$s(\bar{R} + C) + (1 - s)(1 - q)(\bar{R} + C) + (1 - s)qpA = I \tag{2.39}$$

from which we obtain:

$$C = \frac{I - q(1 - s)pA}{1 - q + sq} - \bar{R} \tag{2.40}$$

This policy does not affect the equilibrium price because the liquidity of *good* firms remains the same, but the other firms can borrow at lower interest. In this case, the interest rate policy is optimal even if there is a separating equilibrium.

2.5 Conclusions

I developed a credit rationing model with adverse selection in which optimal debt levels depend on asset price determined on the second hand market. In the model, the assets can be redeployable (Williamson, 1988) or not; their second hand value in fact depends on the number of other firms. In particular, assets are bought exclusively by firms in the industry and not by outsiders. Firms are divided into two groups; *good* firms which are able to earn sufficient cash flow to repay the debt and to invest in distressed assets, even in bad times, and *bad* firms, which fail if there is a depression. This is a model in which financial intermediaries play a role as internal markets for assets. In fact, if a *bad* firm signs a contract with collateral requirement, when it fails, it leaves its assets to the bank and the bank resells the assets on the market. In this model I show that the existence of the separating equilibrium depends on the asset price. If the asset price is too low on the market, the only possible equilibrium is pooling equilibrium. I show that *good* firms can enjoy positive externalities from the existence of *bad* firms, because for a certain number of *bad* firms it is possible to have a more efficient equilibrium. Nevertheless, if the number of *bad* firms increases over a certain threshold, no separating equilibrium is possible. In this model, when firms go bankrupt, if they did not offer guarantees to the bank they can resell their assets on the market. But they cannot obtain the whole value of their assets, because they have to pay some costs. I show that if these costs increase, bad firms' incentive to pretend to be *good* also increases. So, it is more probable that there is no separating equilibrium.

I also discuss what type of policy intervention is better within this framework. I compare investment subsidies and interest rate policy, and I show that interest rate policy is preferable, because it does not affect the equilibrium asset price. This is the case for any number of *bad* firms.

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3. CREDIT RATIONING AND REAL ASSETS: EVIDENCE FROM ITALIAN PANEL DATA

3.1 Introduction

The present work is aimed to study the relationship between fixed assets and credit rationing and the effect of public subsidies on credit rationing.
In the first part, the paper investigates empirically the relationship above. The analysis is based on the idea that in a context of asymmetric information banks use real assets as a guarantee against project default.
Although many papers have explained the relationships between the debt level and the value of real assets, empirical evidence is mainly based on large "listed" firms. The question as to the whether these arguments are valid for smaller firms has received limited attention. One reason is that good data on smaller non-listed firms has not been available until very recently. Moreover, many papers focus on the credit rationing of high-tech firms because they have difficulty in borrowing long term and borrow at high spreads. Indeed, if a high tech project fails, there is no collateral to protect creditors.
Many papers also show that specialized assets should fetch a low resale price. This suggests that a high resale price corresponds to a highly redeployable asset and that the reduction in resale value aggravates credit rationing, so that investment declines.

My purpose is to show empirically how the value of real assets explains credit rationing of unquoted small and medium firms. It is interesting to analyze small and medium firms which, because of their ownership structure and size, have fewer financial options. Large firms can obtain credit on the public markets while small firms depend on financial intermediaries. This implies that their main source of funds is banks. These firms are more likely to face credit rationing or a very high cost of non collateralized debt because banks resolve asymmetric information by charging higher interest rates or collateral requirement on small firms.

Although my work is close to other papers on capital structure, my perspective on the problem is slightly different. I consider the relationship between credit rationing and firms' capital structure, rather than the relationship between debt ratio and firms' capital structure.

In the second part, I investigate the effect of public subsidies on credit rationing. I make separately this analysis because there exists a problem of self-selection. Indeed, in public financing programs firms are not selected randomly but on the basis of common characteristics. To accommodate this, I use the propensity score matching model.

In Section 2, I review some of the most relevant studies on capital structure. In Section 3, I present data and variables. In Section 4, I discuss the model. In Section 5, I show results of the probit analysis, in Section 6 I focus on propensity score matching model to investigate the causal link between the public incentives and firms' rationing and in Section 7 I draw conclusions.

3.2 Related Literature

Many papers have explained that bank financing depends on whether the lending can be secured by tangible assets (Storey (1994) and Berger and Udell (1998)). Moreover, from the literature emerges that several characteristics of a firm affect the level of indebtedness. In my paper, I use many of these characteristics as independent variables to explain credit rationing. In this Section I present some works that underline how the used variables are linked to the firm's debt level.

Titman (1984) suggests that firms manufacturing machines and equipment are financed with relatively less debt because they find liquidation especially costly. Indeed, when assets are highly specialized, their value to the firm is greater than their value to the marketplace. Firms with unique or specialized products therefore have relatively low debt ratios.

Leeth and Scott (1989) reject the hypothesis that the theories of secured debt wrongly predict collateralization, and demonstrate that collateral reduces net borrowing costs. Their analysis shows that the incidence of secured debt is strongly related to default probability, loan size, loan maturity, marketability of assets, economic conditions and legal framework.

Rajan and Zingales (1994) also demonstrate that leverage increases with fixed assets, non-debt tax shields, growth opportunities and firm size and decreases with volatility, advertising expenditure, bankruptcy probability, profitability and uniqueness of the product. Rajan and Zingales focus on four factors: tangibility of assets, the market to book ratio, firm size and profitability. If a large fraction of a firm's assets are tangible, then assets should serve as collateral diminishing the risk of the lender. They should also retain more value in liquidation. Therefore, the greater the proportion of tangible assets on the balance sheet, the more willing should lenders be to supply loans and the lower rationing should be.

Johnson (1997), analyzing the composition of debt, finds that firms with access to public debt markets use little bank debt, but borrow a substantial proportion of their debt from private non-bank lenders. Moreover, he finds a positive relationship between bank debt use and fixed asset ratio for firms with access as well as for firms without access to public debt markets.

Guiso (1998), in his analysis on high tech Italian firms, shows that the probability that a high tech firm is credit-constrained does not depend on the amount of collateralizable assets but on the level and composition of firms' liabilities. Indeed, a large share of short-term liabilities increases credit rationing.

Cassar and Holmes (2003), studying the determinants of capital structure show the differences between long and short forms of debt and underline that given the high proportion of short debt in the firms, overall leverage is negatively related to fixed assets, but long term debt structure is positively related to long term asset structure.

An important determinant of capital structure is also the past profitability of the firm. Profitable firms which have access to retained profits use these for firm financing rather than accessing outside sources.

At the same time, a rationed firm has a lower level of profitability because when a firm is rationed it is excluded from the market, so it obtains a lower level of capital for investment. Rationed firms have a lower predicted performance.

Rajan and Zingales (1994) show that the correlation between the leverage of larger firms with profitability is more negative than the correlation between small firms and profitability.

Another important element is the firm's age because it is a reputational mechanism (Diamond, 1989). Reputation allows borrowers to obtain better cotract conditions and thus have more debt in their capital structure.

The literature also frequently finds a good predictor of difficulty in obtaining credit is firm size.

From Fazzari, Hubbard and Petersen (1987), several papers show that capital-market imperfections limit the availability of external finance to small and young firms. Particularly for smaller firms, any contraction in earnings reduces their total finance because they cannot easily increase their external finance.

In fact, bank credit rationing is less likely among 'large' firms because they can more easily raise funds directly on the market, and because large firms are thought to be able to offer better collateral because their quality is clearer to financial intermediaries.

Titman and Wessels (1988) underline how size can be viewed as a proxy of the probability of default. Larger firms are generally more diversified and have less probability of going bankrupt.

In Rajan and Zingales (1994) the effect of firm size on leverage is ambiguous. Larger firms tend to be more diversified and fail less often, so size may be an inverse proxy for the probability of bankruptcy. However size may also be a proxy for the information outside investors have, which should increase their preference for equity relative to debt.

Beck, Demirguc-Kunt and Maksimovic (2005) have recently shown that small firms are significantly and negatively affected by financing obstacles: collateral requirement, bureaucracy, high interest rates, the need for special connections with banks, banks' lack of money to lend, and access to financing for leasing equipment.

3.3 Data

I use the *Capitalia* database containing data on a sample of Italian manufacturing firms. I use two samples, one for the period 1995-1997, and one for the period 1998-2000.

The samples were stratified according to size, industry and location and thus constitute a statistically significant representation of the Italian manufacturing industry. The database includes almost 500 variables; it provides information on balance sheet items, including assets, liabilities and their composition, as well as information such as ownership structure, availability of external finance, and entitlement to public subsidies.

The panel I analyze includes all those firms which were present in the database for the whole period 1995-2000. From the total sample I exclude the firms that have missing values for all the variables included in my analysis. Small firms with less than 50 employees represent 60 percent of the observations, firms between 50 and 500 are 38 percent, and firms with more than 500 employees are 2 percent. To avoid problems with outliers this last category of firms was excluded.

I therefore consider 1209 firms corresponding to 5791 observations.

I assume that a firm is credit rationed if its answer to whether, at the current market interest rate, they wish to have access to a larger amount, is positive.

3.3.1 Variables

The dependent variable (*RATION*) I use in my analysis is the binary variable representing rationed firms. I use this factor to test the idea that credit rationing can be the rational response of the bank system to asymmetric information. As independent variables I use indicators of profitability, productivity, capital structure, bank indebtedness and geographical localization.

What I want to verify in my paper is whether fixed assets have a role in diminishing credit rationing for Italian small firms. So the most important variable in my analysis is *RASSET*, the share of fixed assets on total assets. As in Johnson (1997) I use it as a proxy for asset collateral value. In fact, tangibility eases the availability of debt and improves the terms on which debt is available.

The collateral value of fixed assets depends directly on the liquidation value, so it is possible to use this measure as a proxy for project liquidation values. Because leverage is positively associated with liquidation value (Harris and Raviv 1990), liquidation value is negatively linked with credit rationing.

Another measure of collateral is the share of long term financial assets on total assets (*LTF*).

STF measures the ratio between short term financial assets, financial assets of less than one year maturity, and total assets. The market for short term financial assets is characterized by a great degree of "openess" in terms of the securitization of assets, so it may be considered another proxy for collateral.

Profitability is measured by the ratio of gross operating surplus on total sales (*GOSSALES*), while productivity is measured by the effect of sales per worker (*SALWORK*).

BANKLEV is the total bank debt of the firm divided by total liabilities. I use this variable because this type of financing is important to SMEs.

There are two geographical dummies to show geographical differences in Italy, *DUMNORTH*, for the North, and *DUMSOUTH* for the South.

The regressor *AGE*, which approximates the firm's reputation (Diamond 1989), is measured from the firm's year of foundation.

Several papers show that capital-market imperfections limit the availability of external finance for small firms, so in order to consider firm size I introduce a dummy (*DUMSMALL*) which is 1 for firms with less than 50 workers, and 0 otherwise.

PAVITT3 is a dummy which identifies the prevalent activity sector among Specialized Sectors (Pavitt=3). I choose this because Leeth and Scott(1989) argue that the liquidation value of assets, and consequently their suitability as collateral, is lower when assets are highly specialized.

3.4 The Model

I test if fixed assets affect banks' rationing behavior. Following Guiso (1997), I assume that the decision to grant or refuse credit depends on a set of observable characteristics of the firm, identified by the vector X_{it}, where the index i refers to the firm and t to the year.

The bank observes the value of X and on the basis of the observed characteristics infers the quality of the firm. X includes only variables that can be observed, such as publicly available information, like firm characteristics and published balance sheet information.

Let P^*_{it} be the variable for the bank decision whether to finance firm i or not. I assume that P^*_{it} depends linearly on X:

$$P^*_{it} = \beta X_{it} + u_{it} \tag{3.1}$$

where β is a vector of coefficients and u_{it} an error term. P^*_{it} is a dummy variable which takes value 1 if firm i is credit-constrained and 0 otherwise. So:

$$prob(P_{it} = 1) = prob(P^*_{it} > 0) \tag{3.2}$$

Assuming that u_{it} is normally distributed, the vectors of parameters β can be estimated by maximum likelihood technique.

In my probit estimates, I use the Random-Effect model. The idea of the random effect model is to consider individual effects as latent random variables. When N is large and the sampling is truly representative of the population, the hypothesis underlying the RE model are satisfied.

For the random-effects model, the likelihood is expressed as an integral which is computed using Gauss-Hermite quadrature. I check the quadrature approximation used in the random-effects estimators and I choose the quadrature points for which the coefficients do not significantly change. The level I choose is 24. In fact, at a high number of points (greater than 20), the results were more stable. Although the size of the coefficients varied according to the number of quadrature points, the findings were similar and the interpretation of the results did not change according to the number of quadrature points used.

3.5 Results

Table 3.1 reports descriptive statistics for the variables in the model, their sample mean, standard deviation and number of independent observations.

Tab. 3.1: Summary Statistics

Variable	Mean	Std.Dev.	Min	Max	Observations
RASSET	0.235	0.149	0	0.912	5855
STF	0.523	0.162	0.001	1	5855
LTF	0.034	0.067	0	0.928	5855
BANKLEV	0.178	0.177	0	0.737	5855
AGE	24.596	18.064	0	146	6249
GOSSALES	0.105	0.078	-1.03	1.333	5839
SALWORK	286.590	377.943	0	15730.6	6291
WORKERS	62.681	81.510	1	500	6306

An examination of the correlation matrix of the sample data (Table 3.2) shows a critical value between *RASSET* and *STF*, but it should be noted that the large positive correlation may be caused by their common denominators (Titman and Wessels 1988).

Moreover, Long (1997) argues that if independent variables are highly collinear, a larger sample is required. He thus suggests that is risky to use maximum likelihood estimators with samples smaller than 100, while samples over 500 seem adequate. He claims that a rule of at least 10 observations per parameter is reasonable, even though this does not imply that a minimum of 100 is needed. My sample is large enough in order to satisfy the above conditions. Multicollinearity is a problem for separation of the effects of two or more variables on an outcome variable. The problem occurs when independent variables are more highly correlated with each other than they are with the dependent variable. As the independent variables become more highly correlated, it becomes more and more difficult to determine which variable is actually producing the effect on the dependent variable.

The Variance-Inflation Factor (VIF) shows us how much the variance of the coefficient estimate is being inflated by multicollinearity. Typically, the threshold of VIF at which we consider multicollinarity to be a problem is 10 for each variable and is 6 for mean VIF. From my analysis, the singular VIFs are not higher than 1.9 and mean VIF is 1.28.

Tab. 3.2: Correlation Matrix

	RASSET	*STF*	*LTF*	*BANKLEV*	*AGE*	*GOSSALES*	*SALWORK*	*DUMSOUTH*	*DUMNORTH*	*DUMSMALL*	*PAVITT3*
RASSET	1										
STF	0.590	1									
LTF	0.252	0.297	1								
BANKLEV	-0.042	0.026	-0.056	1							
AGE	0.187	0.240	0.065	-0.064	1						
GOSSALES	-0.245	-0.201	-0.076	0.051	-0.126	1					
SALWORK	0.132	-0.025	0.049	-0.197	0.125	-0.149	1				
DUMSOUTH	-0.053	0.005	0.086	0.217	-0.180	0.018	0.127	1			
DUMNORTH	-0.002	-0.096	-0.002	0.153	-0.302	-0.074	0.099	0.589	1		
DUMSMALL	0.169	0.121	0.289	0.257	0.179	-0.071	-0.094	0.155	0.128	1	
PAVITT3	-0.001	-0.019	-0.020	0.070	-0.031	-0.055	0.140	0.040	-0.038	-0.136	1

Results of probit regression relating credit rationing to firm characteristics are in Table 3.3.

Tab. 3.3: Probit Estimates

Variable	Coefficient	Std. Error.	z	p>IzI
RASSET	-0.8925	0.4174	-2.14	0.032
STF	-0.8116	0.3849	-2.11	0.035
LTF	-1.8088	1.0322	-1.75	0.080
BANKLEV	0.7607	0.2569	2.96	0.003
AGE	-0.0032	0.0033	-0.97	0.331
GOSSALES	0.4700	0.5853	0.80	0.422
SALWORK	-0.0008	0.0003	-2.94	0.003
DUMSOUTH	0.1007	0.1713	0.59	0.557
DUMNORTH	0.0364	0.1252	0.29	0.771
DUMSMALL	0.0919	0.1047	0.88	0.380
PAVITT3	-0.0558	0.1080	-0.52	0.605
Cons	-7.1879	25.8671	-0.28	0.781
Number of observations	5791			
Number of firms	1209			
Wald chi2(11)	21.32			
Prob>chi2	0.0302			
Log Likelihood	-1441.731			

From the output of estimation, we can see that the Wald test rejects the hypothesis that all of the coefficients except the intercept are simultaneously equal to zero.

Analyzing the effects of the variables we can see that the effect of sales per worker is negative and strongly significant while gross operating surplus as a share of total sales has a positive but not statistically significant effect. This positive sign confirms, although not statistically, the pecking order theory that firms prefer internal to external financing (Myers, 1984, and Myers and Majluf, 1984).

Bank indebtness strongly affects the probability of being rationed. It means that indebted firms have more difficulties in obtaining other funds.

The measures of collateral negatively affect the probability of a firm being denied credit. In fact, the share of long term financial and real assets of total assets both have a negative and significant effect. In this case, the positive incentive effect of collateral requirement prevails over the negative selection effect (Stiglitz and Weiss, 1981).

Short term financial assets also have a negative and significant effect.

Moreover, the probability that a firm will be rationed does not depend on its location. Firms in the South are not more rationed than firms in the North.

The analysis of the regressor firm's age, measured from its year of foundation, shows that it is negative. This is consistent with the argument that the reputational capital of older firms reduces credit constrain, but this effect is not statistically significative.

The firm size dummy does not signal a high difficulty of small firms in obtaining credit.

3.5.1 Goodness of Fit

Several measures are often used in literature to evaluate the fit of binary choice model. In this section I use two measures of fit of the estimated model.

The first ones is the most popular proposed for limited dependent variable models, the McFadden (1973) $Pseudo - R^2$, given by the formula:

$$Pseudo - R^2 = 1 - \frac{L_m}{L_0} \tag{3.3}$$

where L_m is the log-likelihood value of the model and L_0 is the log-likelihood value if the coefficients are restricted to 0. The value of $Pseudo-R^2$ is 0.15. Similar results are found by Berkowitz and White (2004) who in their work on access to credit for small firms in USA compute ranges between 0.16 and 0.19 for the $Pseudo-R^2$, and by Guiso (1998) who, by estimating the credit rationing of Italian high-tech firms, finds a value of 0.18.

The best indicator of the model's performance is its degree of success in predicting the occurrence and absence of rationing.

A useful summary of the predictive ability of the model is a $2x2$ table of the "hits and misses" of a prediction rule such as:

$\hat{y} = 1$ if $\hat{F} > F^*$ and 0 otherwise.

The usual threshold value is 0.5, but as the table shows, this may not be a very good value to use for the threshold.

Tab. 3.4: Frequencies of actual and predicted outcomes

		Predicted		
		D=0	D=1	Total
Actual	D=0	4916	12	4928
	D=1	860	3	863
	Total	5776	15	5791

Indeed, as Greene (2007) suggests, if the sample is unbalanced, that is, has many more zeros than ones, then by this prediction rule it can fail to predict. Considering my data with 863 $Y = 1$ on 5791 observations, the average predicted probability will be 0.15. In such a setting, the prediction rule may fail every time to predict when $Y = 1$. The obvious adjustment is to reduce the threshold. I use a new threshold of 0.2. The results are shown in the table below:

Tab. 3.5: Frequencies of actual and predicted outcomes

		Predicted		
		D=0	D=1	Total
Actual	D=0	1427	3501	4928
	D=1	135	728	863
	Total	1562	4229	5791

From this table is possible to determine the "success rate". It is equal to 0.37. Because of the high number of $y_i = 0$ in the sample, it makes sense to report the percentage correctly predicted for each of the two outcomes. So it is possible to determine a measure of sensitivity, actual $1s$ correctly predicted, which is 0.84, and a measure of specificity, actual $0s$ correctly predicted, which is 0.71. The sum of these two measures is grater than 1, and this is another measure of goodness.

I also compute the Marginal Effects at the sample means of the variables to gain an impression of the magnitudes of the changes in the probability of being rationed. The computation of the marginal effects at the sample means is shown in Table 3.6. The estimates show how the probability of being denied credit changes when the variables move from zero to their mean value.

When the variable $RASSET$ changes from zero to its mean, the probability of being denied credit decreases 2.7 times. These results are consistent with previous findings.

Tab. 3.6: Marginal Effects

Variable	Coefficient
RASSET	-0.027
	(0.012)**
STF	-0.024
	(0.011)**
LTF	-0.055
	(0.031)***
BANKLEV	0.023
	(0.007)*
AGE	-0.000
	(0.000)
GOSSALES	0.014
	(0.017)
SALWORK	-0.000
	(0.000)
DUMSOUTH	0.003
	(0.005)
DUMNORTH	0.001
	(0.003)
DUMSMALL	0.002
	(0.003)
PAVITT3	-0.001
	(0.003)

****,**,* represent significance at ten, five, and one percent levels, respectively.*

3.6 Matching Analysis

Matching has become a popular approach to estimate casual treatment effects and empirical examples can be found in very different fields of study. Since they were introduced by Rosenbaum and Rubin (1983), propensity scores have been used in observational studies in many fields. Propensity score methods are relatively new to the economic literature; recent applications include Dehejia and Wahba (1999), Heckman, Ichimura, and Todd (1997), and Lechner (1999).

In this section I focus on propensity score matching model (Rosenbaum and Rubin (1983)) to investigate a causal link between public incentives and firms' rationing.

Matching methods, of which propensity score matching is an important subset, are attractive because focus attention on a specific causal effect of interest, and treat all variables other than the treatment variable as potentially confounding variables. In the matching approach, the influence of confounding variables is reduced by matching the potentially confounding covariates of the cases that experienced the treatment with cases that did not experience the treatment. However, the underlying identification requirement is that the program choice is independent of outcomes conditional on certain set of observables.

This assumption would be violated if unobserved characteristics of the individual independently impacted the likelihood of receiving treatment. The most common strategy for dealing with this problem is the use of instrumental variables (IV) estimator. Indeed, instrumental variables estimator provides an alternative strategy for the estimation of causal effects. Instrumental variables approach involves identifying instruments that are related to treatment but not to outcomes other than through their effects on treatment.

Imbens and Angrist (1994), however, have shown that the IV estimator for the treatment effect applies only under the unrealistic case where the treatment effect is constant within the population. In the more general case when responses to treatment vary among persons with the same characteristics, the method of instrumental variables breaks down without special assumptions.

Heckman (1997) shows that if responses to treatment vary, and if we are interested in estimating the mean effect of treatment on the treated, any valid application of the method of instrumental variables for estimating the treatment effects requires a behavioral assumption about how persons make their decisions about program participation.

Under a set of additional assumptions the IV estimator estimates the average effect of treatment for the subsample (LATE) of the population that is induced by a specific change in the value of the IV to select themselves into treatment. These assumptions introduce new sources of uncertainty. Furthermore, the LATE estimator relies for its consistency on the assumptions that the assignment to treatment mechanism is ignorable. So, instrumental variables estimation can eliminate endogeneity bias under a set of assumptions that themselves are rather strong and impractical to verify in most real research setting.

Moreover, Ichimura and Taber (2001) show that conditions justifying instrumental variables methods justify the matching method as a special case. With this in mind, in this paper I use propensity score method for its explanatory power and because it allows to appreciate immediately the equivalence of treatment and control groups and to perform simple matched pair analyses which adjust for confounding variables.

The propensity score is the probability for an individual of participating in a treatment given his observed covariates X. In this methodology treatment assignment and potential outcome are independent on propensity score.

In a sample of size N, for each individual i in the sample, for $i = 1...N$, let D_i indicate whether the treatment was received, with $D_i = 1$ if individual i receives the treatment, and $D_i = 0$ if individual i does not receive the treatment. Let $(Y_i(0), Y_i(1))$ denote the two potential outcomes, $Y_i(0)$ is the outcome of individual i when it is not exposed to the treatment and $Y_i(1)$ is the outcome of individual i when it is exposed to the treatment. If both $Y_i(1)$ and $Y_i(0)$ were observable, then the effect of the treatment on i would be $Y_i(1) - Y_i(0)$.

However, only one of the two potential outcomes is observed for each individual and the other is unobserved or missing.

The causal effect θ that results from receiving the treatment is:

$$\theta = E[Y(1) - Y(0)|D = 1] = E[Y(1)|D = 1] - E[Y(0)|D = 1] \tag{3.4}$$

where $D = (0, 1)$ is the indicator of exposure to the treatment. However, the counterfactual mean for those being treated, $E[Y(0)|D = 1]$, is not observable and in non-experimental studies it cannot be calculated as the arithmetic mean of non-treated units since:

$$E[Y(0)|D = 1] \neq E[Y(0)|D = 0] \tag{3.5}$$

Taking the mean outcome of non-treated individuals is not advisable since treated and non-treated individuals differ also in the absence of treatment. In non-experimental studies identifying assumptions need to be made to solve this problem.

Rubin (1977) introduces the *Conditional Independence Assumption* (CIA). The CIA means that participation and potential outcome are independent for individuals with the same set of exogenous characteristics ($X = x_i$):

$$(Y(0), Y(1)) \perp D|X \tag{3.6}$$

If CIA holds, $E[Y(0)|D = 0, X = x_i]$ can be used as a measure of potential outcome. CIA, however, is only valid if all variables that influence treatment assignment and potential outcomes are observed simultaneously. This is a strong assumption that also requires a large number of exogenous characteristics.

Rosenbaum and Rubin (1983) suggest using "balancing scores" to reduce the vector of exogenous variables into a single scalar measure. They show that if potential outcomes are independent of treatment conditional on X, they are also independent of treatment conditional on a balancing score $b(X)$. The propensity score $p(D = 1|X) = p(X)$ is one possible balancing score. Rosenbaum and Rubin proposed propensity score matching as a method of reducing the bias in the estimation of treatment effects with observational data sets. For each individual, other individuals whose characteristics are similar to those being treated, but who were not exposed to the treatment, are used to calculate the counterfactual. The propensity score is used to select from the control group the most comparable counterpart. This corrects for selection bias that stems from differences between the two groups.

The propensity score satisfies two important properties that reduce bias in the estimation procedure:

- *Balancing property*: $D \perp X|p(X)$; ensures that, given the propensity score, the treatment and the observables are independent;

- *Unconfoundedness property*: if $(Y(1), Y(0)) \perp D|X$ then $(Y(1), Y(0)) \perp D|p(X)$; ensures that, given the propensity score, the treatment and potential outcomes are independent.

The difficulty with matching estimators lies in determining when matches for treated and non-treated individuals are close enough.

The methodology I use was developed by Becker and Ichino (2002). The method is based on the computation of the propensity score using a standard probit or logit model. Using the predicted propensity score for each individual, the sample is divided into equally-spaced intervals of the propensity score. Within each block, the mean propensity scores for treated and non-treated individuals are compared and tested to see if they are identical. If they are not, the interval is split in half. Once equality of propensity score has been achieved, characteristics of individuals within blocks are compared to see if they are identical on average. If this balance is achieved within blocks, the *average effect of treatment on treated* (ATT) is calculated.

In calculating the ATT, various methods have been proposed to overcome the problem that the probability of observing two individuals with exactly the same value of the propensity score is in principle zero since $p(X)$ is a continuous variable. In this Section, two different matching methods are applied, Nearest Neighbor Matching and Kernel Matching.

In the Nearest Neighbor Matching estimator, the individual from the comparison group is chosen as a matching partner for a treated individual that is closest in terms of propensity score. It uses a single match and hence ensures the smallest propensity-score distance between the two units.

The Kernel Matching method is a non-parametric matching estimator that uses weighted average of all individuals in the control group to construct the counterfactual outcome. Weights used are inversely proportional to the distances between the propensity scores of treated individuals and comparisons. The main advantage of these approaches is the lower variance achieved because more information is used.

Becker and Ichino (2002) underline that in the Nearest Neighbor method, all treated units find a match. However, it is obvious that some of these matches are fairly poor, because for some treated units the Nearest Neighbor may have a very different propensity score and nevertheless still contribute to the estimation of the treatment effect.

The Kernel Matching method offers a solution to this problem. With Kernel Matching all treated are matched with a weighted average of all controls with weights that are inversely proportional to the distance between the propensity scores of treated and controls.

The data I use in this analysis are from the *Capitalia* dataset. The database contains microdata at firm level for Italian enterprises. It covers the years from 1995 to 2000 and contains balance sheet information as well as information about direct public financial subsidies and credit rationing. In this section I refer to a panel which comprises the subsample of firms that are always present during the time window.

I define outcome Y_i for firm i from a sample of $i = 1....N$ firms. I assume that Y_i is binary and represents whether or not a firm is rationed. The observed covariates X that are used in this analysis are the share of fixed assets on total assets, the share of long term financial assets on total assets, the ratio between short term financial assets and total assets, the ratio of gross operating surplus on total sales, the ratio of sales per worker and the total bank debt of the firm divided by total liabilities. Moreover, there are dummy variables that represent the geographical localization, the sector and firms size.

D represents subsidies to firms; $D = 1$ if the firm receives subsidy, $D = 0$ otherwise. The problem of missing data arises because for each individual only one outcome is observed, that the firm is subsidized or not, but never both. The decision of a firm to apply for public assistance as well as the selection mechanisms generate a group of firms with special characteristics. In fact firms' characteristics influence the probability of receiving subsidies. A comparison between firms using the initial data set would therefore lead to biased results due to the difference between both groups.

In my panel some covariates have missing data. To estimate propensity scores I use a complete-data analysis which uses only observations where all variables are observed.

The hypothesis is that missing values are *missing completely at random* (MCAR), in other words missing values are randomly distributed throughout the panel. If the missing values are MCAR, then the listwise deletion will give unbiased estimates. The only disadvantage is a reduction in statistical power, but this is not a problem if the sample is sufficiently large.

I use the propensity score matching approach to investigate the effects of public subsidies on firms' credit rationing. Credit rationing can thus be thought of as a proxy of a firm's performances, in the same way as firm's productivity and profitability.

3.6.1 Results

In this Section I present the main results of the analysis. They show that direct subsidies significantly lower the level of firms' rationing. This confirms the interpretation of some literature which considers public intervention as an opportunity to correct market failures.

I estimate the propensity score using the procedure developed by Becker and Ichino (2002). In the first step, the procedure identifies the optimal number of blocks that ensures that the mean propensity score is not different for treated units and controls in each blocks. In my case the final number of blocks is 8.

In the second step, the balancing property of the propensity score is tested and is satisfied in my analysis.

I impose the common support condition, which implies that the test is performed only on the observations whose propensity score lies in the intersection of the supports of the propensity score of treated and controls, to improve the quality of the matches used to estimate the ATT. To estimate ATT, I use the Nearest Neighbor Matching method and the Kernel Matching method.

As the Table below shows, both the Nearest Neighbor method and the Kernel method show that the effect of public subsidies on the ATT is always negative and significantly different from zero. This means that subsidized firms are less credit rationed than non-subsidized firms.

More specifically, the likelihood of being rationed is reduced by 3.8 percentage points with the Nearest Neighbor and by 2.5 with the Kernel method.

Tab. 3.7: ATT Estimates

	Nearest Neighbor	Kernel
Estimate (ATT)	-0,038	-0,025
t-value	-2,488	-2,104
n. treated	2270	2270
n.controls	1250	2716

Is possible to interpret these findings in different ways. On the one hand, public subsidies increase the amount of fixed investments and allow firms to have more collateral to offer to the banks. Public subsidies in fact change the firm's capital structure. Bagella and Becchetti (1998) partially confirm this hypothesis in that they find that in the short run, subsidies cause a higher level of indebtedness.

Moreover, the public screening process can be considered by the banks as a preliminary selection process of firms. Firms that receive subsidies have safer investment projects.

Third, because investment in machinery and equipment has a positive effect on productivity, as shown by De Long and Summers (1991), investment subsidies may increase firms' productivity in the short run, diminishing the credit rationing of firms.

3.7 Conclusions

The findings of the paper suggest that real assets are important in diminishing a firm's credit rationing.

The idea I test is that firms with more tangible assets have higher debt levels, particularly when loans are collateralized.

In the analysis I assume that the decision to grant or refuse credit depends on a set of observable characteristics of the firm.

I find that collateral is negatively correlated to rationing.

In fact, measures of collateral negatively affect the probability of a firm being denied credit; the shares of long term financial and of real assets of total assets both have a negative and significant effect.

Finally I analyze the effects of public incentives on credit rationing. I use the propensity score method to avoid auto-selection problems and I find that public subsidies reduce the probability of a firm being credit rationing.

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