BANCA D'ITALIA

Temi di discussione

del Servizio Studi

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by Rafael Repullo (**) and Javier Suarez (***)

Abstract

By identifying the possibility of imposing a credible threat of liquidation as the key role of informed (bank) finance in a moral hazard context, and showing how credibility fails when liquidation values are low, this paper identifies the circumstances under which a mixture of informed and uninformed finance is optimal and explains why bank debt is typically secured, senior, and tightly held. In addition, we study the possibility of collusion between entrepreneurs and their informed lenders, explaining why mixed finance may not lead to a first-best level of effort and predicting that informed debt capacity will be exhausted before recourse is made to supplementary uninformed finance.

Contents

(*) Presentation at a Seminar held by the authors at the Research Department of the Bank of Italy, 18 June 1996.

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1. INTRODUCTION *

This paper develops a model of how firms source their financing needs. We consider optimal security design in a moral hazard setting. There are three alternatives for raising finance: uninformed, informed and a mixture of both. Uninformed and informed finance differ in that under the latter the lender observes at a certain cost the entrepreneur's (unverifiable) level of effort, which determines the probability of success of his project. Although this information cannot be used to enforce a contingent contract, it enables the lender to liquidate the project (and recover part of the investment) if the observed effort does not guarantee her a sufficiently high continuation payoff. When liquidation values are large enough, a credible threat of liquidation can be imposed that leads the entrepreneur to choose first-best effort. Otherwise, it is impossible to ensure a sufficiently tough liquidation policy without compromising the lender's participation constraint.

The conflict between preserving the credibility of the liquidation threat and compensating the lender provides a rationale for mixed finance: adding a passive uninformed lender allows to reduce the funds contributed by the informed lender and, hence, restore the credibility of the threat without violating her participation constraint. Our analysis confirms that, for some entrepreneurs, mixed finance can improve upon both uninformed and informed finance. Thus it may explain why many firms are not exclusively funded by informed lenders (such as banks) or uninformed lenders (such as small bondholders), but by a mixture of both. We show, however, that the effectiveness of mixed finance can be impaired by the possibility of collusion between the entrepreneur and the informed lender (to the detriment of the uninformed lender). In particular, if these informed parties are allowed to renegotiate their share of continuation proceeds after the effort decision has been made, first-best effort is no longer attainable. This issue determines the form of the optimal three-party contracts. Our results predict that, in order to provide the informed lender the right incentives to liquidate, informed debt will be secured and senior to uninformed debt, and, in order to reduce the effects of collusion, informed debt capacity (the maximum informed debt compatible with a credible liquidation threat) will always be exhausted.

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* We would like to thank Leonardo Felli, Julian Franks, Paolo Fulghieri, Denis Gromb, John Moore, and David Webb for helpful comments and discussions. The paper also greatly benefited from the comments of two anonymous referees.

We aim to offer a testable theory of the choice of the mix of informed and uninformed finance. Given the active role assigned to informed lenders under the optimal contracts, we will argue that private debt such as typical bank loans (tightly held, secured and senior) can be associated to informed finance, whereas public debt such as corporate bonds or outside equity (not necessarily secured or senior) can be considered uninformed finance. We identify two key determinants of the optimal mode of finance: the level of entrepreneurial wealth (or firm's net worth) and the liquidation value of the investment project. We predict that among firms with intermediate net worth, investments which involve non-specific, liquid and tangible assets are more likely to be funded exclusively by banks or large active investors, while as we move to projects involving less and less redeployable assets we will observe increasing (and finally total) reliance on arms'-length finance.

This paper is related to several strands of the literature on debt structure. The disciplinary role of liquidation is analyzed by Hart and Moore (1989), Bolton and Scharfstein (1990), and Berglöf and von Thadden (1994) in symmetric information models where the financing problems come from the unverifiability of cash flows. The possibility of strategic default undermines the firm's ability to commit to future payouts. Berglöf and von Thadden (1994) show that if short-term and long-term claims are held by separate investors and short-term claims are secured, the ex post bargaining position of the short-term lenders is strengthened, diminishing the firm's incentives to default strategically. Our results show that the idea of using security and seniority to make lenders tough is also valid in a standard moral hazard setup in which informed lenders can be protected by contractual clauses that give them the right to "call the loan".[1] We make explicit the informational requirements associated to the effective use of these clauses, identifying the circumstances under which it will be worthwhile to incur the monitoring costs.[2]

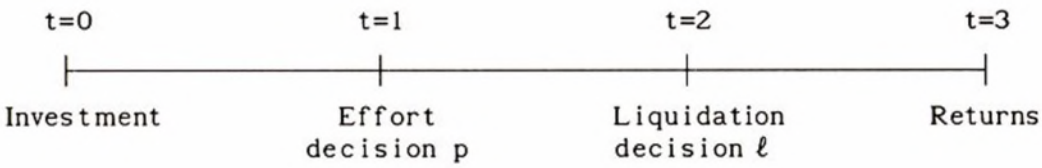
A series of papers initiated by Diamond (1991a) examine the choice of debt maturity and seniority in asymmetric information environments where public (but unverifiable) signals on the quality of borrowers are received at an interim date. In Diamond (1993a,b) high quality borrowers may want to use short-term claims in order to take advantage, when refinancing them, of the good signals that the lenders are likely to receive at the interim date. However, short-term debt entails a risk of liquidation, which destroys the private rents from controlling the firm. Long-term claims can then be used to prevent excessive liquidation. Making short-term debt senior and allowing the dilution of long-term claims minimizes the risk of liquidation for a given level of sensitivity of financing costs to new information. The rationale for mixed finance is therefore very different from ours, since mixed finance and the seniority of informed debt come in to weaken, rather than reinforce, the threat of liquidation.

Finally, some recent papers focus on the lenders' incentives to monitor firms in financial distress, deriving interesting implications for the design of the priority structure and covenants of different classes of debt (e.g., Detragiache, 1994; Rajan and Winton, 1995). In contrast to them, we assume that monitoring is contractible and focus on the disciplinary role of informed lenders instead of their incentives to gather information on their borrowers.

The paper is organized as follows. Section 2 describes the model. Sections 3 and 4 characterize the optimal contracts under, respectively, uninformed and informed finance. Section 5 presents our results on mixed finance. Section 6 analyzes the optimal choice among these modes of finance. Section 7 contains a discussion of the implications of the model. Section 8 summarizes and concludes.

2. THE MODEL

Consider a model with four dates ($t=0,1,2,3$) and a continuum of risk-neutral entrepreneurs characterized by their initial wealth $w \geq 0$. Each entrepreneur has the opportunity of undertaking an *indivisible project* that requires one unit of investment at $t=0$. The entrepreneur can affect the outcome of the project through the amount of *costly effort* put into it. The entrepreneur's decision on effort $p \in [0,1]$ occurs at $t=1$. At $t=2$ the project can be liquidated. The indicator variable ℓ will take the value 1 if *liquidation* occurs and 0 otherwise. Contingent on p and ℓ, the project yields verifiable returns at t=3. The following time line summarizes the sequence of events in the model.



If the project is undertaken and liquidation does not take place ($\ell = 0$), with probability p the project is successful and the return is $Y > 0$, whereas with probability 1-p the project fails and the verifiable return is 0. If the project is liquidated ($\ell = 1$), a certain return $L > 0$ is obtained, irrespective of p. The cost of effort $\phi(p)$ is incurred regardless of the outcome of the project.

We make the following assumptions.

(A1) The function $\phi(p)$ is increasing and strictly convex, and satisfies $\phi(0) = \phi'(0) = 0$ and $\lim_{p\to 1} \phi'(p) = +\infty$.

(A2) There exists a perfectly elastic supply of funds at an expected rate of return which is normalized to zero.

(A3) $\text{Max}\ \{pY - \phi(p)\} \equiv \bar{p}Y - \phi(\bar{p}) > 1$.

(A4) $L < 1$.

Assumption (A1) is standard and is made to ensure that the entrepreneur's maximization problem is convex and has a unique interior solution. Assumption (A2) is used to close the model in a very simple manner, normalizing the expected rate of return required by lenders to zero. Assumption (A3) (together with (A2)) ensures that the net present value of the project when the entrepreneur chooses the first-best level of effort $\bar{p}$ is positive. Assumption (A4) (together with (A2)) states that investing in order to liquidate is not profitable.

By (A1), the first-best level of effort $\bar{p}$ satisfies $0 < \bar{p} < 1$, and is characterized by the condition

$$Y = \phi'(\bar{p}), \tag{1}$$

which equates the marginal benefit of effort to its marginal cost.

If the entrepreneur's initial wealth w were greater than or equal to 1, he could undertake the project efficiently without any external finance. For this reason, we will restrict attention to the case where $w < 1$, so the entrepreneur has to raise at least 1-w from external sources. For the moment, we will assume that the entire wealth w is invested in the project, showing later that this is indeed optimal.

Clearly, if the effort decision p were contractible, all entrepreneurs would undertake their projects efficiently. To see this, note that an entrepreneur with wealth w would be able to borrow 1-w in exchange for a promise to repay $R(p) \in [0,Y]$, with $pR(p) = 1-w$. The entrepreneur would then obtain in expected terms

$$p[Y - R(p)] - \phi(p) = w + [pY - \phi(p) - 1],$$

that is, his initial wealth w plus the net present value of the project which is maximized by setting $p = \bar{p}$. The entrepreneur's expected utility would be $w + [\bar{p}Y - \phi(\bar{p}) - 1]$, which by (A3) is greater than w.

However we are going to assume that p *is not contractible*. This creates a moral hazard problem. In particular, if an entrepreneur with wealth w borrows 1-w in exchange for a promise to repay $R \in [0,Y]$, and the project is never liquidated, he will choose p in order to maximize $p(Y - R) - \phi(p)$. The solution to this problem is characterized by the first-order condition

$$Y - R = \phi'(p), \tag{2}$$

which implicitly defines the entrepreneurial choice of p as a function of R. Comparing (1) and (2), and using the assumption that $\phi'' > 0$, one obtains that the solution for p in (2) is smaller than the first-best level of effort $\bar{p}$. Moreover, as one would expect, increases in the payment R lead to reductions in p, so the moral hazard problem becomes more severe.

In what follows, we examine the *disciplinary role of liquidation threats by lenders* in this moral hazard setup. The relationship between an entrepreneur with wealth w and his lender is assumed to be governed by a contract, signed at t=0, that specifies how the parties agree to share the verifiable returns of the project under both liquidation and no liquidation.

Formally, a *contract* between an entrepreneur with wealth w and a lender is described by a pair (Q,R) that specifies:

(i) the part $Q \in [0,L]$ of the liquidation proceeds which goes to the lender if she decides to liquidate, and

(ii) the payment $R \in [0,Y]$ that is promised to her if she does not liquidate.

Sections 3 and 4 study the optimal contracts between lenders and entrepreneurs under, respectively, uninformed and informed finance. Under uninformed finance, the choice of p by the entrepreneur is not only uncontractible but also unobservable to the lender. Under informed finance, a costly technology is used by the lender to observe p.

3. OPTIMAL CONTRACTS UNDER UNINFORMED FINANCE

Under *uninformed finance*, given a contract (Q,R), the interaction between an entrepreneur with wealth w and his lender can be modeled as a *game with imperfect information*. In this game, the entrepreneur first chooses the level of effort $p \in [0,1]$, and then the lender, without observing the entrepreneur's decision (thus the imperfect information), takes the liquidation decision $\ell \in \{0,1\}$. The payoff to the entrepreneur is $L - Q - \phi(p)$ if the project is liquidated, and $p(Y - R) - \phi(p)$ if it is not. The payoff to the lender is Q if she liquidates the project, and pR if she does not.

A contract (Q,R) for an entrepreneur with wealth w is said to be *feasible under uninformed finance* if there exists a (pure strategy) Nash equilibrium (p^*,ℓ^*) such that

$$(1 - \ell^*)p^*R + \ell^*Q \geq 1-w, \text{ and} \tag{3}$$

$$(1 - \ell^*)p^*(Y - R) + \ell^*(L - Q) - \phi(p^*) \geq w. \tag{4}$$

Conditions (3) and (4) are participation constraints for the lender and the entrepreneur, respectively. A feasible contract has to guarantee the lender the required expected rate of return, and it has to provide the entrepreneur with an expected utility greater than or equal to the value of his initial wealth.

A feasible contract (Q,R) for an entrepreneur with wealth w is said to be *optimal under uninformed finance* if it maximizes the equilibrium expected utility of the entrepreneur in the class of all feasible contracts.

In the definitions of feasible (and optimal) contracts we have restricted attention to pure strategy equilibria. This is done without loss of generality, because allowing for mixed strategy equilibria does not change the set of feasible (or optimal) contracts.[3]

In order to characterize the optimal contracts under uninformed finance, we first note that we can restrict attention to contracts with $Q = 0$, that is contracts in which the lender does not get anything if she decides to liquidate the project. The Nash equilibrium (p^*,ℓ^*) of the game defined by any feasible contract has to satisfy $\ell^* = 0$; otherwise, adding up the participation constraints (3) and (4) we would get $L - \phi(p^*) \geq 1$, which contradicts (A4). But then there is no loss of generality in setting $Q = 0$, and concentrating on the optimal choice of R.

PROPOSITION 1: There exists a critical value $\bar{w}_u$ such that, for any entrepreneur with wealth $w \geq \bar{w}_u$, the optimal contract under uninformed finance is given by

$$Q_u(w) = 0 \quad \text{and} \quad R_u(w) = (1-w)/p_u(w), \tag{5}$$

where $p_u(w)$ is the largest value of p which solves the equation

$$p[Y - \phi'(p)] = 1-w. \tag{6}$$

For $w < \bar{w}_u$ there is no feasible contract under uninformed finance.

Proof: By our previous argument, finding the optimal contract for a given value of w requires finding the best solution for the entrepreneur to the system of equations formed by the entrepreneur's first-order condition (2) and the lender's (binding) participation constraint $pR = 1-w$. Substituting $R = (1-w)/p$ into (2) gives the equation $f(p) \equiv p[Y - \phi'(p)] = 1-w$. Under (A1), the function f(p) is continuous and satisfies $f(0) = f(\bar{p}) = 0$. Moreover, it is positive for $p \in (0,\bar{p})$ and negative for $p \in (\bar{p},1)$. Then it is clear that the equation $f(p) = 1-w$ has at least one solution if $\hat{f} \equiv \max f(p) \geq 1-w$, and any solution will be smaller than $\bar{p}$ (since by assumption $1-w > 0$). Now substituting $pR = 1-w$ into the entrepreneur's payoff function gives the function $U(w,p) \equiv w + pY - \phi(p) - 1$. Since U(w,p) is increasing in p for $p \leq \bar{p}$, it follows that the value of p corresponding to the optimal contract is the largest solution $p_u(w)$ to the equation $f(p) = 1-w$, and $R_u(w) = (1-w)/p_u(w)$.[4]

The entrepreneur's participation constraint requires $V_u(w) \equiv U(w,p_u(w)) \geq w$. The function $p_u(w)$ is increasing, continuous from the right, and satisfies $\lim_{w\to 1} p_u(w) = \bar{p}$. Since U(w,p) is increasing in w and in p for $p \leq \bar{p}$, it follows that $V_u(w)$ is increasing and, by (A3), satisfies $\lim_{w\to 1} V_u(w) > w$, so for large values of w the participation constraint will be satisfied. Now let $\hat{w} \equiv \max \{1-\hat{f},0\}$. Then if $V_u(\hat{w}) \geq \hat{w}$, the critical value $\bar{w}_u$ is given by $\hat{w}$. If, on the other hand, $V_u(\hat{w}) < \hat{w}$, $\bar{w}_u$ is defined by the conditions $V_u(w) \geq w$ for $w \geq \bar{w}_u$, and $V_u(w) < w$ for $w < \bar{w}_u$. ∎

Proposition 1 shows that for $w \geq \bar{w}_u$ the optimal contract under uninformed finance is of the form $(0,R_u(w))$, where $R_u(w) = (1-w)/p_u(w)$. The term $1/p_u(w)$ can be interpreted as a default premium. Since the probability of success $p_u(w)$ chosen by the entrepreneur under this contract is increasing in w, the default premium is decreasing in the level of entrepreneurial wealth. Thus, as

w goes down (increasing the reliance on external financing) the moral hazard problem becomes more severe, and so the lender requires higher and higher interest rates until the cutoff point $\bar{w}_u$ is reached. For $w < \bar{w}_u$ the moral hazard problem is so severe that uninformed finance is not feasible.

It should be noted that since $p_u(w)$ is increasing in w, the equilibrium expected utility for an entrepreneur with wealth $w \geq \bar{w}_u$ satisfies $V_u(w + \varepsilon) > V_u(w) + \varepsilon$ for all $\varepsilon > 0$ (see the proof of Proposition 1 above), so it is indeed optimal for him to invest all his wealth in the project.

To sum up, the analysis in this section has shown that under uninformed finance the option to liquidate has no value to the lender. Moreover, there exists a critical level of wealth $\bar{w}_u$ such that only those entrepreneurs with wealth above $\bar{w}_u$ will be able to fund their projects.

4. OPTIMAL CONTRACTS UNDER INFORMED FINANCE

In this section we introduce an alternative mode of financing the investment projects, which will be called *informed finance*. In order to focus on the discipline introduced by informed lenders, we abstract from the difficulties of endogenizing their information gathering activity. Specifically, we assume that the lender can (contractually) commit to use a monitoring technology that, at a cost $c > 0$ per project, reveals to her the value of p chosen by the entrepreneur.[5] Although this information is assumed to be unverifiable (so it cannot be included in the contract between the lender and the entrepreneur), it is potentially useful to the lender when deciding on liquidation.[6]

Under informed finance, given a contract (Q,R), the interaction between an entrepreneur with wealth w and his lender can be modeled as a *sequential game* in which the entrepreneur first chooses the level of effort p, and then the lender, after observing the entrepreneur's decision, takes the liquidation decision ℓ. The payoffs to the entrepreneur and the lender are the same as those for the case of uninformed finance.

A contract (Q,R) for an entrepreneur with wealth w is said to be *feasible under informed finance* if there exists a subgame perfect equilibrium $(p^*,\ell^*(p))$ such that

$$[1 - \ell^*(p^*)]p^*R + \ell^*(p^*)Q \geq 1-w+c, \text{ and} \tag{7}$$

$$[1 - \ell^*(p^*)]p^*(Y - R) + \ell^*(p^*)(L - Q) - \phi(p^*) \geq w. \tag{8}$$

This definition of feasibility differs from that corresponding to uninformed finance in two respects. First, given the different nature of the game —which becomes genuinely sequential when the lender is informed—, it refers to *subgame perfect* instead of Nash equilibrium. Second, it includes the monitoring cost c in the right hand side of the lender's participation constraint (7). An equilibrium strategy of the lender specifies not only her reaction to the equilibrium strategy of the entrepreneur, $\ell^*(p^*)$, but also her reaction to entrepreneurial decisions off the equilibrium path, $\ell^*(p)$ for all $p \neq p^*$. However, the definition of feasibility only takes into account the players' decisions on the equilibrium path. As under uninformed finance, a feasible contract has to guarantee the lender the required expected rate of return on her initial investment (now including the monitoring cost c), and it has to provide the entrepreneur with an expected utility greater than or equal to the value of his initial wealth.

In order to make informed finance feasible, we will strengthen Assumption (A3) to:

(A3') $\text{Max } \{pY - \phi(p)\} \equiv \bar{p}Y - \phi(\bar{p}) > 1+c.$

A feasible contract (Q,R) for an entrepreneur with wealth w is said to be *optimal under informed finance* if it maximizes the equilibrium expected utility of the entrepreneur in the class of all feasible contracts.

The following proposition characterizes optimal contracts under informed finance when the sum of the initial wealth of the entrepreneur w and the liquidation value of the project L is sufficiently large.

PROPOSITION 2: For any entrepreneur with wealth $w \geq 1+c-L$, the optimal contract under informed finance is given by

$$Q_1(w) = 1-w+c \quad \text{and} \quad R_1(w) = (1-w+c)/\bar{p}. \tag{9}$$

Proof: We first show that under this contract, a subgame perfect equilibrium of the game between the entrepreneur and the informed lender is given by

$$p^* = \bar{p} \quad \text{and} \quad \ell^*(p) = \begin{cases} 0, & \text{if } p \geq \bar{p} \\ 1, & \text{otherwise} \end{cases} \tag{10}$$

To prove this, note that if $p < \bar{p}$ we have $pR_1(w) = p(1-w+c)/\bar{p} < Q_1(w)$, so the lender will choose $\ell^*(p) = 1$. On the other hand, if $p > \bar{p}$ by the same argument she will choose $\ell^*(p) = 0$. Finally, if $p = \bar{p}$ the lender is indifferent between $\ell = 0$ and $\ell = 1$. Setting $\ell^*(\bar{p}) = 0$, the entrepreneur will choose $p^* = \bar{p}$ in the first stage of the game given that, by (A1) and the definition of $\bar{p}$, $p[Y - R_1(w)] - \phi(p)$ is decreasing in p for $p \geq \bar{p}$, and we have

$$L - Q_1(w) - \phi(p) \leq L - Q_1(w) < w < w + \bar{p}Y - (1+c) - \phi(\bar{p}) = \bar{p}[Y - R_1(w)] - \phi(\bar{p})$$

where the first inequality follows from the fact that $\phi(p) \geq 0$, the second from (A4), and the third from (A3'). Since the equilibrium payoff of the lender is $1-w+c$, and the equilibrium payoff of the entrepreneur is greater than w, the contract $(Q_1(w),R_1(w))$ is feasible. To prove that it is optimal it suffices to note that the equilibrium expected utility of the entrepreneur coincides with the maximum that he could achieve in the first-best world in which p were verifiable (but the costs of the project were 1+c). ■

According to Proposition 2, informed finance leads to the first-best choice of effort for those entrepreneurs with wealth w greater than or equal to 1+c-L. Notice that this threshold does not depend on Y but on c and L. This reflects the nature of the disciplinary device that operates under informed finance: the threat of liquidation. When liquidation proceeds are sufficiently large ($L \geq 1-w+c$), a contract that triggers liquidation by the lender whenever the entrepreneur chooses $p < \bar{p}$ can be signed at t=0. The threat of liquidation is *credible* because the contractual value of Q can be chosen large enough to give proper incentives to the lender. On the equilibrium path, however, liquidation does not take place.

By Proposition 2, the equilibrium expected utility under informed finance for entrepreneurs with wealth $w \geq 1+c-L$ is $V_1(w) \equiv w + [\bar{p}Y - \phi(\bar{p}) - (1+c)]$. As the slope of this function is equal to 1, investing all their wealth in the project is weakly optimal for these entrepreneurs (they should invest at least $1+c-L$).

Next we consider what happens when the sum of the initial wealth of the entrepreneur w and the liquidation value of the project L is smaller than $1+c$. In this case there is no loss of generality in restricting attention to contracts with $Q = 0$. To see this, observe that feasible contracts cannot lead to liquidation on the equilibrium path (otherwise the lender's participation constraint (7) would be violated). Moreover since we have $p^*R \geq 1-w+c > L \geq Q$, it must be the case that p^* is strictly greater than the critical $\hat{p}$ that triggers liquidation (i.e. that solves $\hat{p}R = Q$). But then the liquidation threat is not effective and, by the concavity of the entrepreneur's payoff function under no liquidation, p^* will not change if we set $Q = 0$.

Using this result, Proposition 3 characterizes the optimal contracts under informed finance for entrepreneurs with wealth $w < 1+c-L$. The proof is almost identical to that of Proposition 1 and will be omitted.

PROPOSITION 3: There exists a critical value $\bar{w}_1$ such that for any entrepreneur with wealth $\bar{w}_1 \leq w < 1+c-L$, the optimal contract under informed finance is given by

$$Q_1(w) = 0 \quad \text{and} \quad R_1(w) = (1-w+c)/p_1(w), \tag{11}$$

where $p_1(w)$ is the largest value of p which solves the equation

$$p[Y - \phi'(p)] = 1-w+c. \tag{12}$$

For $w < \bar{w}_1$ there is no feasible contract under informed finance.

Comparing equations (6) and (12), it is immediate to get $p_l(w) = p_u(w-c)$. Moreover, one can show that $\bar{w}_l \geq \bar{w}_u$.[7] Since $p_u(w)$ is increasing, it follows that $p_l(w) < p_u(w)$, which implies $R_l(w) > R_u(w)$. For entrepreneurs with wealth $\bar{w}_l \leq w < 1+c-L$, informed finance will therefore be dominated by uninformed finance. Intuitively, if liquidation threats are ineffective, it does not pay to incur the monitoring cost in order to observe p.

Summing up, under informed finance the lender observes the effort put by the entrepreneur at a certain cost. This information may be used by the lender to decide on the liquidation of the project, but this is not always valuable. The threat of liquidation is effective in disciplining entrepreneurs if the liquidation value L is greater than the lender's total investment in the project 1-w+c (including the monitoring cost). When this condition is not satisfied, the threat of liquidation cannot be credible, and so (given the monitoring cost) informed finance will be dominated by uninformed finance.

5. MIXED FINANCE

In Sections 3 and 4 we have analyzed the problem of designing optimal two-party contracts between lenders and entrepreneurs under informed and uninformed finance. Somewhat surprisingly, informed finance leads to the first-best level of effort $\bar{p}$ for those entrepreneurs with wealth $w \geq 1+c-L$, whereas it does not allow to improve on uninformed finance when $w < 1+c-L$. The reason for this is that low values of w+L impede the use of the threat of liquidation to discipline the entrepreneur. There is a conflict between providing the informed lender with incentives to liquidate if a deviation from $\bar{p}$ occurs (that is, setting Q and R such that $\bar{p}R = Q \leq L$) and compensating her for her initial investment in the project (that is, setting R such that $\bar{p}R \geq 1-w+c$): if $w+L \geq 1+c$ there exist Q and R such that $\bar{p}R = 1-w+c = Q \leq L$; otherwise, the liquidation threat cannot be binding, and the information acquired by the lender at a cost c is completely worthless. The nature of this conflict provides a prima facie case for *mixed finance*: the co-existence of an informed active lender whose contribution to the initial investment is reduced to a level which provides her the right incentives to liquidate (if the entrepreneur deviates from $\bar{p}$), and an uninformed passive lender who contributes the rest. Such possibility is explored in this section.

In what follows, we first analyze the optimal three-party contracts in the absence of any renegotiation. Secondly, we show that allowing for renegotiation modifies the nature of the optimal contract. In particular, the asymmetry of information between informed and uninformed lenders at the date in which the option to liquidate has to be exercised introduces the possibility of collusion between the entrepreneur and the informed lender to the detriment of the uninformed lender. The optimal contract with renegotiation will aim to minimize the impact of this collusion.

5.1. Mixed finance without renegotiation

Under mixed finance, the relationship between an entrepreneur with wealth w and two lenders, one informed and another uninformed, is assumed to be governed by a contract, signed at t=0, that specifies how the parties agree to share the funding and the verifiable returns of the project under both liquidation and no liquidation.

Formally, a *contract* between an entrepreneur with wealth w, an informed, and an uninformed lender is a vector $(I_i,I_u,Q_i,Q_u,R_i,R_u)$ that specifies:

(i) the funds $I_i > 0$ and $I_u > 0$ provided by, respectively, the informed and the uninformed lender, where $I_i + I_u = 1-w+c$,

(ii) the parts $Q_i \geq 0$ and $Q_u \geq 0$ of the liquidation proceeds which go, respectively, to the informed and the uninformed lender if the former decides to liquidate, where $Q_i + Q_u \leq L$, and

(iii) the payments $R_i \geq 0$ and $R_u \geq 0$ that are promised, respectively, to the informed and the uninformed lender if the project is not liquidated, where $R_i + R_u \leq Y$.

For the same reasons as in the case of pure uninformed finance, the uninformed lender will be a passive player in the game between the three parties to the contract. Given this, the interaction between the entrepreneur and the informed lender can be modeled as a sequential game in which the entrepreneur first chooses the level of effort p, and then the informed lender takes the liquidation decision ℓ. The payoff to the entrepreneur is $L - Q_i - Q_u - \phi(p)$ if the project is liquidated, and $p(Y - R_i - R_u) - \phi(p)$ if it is not. The payoff to the informed lender is Q_i if she liquidates the project, and pR_i if she does not. Finally, the payoff to the uninformed lender is Q_u if the project is liquidated, and pR_u if it is not.

Our earlier definitions of feasible and optimal contracts can be easily extended to the mixed finance case, so for the sake of brevity we will skip their formal statement.

For entrepreneurs with wealth $w \geq 1+c-L$, the equilibrium expected utility under informed finance is already at its highest possible level under mixed finance (the corresponding to the first-best with costs 1+c). For this reason, we will focus on the case of entrepreneurs with wealth $w < 1+c-L$. The following proposition characterizes the optimal contracts under mixed finance when the informed parties can commit not to renegotiate at t=2.

PROPOSITION 4: For any entrepreneur with wealth $w < 1+c-L$, there is a family of optimal contracts under mixed finance, parameterized by $x \in (0,L]$, which is given by

$$I_i(w,x) = Q_i(w,x) = x, \quad I_u(w,x) = (1-w+c) - x, \quad Q_u(w,x) = L - x,$$
$$R_i(w,x) = I_i(w,x)/\bar{p}, \quad \text{and} \quad R_u(w,x) = I_u(w,x)/\bar{p}. \tag{13}$$

Proof: We first show that for any $x \in (0,L]$, a subgame perfect equilibrium of the game between the entrepreneur and the informed lender is given by (10). To prove this, note that if $p < \bar{p}$ we have $pR_i(w,x) = px/\bar{p} < Q_i(w,x)$, so the lender will choose $\ell^*(p) = 1$. On the other hand, if $p > \bar{p}$ by the same argument she will choose $\ell^*(p) = 0$. Finally, if $p = \bar{p}$ the lender is indifferent between $\ell = 0$ and $\ell = 1$. Setting $\ell^*(\bar{p}) = 0$, the entrepreneur will choose $p^* = \bar{p}$ in the first stage of the game given that, by (A1) and the definition of $\bar{p}$, $p[Y - R_i(w,x) - R_u(w,x)] - \phi(p)$ is decreasing in p for $p \geq \bar{p}$, and we have

$$L - Q_l(w,x) - Q_u(w,x) - \phi(p) = - \phi(p) \le 0 < w + \bar{p}Y - (1+c) - \phi(\bar{p}) =$$

$$\bar{p}[Y - R_l(w,x) - R_u(w,x)] - \phi(\bar{p}),$$

where the first inequality follows from the fact that $\phi(p) \ge 0$ and the second from (A3'). Moreover, the players' participation constraints are satisfied, so the family of contracts described in (13) is feasible. To prove that they are optimal it suffices to note that the equilibrium expected utility of the entrepreneur coincides with the maximum that he could achieve in the first-best world in which p were verifiable (but the cost of the project were 1+c). ■

According to Proposition 4, mixed finance leads to the first-best choice of effort even for relatively poor entrepreneurs (i.e. those with $w < 1+c-L$). The explanation for this result is very simple: the presence of an uninformed lender allows to reduce the contribution of the informed lender to $I_l \le L$, thereby restoring her incentives to liquidate if the entrepreneur deviates from $\bar{p}$ (by setting Q_l and R_l such that $\bar{p}R_l = Q_l \le L$), while compensating her for her initial investment in the project (by setting R_l such that $\bar{p}R_l = I_l$).

It is interesting to note that in these optimal three-party contracts the informed lender is fully secured in case of liquidation, that is $Q_l(w,x) = I_l(w,x)$, while the uninformed lender is not, that is $Q_u(w,x) < I_u(w,x)$. This feature of the optimal contracts may be interpreted as *seniority of informed debt*, which arises endogenously in this context as the means of restoring the effectiveness of the liquidation threat. Further discussion of this finding will be provided in Section 7.

5.2. The effects of renegotiation between the informed parties

The results obtained so far on mixed finance do not take into account the possibility of renegotiation between the entrepreneur and the informed lender after the former has made his effort decision but before the latter decides on liquidation. Given the presence of a third party (the uninformed lender), renegotiation in this context should be understood in terms of an additional contract between the two informed parties that changes the payment promised to the informed lender, if she does not liquidate the project, to R'_l.

The exclusion of the uninformed lender from this renegotiation is explained by the fact that she is not informed about p. This may seem restrictive since, with two informed agents (and no constraints on contractibility), it is generally possible to design a mechanism that truthfully reveals this information to a third, uninformed, agent. However, the introduction of such a mechanism is impeded by the uncontractibility of p (that is, the impossibility of describing the level of effort in a way suitable for enforcing contracts contingent upon it).[8]

In what follows we first show that the contracts described in Proposition 4 are not robust to renegotiation. We will then characterize the optimal contracts under mixed finance with renegotiation between the informed parties.

In the *renegotiation game*, the status quo payoffs of the entrepreneur and the informed lender are $p(Y - R_l - R_u) - \phi(p)$ and pR_l, respectively, and in addition the lender has an *outside option* (the option to liquidate) which is worth Q_l to her. If $p(Y - R_u) < Q_l$, the informed lender would liquidate the project, since the maximum expected payment under continuation is smaller than what she can get upon liquidation. On the other hand, if $p(Y - R_u) \geq Q_l$, by the "outside option principle"[9] the equilibrium outcome of the renegotiation game will be

$$R_l'(p) = \begin{cases} R_l, & \text{if } pR_l \geq Q_l \\ Q_l/p, & \text{otherwise} \end{cases}$$

Thus, the initial contract will be renegotiated if the probability of success p chosen by the entrepreneur satisfies $Q_l/(Y-R_u) \leq p < Q_l/R_l$,[11] in which case the informed lender's payoff $pR_l'(p)$ will be equal to her liquidation payoff Q_l. Anticipating this outcome, the entrepreneur will choose $p \geq Q_l/(Y-R_u)$ in order to maximize

$$p[Y - R_l'(p) - R_u] - \phi(p) = \begin{cases} p(Y - R_l - R_u) - \phi(p), & \text{if } pR_l \geq Q_l \\ p(Y - R_u) - \phi(p) - Q_l, & \text{otherwise} \end{cases}$$

Given the contract in Proposition 4, the condition $pR_l \geq Q_l$ reduces to $p \geq \bar{p}$.

But by (A1) and the definition of $\bar{p}$, we have

$$(Y - R_l - R_u) - \phi'(p) \leq (Y - R_l - R_u) - \phi'(\bar{p}) < Y - \phi'(\bar{p}) = 0,$$

for $p \geq \bar{p}$, and $(Y - R_u) - \phi'(\bar{p}) < Y - \phi'(\bar{p}) = 0$, so we conclude that the entrepreneur will choose $\hat{p} < \bar{p}$, and the initial contract will be renegotiated. However, the uninformed lender will get $\hat{p}R_u < \bar{p}R_u = I_u$, so anticipating this outcome she will not be willing to participate in the funding of the project.[10]

Given this negative result, the following proposition characterizes the contracts which are optimal under mixed finance when we allow for renegotiation between the informed parties.

PROPOSITION 5: There exists a critical value $\bar{w}_m(L) \equiv \max\{\bar{w}_l-L,0\}$ such that, for any entrepreneur with wealth $\bar{w}_m(L) \leq w < 1+c-L$, the optimal contract under mixed finance with renegotiation between the informed parties is given by

$$\begin{aligned} &I_l(w,L) = Q_l(w,L) = L, \quad I_u(w,L) = (1-w+c) - L, \quad Q_u(w,L) = 0, \\ &R_l(w,L) = I_l(w,L)/p_m(w,L), \quad \text{and} \quad R_u(w,L) = I_u(w,L)/p_m(w,L). \end{aligned} \tag{14}$$

where $p_m(w,L)$ is the largest value of p which solves the equation

$$p[Y - \phi'(p)] = 1-w+c-L. \tag{15}$$

For $w < \bar{w}_m(L)$ there is no feasible contract under mixed finance.

Proof: See the Appendix.

The result in Proposition 5 can be explained as follows. Mixed finance uses a liquidation threat by the informed lender in order to punish the entrepreneur whenever he deviates from a certain level of effort. However, in the model with renegotiation, entrepreneurial deviations are not followed by liquidation because the informed parties will bargain over the sharing of the continuation surplus: the liquidation threat enters as an outside option for the informed lender that provides a lower bound to her expected payoff. Since the uninformed lender is an outsider to this renegotiation, her stake will not be considered as a component of the expected continuation surplus to be bargained between the informed parties. By the "outside option principle", the equilibrium renegotiation payoffs of the entrepreneur and the informed lender will then be $p(Y - R_u) - \phi(p) - Q_i$ and Q_i, respectively. Given this outcome, the solution to the entrepreneur's maximization problem will be a decreasing function of R_u that approaches the first-best level of effort $\bar{p}$ as R_u tends to zero. From here it follows that the entrepreneur will be interested in signing a contract in which the contribution I_u of the uninformed lender, and so the (irrevocable) payment R_u promised to her under continuation, is minimized. Using the participation constraint of the informed lender $I_i = Q_i$ together with the constraint $Q_i \leq L$ then leads to the contract in Proposition 5.

Comparing equations (6) and (15), one can see that the probability of success $p_m(w,L)$ chosen by an entrepreneur with wealth w under this contract is equal to $p_u(w+L-c)$, that is the probability of success chosen by an entrepreneur with wealth w+L-c under uninformed finance. This means that, under mixed finance, the liquidation value of the project plays the role of additional wealth that helps improving entrepreneurial incentives —since as noted in Section 3 the function $p_u(w)$ is increasing.

Using this result, the equilibrium expected utility for an entrepreneur with wealth $w \geq \bar{w}_m(L)$ can be written as $V_m(w,L) \equiv w + p_u(w+L-c)Y - \phi(p_u(w+L-c)) - (1+c)$, so it is again optimal for him to invest all his wealth in the project.

Two final comments are in place. First, although collusion reduces the efficiency of mixed finance (given that $p_m(w,L) < \bar{p}$), it makes still possible for some entrepreneurs to obtain funds that they could not get under pure informed or uninformed finance (in particular, those with wealth $\bar{w}_m(L) \leq w < \min\{\bar{w}_u, 1+c-L\}$). Second, the feature $Q_i(w,L) = I_i(w,L)$ that characterizes the optimal contract in Proposition 5 confirms the role of the seniority of informed debt in restoring the credibility of liquidation threats under mixed finance.

6. THE CHOICE BETWEEN INFORMED, UNINFORMED, AND MIXED FINANCE

This section brings together the results of the previous sections in order to analyze the optimal choice between informed, uninformed, and mixed finance. We begin by summarizing in Figure 1 our results on the regions of the w-L space where informed, uninformed and mixed finance are feasible.

(FIGURE 1)

According to Proposition 1, uninformed finance is feasible for all $w \geq \bar{w}_u$, that is in Regions I, II and III. Informed finance is feasible for all pairs (w,L) above or on the line $w+L = 1+c$ (Proposition 2), that is in Regions I and VI; it is also feasible for pairs (w,L) below the line $w+L = 1+c$ with $w \geq \bar{w}_I$ (Proposition 3), although in this case it is strictly dominated by uninformed finance. Finally, by Proposition 5, mixed finance (with renegotiation between the informed parties) is feasible in Regions II and V. Therefore, we have the following characterization of feasible modes of finance in the w-L space.

Regions	Feasible mode of finance
I	Informed and uninformed
II	Uninformed and mixed
III	Uninformed
IV	None
V	Mixed
VI	Informed

Since two modes of finance are feasible in Regions I and II, we next consider which one dominates in each of these regions.

PROPOSITION 6: There exists a unique $w^* \in [\bar{w}_u, 1)$ such that uninformed finance dominates informed finance for those values of w in Region I greater than or equal to w^*.

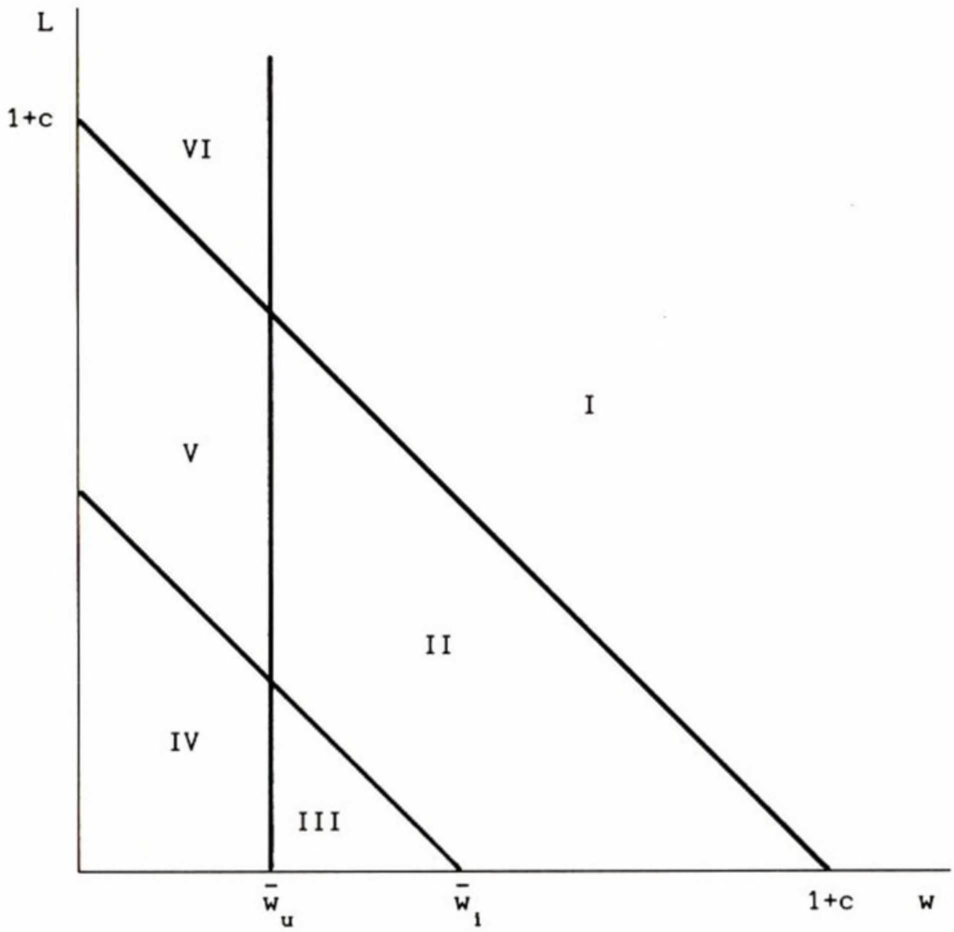


FIGURE 1. Characterization of Feasible Modes of Finance

Proof: The equilibrium expected utility of an entrepreneur with wealth w under uninformed finance is $V_u(w) \equiv w + p_u(w)Y - \phi(p_u(w)) - 1$, whereas his expected utility under informed finance is $V_I(w) \equiv w + \bar{p}Y - \phi(\bar{p}) - (1+c)$. Since $\lim_{w\to 1} p_u(w) = \bar{p}$, we have $\lim_{w\to 1} [V_u(w) - V_I(w)] = c > 0$. But then using the fact that $p_u(w)Y - \phi(p_u(w))$ is increasing in w, the result follows. ■

It is immediate to show that the critical value w^* is decreasing in the monitoring cost c, reaching the value $\bar{w}_u$ for large c.

PROPOSITION 7: There exists a unique $L(w) \in [\max\{\bar{w}_I - w, 0\}, 1-w+c]$ such that uninformed finance dominates mixed finance for those pairs (w,L) in Region II with $L < L(w)$. Moreover, $L(w) = 1-w+c$ for $w \geq w^*$.

Proof: The equilibrium expected utility of an entrepreneur with wealth w under mixed finance is $V_m(w,L) \equiv w + p_u(w+L-c)Y - \phi(p_u(w+L-c)) - (1+c)$. Given that $\lim_{L\to 1-w+c} p_u(w+L-c) = \bar{p}$, we have $\lim_{L\to 1-w+c} V_m(w,L) = V_I(w)$. But by the definition of w^* in Proposition 6 we have $V_I(w) \leq V_u(w)$ if and only if $w \geq w^*$. Since $V_m(w,L)$ is increasing in L, the result follows. ■

Figure 2 summarizes our results on the characterization of the optimal modes of finance. Informed finance is optimal for high liquidation values and low entrepreneurial wealth. Uninformed finance is optimal for either high wealth or intermediate wealth and low liquidation values. Mixed finance is optimal for low entrepreneurial wealth and intermediate liquidation values. Finally, no mode of finance is feasible for low wealth and low liquidation values.

(FIGURE 2)

To conclude this section, we comment on the behavior of equilibrium interest rates for the different regions of Figure 2. According to Proposition 1, in the region where uninformed finance is optimal, equilibrium interest rates $R_u(w)/(1-w) = 1/p_u(w)$ are decreasing in the level of entrepreneurial wealth w, because reducing the external financing requirement ameliorates the moral hazard problem. In the limit when w tends to 1, this problem disappears,

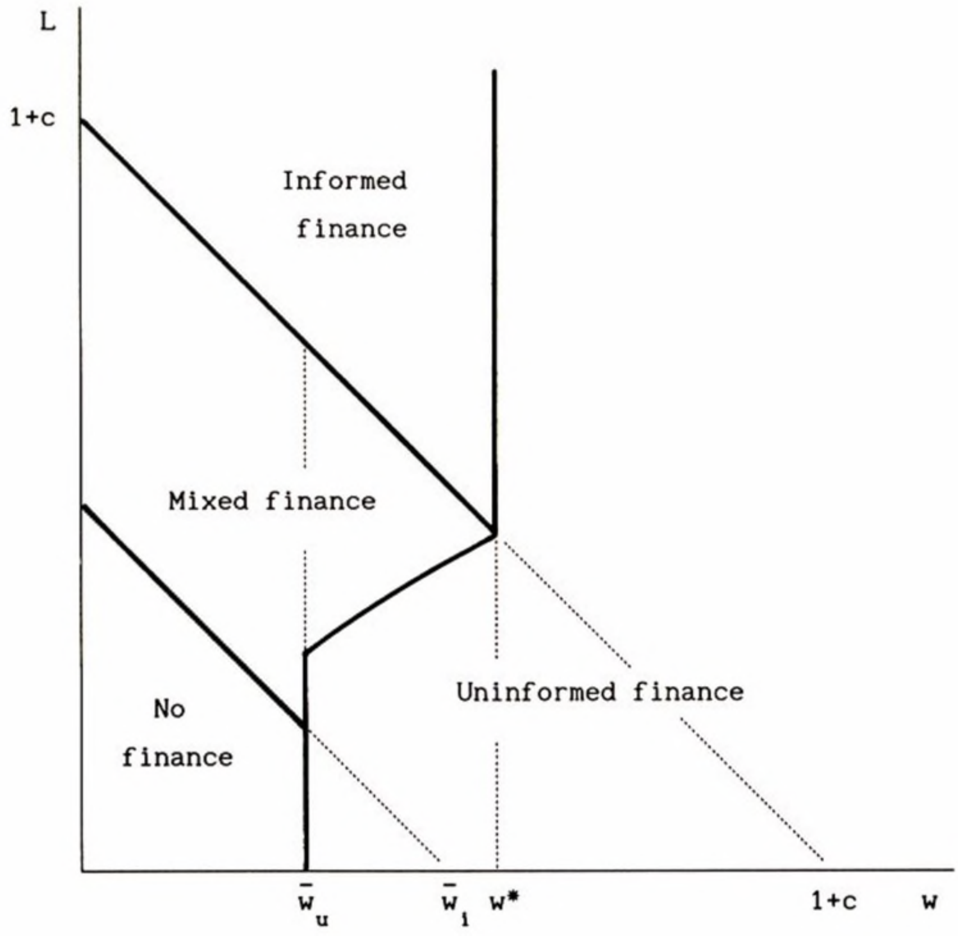


FIGURE 2. Characterization of Optimal Modes of Finance

and $1/p_u(w)$ approaches the value $1/\bar{p}$. By the reasons explained in Section 4, in the region where informed finance is optimal, the threat of liquidation eliminates the moral hazard problem, so equilibrium interest rates are constant and equal to $1/\bar{p}$. Finally, in the region where mixed finance is optimal, the moral hazard problem reappears due to the possibility of collusion between the informed parties. By Proposition 5, equilibrium interest rates $1/p_m(w,L)$ are in this case decreasing in both the level of entrepreneurial wealth w and the liquidation value of the project L. Moreover, $1/p_m(w,L)$ tends to $1/\bar{p}$ as w+L approaches the value 1+c.

7. DISCUSSION

7.1. Who are the informed and the uninformed lenders?

The need for active monitoring under informed and mixed finance suggests the desirability of assigning this task to a single informed lender: it will save on the cost of monitoring (avoiding duplication) and will eliminate potential free-rider problems as well as conflicts over the exercise of the liquidation option. On the contrary, the passive role of uninformed lenders in uninformed or mixed finance can be performed by one or multiple lenders. These differences provide a rationale for identifying uninformed finance with the *placing of publicly traded securities* in the market (arms'-length finance) and informed finance with either *bank lending* or the *issuance of tightly held (private) securities.*[12]

With this interpretation, our model may help to explain the characteristics and coexistence of financial contracts such as typical bank loans and corporate bonds. In particular, our characterization of the securities associated to, respectively, informed and uninformed lenders seems broadly consistent with the description of these contracts made by Gorton and Kahn (1994): "A typical bank loan contract with a firm involves a single lender who is a secured senior debt claimant on the firm. The contract contains a large number of covenants which effectively give the lender the right to force the borrower to repay the loan early if demanded. In contrast, corporate bonds typically involve multiple lenders who are not secured, may not be senior, have less detailed covenants, and have no option to force the borrower to repay."

7.2. Firms' net worth, liquidation values, and the optimal mode of finance

As an alternative to the setup analyzed in previous sections, we may consider the entrepreneur as the owner-manager of an existing firm and w as the value at t=3 of the firm's pre-investment net worth. Assuming that the entrepreneur has no liquid funds at t=0, undertaking the project would require him to borrow the entire unit investment against both the firm's net worth and the project's cash flows.

Would this alternative change our characterization of the optimal financial contracts? To see that the answer to this question is negative, all we need to do is to reinterpret the variables of our original model. In the new setting, if the project is not liquidated, the total value of the firm would be w+Y with probability p and w with probability 1-p. If the project is liquidated, the total value of the firm would be w+L. This means that it would be feasible to guarantee a fixed payment w to the lenders at t=3. In fact, this would be optimal since it maximizes the owner-manager's share of the returns which are sensitive to his effort decision. Thus the contracting problem would reduce to finding the additional part $Q \in [0,L]$ of the liquidation proceeds which goes to the lender if she decides to liquidate, and the additional payment $R \in [0,Y]$ that is promised to her if she does not liquidate. These payments should provide the lender an additional payoff of 1-w (so as to satisfy her participation constraint), and should leave the owner-manager with a payoff greater than or equal to the firm's initial net worth w. Clearly, this problem is formally identical to that analyzed in previous sections.

This reinterpretation allows us to state the empirical implications of the results summarized in Figure 2 in terms of variables which are closer to those employed when working with firm-level data. Firms' net worth (or some measure of inside equity) would be represented in the horizontal axis, whereas projects' liquidation values (that is, some measure of the redeployable value of the investment) would be represented in the vertical axis. Among highly capitalized firms (relative to the size of their investment opportunities), we would expect to observe a preference for the use of public securities such as public debt or outside equity. In contrast, banks or large active security-holders would have a prominent role among poorly capitalized firms: either as the only financiers (for high liquidation values) or in conjunction with some form of arms'-length finance (for lower liquidation values). The richest variety of modes of finance would be observed for firms in the middle range of net worth values. Among them, investments which involve non-specific, liquid and tangible assets —for example, those in basic industrial activities— would be funded exclusively by banks or large active investors (informed finance). As we move to projects involving more and more specific, illiquid or intangible assets —for example, those in high-tech and service activities— we would observe increasing (and finally total) reliance on arms'-length finance. This characterization of the optimal modes of finance suggests the need for a two-dimensional approach in empirical studies on firms' financing decisions.

7.3. Short vs. long-term contracts

The model presented in this paper may not seem suitable to discuss the maturity of financial contracts, since all the returns are obtained at the terminal date. Nevertheless, the optimal contract under informed finance can be shown to be equivalent to a sequence of short-term contracts. Similarly, the optimal contract under mixed finance is equivalent to a sequence of short-term contracts (with the informed lender) plus a long-term contract (with the uninformed lender).

Starting with the case of pure informed finance, let P_1 denote the payment promised to the informed lender before any cash flow has been generated but after the lender has observed the effort put by the entrepreneur. Continuing the project would then require rolling P_1 over to the terminal date, and hence negotiating with the lender the payment P_2 promised under the new loan. The status quo payoffs of the entrepreneur and the lender in this bargaining game are $L - P_1 - \phi(p)$ and P_1, respectively, and the expected surplus (relative to the liquidation outcome) that could be obtained under continuation is $pY - L$. Assuming a Nash bargain between the entrepreneur and the informed lender, with bargaining powers μ and $1-\mu$, respectively, the final payoffs of the entrepreneur and the lender would be $L - P_1 - \phi(p) + \mu(pY - L)$ and $P_1 + (1-\mu)(pY - L) \equiv pP_2$, respectively. Anticipating this outcome, the effort level p^* chosen by the entrepreneur would solve the first-order condition $\mu Y = \phi'(p)$. The feasibility of the sequence of short-term contracts requires $P_1 \in [0,L]$ and $P_2 \in [0,Y]$ to satisfy $p^*P_2 = 1-w+c$ and $L - P_1 - \phi(p^*) + \mu(p^*Y - L) \geq w$. In the polar case in which the entrepreneur has all the bargaining power ($\mu = 1$),[13] we would have $p^* = \bar{p}$. Then it is immediate to check that, if $w \geq 1+c-L$, the sequence of short-term contracts $P_1 = 1-w+c$ and $P_2 = (1-w+c)/\bar{p}$ implements the same outcome as the contract in Proposition 2.

In the case of mixed finance, the same arguments may be used to conclude that if $\mu = 1$ the contract described in Proposition 5 yields the same outcome as a combination of a long-term contract with the uninformed lender setting a promised payment at the terminal date, and a short-term contract with the informed lender which is subsequently rolled over to this date. In this case, the project is funded with a mix of short-term and long-term claims, with the interesting property that the former are senior and would receive all the proceeds if the project were liquidated.

These results imply that having the entrepreneur tied up with securities that mature before the project yields sufficient cash flows may be an equivalent way of granting an informed lender the option to liquidate which characterizes our optimal contracts under both informed and mixed finance. A similar effect could be achieved if the project were (totally or partially) financed by a line of credit callable at the option of the lender under "materially adverse circumstances": these vaguely specified circumstances would correspond, in terms of our model, to the observation of an unsatisfactory level of effort.

8. CONCLUSION

This paper develops a model of mixed finance which provides an explanation for the seniority of informed (bank) debt. We have started analyzing two basic modes of financing investment projects in a moral hazard setup, called informed and uninformed finance. Under informed finance the lender observes the borrower's (unverifiable) effort at a certain cost. This information may be used to liquidate the project. Our characterization of the optimal contracts under each mode of finance reveals that the optimality of informed finance hinges upon the possibility of imposing a credible threat of liquidation on the borrower. This possibility disappears for low liquidation values due to a conflict between preserving the credibility of the liquidation threat and compensating the lender for her investment in the project.

The nature of this conflict provides our rationale for mixed finance: by introducing a passive uninformed lender, the stake of the informed lender in the continuation proceeds can be reduced (in parallel with the funds that she contributes to the project) so as to restore the credibility of the liquidation threat. We have shown, however, that the possibility of collusion between the entrepreneur and the informed lender affects the effectiveness of this mode of finance and determines the form of the optimal three-party contracts. These contracts may be interpreted as the combination of short-term informed debt and long-term uninformed debt, with the additional interesting properties that (i) informed debt is senior, and (ii) informed debt capacity (the maximum informed debt compatible with a credible threat of liquidation) is always exhausted. Our results may explain the characteristics and coexistence of contracts such as typical bank loans (tightly held, secured, senior, and with embedded call options) and corporate bonds (publicly traded, not necessarily secured or senior, and without the option of forcing early repayment).

A key aspect that differentiates the contracts signed under each mode of finance is the role of the entrepreneur's equity stake in the firm w and the liquidation value of the project L. Our model predicts that, on the one hand, interest rates will not depend much on either w or L under informed finance (though their values are essential for being granted the loan in the first place), they will significantly depend on w but not on L under uninformed finance (where L is not even a determinant of the feasibility of the contract), and they will significantly depend on both w and L under mixed finance. On the other hand, the participation of the lender in the liquidation proceeds will be unimportant under uninformed finance, while it is a crucial element of the optimal contract under both informed and mixed finance —where the stake of the informed lender is always protected by the option to liquidate.

From these features, one can derive several testable implications. For instance, one would expect a lower dispersion of the implicit default premia for firms that borrow exclusively from banks (pure informed finance) than for firms that borrow from both banks and the market (mixed finance) or exclusively from the market (pure uninformed finance). We would also expect that a credit rating agency involved in assessing the quality of a public issue of corporate bonds would focus on the valuation of the firm's financial condition (w) rather than the specificity or liquidity of the assets involved in the new investments (L). In contrast, a bank or a large corporate lender would also pay attention to the characteristics of the investments. These predictions seem broadly consistent with casual observations of real world finance. Finally, firms that rely on informed finance would be expected to be more sensitive to macroeconomic or industry-specific factors which depress or enhance the liquidity of the markets for real assets. In particular, the variations in L over the business cycle stressed by Shleifer and Vishny (1992) would affect very especially those firms with strong dependence on short-term bank finance. This may explain findings such as those of Gertler and Gilchrist (1994), as well as some of the puzzling movements in the ratio of commercial paper to bank loans documented by Kashyap, Stein and Wilcox (1993).

There are some predictions for which there is already some positive evidence. In particular, the results by Alderson and Betker (1995) from a survey of firms with different observed liquidation costs (inversely related to our variable L) show that firms in the lowest quartile (high L) have an average ratio of private debt to total debt of 0.816, whereas for those in the highest quartile (low L) the ratio is 0.531. Similarly, the average ratios of secured debt to total debt for the same groups of firms are 0.845 and 0.630, respectively. This is consistent with our theoretical findings.

Although our model provides new explanations to some puzzling micro and macroeconomic stylized facts, and its predictions seem in accordance with the available evidence, we do not claim to provide a comprehensive explanation of firms' financing decisions. The model is intentionally simple, and so some interesting issues have not been addressed. One limitation is that we have dealt with entrepreneurial rather than managerial firms. This means that the model is possibly more adequate for small firms than for large corporations (where the relationship between the firm and its external financiers may be affected by non-trivial internal control issues). On the other hand, the noiseless observation by the informed lender of the entrepreneur's effort decision simplifies the problem of designing the optimal liquidation threat, and rules out the possibility of any ex post inefficient liquidation; moreover, without noise liquidation never happens in equilibrium. Finally, in order to focus on the disciplinary role of informed lenders, we have assumed that the decision to monitor is contractible. Thus, although we have pointed out several reasons why informed lenders could be identified with financial intermediaries, we have not addressed the classical question of who monitors the monitor.

APPENDIX

Proof of Proposition 5: The optimal contract under mixed finance with renegotiation between the informed parties is a solution to the problem:

$$\mathrm{Max}_{(I_l,I_u,Q_l,Q_u,R_l,R_u)}\ [\hat{p}(Y - R_u) - \max\{\hat{p}R_l,\ Q_l\} - \phi(\hat{p})] \tag{16}$$

subject to the constraints:

$$\hat{p} \equiv \mathrm{argmax}_{p\ \geq\ Q_l/(Y-R_u)}\ [p(Y - R_u) - \max\{pR_l,\ Q_l\} - \phi(p)], \tag{17}$$

$$I_l + I_u = 1-w+c,\quad Q_l + Q_u \leq L,\quad R_l + R_u \leq Y, \tag{18}$$

$$\max\{\hat{p}R_l,\ Q_l\} = I_l,\quad \hat{p}R_u = I_u,\text{[14] and} \tag{19}$$

$$\hat{p}(Y - R_u) - \max\{\hat{p}R_l,\ Q_l\} - \phi(\hat{p}) \geq w. \tag{20}$$

To prove the result we first show that if $w \geq \bar{w}_m(L) \equiv \max\{\bar{w}_l - L, 0\}$ the contract stated in the proposition satisfies the constraints (17)-(20). By construction, $p_m(w,L)[Y - \phi'(p_m(w,L))] = 1-w+c-L = p_m(w,L)R_u(w,L)$, which implies $[Y - R_u(w,L)] - \phi'(p_m(w,L)) = 0$, so $p_m(w,L) = \mathrm{argmax}\ [p(Y - R_u(w,L)) - \phi(p)]$. But since $p_m(w,L)R_l(w,L) = Q_l(w,L)$, we also have

$$p_m(w,L) = \mathrm{argmax}\ [p(Y - R_u(w,L)) - \max\{pR_l(w,L),\ Q_l(w,L)\} - \phi(p)].$$

Now, comparing (12) and (15) it follows that $p_m(w,L) = p_l(w+L)$. Moreover, if $w \geq \bar{w}_m(L)$ we have $p_l(w+L)Y - (1-w+c) \geq w + \phi(p_l(w+L))$. Since by construction $p_m(w,L)[Y - R_l(w,L) - R_u(w,L)] = p_m(w,L)Y - (1-w+c)$, we conclude

$$p_m(w,L)[Y - R_l(w,L) - R_u(w,L)] \geq w + \phi(p_m(w,L)) > 0. \tag{21}$$

This implies $p_m(w,L)[Y - R_u(w,L)] > p_m(w,L)R_l(w,L) = Q_l(w,L)$, so $p_m(w,L) > Q_l(w,L)/[Y - R_u(w,L)]$, and the proposed contract satisfies (17). As for the other constraints, they are either trivially satisfied or follow immediately from (21).

Next consider an arbitrary contract $(I_l,I_u,Q_l,Q_u,R_l,R_u)$ for an entrepreneur with wealth w that satisfies the constraints (17)-(20). We are going to prove that this contract is dominated by the contract stated in the proposition. Substituting (19) into (16), and using the constraint $I_l + I_u = 1-w+c$, it suffices to show that $w \geq \bar{w}_m(L)$ and

$$p_m(w,L)Y - \phi(p_m(w,L)) \geq \hat{p}Y - \phi(\hat{p}). \tag{22}$$

For this, we first note that since the function in (17) is concave (because $\phi''(p) > 0$ and for $p = Q_l/R_l$ we have $(Y - R_u) - \phi'(p) > (Y - R_l - R_u) - \phi'(p))$, and $Q_l/(Y-R_u) \leq Q_l/R_l$ (because $R_l + R_u \leq Y$), $\hat{p}$ must satisfy one of the following conditions:

(a) $\hat{p} \geq Q_l/R_l$ and $(Y - R_l - R_u) - \phi'(\hat{p}) = 0$.

(b) $\hat{p} = Q_l/R_l$, $(Y - R_u) - \phi'(\hat{p}) > 0$ and $(Y - R_l - R_u) - \phi'(\hat{p}) < 0$.

(c) $\hat{p} \leq Q_l/R_l$ and $(Y - R_u) - \phi'(\hat{p}) \leq 0$ (with strict inequality only if $\hat{p} = Q_l/(Y-R_u)$).

If $\hat{p}$ satisfies (a), then using (18) and (19) we can write $[Y - (1-w+c)/\hat{p}] - \phi'(\hat{p}) = 0$, that is $\hat{p}[Y - \phi'(\hat{p})] = 1-w+c$. But then using the properties of the function $f(p) \equiv p[Y - \phi'(p)]$ noted in the proof of Proposition 1 together with the definition of $p_m(w,L)$ we conclude that $w > \bar{w}_l$ and $\hat{p} < p_m(w,L) < \bar{p}$. But since $pY - \phi(p)$ is increasing for $p \leq \bar{p}$, this implies that (22) holds.

Suppose next that $\hat{p}$ satisfies condition (b). Then using (18) and (19) we have $(Y - I_u/\hat{p}) - \phi'(\hat{p}) > 0$ and $[Y - (1-w+c)/\hat{p}] - \phi'(\hat{p}) < 0$, which implies $I_u < \hat{p}[Y - \phi'(\hat{p})] < 1-w+c$. Moreover, $I_l = Q_l < L$ together with (18) imply $1-w+c-L \leq I_u$. Hence we have $1-w+c-L < \hat{p}[Y - \phi'(\hat{p})] < 1-w+c$. But then by the properties of the function f(p) and the definition of $p_m(w,L)$ we conclude that $\hat{p} < p_m(w,L) < \bar{p}$ and $w > \bar{w}_l$, so (22) also holds.

Finally if $\hat{p}$ satisfies condition (c), we first note that if $\hat{p} = Q_l/(Y-R_u)$, then using the fact that $Q_l/(Y-R_u) \leq Q_l/R_l$ we would have

$$\hat{p}(Y - R_u) - \max\{\hat{p}R_l, Q_l\} = \hat{p}(Y-R_u) - Q_l = 0,$$

which contradicts (20). Hence it must be $(Y - R_u) - \phi'(\hat{p}) = 0$, so using (19) we have $(Y - I_u/\hat{p}) - \phi'(\hat{p}) = 0$, that is $\hat{p}[Y - \phi'(\hat{p})] = I_u$. Moreover, $I_l = Q_l < L$ together with (18) imply $1-w+c-L \le I_u < 1-w+c$. Hence we have $1-w+c-L \le \hat{p}[Y - \phi'(\hat{p})] < 1-w+c$. But then by the properties of the function $f(p)$ and the definition of $p_m(w,L)$ it must be the case that $\hat{p} \le p_m(w,L) < \bar{p}$ and $w \ge \bar{w}_l$, so (22) holds. ■

NOTES

1. Gorton and Kahn (1994) analyze the role of these clauses in a setup in which entrepreneurial incentives for inefficient asset substitution depend on the realization of an unverifiable state of nature. The callability of the loan allows the lender to force the renegotiation of the terms of the initial debt contract. Focusing on the possible outcomes of this renegotiation, the paper contains an interesting discussion of the differences between bank loans and corporate bonds. However, the problem of designing contracts in order to provide proper incentives to the informed lenders (from which we derive our result on the optimality of mixed finance) is not fully addressed.

2. Rajan (1992) studies the trade-off between private and public debt in a moral hazard setting similar to ours, examining the impact of the lender's ex post bargaining power on the efficiency of the entrepreneur's effort decision. He ignores security design issues and, taking debt contracts for granted, stresses the importance of the *hold-up* problem as a cost of informed finance, suggesting (unlike us) that arms'-length debt should have priority over bank debt.

3. To sketch why this is so, notice first that for any given probability of liquidation chosen by the lender, the payoff to the entrepreneur is strictly concave in the level of effort p, so the entrepreneur will never mix. Moreover, the value of p chosen by the entrepreneur will be decreasing in the probability of liquidation. With regard to the lender, there might be equilibria in which she randomizes her choice of ℓ, while the participation constraints (3) and (4) are satisfied. Still, liquidating with positive probability would be inefficient, since it worsens entrepreneurial incentives and (given $L < 1$) reduces the overall surplus. Therefore, the mixed strategy equilibria associated to feasible contracts (if they exist) are always Pareto dominated by the unique pure strategy equilibrium of the game.

4. It should be noticed that the first-order condition (2) implies $Y - R_u(w) = \phi'(p_u(w)) > 0$, so the payment promised to the lender is always smaller than Y.

5 This assumption is standard; see Diamond (1991b) or Rajan (1992). Endogenizing the lender's monitoring decision entails difficulties which are beyond the scope of this paper.

6. One can think of the information obtained by the lender as the result of a continuous close relationship with the borrower. This may involve, for example, regular interviews with the firm's executives and main customers, visits to the firm's premises, as well as the observation of the movements in the firm's bank accounts (in the case of informed bank finance).

7. The inequality will be strict except in the limit case where $\bar{w}_l = \bar{w}_u = 0$.

8. If, nevertheless, the uninformed lender became informed and participated in the renegotiation, mixed finance would not improve on pure informed finance since liquidation threats would become ineffective: assuming efficient renegotiation, the critical $\hat{p}$ that triggers liquidation would solve $\hat{p}Y = Q_l + Q_u \leq L$, whilst feasibility would require $p^*Y \geq 1-w+c > L$. Then, the equilibrium p^* would have to be strictly greater than $\hat{p}$, and it would not change if we shut down the possibility of liquidation setting $Q_l = Q_u = 0$.

9. Roughly, this principle states that in the context of a non-cooperative bargaining model with alternating offers in which one of the players (say player 1) can quit the negotiations to take up an outside option, if the value of this option is smaller than the equilibrium payoff of player 1 in the game with no outside option, then this option has no effect on the outcome of the game; if, on the other hand, this condition is not satisfied, then the equilibrium payoff of player 1 is equal to the value of his option (see Sutton, 1986, or Osborne and Rubinstein, 1990). Following the standard interpretation in this literature, in our model the informed lender's option to liquidate should be taken as an "outside option" (and not as a status quo point). To quote Binmore (1989): "In summary, where the defense of the use of the Nash bargaining theory is to be based on an alternating offers model, the status quo should correspond to the consequences of a deadlock (during which the players remain at the negotiation table but never reach an agreement). The outside options that they may obtain by abandoning the negotiations serve only as constraints on the range of validity of the Nash bargaining solution."

10. In the case of pure informed finance $R_u = 0$ implies $\hat{p} = \bar{p}$, so the contract in Proposition 2 will be robust to renegotiation.

11. Note that $R_l + R_u \leq Y$ implies $Q_l/(Y-R_u) \leq Q_l/R_l$. Moreover, for the contracts described in Proposition 4, the inequality will be strict.

12. Whether informed finance can be identified in a narrower sense with *intermediated finance* is beyond the scope of this paper: further specification of the relative sizes of investors' financial capacities and entrepreneurs' financial needs, the stochastic dependence of the returns of the different investment projects, and the nature of the intermediaries would be required to address this issue.

13. This is the same assumption as in Berglöf and von Thadden (1994).

14. We are assuming, without loss of generality, that the lenders' participation constraints are satisfied with equality.

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