Università Commerciale "Luigi Bocconi"
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PhD in Business Administration and Management

Collateral in debt contracts.
The case of a securitised leasing portfolio.

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To my son, Arrigo Claudio, and to Marina.

Abstract.

The research originates from a comment to the famous 1981 Stiglitz - Weiss paper. In their work, mainly focused on the problem of credit rationing, the authors point out that nor the interest rate nor collateral are instruments suited for achieving a market clearing equilibrium. The idea here analysed is, instead, that the posting of collateral by entrepreneurs could be interpreted as a signalling strategy about the "goodness" of the investment project. This hypothesis can be of interest not only, let say, for macroeconomic considerations, but even for the bank internal rating process. In fact lenders could theoretically use information gained in the contracting process as an input for the assessment of borrowers creditworthiness.

We first present a review of theoretical and empirical literature; then we study the optimisation problems of banks and entrepreneurs with reference to the bargain of credit contracts variables; a simple numerical example is also presented. The last part of the research, after the specification of two main testable hypotheses, is devoted to the analysis of a detailed database of credit contracts. Findings are against the hypothesis that collateral is positively related to project quality.

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PART I

Background

1. Introduction.

It is self evident, and widely discussed in the literature, that credit markets are characterised by a very high degree of information asymmetry. Specifically, the lender could not assess ex ante in a proper way the quality and the riskiness of the project to be financed. Information asymmetries cause the well known problems of adverse selection and moral hazard.

A great part of the literature, starting from the path breaking 1981 paper by Stiglitz and Weiss, demonstrated how the above features of credit markets could cause the profit function of banks to be not monotonically increasing in the interest rate, and even in the collateral requirements. This is as to say that, above a certain threshold of interest rate or collateral (or both), only the riskier entrepreneurs apply for credit; so that banks experience higher default rates with higher levels of the two variables. In particular Stiglitz and Weiss (1981) showed how the increase in interest rates could make bank profits decrease for the adverse selection effect; moreover they argued that even "*increasing collateral requirements (would), under plausible conditions, lower the bank's return*".

The results of the above findings are that credit rationing occurs and nor interest rate nor collateral requirements are effective instruments to be used for equating the supply of loanable funds with the demand for them.

While the explanation and the proof about how the interest rate tool works seem plain and convincing, on the contrary, the discussion offered insofar by the mainstream literature about the collateral related problem is, in our opinion, counterintuitive and troublesome.

The interest rate charged on a loan effectively acts directly on the expected return of the project for the entrepreneur, so that its raising can sort out the more safe projects and the more risk averse entrepreneur.

The role of collateral is far more controversial. First of all collateral and warranties can be of many different sorts, with potentially different effects. Indeed, as it will be analysed later on, the collateral posted aside a credit contract could be theoretically interpreted in various different ways. For example one could think at the collateral as an instrument which the entrepreneurs with more safe projects are more willing to post than those with "risky" projects, as the probability of default and of effectively "paying" the collateral is not so high as for the others.

The main objective of the present research is that of theoretically showing how, and if, in a world with perfect ex ante information asymmetry, lenders competition and strategic interaction between lenders and borrowers, the collateral offered (or the collateral requirement chosen) by borrowers could act as a signal strategy of the riskiness of the project to be financed.

We will briefly target the taxonomy of warranties, for then exhaustively discussing both theoretical and empirical literature. In the second part we'll analyse the optimisation problems of both kind of subjects involved in credit contracts and outline a simple equilibrium model. The third part, finally, will be devoted at answering, with the analysis of a specific and unique database, the main hypothesis stemming from our discussion: the probability of default is inversely related to the collateralisation of the credit.

2. Warranties, collaterals, guarantees.

Warranties in credit contracts can be distinguished in two broad classes:

- "Inside" warranties, let say collaterals[1], that are the assets used in the project to be financed. This type is assumed in most standard debt models and its meaning is quite obvious: when the borrower defaults, control of the project and ownership of depreciated assets goes to the lender.
- "Outside" warranties, i.e. when the borrower offers a protection to the lender with a fraction of its personal wealth, not directly used in the project to be financed. This type could be further distinguished between two narrower categories:
  - o real warranties consisting in the pledge of specific assets, what we would call again collateral (outside collateral),
  - o personal warranties, more properly defined as guarantees, taking the form of obligations to maintain the lender safe from negative effects.

The different cases have always to be appropriately commented, as they are different both in practical terms and in the theoretical implications involved.

The issue of collaterals and guarantees has been exhaustively investigated due to their widespread use in credit contracts. Evidence and available data strongly support this fact: for example Black, de Meza and Jeffreys (1996) report that for 85% of small business loans in UK, the ratio of collateral to loan size exceeds unity. Berger and Udell (1990) report that in the United States about 70% of loans to enterprises are made on a secured basis. Harthoff and Koerting (1998) report similar data for Germany.

[1] There isn't a consensus in the literature about the different definitions of collateral, guarantee or warranty; we'll adopt a taxonomy that is pretty consolidated in banking and finance.

3. Theorethical literature.

Both theoretical and empirical literature studied what could justify or cause such an extensive use. First of all it is clear how warranties have a risk mitigating effect for lenders. But it has to be understood how equilibrium is achieved on its optimal level of posting. To properly discuss the issue, we have to acknowledge that collaterals could have many different functions, depending on:

- the distinction concerning their type,
- the assumption made about information distribution among contracting parties.

At this last regard we have to separate the cases of:

1. information symmetry,
2. some form of information asymmetry.

In case 1 the hypothesis is that the bank can observe the characteristics (and the riskiness) of every single borrower. In such an occurence the only function of the collateral would be that of reducing the risk for the bank, that is as to say of minimising its Loss Given Default (LGD). Anyway collateral involves some costs (of administration and of immobilisation), so that is not straight for collateralisation, nor full nor partial, to always occur.

Case 2, which is the far more realistic one, involves the hypothesis that the bank could not properly assess ex-ante the type of the borrower, whilst the latter is in a better situation for judging the goodness of the investment projects to be financed.

As widely accepted, cases of information asymmetries can ingenerate two different situations[2]:

- Moral hazard;
- Adverse selection.

The two phenomena have been deeply investigated by the mainstream theoretical literature and researchers have proposed many possible explanations for the role collaterals and guarantees can play in credit contracts for addressing the two outlined problems.

When the issue is the first one, moral hazard, collateral could serve at some different scopes; among the most important ones, outside collaterals and guarantees, on one side, can:

- Reduce the borrowers' incentive to risk taking;
- Reduce incentives to strategic default and enhance renegotiation possibilities;

On the other, the inside collateral can:

- Limit the probabilities of asset substitution and of dividend payment;
- Solve under-investment problems.

First, in the following two boxes, we provide an analytical review of the first and second hypothesis:

[2] We'll consider the two issues as known; anyway it would be worth specifying that the moral hazard case, or of opportunistic behaviour, has to do more properly with ex-post information asymmetries, whilst the adverse selection with ex-ante ones.

Box.1. Outside Collateral as an incentive to reduce risk .

suppose:
$W \equiv$ *personal wealth of the entrepreneur*
$C \equiv$ *collateral*
$L \equiv$ *loan*
then take two different investment strategies $(\bar{x}_1, \bar{x}_2)$ which the entrepreneur could undertake, the two strategies are random variables defined as:

$$\bar{x}_1 \left| \begin{array}{l} x_1 \succ 0 \text{ with probability } p_1 \\ 0 \text{ with } (1-p_1) \end{array} \right. , \qquad \bar{x}_2 \left| \begin{array}{l} x_2 \succ 0 \text{ with probability } p_2 \\ 0 \text{ with } (1-p_2) \end{array} \right.$$

moreover we define: $p_1 \succ p_2, \quad x_1 \succ x_2 \succ L,$
so that $\bar{x}_1$ is the best strategy $(p_1 x_1 \succ p_2 x_2)$
and we state $L \equiv C$, i.e. a fully collateralised loan.

Hence the borrower will be induced to adopt x_1 only if :

$$p_1(W + x_1 - L) + (1 - p_1)(W - L) \geq p_2(W + x_2 - L) + (1 - p_2)(W - L)$$

$$\Rightarrow \quad W - L \leq \frac{p_1 x_1 - p_2 x_2}{p_1 - p_2}$$

In this setting it is clear that , as greater is L the smaller is the incentive to undertake the "bad" strategy.

Box.2. The role of (outside) collateral in reducing "strategic default" opportunities and in promoting debt renegotiation (Bester 1994).

Define

$E \equiv entreprenaur$

$B \equiv bank$

$I \equiv investment$

$P \equiv principal\ of\ the\ loan$

$L = (1+i)P$ *loan due at maturity*

the outcome of the investment is a random variable

$$\bar{x} = \begin{cases} x_a \text{ with probability } p \\ x_b \text{ with probability } (1-p) \end{cases}$$

let define $x_a \succ L \succ x_b$

at the end of the investment period B can observe $\bar{x}$ only incurring in a cost $(1-v)x$

at maturity we can observe the two different realisations of $\bar{x}$

hp: $\bar{x} = x_b \Rightarrow E$ can't pay L

$$B \text{ can } \begin{cases} \text{liquidate } I \text{ having the return } vx_b + C \\ \text{work-out and have the return } x_b + C \end{cases}$$

the two choices of B are indifferent for E, in fact he always gets $-C$

hp: $\bar{x} = x_a \Rightarrow E$ can

- pay L and have $x_a - L$

or

- do not pay L and have $\begin{cases} -C \\ \text{or } x_a - x_b - C \end{cases}$, depending on Bank's behaviour

let say r the probability of renegotiaton behaviour by B

- E will pay L if: $(x_a - L) \geq r(x_a - x_b - C)$

so that greater C, greater the probability of not observing a "strategic default".

This in turn will increase the willingness of the Bank to renegotiate in case of an announced default

As for the effects of "inside" collateral, it could always be regarded as a device for solving agency problems between the lender and the borrower; the two above outlined interpretations have been given to it.

In the first, the main scope of collateral is to make the entrepreneur not to change the destination of the assets and not to liquidate them for paying out dividends; in fact, as the entrepreneur pledges specific assets of the firm for securing the lender, he can not freely dispose of them. With inside collateral posted aside a credit contract, the lender could be sure that value is not discretionarily transferred to shareholders (or owners).

In the second, the role of collateral would be that of contributing to mitigate the under-investment problem (Myers -1977- Stulz & Johnson -1985-). These authors showed that cases can occur where a firm's management doesn't undertake profitable investment projects because they could result to be unprofitable to shareholders due to the specific financing mix of the firm. Pledging the asset of the project to the financiers can solve this situation; or, at least, can avoid value transfers from the "new" to the "old" debt and from shareholders to "old" debt holders.

Slightly different is the problem in the adverse selection hypothesis, which is strictly related to the issue of credit rationing. Adverse selection occurs when a party, the lender in this case, can not properly assess, ex ante, the quality (riskiness) of the other party, the borrower. For maintaining a positive expected profit on loans, the lender tends to increase their overall remuneration (interest and collateral); but this, in turn, could sort out from the loan portfolio the safer borrowers, entrepreneurs undertaking investment projects with an expected return not enough high to pay the financiers. It then happens that lenders experience decreasing profits with higher remunerations of loans, so that they could find optimal to cut the offer of loans above at a certain threshold of risk, represented by a certain marginal return[3] on new loans.

This phenomenon produces a credit rationing equilibrium in the market, where not all the investment projects with Net Present Value (NPV) greater than zero can find finance.

Collaterals, in this setting, could in principle play a role in mitigating credit rationing, but it has to be clearly understood how this tool effectively works in the

[3] The return is intended as overall expected return: a combination of interest rate and collateral.

credit market. The theoretical controversy about the function of collaterals and guarantees regards whether they could act as a signalling device for the quality of the underlying project, or they are merely relegated to be a loss mitigating tool for financiers.

The literature on the issue is wide and extensive. We already mentioned how Stiglitz and Weiss, in their 1981 paper showed that, when there is information asymmetry, the collateral requirement effectively acts as a screening mechanism. But, they argue, increasing it causes that both the average and the marginal borrowers are riskier, so that, in the end, it doesn't have any power in reducing the adverse selection effect.

This argument was further extended by H. Wette (1983). She took into consideration a Stiglitz-Weiss type model shifting from the assumption of risk averse investors to the more relaxed one of risk neutrality. In her model entrepreneur are endowed with investment projects with two possible outcomes: success or default. Different types of projects (j) have the same expected value and differ only for the value of the outcomes: riskier projects have higher return (R_j) in case of success and a lower return (F_j) in case of failure. Furthermore interest rate r^* is fixed and banks compete on the collateral requirements, C. The entrepreneur expected profit could be written as:

$$\Pi_j = p(R_j - (1 + r^*)L) - (1 - p)C \qquad \textbf{(1)}$$

where p is the probability and L is the loan size. Hence an increase in the collateral requirement, C, induces the exit from the market of the entrepreneurs with the lowest successful outcomes, i.e. the safest ones. Therefore collateral may cause a similar adverse selection effect as the interest rate. The adverse selection effects may be understood even by analysing the expected profit function of the bank: an increase in the collateral requirement has a positive direct effect, but a negative indirect effect due to an adverse change in the pool of entrepreneurs.

Other later studies, on the contrary, showed (Chan and Kanatas (1985)) that if the collateral's value is more stable or more "objective" than the distribution of returns from the project, the entrepreneur could profitably trade it for better interest rates. To understand this, suppose that an entrepreneur owns an investment project with a two points return distribution (0 and R). The asymmetry in information is intended as that the entrepreneur's assessment of the project success probability, p_e, exceeds the bank's assessment, p_b. Suppose that the project size is B and the entrepreneur finances the whole project through the loan. A "fair" loan would involve zero expected profit to the bank:

$$(1+i)B = (1-p_b)C + p_b(1+r)B \qquad (2)$$

where C is the amount of outside collateral, r is the interest rate on loans, and i is the interest rate at which the supply of funds to the bank is perfectly elastic. The entrepreneur's expected profit is:

$$\Pi_e = p_e\left(R_j - (1+r)B\right) - (1-p_e)C \qquad (3)$$

As the entrepreneur's marginal valuation of collateral in terms of interest rates (the marginal rate of substitution) is always lower than the rate at which the bank is willing to exchange collateral for interest rate in its zero-profit contract, the optimal contract necessarily involves full collateralization. Partial collateralization may occur, as Chan and Kanatas argue, only if there are some increasing costs in using collateral. The extent at which collateral is used is proportional to the asymmetry of information $(p_e - p_b)$ and inversely proportional to its cost.

The two above approaches are subject to the obvious criticism that the bank, as could use two different instruments (collateral and interest rate), may want to use them jointly, rather than considering one of the two as fixed. Furthermore the cited studies seem to ignore that Spence (1973) showed that adverse selection problems could be solved by the use of contracts that give signals about the quality of different types. Signals allow screening and separation of types in equilibrium.

Bester (1987) investigated this problem and found that, under some "fairly" strict assumptions, the banks may design contracts which are effective in screening different type of borrowers, and therefore the market could achieve a separating equilibrium with no credit rationing. The main hypotheses applied by Bester that ensures the feasibility of perfect separation is that for entrepreneurs $U(0)=-\infty$, and that the availability of collateral is not scarce. The main point of his model is the observation that, for any pair of debt and collateral, the marginal rate of substitution between interest rate and collateral of the less risky entrepreneurs is lower than the one of riskier entrepreneurs because of their lower probability of default.

However Besanko and Thakor (1987) found that, relaxing the two main Bester's hypotheses, self-separation may prove to be impossible. Furthermore they found that a monopolistic bank would never use collateral to screen entrepreneurs: it will design contracts in order to extract the maximum possible surplus from all type of borrowers.

4. Empirical evidence.

Many different researchers have tried to investigate the empirics of the relation between collateral and risk; the evidence insofar found is, however, controversial, so that there isn't unanimity on the role collaterals and guarantees play in credit markets.

A considerable part of available literature is in favour of a positive correlation between project risk and collateral postings. In this sense is the pioneering work of Orgler (1970), followed by Leeth and Scott (1989), by Berger and Udell (1990,1995)[4] and by John, Lynch and Puri (2002). Harthoff and Korting (1998) and Elsas and Kranen (2000) show that larger loans display higher collateralisations. The problem, however, becomes of understanding if larger loans are riskier or safer.

[4] The measures of risk employed by different authors are very diverse: they can be whether ex-ante or ex-post measures and can be proxied by many different variables; for example Leeth and Scott use the age of a firm as a negative proxy for its riskiness; Berger and Udell use an ex ante variable such as risk premia.

In a slightly different direction goes the recent contribution of Pozzolo A.F. (2004). He finds that ex ante riskier borrowers are more likely to be given credit secured with guarantees, but that there isn't any relationship between riskiness and collateral. Moreover he shows a novel result, in contradiction with all previous literature, indicating a negative relationship between the interest rate on bank loans and the presence of warranties.

Krahnen (2000), studying the relations among collateral, default risk and relationship lending on the basis of credit files data of five German banks[5], finds that there is no correlation between borrower quality and the incidence of collateralisation.

Krahnen's research opens a window on a contiguous stream of research, which, studying the nature and role of relationship lending, takes often into account also how collateral and guarantees are related to borrowers riskiness. In this sense is of particular interest the Forestieri and Tirri (2002) research. They analyse a very complete database from a leading Italian bank, covering information on firm level characteristics, contract variables, macroeconomic conditions, information asymmetries and competition. Showed results support the hypothesis that secured loans are riskier and associated with higher interest rate spreads.

[5] Risk assessment, very interestingly, is derived from bank internal borrower ratings.

PART II

Research hypotheses.

1. Collateral as a signal.

Relying on the above literature, and even despite a part of it, we would like to further investigate the role collateral and guarantees could play. In particular we would study the hypothesis that collateral could act as a signal device, that is as to say that entrepreneurs going to invest in better and safer projects are more willing to post outside collateral than their "colleagues" with worst and riskier projects.

The basic idea is that entrepreneurs with riskier projects consider external guarantees as more costly, because they have, due to the higher probability of default, a higher probability of effectively paying the value of the guarantee. In this sense they should have a stronger incentive to rely on debt finance, even if at possibly high interest rates.

For analysing the issue, we will investigate the problem from the point of view of the optimisation problems (expected profit maximisation) both of the lender and of the borrower.

Pure rational behaviour and no risk aversion is assumed. Indeed there is perfect ex-ante information asymmetry between borrowers and banks: entrepreneurs know exactly all the elements of the project they are going to undertake, while banks could not distinguish ex-ante any of those characteristics. Furthermore, as the banks are not aware of the projects quality and are competing between them, the entrepreneur could choose, at any given interest rate, contracts with high or low collateral requirements.

2. Entrepreneurs behaviour.

We'll study a simple problem of expected profit maximisation for two entrepreneurs, supposed to be perfectly similar rational individuals. What differentiates one from the other is the fact that one is "endowed" with a good investment project, the other with a bad one.

Assumptions are as follows:

- Overall return from the undertaken investment project is R, which is a random variable with a given probability distribution.
- Entrepreneurs use both debt and equity finance; amount of debt received is L[1].
- External collateral or guarantees, C, are posted aside of debt finance, whose value is the same for the bank and for the entrepreneur.
- Debt (with interest factor $i=(1+r)$) is repaid i.if $R > Li$.
- R can get only two determinations: success ($R > Li$) with probability p, or default ($R < Li$) with $(1-p)$.

Entrepreneurs projects are different in the sense that the "good" one succeeds with p_g greater than the "bad", p_b.

Calling π_i $(i = g,b)$ the expected profit for the two entrepreneurs (g with the "good" project, b with the "bad" one), expected profit functions are:

$$\pi_g = p_g(R-iL)+(1-p_g)(-C+R) \qquad \textbf{(4)}$$

$$\pi_b = p_b(R-iL)+(1-p_b)(-C+R) \qquad \textbf{(5)}$$

[1] Collateral is in the form of assets, not usable as substitutes for debt finance because their sale would be unprofitable or impossible for the entrepreneur.

We can study the behaviour of profit functions in relation two the two credit contract variables (i,C):

$$\frac{\partial \pi_g}{\partial i} = -p_g L \qquad \frac{\partial \pi_g}{\partial C} = -(1-p_g) \qquad \textbf{(6a}^{\textbf{I}}\textbf{)}$$

$$\frac{\partial \pi_b}{\partial i} = -p_b L \qquad \frac{\partial \pi_b}{\partial C} = -(1-p_b) \qquad \textbf{(6a}^{\textbf{II}}\textbf{)}$$

With the assumptions made about the nature of the two projects, expected profit is negatively steeper in the interest rate dimension for who has the "good" one. On the contrary, for him it diminishes less at the margin with an increase in collateral posting than for the "bad" project holder.

What above means that collateral costs less in terms of interest rate for who has a good project, as it is evident from the marginal rates of substitution, easily derived from partial derivatives (2a):

$$\left(\frac{\partial C}{\partial i}\right)_g = \frac{p_g}{1-p_g} < \frac{p_b}{1-p_b} = \left(\frac{\partial C}{\partial i}\right)_b \qquad \textbf{(6b)}$$

3. Bank.

Let us make the hypothesis that the bank assume a certain probability distribution for the projects to be financed[2], but that, in our case, doesn't properly distinguish the distribution of the "good" project from that of the "bad" one.

The bank's expected profit is given by[3]:

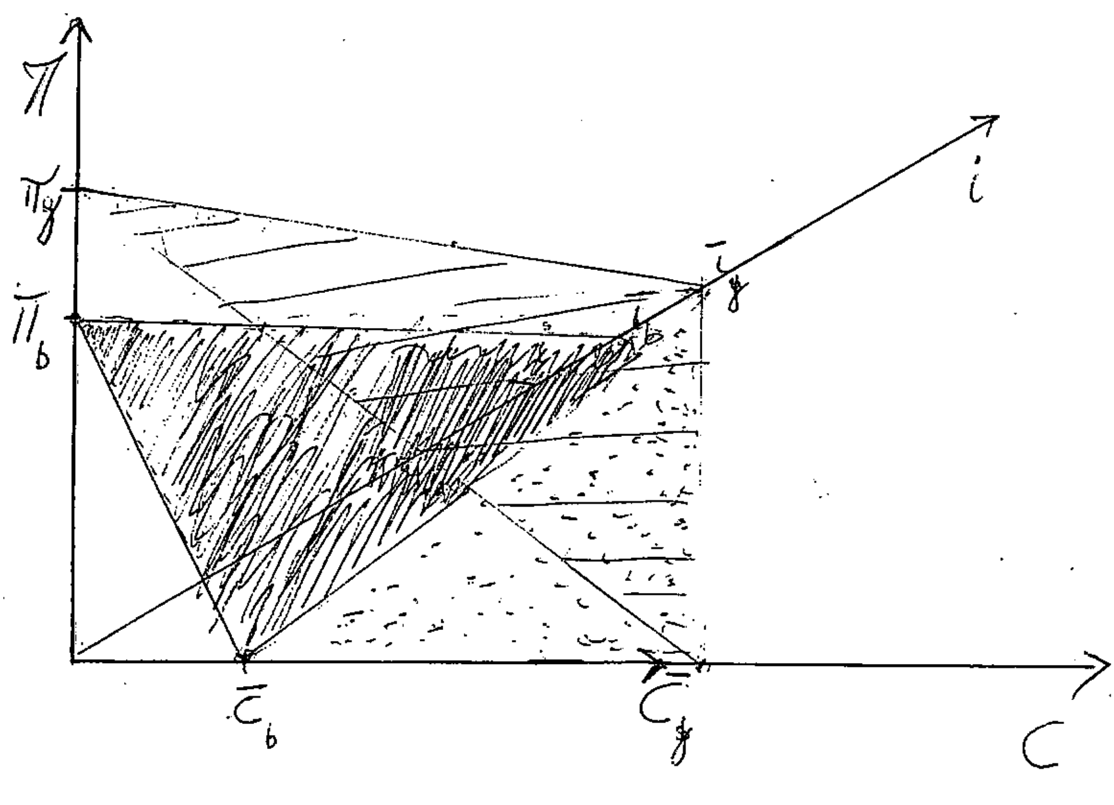
[2] For example we can refer to the praxis: banks estimate probability of default distributions for borrowers on the basis of information both supplied by the borrower itself and system available.

[3] The interest rate is set by the bank so as to:

$$(i+i)*(1-PD*LGD) = 1 + IR*(1-Var) + K_e * VaR + \cos ts$$

G.1. Profit functions of entrepreneurs (g, b).

Different steepness in the two dimensions for the two different types of entrepreneurs can be recognided.



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dove:

- PD is the probability of default, $(i-p)$ in our notation;
- LGD is the loss given default, $(C-L)$;
- IR is the internal transfer rate (the marginal cost of funds;
- VaR is the value at risk, defined as usual in credit risk models;
- K_e is the cost of equity;
- $\cos ts$ are all the other here unspecified: administration, management, etc.

$$\Pi = piL + (1-p)(C-L) \qquad (7)$$

The term $(C-L)$ can be viewed as what is called the Loss Given Default (LGD) in the special case that the value of C is entirely realised and that there isn't nothing more to recover than the value of collateral[4].

Withstanding the validity of the conditions derived by Stiglitz and Weiss (1981) for the profit functions of banks, with (7) it is clear enough that, at the margin, partial derivatives on both interest rates and collateral are positive. This makes possible for the bank a bargaining process on the two variables, which would, at least, leave its expected profit undiminished.

4. Negotiation.

If the bank negotiates with each entrepreneur on a separate table, the bargaining process could be represented as a two players game on a two dimension space (interest rate and collateral[5]).

Much depends on the form the game takes and on the assumptions about the bargaining process. But, if certain regularity conditions are in place[6], we can be sure that a solution exists (Nash 1950). This is represented by the couple (i, C) that maximises the product of profit functions. For each different type of borrower there should be a different couple, in function of probability distributions and amount of credit.

[4] For example from legal actions on the personal wealth of the entrepreneur or of third party guarantors.

[5] The amount of credit (L) can be another dimension, but it can be regarded as a special case of the amount of collateral, when the entrepreneur is constrained on it.

[6] Nash (1950).

In this way, banks which bargain on the variables of the credit contract can receive proper signals on the quality of the borrower. Indeed, what is more important, this can be achieved without incurring in any unexpected risk or, in other words, without incurring in greater expected losses.

5. A numerical example.

Hereon we provide a numeric example of our suggested model. The example assume all the main previously specified hypothesis, but, for realism, it furthermore assumes a simple two period context.

The framework of reference is a very simple one, with entrepreneurs searching debt financing for their investment projects in a two times horizon and lenders taking decisions on the basis of expected profit maximisation.

Finally we want that our theoretical setting try to approximate the reality of a firm, where investment decisions have effect on more than one period and liquidation of assets is costly.

Summarising, the main assumptions are:

- there are only two expected profit maximisers entrepreneurs;
- one of them is endowed with a "good" investment project, while the other with a "bad" one;
- projects have only two possible outcomes: success (S) or default (F);
- a project is to be implemented in a firm in a two period time, and gives (S) or (F) for each period;
- the result over the two periods are statistically independent;
- at the end of the first period both the entrepreneur and the bank observe the result, and the firm has to decide whether to continue the investment or to exit it;
- exit from the project through liquidation of assets is costly: for example in terms of loosing expenses for workers training or the firm reputation;

- the "good" project is stochastically dominating the second, in the sense that has higher expected value, lower variance and assigns a greater probability, p_S, to the event of a successful outcome.

Hereafter we will use a numerical example to illustrate our model, making some necessary quantification of variables, even though somehow unrealistic[7]:

- both investments projects involve an initial (t_0) investment of 100, to be financed for 90 with debt, and for 10 with equity;
- for simplicity there is no interest rate charged on the debt;
- at time 1 (t_1) the project gives a return (S) or (F) and the borrower has to pay back a part of the debt (40);
- in (t_1) the project could be liquidated only suffering a cost of, say, 50;
- for continuing the project the entrepreneur has to invest[8] a certain amount, 20, let say all financed with equity;
- at time 2 (t_2) the project again gives a return (S) or (F) and the borrower has to pay back the remainder of the debt; the liquidation value of the assets is V.

The two projects are made as follows:

- "Good" project: $S_g = 50$ and $F_g = 0$ with $p_S = 0.75$, $V_g = 50$;
- "Bad" project: $S_b = 110$ and $F_b = 0$ with $p_S = 0.50$, $V_b = 10$.

Hence the two projects present the following cashflows, with the associated joint probabilities[9]:

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[7] For example a debt/equity ratio of 9 appears to be very far from what considered normal by financial accounting experts.

[8] For example for maintenance expenses.

[9] Due to the independence hypothesis, joint probability in this case is $p*(i-p)$

"Good":

t_0	t_1	t_2	joint prob.
-100	30	100	0,5625
-100	30	50	0,1875
-100	-20	100	0,1875
-100	-20	50	0,0625

Its expected net present value is: $E(g) = 5$ with variance $Var(g) = 113{,}5254$.

"Bad":

t_0	t_1	t_2	joint prob.
-100	90	120	0,25
-100	-20	120	0,25
-100	90	10	0,25
-100	-20	10	0,25

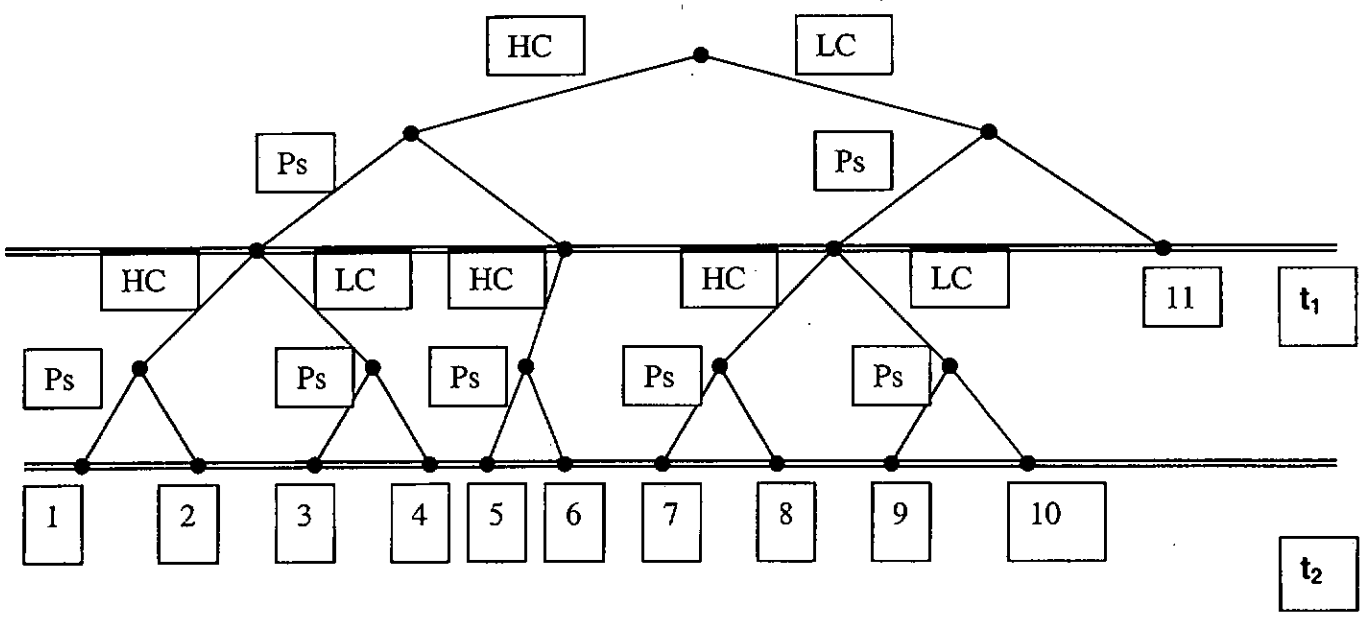
Its expected net present value is: $E(b) = 0$ with variance $Var(b) = 378{,}125$.

In t_0 the entrepreneur could choose between two different types of loan contracts: one with high collateral posting (collateral = debt), and one with low collateral (let say 50).

In (t_1) the bank observes the first outcome of the project and on its basis estimates the quality of the project. We assume in (t_1) there is a possibility to renegotiate the collateral posting for the contract; if the bank observes a success is willing to offer again all the two alternatives (high or low collateral). If, on the contrary, the project incurs in a failure in the first period, then we could distinguish two different cases: if the bank had received high collateral it could permit the continuing of the project to time 2, while if the bank had received low collateral it could force the entrepreneur to bankruptcy and to abandon the project, because it re-estimates the borrower's probability of default so high to make any credit grant unprofitable. Furthermore, on the side of the entrepreneur, we assume that if the project incurs in a failure in the first period he consider a better alternative that to continue the investment in period two, rather than incurring the liquidation costs[10].

The possible outcomes (from num.1 to num.11) are represented in the following graph as the results of the interaction between the choices of the entrepreneur, the bank and the Nature, which determines results probability (Success with probability p_s).

G.2.



The returns to the entrepreneur associated to the projects' outcomes (1 to 11) areoutlined in the following table (T.1.)[11]. It is important to note that results 1, 2, 7, 8, are impossible to occur with rational individuals, because the associated strategies are dominated by alternative available strategies in t_1.

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[10] This is often observable in the reality and could be due to many different reasons and considerations.

[11] The returns to the entrepreneur are calculated as: $\Pi = R_1 + R_2 + L - D - E$, or $\Pi = R_1 + R_2 + L - C - E$ when the results are failures and the collateral posted is less than the debt; R_i, E are respectively the results of the project in the two periods and the equity invested (30).

T.1. Payoffs.

outcomes	1	2	3	4	5	6	7	8	9	10	11
"good" proj	30	-20	30	-5	-20	-70	30	-20	30	-5	-50
"bad" proj	110	0	110	0	0	-110	110	0	110	0	-50

Given the above possible payoffs we can compute the expected profit to the entrepreneur of choosing high or low collateral contracts in (t_0). For doing this we can compute the probabilities associated to each of the 7 feasible outcomes.

Hence for the entrepreneur endowed with the "good" project the expected profit of the strategy "choose high collateral" in t_0 (associated to outcomes 3 to 6) is 7,8125, while that of the strategy "choose low collateral" (associated to outcomes 9 to 11) is 3,4375.

On the contrary for the entrepreneur endowed with the "bad" project the expected profit of the strategy "choose high collateral" (associated to outcomes 3 to 6) is 0, while that of the strategy "choose low collateral" (associated to outcomes 9 to 11) is 2,5.

Summarising, for the sake of clarity:

T.2. Payoff associated to collateral posting strategies.

		EXP.PROFIT
"Good" proj.	strat. High c.	7,8125
	strat. Low c.	3,4375
"Bad" proj.	strat. High c.	0
	strat. Low c.	2,5

Therefore it is evident that in our setting, with expected profit maximising entrepreneurs, who has a "good" project does prefer to post high collateral in loan contracts, while entrepreneurs with not enough good projects do prefer to sign contracts with low collateral requirements.

6. Testable hypotheses.

In the following part of the research we would like to test our conjectures on available evidence.

The main hypothesis drawn from our study is that collateral is a proper second[12] dimension of credit contracts and that a negotiation on it could provide lenders with a signal of borrowers' quality.

If that it is true, and indeed if a proper negotiation is applied in the reality, we should observe higher levels of collaterals and guarantees associated with safer projects/entrepreneurs.

We would incorporate this idea in a first testable hypothesis of the form:

- $H_{1\,0}$: *the presence of external guarantees diminishes with the probability of default.*

Moreover, as the price of credit should be directly related to its riskiness, if collaterals are associated with safer credit exposures, they have to be inversely related to credit prices. Therefore a second, subsidiary, testable hypothesis is:

- $H_{2\,0}$: *the presence of external guarantees is negatively related to the interest rate spread (the price of credit).*

Later on, in part III we make explicit the form of the two null[13] hypothesis and illustrate practical testing strategies.

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[12] The other is the interest rate.

[13] Clearly enough, the alternatives are that guarantees have the opposite effect then what specified.

PART III

EMPIRICAL EVIDENCE

1. Data description.

The present analysis relies on a database of securitised leasing exposures, originated from a leading Italian financial institution[1]. The available variables were contractual data covering many key issues on a huge set of 54.996 leasings, segmented mainly in the three categories of machinery and equipment, real estates and car leases[2]. From these we extrapolated some basic information we regarded as interesting for our analysis.

Specifically we considered information on the status of the leasing (defaulted or not), on its length, on the level and kind of external guarantees, on the value of the internal underlying guarantee, on the price of credit.

As for the first variable we computed an indicator ("indicatoredef"), taking value 1 for defaulted contracts, 0 otherwise. For the length we considered the original contract maturity in months ("durata_mesi"). Indeed the database contained detailed information on the kind and overall value of external guarantees, divided in collaterals, bank guarantees, personal guarantees an unspecified other kinds. We took

[1] The database was obtained for research purposes under a confidentiality agreement.

[2] From here on, the three categories shall be indicated even as, respectively, type 1, type 2 and type 3 leases (contracts).

into account both their absolute level ("sumgar") and indicator variables for their presence or not and for their type:

- "indgar" taking value 1 if there were any external guarantee, 0 otherwise;
- "indgarreale" taking value 1 if there were any external collateral, 0 otherwise;
- "indgarfidebanca" taking value 1 if there were any bank guarantee, 0 otherwise;
- "indgarfideind" taking value 1 if there were any other personal guarantee, 0 otherwise;
- "indgarunsp" taking value 1 if there were any other unspecified external guarantee, 0 otherwise.

Then, we regarded the internal guarantee in two different manners; on one side we took into consideration the kind of the leased asset[3] (mainly distinguishing machinery from real estates), on the other we computed a proxy ("gint") of its value as the ratio between the credit given and the price of the asset:

- $\text{gint} = \frac{\text{credit}}{\text{asset price}}$

Finally, as the price of credit we took the contractual interest rate ("ispread").

In the following tables and graphs some descriptive statistics on the examined variables are displayed.

[3] On the assumption that the implicit value of the assets itself is different from type to type; in this sense we assume the value of real estates as more stable than that of machinery, so as to be more "valuable".

T.3. Frequency table

indicatoredef

Default (indicatoredef)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	,00	53616	97,5	97,5	97,5
	1,00	1380	2,5	2,5	100,0
	Total	54996	100,0	100,0	

indgar

External gurantees (indgar)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	,00	37725	68,6	68,6	68,6
	1,00	17271	31,4	31,4	100,0
	Total	54996	100,0	100,0	

indgarreale

Real external collateral (indgarreale)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	,00	54666	99,4	99,4	99,4
	1,00	330	,6	,6	100,0
	Total	54996	100,0	100,0	

indgarfidebanca

Bank guarantee (indgarfidebanca)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	,00	54890	99,8	99,8	99,8
	1,00	106	,2	,2	100,0
	Total	54996	100,0	100,0	

indgarfideind

Personal guarantee (ingarfideind)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	,00	39404	71,6	71,6	71,6
	1,00	15592	28,4	28,4	100,0
	Total	54996	100,0	100,0	

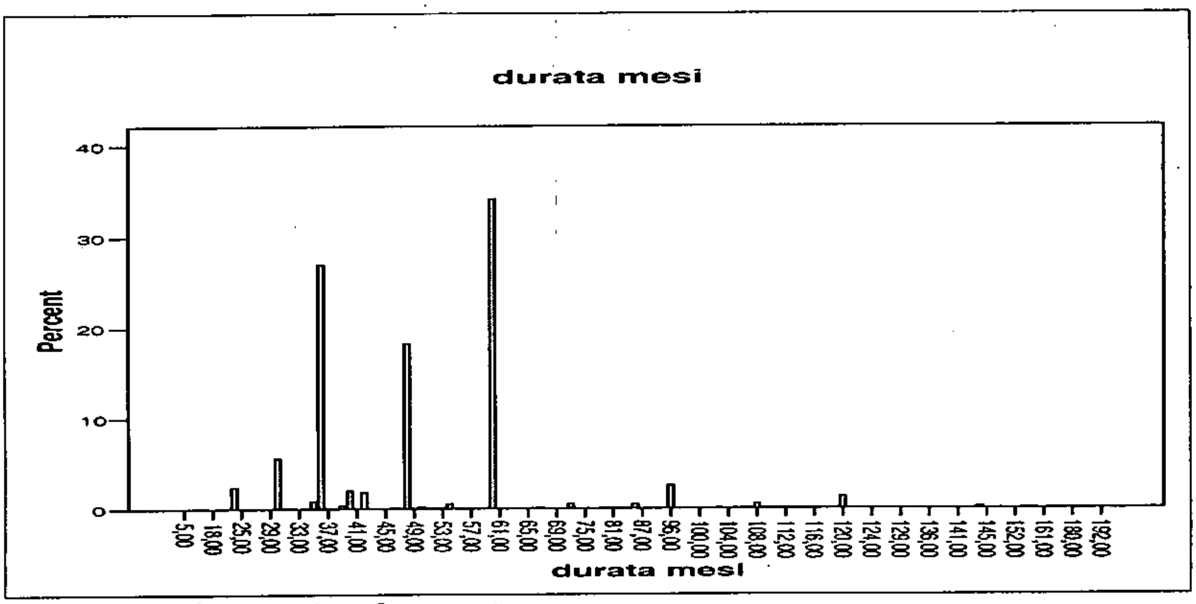
indgarunsp

Unspecified guarantee (indgarunsp)		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	,00	53028	96,4	96,4	96,4
	1,00	1968	3,6	3,6	100,0
	Total	54996	100,0	100,0	

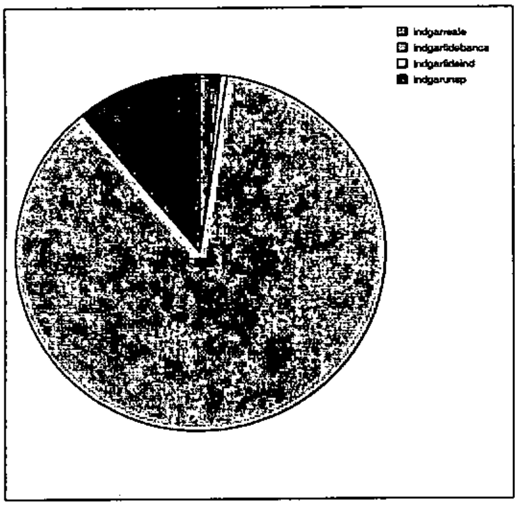
T.4. Frequencies

		indicatoredef	indgar	ispread	gint	durata mesi
N	Valid	54996	54996	54996	54996	54996
	Missing	0	0	0	0	0
Mean		,0251	,3140	2,8005	,9105	50,1783
Median		,0000	,0000	2,6680	,9000	48,0000
Variance		,024	,215	1,816	,006	320,698
Skewness		6,073	,801	,849	-1,360	1,917
Std. Error of Skewness		,010	,010	,010	,010	,010
Kurtosis		34,881	-1,358	4,200	2,791	6,486
Std. Error of Kurtosis		,021	,021	,021	,021	,021
Minimum		,00	,00	-10,67	,03	5,00
Maximum		1,00	1,00	25,41	1,00	240,00
Percentiles	25	,0000	,0000	1,9010	,8872	36,0000
	50	,0000	,0000	2,6680	,9000	48,0000
	75	,0000	1,0000	3,4980	,9736	60,0000

G.3. Distribution of contracts' maturities.



G.4. Relative frequencies of guarantees.

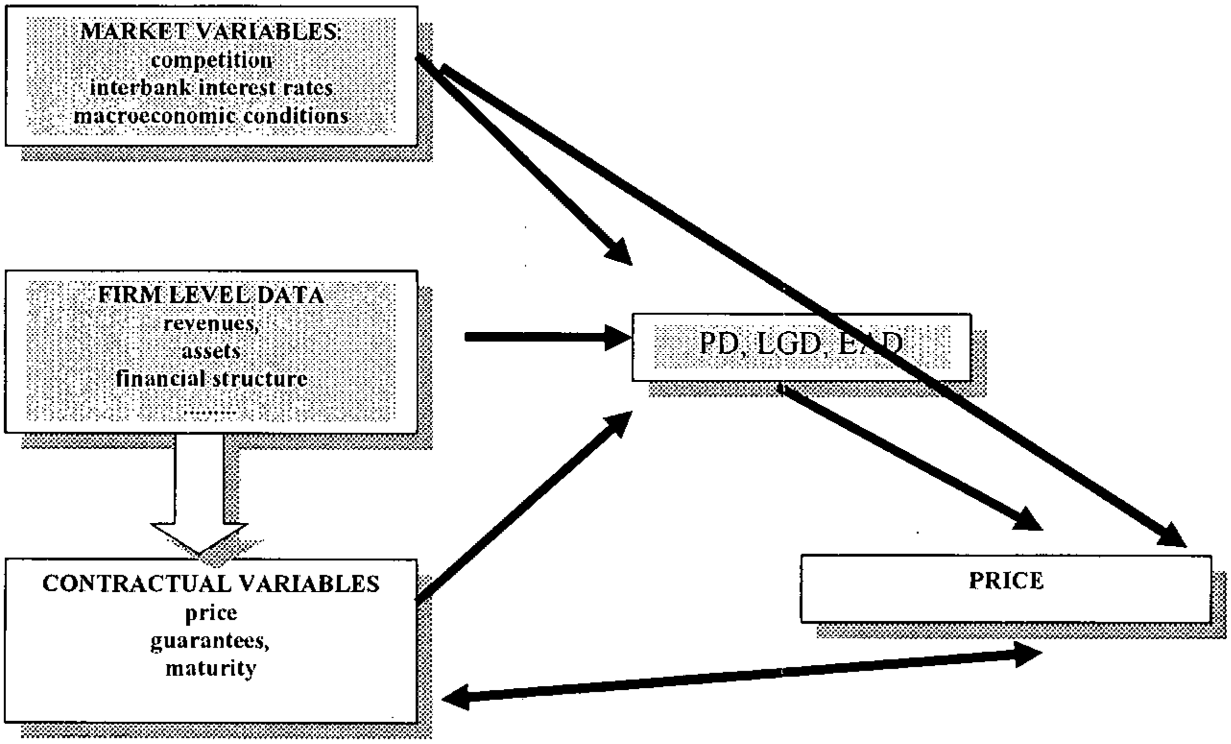


2. Methodology

The data we had, although very detailed and on a huge set, presented a major drawback. In fact the variables we considered are only contractual ones, and we miss any information on debtors fundamentals (creditworthiness, asset size, revenues and so on), so that all the analysis is partial and relying on information stemming from an underlying process[4].

[4] Information we deal with, is, let say, second hand; it derives from a contracting process based on previous information at this level of analysis we can't observe. The ideal testing procedure would be that of running a "ad hoc" experiment in the internal contracting and rating process.

Hence we need to be extremely cautious in controlling possible too strong interrelations among the variables we cope with. Theoretically we can suppose the following interactions:



Only data in clear boxes are observable in the database used. Therefore some hidden causalities could then affect our variables.

For avoiding any major statistical problem we always carefully control var-covar matrices and, where appropriate, collinearity diagnostics. For example the sample correlations, divided per leasing type, among gint, ispread, sumgar and durata_mesi are as follows in T.3, none of them causing serious preoccupation. It could be of interest to note, among the others, the negative correlation, although weak, between internal and external guarantees, what points out a substitution effect between the two.

Preliminarily, before directly testing our hypothesis, we tried to understand something more of the data we cope with, by means of a discriminant analysis for the two groups of defaulted and non defaulted contracts. With this tool we analysed the predictive power on defaults of some different independent variables and the direction of their effect.

T.5. Sample corelations.

			gint	ispread	sumgar	durata mesi
Tutti i contratti	Correlation	gint	1,000	-,211	-,022	,061
		ispread	-,211	1,000	-,072	-,245
		sumgar	-,022	-,072	1,000	,282
		durata mesi	,061	-,245	,282	1,000
			gint	**ispread**	**sumgar**	**durata mesi**
Leasing strumentale	Correlation	gint	1,000	-,256	-,054	,057
		ispread	-,256	1,000	-,051	-,165
		sumgar	-,054	-,051	1,000	,151
		durata mesi	,057	-,165	,151	1,000
			gint	**ispread**	**sumgar**	**durata mesi**
Leasing immobiliare	Correlation	gint	1,000	-,160	-,017	,058
		ispread	-,160	1,000	-,062	-,114
		sumgar	-,017	-,062	1,000	,211
		durata mesi	,058	-,114	,211	1,000
			gint	**ispread**	**sumgar**	**durata mesi**
Leasing auto	Correlation	gint	1,000	-,094	-,111	,163
		ispread	-,094	1,000	,025	-,061
		sumgar	-,111	,025	1,000	,080
		durata mesi	,163	-,061	,080	1,000

First of all we run a discriminant analysis, to understand differences among the two groups, defaulted and non defaulted leases. Then we used two different econometric tools for testing our main hypotheses. Specifically we tested $H_{1,0}$ through a logistic model on the probability of default, approximated by observed default frequencies. We used a step by step process, trying at first four logistic regressions on each single variable (internal and external collateral, length and interest rate spread) for understanding bivariate interrelations; then we searched for the best fit multivariate model selecting relevant covariate variables on the basis of the Likelihood Ratio (LR); moreover we estimated partial best fit models for the main different types of leasing contracts (machinery, real estates and car).

On the second hypothesis, $H_{2,0}$ we built a linear regression model with the interest rate spread as the independent variable, following almost the same procedure of analysing first univariate effects, for then trying to estimate a best fit model.

3. Discussion.

From the preliminary analysis of group statistics (T.4) some interesting features clearly emerge:

- the average level of internal guarantees is always, in all types of leases, greater for defaulted contracts (gint is smaller);
- the interest rate spread is, similarly, greater in defaulted sub-samples;
- external guarantees, are, in absolute value, grater in the non defaulted contracts, apart from the case of real estates leases;
- differences in original maturity don't seem to be relevant.

F tests of equality for group means indicate that only the level of internal guarantees and the interest rate spread are significantly different among different sub-samples (T.5).

The results grasped from descriptive statistics are confirmed even by the discriminant functions, whose structure matrix indicate gint and ispread as the variables with the greater discriminating power. Anyway it has to be noted that the Wilk's lambdas don't indicate a strong power of those functions; nonetheless the functions at group centroids are slightly different, so that we are confident to report the classification functions coefficients, from the analysis of which previous main effects are confirmed.

***H_{1_0}* test.**

The dependent variable, the probability of default (PD), is theoretically a continuous variable over the interval [0-1]. Hence the ordinary least square (OLS) regression, can't be used:

$$E(PD/x)=\beta_1+\beta_2 x_2+\ldots+\beta_k x_k=x\beta \qquad \textbf{(8)}$$

as it cannot guarantee that the predicted values from the model will lie in the bounded interval (Greene, 1993). A common econometric technique is to use a transformation G(y) that maps the [0-1] interval onto the whole real line. For instance, one can model the log-odds ratio transformation as a linear function of

T.6. Group Statistics.

	Indicatoredef		Mean	Std. Deviation	Valid N (listwise)	
					Unweighted	Weighted
Tutti i contratti	,00	gint	,9110	,07652	53616	53616,000
		Ispread	2,7810	1,33489	53616	53616,000
		Sumgar	220412379,0757	1707835651,01305	53616	53616,000
		durata mesi	50,1687	17,98715	53616	53616,000
	1,00	Gint	,8895	,07557	1380	1380,000
		Ispread	3,5592	1,59175	1380	1380,000
		Sumgar	165295993,7630	724829073,04146	1380	1380,000
		durata mesi	50,5514	14,50502	1380	1380,000
	Total	Gint	,9105	,07657	54996	54996,000
		ispread	2,8005	1,34743	54996	54996,000
		sumgar	219029358,2791	1690195666,02466	54996	54996,000
		durata mesi	50,1783	17,90805	54996	54996,000
Leasig strumentale	,00	gint	,9162	,06960	32012	32012,000
		ispread	2,7026	1,37108	32012	32012,000
		sumgar	146536955,6729	688328279,83348	32012	32012,000
		durata mesi	50,8018	11,20621	32012	32012,000
	1,00	gint	,8932	,07309	922	922,000
		ispread	3,5238	1,72765	922	922,000
		sumgar	137519456,3200	381009331,22029	922	922,000
		durata mesi	53,1920	9,79214	922	922,000
	Total	gint	,9156	,06980	32934	32934,000
		ispread	2,7256	1,38890	32934	32934,000
		sumgar	146284507,3094	681610803,23851	32934	32934,000
		durata mesi	50,8687	11,17588	32934	32934,000
Leasing immobiliare	,00	gint	,8958	,08394	2393	2393,000
		ispread	1,8929	,89494	2393	2393,000
		sumgar	2326859918,6055	6642906510,64477	2393	2393,000
		durata mesi	108,0301	16,23575	2393	2393,000
	1,00	gint	,8481	,08122	35	35,000
		ispread	2,6780	,94621	35	35,000
		sumgar	2383385408,5714	3459037395,28205	35	35,000
		durata mesi	105,2571	12,03021	35	35,000
	Total	gint	,8951	,08408	2428	2428,000
		ispread	1,9042	,90037	2428	2428,000
		sumgar	2327674742,3900	6607533036,48493	2428	2428,000
		durata mesi	107,9901	16,18440	2428	2428,000
Leasing automobilistico	,00	gint	,9017	,08758	14464	14464,000
		ispread	3,2063	1,21478	14464	14464,000
		sumgar	16590096,9944	54271961,46058	14464	14464,000
		durata mesi	38,5158	9,54736	14464	14464,000
	1,00	gint	,8908	,07636	346	346,000
		ispread	3,7245	1,19104	346	346,000
		sumgar	22888759,1503	53850985,92665	346	346,000
		durata mesi	38,2023	7,62221	346	346,000
	Total	gint	,9014	,08735	14810	14810,000
		ispread	3,2185	1,21671	14810	14810,000
		sumgar	16737250,0738	54268699,85284	14810	14810,000
		durata mesi	38,5084	9,50674	14810	14810,000

T.7. Tests of Equality of Group Means.

		Wilks' Lambda	F	df1	df2	Sig.
Tutti i contratti	gint	,998	106,252	1	54994	,000
	ispread	,992	452,438	1	54994	,000
	sumgar	1,000	1,431	1	54994	,232
	durata mesi	1,000	,614	1	54994	,433
Leasing strum.	gint	,997	97,763	1	32932	,000
	ispread	,990	316,276	1	32932	,000
	sumgar	1,000	,157	1	32932	,692
	durata mesi	,999	41,042	1	32932	,000
Leasing immobi.	gint	,995	11,162	1	2426	,001
	ispread	,989	26,505	1	2426	,000
	sumgar	1,000	,003	1	2426	,960
	durata mesi	1,000	1,013	1	2426	,314
Leasing auto	gint	1,000	5,249	1	14808	,022
	ispread	,996	61,528	1	14808	,000
	sumgar	1,000	4,553	1	14808	,033
	durata mesi	1,000	,367	1	14808	,544

T.8. Discriminant analysis (1).

	Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
Tutti	1	,990	526,985	4	,000
Tipo 1	1	,987	436,600	4	,000
Tipo 2	1	,986	33,007	4	,000
Tipo 3	1	,995	66,976	4	,000

T.9. Discriminant analysis (2).

		indicatoredef	
		,00	1,00
Tutti	gint	168,415	166,198
	ispread	4,191	4,628
	sumgar	-9,023E-11	-1,181E-10
	durata mesi	,192	,203
	(Constant)	-88,045	-87,961
Tipo 1	gint	209,157	206,303
	ispread	4,700	5,131
	sumgar	9,330E-10	8,698E-10
	durata mesi	,420	,450
	(Constant)	-113,597	-113,883
Tipo 2	gint	131,221	126,030
	ispread	5,128	6,025
	sumgar	-8,935E-11	-7,951E-11
	durata mesi	,413	,409
	(Constant)	-86,513	-83,609
Tipo 3	gint	119,088	118,241
	ispread	3,080	3,424
	sumgar	2,160E-08	2,341E-08
	durata mesi	,261	,261
	(Constant)	-64,534	-64,987

T.10. Discriminant analysis (3).

		Structure Matrix*
		Function
		1
Tutti	ispread	,924
	gint	-,448
	sumgar	-,052
	durata mesi	,034
		Function
		1
Tipo1	ispread	,848
	gint	-,472
	durata mesi	,306
	sumgar	-,019
		Function
		1
Tipo 2	ispread	,893
	gint	-,579
	durata mesi	-,174
	sumgar	,009
		Function
		1
Tipo 3	ispread	,957
	gint	-,280
	sumgar	,260
	durata mesi	-,074

T.11. Discriminant analysis (4).

	Functions at Group Centroids*	
Tutti	indicatoredef	Function 1
	,00	-,016
	1,00	,612
Tipo 1	indicatoredef	Function 1
	,00	-,020
	1,00	,681
Tipo 2	indicatoredef	Function 1
	,00	-,014
	1,00	,968
Tipo 3	indicatoredef	Function 1
	,00	-,010
	1,00	,435

explanatory variables. In other words, instead of having y as the dependent variable, the model uses the following transformation of y[5]:

$$PD \rightarrow \log \frac{PD}{1-PD}$$

and the regression becomes:

[5] Called the log-odds transformation.
$\frac{PD}{1-PD}$ is the odds of the probability of default.

$$E\left(\log\left(\frac{PD}{1-PD}\right)/x\right)=x\beta$$

where x is a $k*1$ vector of explanatory variables, and β is a $k*1$ vector of slope coefficients. The drawback of the log-odds ratio transformation is that it is not defined for the dependent variable taking values of 0 or 1, i.e. as in our case the proxy does. The suggested solution shown in Greene (1993) is to consider, for a generic dependent variable:

$$E(y/x)=G(x\beta) \qquad \textbf{(9)}$$

where $G(.)$ is a known function satisfying $0<G(x_i\beta)<1$ for all $x_i\beta$. This ensures that the predicted values of y lie in the interval (0,1). Equation (3) is well defined even if y_i can take on the 0 or 1 with positive probability. Typically, $G(.)$ is chosen to be a cumulative distribution function (cdf). There are several possible functional forms, but we used the logistic function, defined as:

$$G(x\beta)=\frac{\exp(x\beta)}{1+\exp(x\beta)},$$

The model is estimated through iterative maximum likelihood and one of the main features distinguishing it from OLS regression is that the R^2 index couldn't be properly computed; instead we considered the approximation represented by the Nagelkerke R^2.

First the model was estimated on each single variable, then trying to approximate a best fit multivariate model and finally separately for the three main types (machinery and equipment, real estates and car). Hereafter are reported model summaries (T.10), classification tables (T.11) and variable coefficients(T.12) for the logistic regressions.

T.12. Model summaries (logistic regression).

	Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
gint	1	12801,255(a)	,002	,008
ispread	1	12513,942(a)	,007	,033
durata	1	12895,560(a)	,000	,000
indgar	1	12859,076(a)	,001	,003
Best fit	3	12461,839(a)	,008	,038
Type 1	2	8116,684(a)	,009	,040
Type 2	2	340,709(b)	,010	,075
Type 3	2	3216,142(a)	,005	,023

One main result is that the original length of the contract doesn't affect the PD, as it is clear from the value of the coefficient, from the Naglekerke R^2 and from the lack of power in classifying cases.

On the other side the remaining regressors do have some power, even though it can be regarded as weak; this is certainly due to the lack of observation on underlying firm level data, which account for a great part of influence on the dependent variable.

The interest rate spread is the variable with the greater effect by its own (it correctly classifies 78,9% of non defaulters and 40,4% of defaulters), whilst the partial model on real estates leasing is the one with the best fit. Nonetheless the "best fit" overall model, stepwise selected on the basis of likelihood ratios, is behaving in a fairly proper manner.

The effect of single regressors is always in the same direction: PD is directly related to the interest rate spread, to the level of internal guarantees and to the presence of external ones[6].

[6] Exp(B) represents the ratio-change in the odds of the event of interest for a one-unit change in the predictor. For example, Exp(B) for gint in the "best fit" overall model is equal to 0.153, which means that the odds of default for a contract which has a unit level change in the value of gint are 0.153 times the previous odds of default, all other things being equal. In this case an increase in gint means, for definition, a lower level of internal guarantees. Hence a lower level of internal guarantees implies lower odds of default, what means, in turn, lower PD.

T.13. Classification tables (logistic regression).

	Observed		Predicted		
			indicatoredef		Percentage Correct
			not defaulted	defaulted	
Gint	indicatoredef	not defaulted	46887	6729	87,4
		defaulted	1162	218	15,8
	Overall Percentage				85,7
Ispread	indicatoredef	not defaulted	42318	11298	78,9
		defaulted	823	557	40,4
	Overall Percentage				78,0
Durata	indicatoredef	not defaulted	53615	1	100,0
		defaulted	1380	0	,0
	Overall Percentage				97,5
Indgar	indicatoredef	not defaulted	36884	16732	68,8
		defaulted	841	539	39,1
	Overall Percentage				68,0
Best fit	indicatoredef	not defaulted	40790	12826	76,1
		defaulted	775	605	43,8
	Overall Percentage				75,3
Tipo1	indicatoredef	not defaulted	22282	9730	69,6
		defaulted	415	507	55,0
	Overall Percentage				69,2
Tipo 2	indicatoredef	not defaulted	2207	186	92,2
		defaulted	24	11	31,4
	Overall Percentage				91,4
Tipo 3	indicatoredef	not defaulted	11766	2698	81,3
		defaulted	226	120	34,7
	Overall Percentage				80,3

a The cut value is ,030

The overall "best fit" model includes as variables with a statistically significant explanatory power all the cited three (gint, ispread and indgar), the partial models on type 1 and type 2 contracts include only the first two and the model on type 3 only the internal and external guarantees. That is as to say that PD in machinery and equipment and real estates leases is not predicted by the level of external guarantees, while, instead, PD for car leases is unaffected by the interest rate spread. Many different interpretations can be given to this fact; a possible one is that the car leasing market can be more competitive and financiers, losing contracting power on the interest rate, try to recover the guarantees tool.

T.14. Variables in the equations (logistic regression).

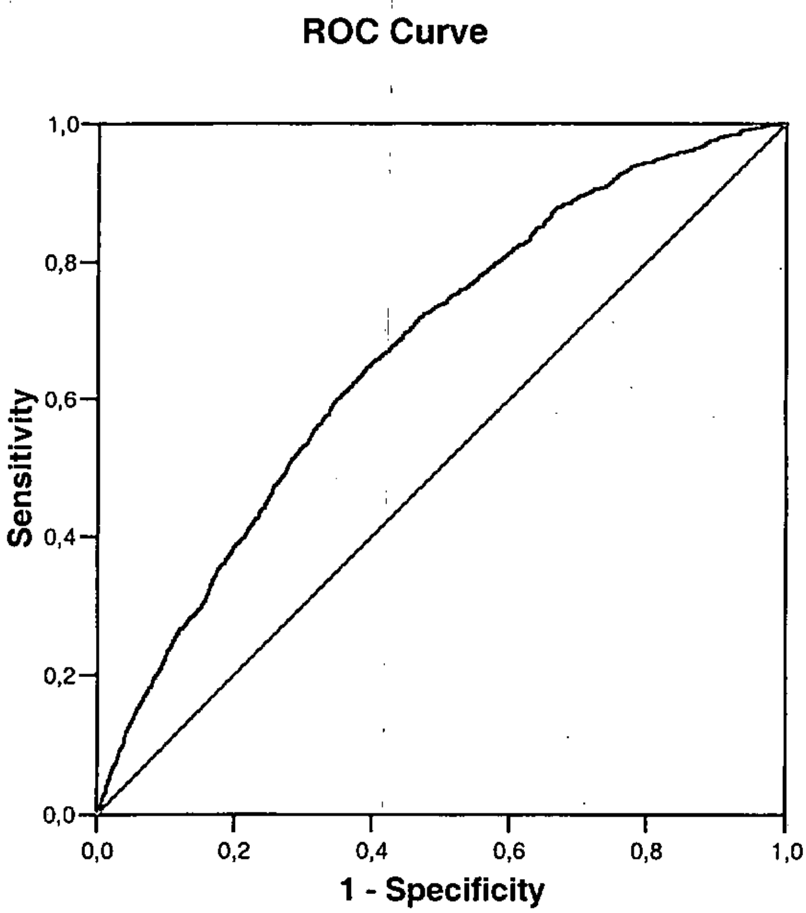
		B	S.E.	Wald	df	Sig.	Exp(B)
Gint Step 1(a)	gint	-3,115	,303	105,346	1	,000	,044
	Constant	-,853	,272	9,872	1	,002	,426
Ispread Step 1(a)	ispread	,343	,017	417,437	1	,000	1,409
	Constant	-4,734	,065	5364,900	1	,000	,009
Durata Step 1(a)	durata_mesi	,001	,001	,614	1	,433	1,001
	Constant	-3,719	,080	2147,483	1	,000	,024
Indgar Step 1(a)	indgar(1)	,346	,056	38,140	1	,000	1,413
	Constant	-3,781	,035	11754,515	1	,000	,023
Best fit Step 3(c)	gint	-1,877	,329	32,604	1	,000	,153
	ispread	,322	,017	348,169	1	,000	1,380
	indgar	,216	,057	14,397	1	,000	1,241
	Constant	-3,054	,314	94,804	1	,000	,047
Tipo 1 Step 2(b)	gint	-2,558	,435	34,531	1	,000	,077
	ispread	,309	,021	225,332	1	,000	1,362
	Constant	-2,181	,412	28,029	1	,000	,113
Tipo 2 Step 2(b)	gint	-4,347	1,525	8,126	1	,004	,013
	ispread	,591	,128	21,408	1	,000	1,805
	Constant	-1,744	1,360	1,644	1	,200	,175
Tipo 3 Step 2(b)	ispread	,286	,038	56,987	1	,000	1,331
	indgar	,449	,120	13,902	1	,000	1,567
	Constant	-4,829	,153	996,444	1	,000	,008

The model correctly classifies 76,1% of non defaulters and 43,8 % of defaulters.

A further tool to understand the predictive power of the model is to build a ROC curve on the predicted probabilities of default, with the indicator for default as the state variable.

As it is shown in G.3, the logistic model have some statistically significant predictive power.

G.5.



Diagonal segments are produced by ties.

Area Under the Curve

Area	Std. Error(a)	Asymptotic Sig.(b)	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
,668	,007	,000	,654	,681

H_{20} test.

For testing our second hypothesis we could use a linear regression estimated through the OLS procedure on the functional form:

$$E(ispread / x) = x\beta$$

We used a strategy similar to the one previously adopted for the logistic model:

- first we estimated models on single different possible predictors, including a wide array of possible variables (we were interested to our four main regressors, but in this case we wanted to understand possible effect of the different types of external guarantees[7] and of a different proxy for the value of internal guarantees[8]);
- then we tried to adapt a best fit model trough a stepwise procedure based on the F-statistic value.

T.15. Model summaries (OLS regression)

Regressors	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	Sig
Constant, gint	,214(a)	,046	,046	1,31623	2638,599	,000
Constant, indgar	,099(a)	,010	,010	1,34085	541,631	,000
Constant, durata mesi	,244(a)	,059	,059	1,30684	3470,413	,000
Constant, indgarreale	,028(a)	,001	,001	1,34693	42,123	,000
Constant, ingarfidebanc a	,024(a)	,001	,001	1,34705	31,915	,000
Constant, indfideind	,103(a)	,011	,011	1,34022	594,162	,000
Constant, Indgarunsp	,015(a)	,000	,000	1,34728	13,058	,000
Constant, type dummy (strumentale)	,151(a)	,023	,023	1,36099	823,803	,000

From the analysis of table T.13 we can understand that all the eight different explanatory variables have some explanatory power on the basis of the F-statistic. In terms of explained variance the stronger effects are those of the length and of internal guarantees.

The internal guarantee, as approximated by gint and as represented by the real estate type, the length, the presence of external collateral and the presence of bank guarantees have an inverse effect on the interest rate spread (T.14); on the contrary the presence of a generic external guarantee or the presence of a personal guarantee or of an unspecified one have a direct effect.

[7] Collaterals, bank guarantees, personal guarantees and unspecified guarantees (indgarreale, indfidebanca, indfideind, indgarunsp).

[8] The type of the financed asset (the dummy variable takes value 1 for equipment and machinery leases.

Anyway we excluded gint from subsequent analyses, because it could generate a collinearity problem; in fact its condition index(T.15) lies very close around the critical value[9].

T.16. Coefficients.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6,229	,067		93,002	,000
	gint	-3,765	,073	-,214	-51,367	,000
2	(Constant)	2,710	,007		392,627	,000
	lndgar	,287	,012	,099	23,273	,000
3	(Constant)	3,720	,017		224,401	,000
	durata mesi	-,018	,000	-,244	-58,910	,000
4	(Constant)	2,803	,006		486,634	,000
	indgarreale	-,483	,074	-,028	-6,490	,000
5	(Constant)	2,802	,006		487,329	,000
	indgarfidebanca	-,740	,131	-,024	-5,649	,000
6	(Constant)	2,713	,007		401,815	,000
	indgarfideind	,309	,013	,103	24,375	,000
7	(Constant)	2,797	,006		477,983	,000
	indgarunsp	,112	,031	,015	3,614	,000
8	(Constant)	1,904	,028		68,941	,000
	strumentale	,821	,029	,151	28,702	,000

T.17. Collinearity diagnostics.

Model	Dimension	Eigenvalue	Condition Index
1	1	1,996	1,000
	2	,004	23,823
2	1	1,560	1,000
	2	,440	1,884
3	1	1,942	1,000
	2	,058	5,777
4	1	1,077	1,000
	2	,923	1,081
5	1	1,044	1,000
	2	,956	1,045
6	1	1,532	1,000
	2	,468	1,810
7	1	1,189	1,000
	2	,811	1,211
8	1	1,965	1,000
	2	,035	7,499

[9] Greene (1993) suggests not to consider models with condition numbers close to the value of 20.

T.18. Residual statistics[10].

Model 1	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2,4635	6,1329	2,8005	,28831	54996
Residual	-13,69332	21,30989	,00000	1,31622	54996
Std. Predicted Value	-1,169	11,558	,000	1,000	54996
Std. Residual	-10,403	16,190	,000	1,000	54996
Model 2	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	2,7105	2,9972	2,8005	,13307	54996
Residual	-13,37548	22,69452	,00000	1,34084	54996
Std. Predicted Value	-,677	1,478	,000	1,000	54996
Std. Residual	-9,975	16,925	,000	1,000	54996
Model 3	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	-,6792	3,6287	2,8005	,32828	54996
Residual	-13,72543	22,78453	,00000	1,30683	54996
Std. Predicted Value	-10,600	2,523	,000	1,000	54996
Std. Residual	-10,503	17,435	,000	1,000	54996
Model 4	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	2,3207	2,8034	2,8005	,03728	54996
Residual	-13,46842	22,60159	,00000	1,34691	54996
Std. Predicted Value	-12,871	,078	,000	1,000	54996
Std. Residual	-9,999	16,780	,000	1,000	54996
Model 5	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	2,0621	2,8019	2,8005	,03245	54996
Residual	-13,46694	22,60305	,00000	1,34704	54996
Std. Predicted Value	-22,756	,044	,000	1,000	54996
Std. Residual	-9,997	16,780	,000	1,000	54996
Model 6	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	2,7129	3,0220	2,8005	,13931	54996
Residual	-13,37789	22,69211	,00000	1,34021	54996
Std. Predicted Value	-,629	1,590	,000	1,000	54996
Std. Residual	-9,982	16,932	,000	1,000	54996
Model 7	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	2,7965	2,9083	2,8005	,02076	54996
Residual	-13,46152	22,60848	,00000	1,34727	54996
Std. Predicted Value	-,193	5,191	,000	1,000	54996
Std. Residual	-9,992	16,781	,000	1,000	54996
	Minimum	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	1,9042	2,7256	2,6692	,20773	35362
Residual	-13,39064	22,67936	,00000	1,36097	35362
Std. Predicted Value	-3,683	,272	,000	1,000	35362
Std. Residual	-9,839	16,664	,000	1,000	35362

The second phase of OLS regression analysis was that of trying to estimate a best

[10] Residuals from the models are fairly clear. Standard deviation are slightly greater than in the Normality case and there may be a little negative skewness (judged on the basis of graphs and indexes here not reported).

fit model on the basis of a stepwise – F statistic based methodology[11]. The reference sample was reduced to type 1 and type 2 leases, for taking into consideration the effect of real estates as opposed to machinery and equipment (this distinction was significant on the basis of the relative partial model).

The final best fit model, whose main statistics and diagnostics are reported in tables from T.17 to T.21, was:

$$E(ispread / x) = 3{,}891 - 0{,}021 durata\_mesi + 0{,}533 indgar - 0{,}277 strumentale$$ [12]

The same notations as for the partial models are in place with regard to residual statistics, as it can be noted also with the help of graphs G.3 and G.4.

T.19. Correlations.

		ispread	strumentale	indgar	durata mesi
Pearson Correlation	ispread	1,000	,151	,144	-,213
	strumentale	,151	1,000	-,103	-,780
	indgar	,144	-,103	1,000	,163
	durata mesi	-,213	-,780	,163	1,000
Sig. (1-tailed)	ispread	.	,000	,000	,000
	strumentale	,000	.	,000	,000
	indgar	,000	,000	.	,000
	durata mesi	,000	,000	,000	.
N	ispread	35362	35362	35362	35362
	strumentale	35362	35362	35362	35362
	indgar	35362	35362	35362	35362
	durata mesi	35362	35362	35362	35362

T.20. Model summary.

Model	R Square	Adjusted R Square	Std. Error of the Estimate		
1	,045	,045	1,34511	1683,150	,000
2	,078	,078	1,32168	1504,514	,000
3	,079	,079	1,32097	1017,088	,000

[11] Variables are entered if probabilities on sample realisations of the F distribution are less than .05.

[12] strumentale is a dummy taking value 1 if the leased asset is machinery or equipment.

T.21. Coefficients.

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3,537	,022		158,352	,000
	durata mesi	-,016	,000	-,213	-41,026	,000
2	(Constant)	3,472	,022		157,593	,000
	durata mesi	-,018	,000	-,243	-47,000	,000
	indgar	,529	,015	,184	35,576	,000
3	(Constant)	3,891	,071		55,009	,000
	durata mesi	-,021	,001	-,283	-34,417	,000
	indgar	,533	,015	,185	35,817	,000
	strumentale	-,277	,044	-,051	-6,245	,000

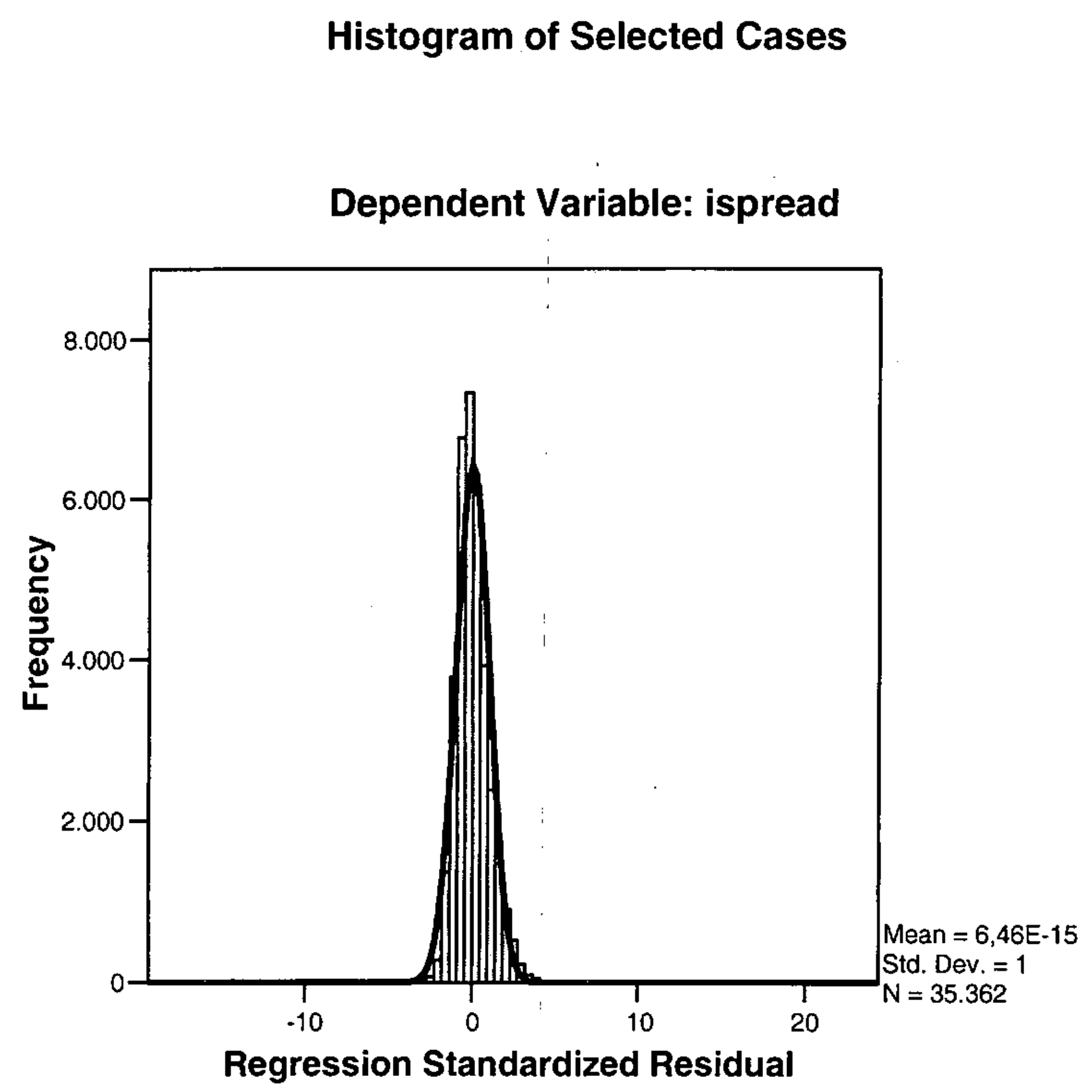
T.22. Collineaity diagnostics.

Model	Dimension	Eigenvalue	Condition Index
1	1	1,947	1,000
	2	,053	6,082
2	1	2,448	1,000
	2	,500	2,213
	3	,053	6,825
3	1	3,291	1,000
	2	,554	2,437
	3	,148	4,710
	4	,006	22,715

T.23. Residual statistics.

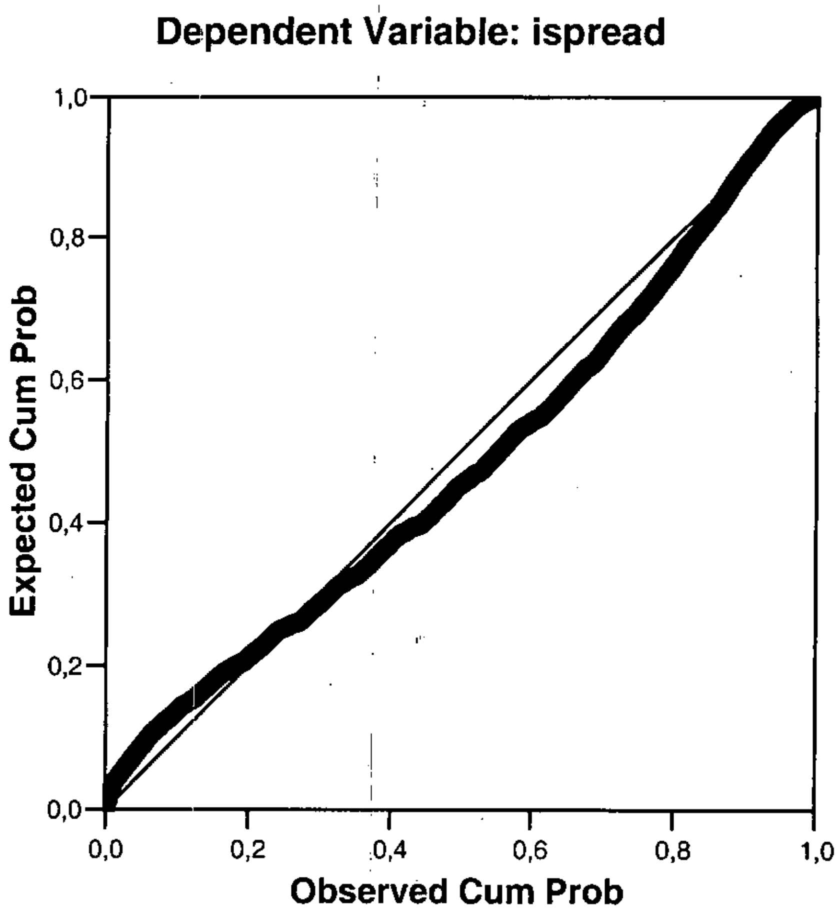
	tipona = 1,00 (Selected)				
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-1,1609	4,0418	2,6692	,38804	35362
Residual	-13,52109	23,05413	,00000	1,32092	35362
Std. Predicted Value	-9,871	3,537	,000	1,000	35362
Std. Residual	-10,236	17,452	,000	1,000	35362

G.6.

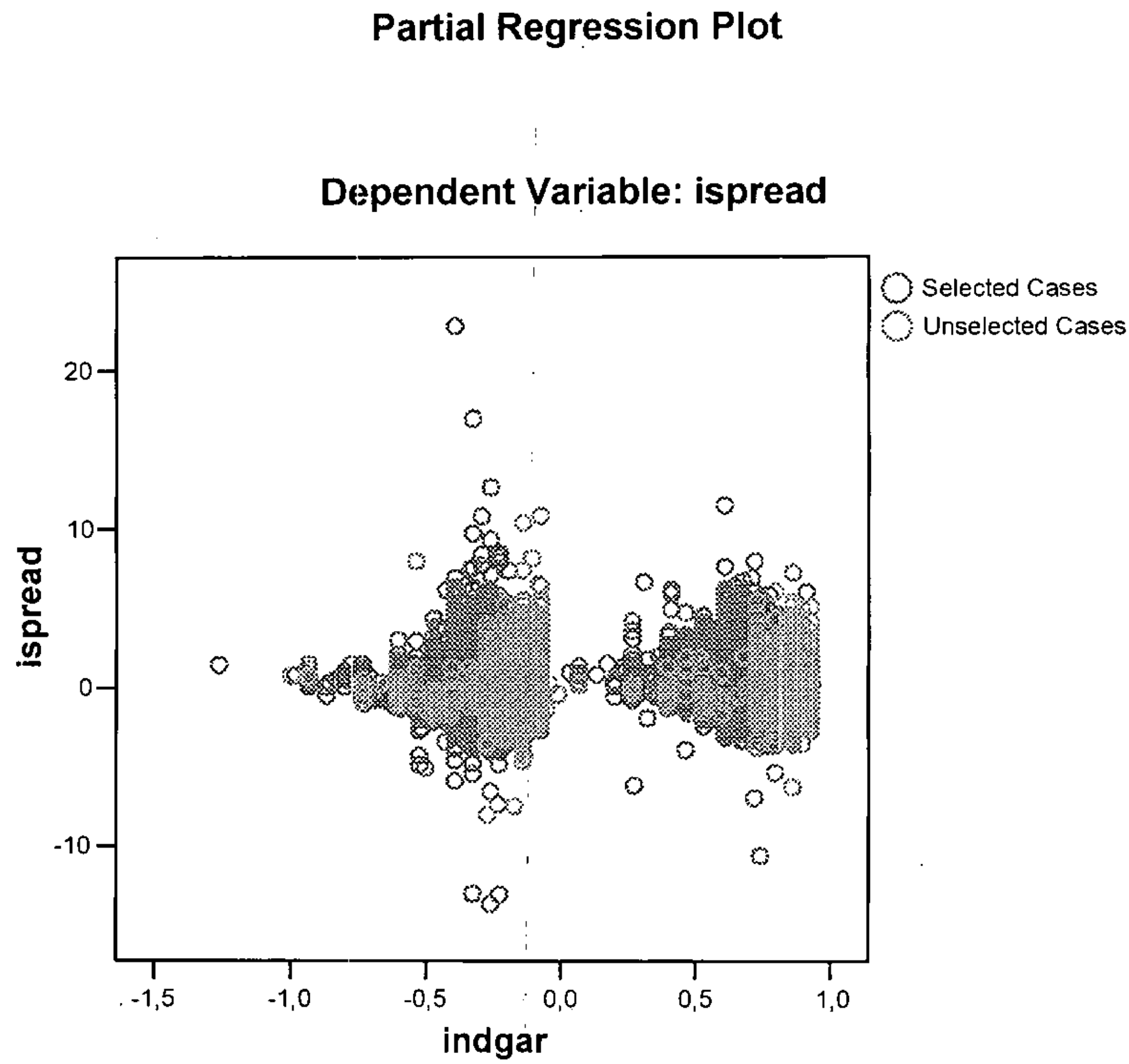

Histogram of Selected Cases
Dependent Variable: ispread
8.000
6.000
4.000
2.000
0
Frequency
-10
0
10
20
Regression Standardized Residual
Mean = 6,46E-15
Std. Dev. = 1
N = 35.362

G.7.

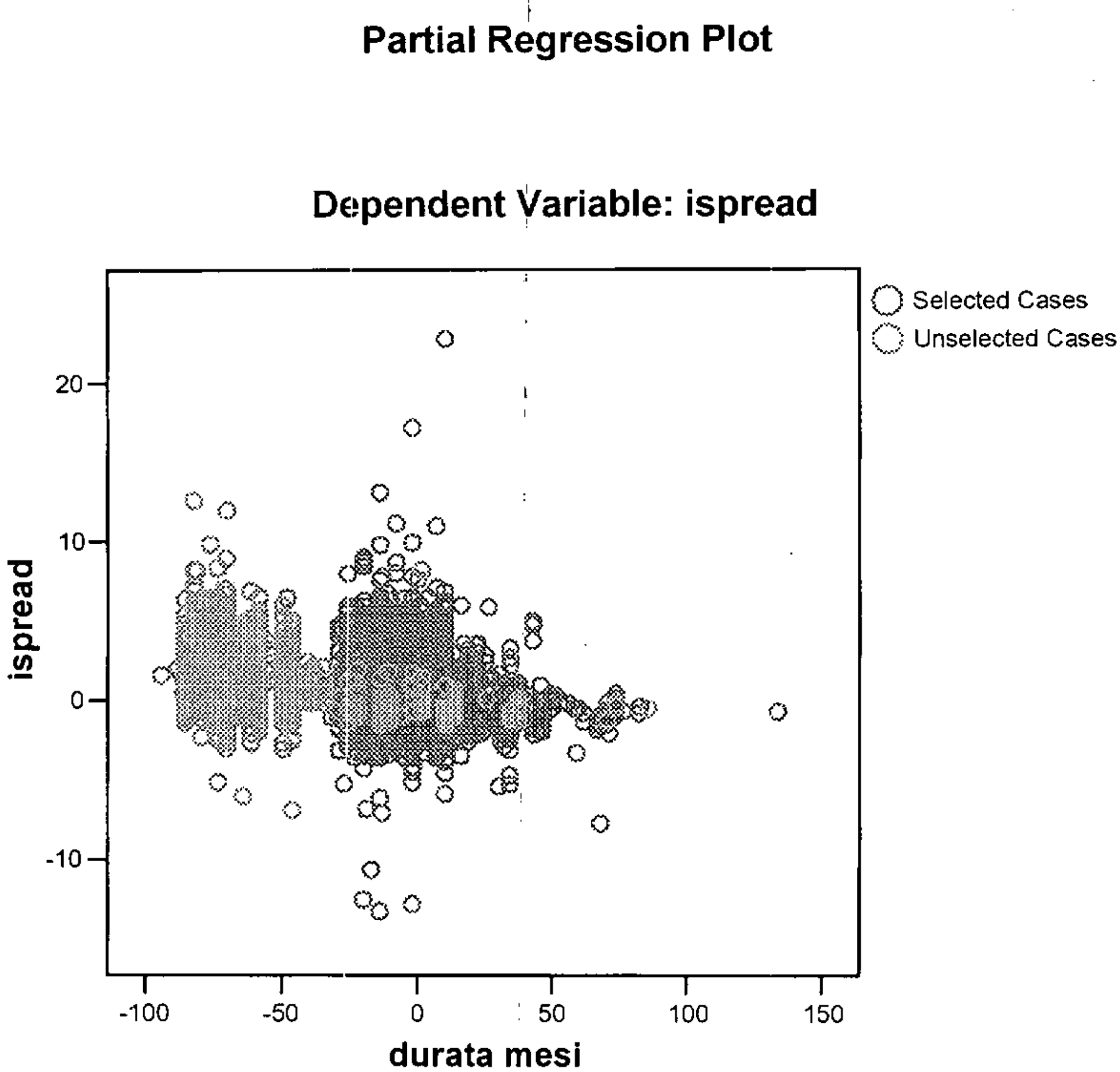
Normal P-P Plot of Standardized Residual for Selected Cases



G.8.


Partial Regression Plot
Dependent Variable: ispread
Selected Cases
Unselected Cases
ispread
20
10
0
-10
-1,5
-1,0
-0,5
0,0
0,5
1,0
indgar

G.9.


Partial Regression Plot
Dependent Variable: ispread
Selected Cases
Unselected Cases
ispread
20
10
0
-10
-100
-50
0
50
100
150
durata mesi

4. Conclusions.

The database here analysed had, on one side, the great quality of being composed of a huge number of cases, but, on the other, we could observe only a part of the story, that is as to say only contractual data stemming, as previously argued, from an underlying process. Hence the regressions presented have a limited overall explanatory power (of around 10 % of the total variance). Nonetheless single variables have a distinct effect (as measured with appropriate statistics) and none measure indicates to accept a joint hypothesis of all coefficients constrained to be zero. Specifically ROC curves, with relative tests on predicted probabilities, and classification results indicate a proper predictive power of the logistic model, while F-tests are in the same sense for OLS regressions.

Referring to the two main hypotheses we wanted to test, for the sake of clarity:

- $H_{1\,0}$: *the presence of external guarantees diminishes the probability of default.*

  Specified as the restriction for the sign of the coefficient on x_3 to be negative, in the model:

  $$PD = f(x_1, x_2, x_3, x_4)$$

  with the regressors intended and specified as:

  x_1 = spread ≡ *ispread*

  x_2 = length ≡ *durata_mesi*

  x_3 = external guarantees ≡ *indgar*

  x_4 = internal guarantees ≡ *gint*

- $H_{2\,0}$: *the presence of external guarantees is negatively related to the interest rate spread (the price of credit).*

  This is specified as the hypothesis that the sign of β_{indgar} is negative in the model:

$$ispread = c + \beta_1 x_1 + \ldots + \beta_{indgar} indgar + \ldots + \beta_k x_k + \varepsilon$$

Both nulls are rejected on the basis of available evidence. In fact estimated best fit models are:

1. $E\left(\frac{PD}{1-PD}\right) = -3{,}054 - 1{,}877 gint + 0{,}322 ispread + 0{,}216 indgar$

2. $ispread = 3{,}891 - 0{,}021 durata\_mesi + 0{,}533 indgar - 0{,}277 strumentale$ [13]

The presence of guarantees, in whatever form, are directly related (have a positive effect) with the probability of default of a leasing exposure. In the same direction it is the result saying that the presence of external guarantees causes an increase in the interest rate spread.

Our theoretical conjectures about the signalling role of guarantees and collaterals are strongly refused on the basis of examined data. This, which is in accord with many other empirical researches, could be due to the nature and structure of the contracting process on credit[14]. As it has been shown, if banks (in general financiers) have a strong contracting power[15], what could be due to many different reasons, can "impose" guarantees as they are a tool for diminishing expected losses in case of default. They ask for greater collateralisations when they, on the basis of data we didn't observe and of the internal rating process, forecast a greater probability of default. This is a sign, on one side, that financiers have a fairly good risks discriminating ability, so that they can sensibly reduce information asymmetries, on the other that there doesn't exist a proper contracting mechanism about all credit variables[16].

The explanation is in accord with:

[13] We remind that strumentale is a dummy taking value 1 if the leased asset is machinery or equipment. See above for the other variables definitions.

[14] It can also be due to the Manove – Padilla – Pagano (2000) hypothesis, i.e. that collateral, being a short cut for credit risk mitigation, reduces banks incentives to project screening.

[15] Whether this is due to market considerations (competition), or to the nature of the single relationship with prospective debtors.

[16] With Bester (cited) we can say that maybe credit isn't contracted on all the available tools (dimensions).

- the fact that the presence of external guarantees is associated with greater PD,
- with the fact that lower credit (higher internal guarantees) is associated with higher PD,
- with the fact that collaterals are associated with higher interest rate spreads (the price reflects underlying conjectures about the exposure risk and is set as to cover any expected loss).

It could be worth noting, that even the nature of the leased asset (what could be interpreted as another specification of internal guarantees) as the expected effect on risk; in fact real estate leases are associated with higher prices. This, although very strange, could be due to market conditions (maybe less competition), then to risk considerations.

The results obtained, as noted, are in contrast with what hypothesised in a previous section of this research. Nonetheless we are of the opinion that theoretical results can be used.

For example banks can try to use guarantees and collaterals, in a properly designed contracting process, as a screening device. In this way they could take into account guarantees not only as a loss given default (LGD) mitigating tool, but also as an input in the borrower rating process. We are of the idea that further research is needed to properly address the issue. Specifically a "field" experiment in a real internal rating process (even on a much smaller sample, but with access to all relevant data) could certainly be a strong contribution to the understanding of debtors behaviour on collaterals in an asymmetric information context.

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