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Moral hazard and credit screening: An experiment

C. Monica Capra [a], Irene Comeig [b], and Matilde O. Fernandez [c]

[a] Department of Economics, Emory University, Atlanta, GA 30322, USA; Ph. 404-727-6387 | E-mail: mcapra@emory.edu, To who correspondence should be sent
[b] University of Geneva (Swiss Center for Affective Sciences), University of Valencia and LINEEX, 7 rue des Battoirs, 1205 Geneva, Switzerland; E-mail: Irene.Comeig@uv.es
[c] Department of Finance, Facultad de Economía, Universidad de Valencia, Avda. de los Naranjos s/n, 46022 Valencia (Spain); E-mail: Matilde.Fernandez@uv.es

Abstract: In credit contracting under asymmetric information, lenders formulate sets of incentive compatible contracts that consider collateral and interest rates simultaneously as a mechanism to reveal the borrower's ex ante risk level. In this paper, we design an experiment to test how moral hazard due to ex ante asymmetric information affects the screening models by Bester (1985, 1987). Our experimental results confirm that by appropriately combining collateral with the interest rate, borrowers with different risk levels are separated, even in moral hazard settings.

Keywords: Contracts, Credit Screening, Experiments, Incentives, Moral Hazard

1. Introduction

In credit markets with asymmetric information, early theoretical studies considered collateral and interest rates in an isolated manner. These studies showed that adverse selection resulted in riskier credit applicants selecting high interest rates, or high collateral (see Stiglitz and Weiss, 1981 and Wette, 1983). Later analyses by Bester (1985) and Chan and Kanatas (1985), however, considered contracts that lead to separation of types by offering rates of interest and collateral simultaneously. Bester (1985) showed that by offering pairs of incentive compatible contracts with different interest rate-collateral combinations, lenders are capable of indirectly distinguishing between borrowers of different risk levels. In his later work, Bester (1987) also considered the possibility of moral hazard due to ex ante asymmetric information. Bester hypothesized that the demanded collateral softens the effects of moral hazard, since higher collateral gives incentives to borrowers to choose projects involving a smaller risk ex-post.

In this paper, we perform an experiment designed to test Bester's hypothesis that contracts that combine collateral and interest rates are incentive compatible and that these contracts can also smooth moral hazard. We find that offering menus of contracts that combine interest rates and collateral allows creditors to separate borrowers by their type; in addition, we also find that contracts with higher collateral make subjects less likely to increase the probability of failure of their projects in an environment with moral hazard. Thus, we provide evidence in support of Bester's hypothesis.

The possibility of screening borrowers by their risk level is of great importance. When creditors offer a menu of contracts inducing the selection of firms, there is a separating equilibrium that reveals information and can resolve rationing. Notwithstanding the relevance of these results, the hypothesis that contracts combining pairs of collateral and interest rates are incentive compatible for borrowers with different risk levels, with or without moral hazard, is difficult to test using field data. Indeed, there is a scarcity of micro data on the contractual terms of commercial bank loans, which are usually confidential.[1] Because of these restrictions, most of the existing empirical literature relies on data from surveys, and implicitly assumes that borrowers can correctly and honestly assess their ex ante (project) risk. Given the difficulties inherent with field data, laboratory experiments offer an attractive "complementary" approach, because they make it possible to control, isolate, and vary the factors of interest while keeping all others constant.

There are only a few experimental papers on screening; these include Shapira and Venezia (1999), Posey and Yavas (2004), and Kubler et al. (2006). Experimental studies that have examined agents' behaviour in static moral hazard situations include Berg et al. (1992), Epstein (1992), Keser and Willingwer (2000), Anderhub, Gächter, and Königstein (2002), Charness and Dufwenberg (2006).[2] However, as far as we know, ours is the first study that studies credit screening and moral hazard in conjunction.

[1] Some evidence has been generated on the effect of collateral in an isolated manner (i.e., not in combination with interest rates). Leeth and Scott (1989), Boot, Thakor and Udell (1991), Machauer and Weber (1998), Jimenez and Saurina (2004), and Burke and Hanley (2006) examine the characteristics of loans with collateral to establish a relationship between collateral and credit risk. All of these papers, except Machauer and Weber, show that collateral is highly correlated to higher risk.

[2] Other papers on agents' behaviour in static moral hazard situations concentrate on contract design (Bull, Schotter, and Weigelt (1987), Nalbantian and Schotter (1997); Hackett (1993)) or competition (Plott and Wilde (1982), and Cabrales, Charness and Villeval (2006)).

2. Experimental Design and Procedures

We use experimental methods to analyze incentive compatibility in loan contracts that combine collateral and interest rate requirements under two different environments: first without moral hazard, and then with moral hazard due to ex ante asymmetric information as in Bester (1987). As in theory, we design ad hoc incentive compatible contracts to test the following hypotheses.

Hypothesis 1. By offering two incentive compatible contracts, borrowers can be separated by their risk levels. Lower risk borrowers choose contracts with higher collateral (Separating effect of contracts).

Hypothesis 2. When there is moral hazard generated by ex ante asymmetric information, higher collateral incentive borrowers choose lower risk projects (Positive incentive effect of collateral).

An environment was designed in which there are N_i subjects that can have one of the two types $i = s$ (safer) *or* r (riskier), according to the risk level of their project. It is assumed that individuals are risk neutral. Subjects in the experiment can acquire an asset in order to develop their projects with some expected future return. The project of a type *s* borrower has a return of 600 monetary units in case of success with a probability of 0.9 and a return of zero in case of failure. Type *r* can develop a project that provides a return of 1080 monetary units in case of success and zero in case of failure, each with equal probability.

We offered two contracts for the purchase of the asset. Each contract includes two features: the price to be paid and a security deposit, representing the collateral. In this experimental market, the buyers do not pay for the asset at the time the contract is signed, but at the end of the round when the buyer learns about the return the asset yields. If the project succeeds, they earn the asset's return and pay the contract price. However, if the project fails, they pay the security deposit. Each individual starts each market round with an initial wealth of 300 units; any amount equal to 300 or less can be used as a security deposit. There are five rounds in the market and each subject makes five independent decisions (one for each round) in which only the contracts (price and security deposit) change. Each subject must choose one or none of the two offered contracts in each round, whichever he/she prefers. The subjects who do not choose any contract in the round receive a return of 30 monetary units at the end of the round from a risk free investment. The individuals expected returns for acquiring the asset are:

$$ER_s = 0.9\ (300 + 600 - \text{Price}) + 0.1\ (300 + 0 - \text{Deposit})$$

$$ER_r = 0.5\ (300 + 1080 - \text{Price}) + 0.5\ (300 + 0 - \text{Deposit})$$

In each of the rounds, we offered a pair of theoretically incentive compatible contracts (C_1, C_2) with ER_s (C2) ≥ ER_s (C1) and ER_r (C1) ≥ ER_r (C2)

Table 1 shows the pairs of contracts offered to the subjects in each round. Subjects made their choices based on their own risk tolerance, the price, and security deposit of each contract. Treatment A is devoted to test whether the pairs of contracts designed, which combine prices and security deposits, permit the separation of heterogeneous individuals by their risk level.

Table 1: Pairs of offered contracts

Round	C_1		C_2	
	Price	Dep.	Price	Dep.
1	360	0	166	300
2	335	25	169	275
3	310	50	172	250
4	285	75	175	225
5	260	100	177	200

After making their decisions in Treatment A, all subjects read the instructions for Treatment B. In treatment B, we introduced moral hazard due to ex ante asymmetric information to test the effectiveness of these contracts as a mechanism to separate borrowers with different risk levels. We started within the same, previously described context, the only change being that subjects had the opportunity to make another decision before learning about the project's success or failure. This second decision was whether to modify the original project, which entailed an increase in the projects' expected return and probability of failure. Thus, moral hazard originated from the lack of control that sellers had on the buyers' project choice. Note that in our design, if the buyer was successful, he automatically paid the contract price; thus, we excluded moral hazard derived from the ex post asymmetric information between buyers and sellers.

The second treatment also contained several rounds in which each subject $i = s, r$ was offered a pair of incentive compatible contracts, exactly as in Treatment A. Consequently the expected results were identical to those in Treatment A, in case individuals did not modify original projects. However, when individuals modified original projects, they also modified their expected returns. The modified project of *s* individuals provided a return of 1,200 monetary units in case of success, with a probability of 0.6, and zero in case of failure. For subjects *r*, modifying the original projects had a success probability of 0.3 and resulted in a return of 2,160 monetary units; failure resulted in a payoff equal to zero. Hence, the expected returns for each *s* and *r* subjects for modifying the initial project were:

$$ER_{sm} = 0.6\ (300 + 1\ 200 - \text{Price}) + 0.4\ (300 + 0 - \text{Deposit}) \quad (3)$$

$$ER_{rm} = 0.3\ (300 + 2\ 160 - \text{Price}) + 0.7\ (300 + 0 - \text{Deposit})$$

Thus, a situation was created in which both types of individuals experienced an increase in their expected return, if they changed the original project.

We are interested in testing Bester's (1987) hypothesis that contracts with higher co-payment have a positive incentive effect in agents, making higher risk projects less attractive. If this hypothesis is not rejected in the experiments, the *s* subjects that choose to increase the risk of the project must choose Contract C_1, with the lower security deposit. However, the *s* subjects that choose not to increase the risk of the project must choose Contract C_2, with the higher security deposit (as in treatment A).

We organized four experimental sessions with students at a European University and a University located in the US; subjects were recruited from various courses using flyers. There were 10 participants in each experimental session except the second, which had 14 participants; no single subject participated in more than one session. Each session lasted for one hour and 30 minutes and consisted of 10 rounds. After privately assigning their types, riskier or safer, we read the instructions and answered questions. The subjects, in each round, had an initial wealth of 300 monetary units and made their choices privately. During the experiment they were not allowed to communicate with the rest of the participants and each subject only knew their own project success and failure probabilities as well as their returns. After ending the five rounds of Treatment A, the subjects read instructions for the five rounds of Treatment B.[3] At the end of the session we paid in cash each subject's amount made during five randomly chosen rounds from Treatments A and B. Subjects made on average $45.

3. Results

The results of the experiment are summarized in Table 3. There were a total of 440 observations; 220 corresponded to Treatment A. As shown in Table 3, most of the

[3] The instructions and other documents used in this experiment are available upon request.

subjects endowed with the safer project chose contract C_2, whereas most of the subjects endowed with the riskier project, chose contract C_1. The hypothesis that the mean number of C_1 choices is the same among the two risk types is rejected (ANOVA p=0.001). In Treatment B, we observe that type *s* subjects who choose to change their projects chose contract C_1. Among those who had a risky project, we observe that most of the time, they chose contract C_1 and change their project, as predicted.

Table 3: Experimental Results

Treatment A

Contracts	Subjects with safer projects		Subjects with riskier projects	
	Numbers and percentages			
C_1	14	12.7%	70	**63.6%**
C_2	94	**85.5%**	35	31.8%
None	2	1.8%	5	4.5%
Total	110	100%	110	100%

Treatment B

Contracts	Subjects with initial safer projects			Subjects with initial riskier projects		
	Numbers and percentages					
	Choice	Change project		Choice	Change project	
C_1	48	48	100%	87	49	56.3%
C_2	57	38	66.7%	22	4	18.2%
None	5			1		
Total	110		82%	110		49%

To test for significance of differences in contract choice, we run logit regressions. For this analysis, we excluded from the total of the observed subject choices risk-free investment decisions. Hence, we analyzed 427 choices only, 219 of Contract C_1 and 208 of Contract C_2. The variable selection method was the forward stepwise process of the likelihood ratio. Table 4 summarizes the results.

Table 4: Test for differences based on contract choice

CONTRACT	
Const.	-0.4761
	(7.1822)
PROJECT (risky=0; safe=1)	2.0037***
	(75.4433)
TREATMENT (A=0; B=1)	-1.2396***
	(28.7929)
$-2Ln\lambda_{LR}$	113.912***
Cox-Snell R^2	0.234
Nagelkerke R^2	0.312
Correct classification	71.66%

CONTRACT is the endogenous variable (value 0 given to contract C_1 (219 observations) and value 1 given to contract C_2 (208 observations)). *** Significant at the 1% level. Wald statistics are in parenthesis.

The positive coefficient for the variable PROJECT indicates that the safer the project, the greater the probability of choosing Contract C_2. This result confirms the significance of the differences between subjects with safer projects and subjects with riskier projects mentioned above. Hence, we find support for **Hypothesis 1** that predicts high collateral combined with an adequate low rate of interest (i.e., Contract

C_2) principally attracts subjects with safer projects, resulting in separation of borrowers by their risk level. Moreover, the above regression results suggest that high collateral does not generate adverse selection of borrowers. The negative coefficient for the TREATMENT variable shows that in Treatment B (with moral hazard), the likelihood of choosing C_2 (the high collateral contract) is lower than in Treatment A. Thus, moral hazard alters initial contract choices.

5. Discussion

We conducted an experiment based on models of contracting under asymmetric and hidden information that closely follows Bester (1985, 1987). The main predictions of these models is that by offering a menu of contracts that combine different levels of interest rates and collateral, borrowers can be separated by their risk level. In addition, we find that the separating effect of this menu of contracts exists even in the moral hazard environment designed in Treatment B. However, moral hazard generates an increase in the failure probability of the projects, once the loan is granted.

Despite of the important implications of these theories on economic policy, empirical studies, so far, have been limited in their ability to examine the incentive compatibility of this menu of contracts. Individualized information on loan contract features is unusual and does not include a direct and objective approximation to the ex ante unobservable borrower risk. In contrast, in the lab, the experimenter is able to control the variables that are unobserved in the field. This control provides a unique advantage for empirically testing predictions of the above mentioned models.

Consistent with theory, we found evidence that by appropriately combining collateral with the interest rate, borrowers with different risk levels are separated; borrowers with higher risk tend to ask for loans without collateral and with higher interest rates. Hence, we provide support for the predictions of screening models of Bester (1985, 1987), Chan and Kanatas (1985), Besanko and Thakor (1987), Deshons and Freixas (1987), Igawa and Kanatas (1990), Stiglitz and Weiss (1986, 1992), Boot, Thakor and Udell (1991) and Coco (1999). Moreover, our experimental results showed that the separating effect of this menu of contracts remains even in moral hazard settings. We also observe that safer borrowers willing to increase their project risk once the loan is granted, choose contracts with lower collateral.

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