Relying on the Information of Others: Debt Rescheduling with many Lenders

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Abstract

Can inertia in terminating unsuccessful projects be due to the presence of multiple lenders in loan arrangements? Is it possible that a lender reschedules, apparently betting against his odds? We show that the fear of being last in a liquidation prevents the aggregation of the lenders' private information about the value of continuation. Then, in a loan with multiple lenders, privately observed bad news that would prompt liquidation if information was aggregated or if the lender acted myopically, may instead lead to rescheduling.. The rational gamble is that other lenders may have more precise information. At the resulting equilibrium, it turns out that rescheduling may occur even if all lenders received bad news. This is a source of inefficiency (increasing the cost of capital) compared to the ideal of perfect information sharing. However, from a social point of view, given that information cannot be shared, the equilibrium does not exhibit excessive reliance

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1 Introduction

Large and dramatic defaults give rise to debates, more or less technical in kind, wether banks have properly done their work in processing information. Large defaults by firms in Europe and the US, as well as by sovereigns around the world, have often raised questions if some banks knew that continuation was unlikely to be profitable, and if yes , why they did not act. Often, events making the news originate from large loans, like loans to large firms or sovereigns, with enormous amounts of money at stake, and multiple creditors involved. Collusion "behind the doors",between subgroups of lenders and the borrower, trying to conceal information and to protect reciprocally at the expenses of other lenders, can sometimes be invoked to explain matters, but one does not expect misbehavior of this sort to be too frequent in developed financial markets, where public institutions and the markets operate to discipline managers in both, banks and firms. Also, skepticism towards big banks may simply arise out of political prejudice against sophisticated financial institutions and finance in general. However, to dismiss the issue may also be a mistake. Indeed, is it trivially true that banks, and lenders in general, because they protect their own interests, make the socially optimal use of the information they collect? Must a lender that receives news about a borrower's financial health going to act accordingly? What if other lenders are involved in the same loan arrangement?

To note, when a borrower gets in trouble, if a lender does not renew a loan it will likely trigger liquidation, which is quite an irrevocable act. In the presence of a foggy view of the borrower's current profile, a lender can "think twice", and consider rescheduling, which can be "undone" at a later period by refusing further delays, may. This can be relevant, in particular, if the loan arrangement is with multiple lenders. Then, the single lender knows that the others also receive information about the prospects of a trouble borrower. In this context, information precision should be an important matter for taking a decision. A lender receiving a bad but imprecise signal about the borrower, if other lenders are involved, may be reluctant to liquidate. The gamble is that other lenders may have obtained more precise information and be in a better position to decide. Can this be rational? And, suppose then that a loan arrangement is with two lenders, what happens if both decide to reschedule if they are ill informed? Is there too much relying on the possibility of other lenders being better informed? Does this mean that there is excessive rescheduling at equilibrium? And what is meant by this?

To answer these questions we shall make use of a simple two lenders-one borrower model, where agents are involved in a multi-stage game, under imperfect information.

The inefficiencies arising from resorting to multiple lenders in financing firms are well known and the literature has been trying to explain multiple lending arrangements as a response to problems of asymmetric information or other imperfections in the loan market. Papers in this vein include Bolton and Scharfstein (1996), Rajan (1992), Detragiache, Garella and Guiso (2000) and, more related to the present framework, Dewatripont and Maskin (1995). The presence of multiple lenders in recontracting of loan arrangements may lead to a lack of coordination, or to free riding, that prevents socially optimal debt restructuring (Detragiache (1994), Hart and Moore (1995), Bolton and Scharfstein (1996), Detragiache and Garella (1996). In particular, making renegotiation difficult may act as a device to correct for borrowers' incentives to use funds in suboptimal ways, like for instance to undertake socially inefficient projects (Hart and Moore 1995). On the other hand, having more than one lender dilutes the incentives to monitor the borrower, counterbalancing the discipline effect. As Dewatripont and Maskin (1995) argue, in a setup where (i) initial debt is signed with one lender only, (ii) due to limited fund availability, refinancing involves a second lender, the incentives to monitor by the first lender are reduced, because part of the gains are appropriated by the second. Then, less refinancing will occur at equilibrium, mitigating the inefficiencies from a "soft budget constraint" problem that would arise if credit were to be provided by a centralized agency. While, however, insufficient incentive to gather information, or also to monitor, has been a concern in the case of multiple lenders, so far the literature seems to have neglected the question whether lenders, and banks more specifically, make the socially optimal use of the information *in their possession*, so as to provide a framework for addressing the issues here recalled at the outset. Minetti and Guiso (2004) and Minetti (2203) study a setup that shares some assumptions with the present paper: multiple lenders arrangements involve banks that are either relationship banks, or transaction banks, where relationship banks have better information about the borrower than transaction banks do. Further, they assume that relationship banks, thanks to their superior information, have the advantage that they can selectively choose which assets to repossess in a liquidation. Related to this issue, Berger, Klapper and Udell (2001) empirically test various hypotheses about the role of relationship vs. arms-length loans in Argentina. Our paper shares with Minetti and Guiso (2004) the idea that lenders receive private information that can differ in precision, although, in our framework, in order to build our argument, bad news necessarily come bundled into coarse signals. We analyze a simple recontracting game involving one (large) borrower and two creditors. The project financed at date 0 may terminate successfully at date 1, with full payments of all debt obligations. However, with some probability, the project does not deliver any return at date 1 but it does so at date 2, with uncertain prospects, but with no need for fresh funds. By assumption, according to the common priors, the expected value of returns at date 2 is such that if the project does not delivers at date 1, liquidation is better than rescheduling. Returns, however, can also end up to be high enough to make rescheduling worthwhile. The date 1 liquidation value of the loan is common knowledge and deterministic and liquidation follows if at least one lender goes for it. At date 1, each lender decides wether to accept rescheduling or file for bankruptcy, after observing a private signal about the value of the loan returns at date 2. The signal that banks receive can be of two kinds: "precise" or "coarse", according to a random draw by Nature. The *coarse* signal is also assumed to be "bad" in that it brings no more favorable information than it was contained in the common priors, so that a bank should file for liquidation if based its decision only upon it. The *precise* signal reveals the true state of Nature and can be, therefore, good or bad. One could also enlarge the spectrum of possible signals so as to allow for a coarse but good signal in addition to the two here considered. As it will be clear from the analysis below, this change could be accommodated, without essentially altering the equilibrium strategies of lenders when they receive the bad and coarse signal. Hence, without altering the basic results. Information received at the rescheduling stage could be merged, but, as we shall show, a communication game will in general fail to provide equilibria where truthful revelation of information occurs, and therefore information is not merged. Accordingly, decisions wether to reschedule or not must be taken based only upon the received signal.[1] The idea that information received by lenders can differ not only in value, but also in precision is central to the developments below. Strikingly, we show that if a bank receives the coarse signal, that would unambiguously trigger liquidation if information was merged, *or if there was not a second lender*, will not do so at equilibrium and will adopt a softer attitude. If, at one extreme, the (exogenous) likelihood that the other lender is informed is large, indeed, rescheduling by a coarsely informed bank is a dominant strategy and occurs with probability equal to one. When both banks receive the bad, but coarse, signal, they both ignore it and reschedule instead of liquidating. This behavior, that an external observer would address as "irresponsible", because it amounts to act as if the information was favorable, arises out of equilibrium strategies enacted

[1]Other reasons may prevent information to be merged. Guiso and Minetti (2004) argue that the borrower can selectively control the information flows. We can also think of cases where lenders have private interests with large firms, for instance when they also finance suppliers of these firms, or when they can buy or sell outstanding bonds issued by the borrower. In both cases the lenders have incentives to manipulate the revelation of information.

by rational players and its economics is fully understandable when the analysis of the game is fully developed. Of course, the use of the information, is not socially optimal if compared to a situation where information is merged. However, we prove that a social planner, were it able to direct the banks' actions, given the same information structure, could not improve upon the equilibrium solution. Hence, roughly speaking, there need not be excessive rescheduling at equilibrium. Lenders in our game have interests that are not fully conflicting: if some *good* information is around, everybody is better off by rescheduling rather than liquidating. Key to the decision to reschedule by an ill informed lender is the possibility that the other bank is informed and triggers liquidation when it is optimal to do so. Of course, and paradoxically, when both lenders are ill informed they both rely on this likelihood and inefficient rescheduling occurs. Finally, suppose that if liquidation occurs the two banks are treated asymmetrically, in the sense that if one triggers liquidation while the other reschedules, the first gets some higher payoff than the second—if both liquidate, one can simply assume that they are treated equally. The analysis of the game played by the two banks, then, reveals that a lender receiving the precise signal will liquidate also for some values of the date 2 returns in the range where rescheduling is optimal. This excessive liquidation is chosen because there is a chance that the other bank is not fully informed and does not reschedule with probability equal to one. Therefore, our model also predicts that equilibrium runs on the borrower's assets can occur, or excessive rescheduling can occur, the effective path of play depending upon how Nature distributes information to the lenders. The paper is organized as follows. Section 2 provides the model under the assumption that if banks take different decisions at the rescheduling stage, the one that triggers liquidation has a higher payoff than the other. There, it is shown that information cannot be merged as an equilibrium of a communication game. In section 3 we simplify our analysis by assuming that the advantage from unique liquidation tends to zero, a merely technical device that grants that a well informed bank always takes the socially efficient decision. This allows to focus on the strategic aspects related to the ill informed bank ”relying on the information of the other”. Section 4 deals with the efficiency property of the equilibria and contains comments on the economics of over-rescheduling. Section 5 gives the results stemming from the analysis of the game where the advantage from unique liquidation does not vanish, so that a well informed lender may not reschedule for values of the observed date 2 returns that exceed the liquidation value. Section 6 provides the conclusions.

2 The model

There are three periods, an entrepreneur with no endowment, and lenders. At date 0, the entrepreneur seeks financing for a project. The amount to be raised is normalized to 1 and two lenders, henceforth the "banks", participate in equal measure to the provision of funds by means of a debt contract. Banks are small or the project is large, so that financing must be obtained from two lenders. The credit market is competitive and lenders earn zero expected profit at equilibrium. For simplicity, their opportunity cost of funds is zero. If successful, which occurs with probability γ, the project is completed by date 1 and yields the return $R > 1$, where R is sufficiently large for the net expected value of the project to be positive. With probability $1 - \gamma$, the project runs into problems and is not completed by date 1. It can then be liquidated, yielding $L < 1$. If allowed to continue, it delivers the random return $\widetilde{X}$ at date 2. We take $\widetilde{X}$ to be distributed over the interval $[0, 1]$ with cumulative distribution function $F(X)$. The expected return from continuation is denoted by $\overline{X}$. An unsuccessful project continues up to date 2 only if both banks reschedule their loan. Banks do not coordinate for reasons to be explained below. The payoffs from rescheduling or filing to liquidate are as follows. When each bank reschedules, they each get $\widetilde{X}/2$ at date 2. When each bank seeks to liquidate, they each get $L/2$. However, when one bank reschedules and the other refuses to do so, the latter obtains βL where $\beta \in (\frac{1}{2}, 1)$ and the former $(1-\beta)L$. Non rescheduling by one bank ultimately entails liquidation and $\beta > \frac{1}{2}$ reflects the first-mover advantage in a run on the firm's assets. At date 1, prior to the rescheduling decision, each bank obtains independent information about the value of continuation. This information is either perfect or it is unfavorable but imprecise. Perfect information means that the bank learns X. The imprecise information is denoted by ϕ. This information is unfavorable in the sense that $E(\widetilde{X} \mid \phi) < L$, where E is the expectation operator; i.e., taken on its own, ϕ means that the socially appropriate decision is to liquidate the project. A bank does not know how well informed the other bank is. Moreover, the information received by the banks is non verifiable or "soft". Specifically, a bank may announce that it learned that the value of continuation was some X, but it can offer no proof even if the announcement is true. Thus, any exchange of information at date 1 is cheap talk. The consequence is that information will not be shared because of the first-mover advantage in a liquidation run. To show this, we expand the set of actions at date 1 to allow for a communication game. One can imagine that, prior to the play of the rescheduling decisions, banks simultaneously make announcements, m_i, of the form $m_i = \hat{X}$ or $m_i = \phi$, after which they simultaneously play "reschedule" or "liquidate" as described above. The following result justifies the analysis of the full game under the assumption that no communication between banks is possible.

Lemma 1 *If a communication game is played at date 1, it is a dominant strategy to announce $m_i = \hat{X}$ such that $\frac{1}{2}\hat{X} \geq \beta L$.*

The result is obvious. If a bank indeed learned X satisfying the inequality, it would like to convince the other bank that continuation is profitable for both of them. However, a bank learning X such that $\frac{1}{2}X < \beta L$ would also gain from making the same announcement if it were believed (which requires that the other is ill informed), since it would be the first mover in liquidation. Similarly, a bank learning ϕ cannot gain by announcing that it received a poor but unfavorable signal. For instance, suppose the two banks are ill informed and each truthfully announces ϕ, prompting liquidation at the next stage. Then one bank would have been better off announcing a favorable X and be the first mover should the announcement be believed. Thus, in equilibrium, favorable announcements will never be believed and will be equivalent to being told nothing. We now return to the original game tree and take it that banks do not communicate at all. To simplify the exposition, we henceforth assume that ϕ is in fact "no information", so that $E(\widetilde{X} \mid \phi) = \overline{X}$. With probability θ a bank learns the true X, with probability $1 - \theta$ it learns nothing. To preserve that ϕ is unfavorable, we assume

$$\overline{X} < L < 1. \tag{1}$$

Thus, taken on its own, "no information" means that from a collective standpoint it would be best to liquidate. The next section analyzes the rescheduling game. Figure 1 summarizes the set-up.

3 Rescheduling decisions

To simplify the exposition further, we now assume that β is close to one half. In effect, we will write all payoffs as if $\beta = \frac{1}{2}$. By continuity, the actual equilibrium will be close to what we compute, but encumbered by "second order" terms. With β arbitrarily close to one half, when one bank reschedules and the other liquidates, the payoffs simplify to $L/2$ for each bank. In section 5, we derive the banks' strategies when β differs from one half and discuss how this affects the equilibrium outcome. Let *liq* and *res* refer to "liquidate" and "reschedule". Strategies are denoted by α, the probability that a bank plays *liq*. We write $\alpha(X)$ for the strategy played by a well informed bank which learns X; similarly, $\alpha(\phi)$ is the strategy played when ill informed. A bank's expected payoff is denoted by u.[2] Given the simplification that β is arbitrarily close to one half, bank i's expected payoff from playing *liq* does not depend on its information nor on bank j's strategy ($i, j = 1, 2;\ i \neq j$). Thus,

$$u_i(liq, \alpha_j \mid \phi) = u_i(liq, \alpha_j \mid X) = \frac{L}{2}, \quad \text{for all } X. \tag{2}$$

This is not so for the expected payoff from playing *res.* If bank i is informed, its expected payoff is

$$u_i(res, \alpha_j \,|\, X) = \\ \frac{1}{2}\left\{(1-\theta)\left[\alpha_j(\phi)L + (1-\alpha_j(\phi))\,X\right] + \theta\left[\alpha_j(X)L + (1-\alpha_j(X))\,X\right]\right\}. \tag{3}$$

If it is ill-informed, the expected payoff from *res* is

$$u_i(res, \alpha_j \,|\, \phi) = \\ \frac{1}{2}E\left\{(1-\theta)[\alpha_j(\phi)L + (1-\alpha_j(\phi))\,X] + \theta[\alpha_j(X)L + (1-\alpha_j(X))\,X]\right\}. \tag{4}$$

In the last two equations, θ is the probability that bank j is well informed. The difference between (3) and (4) is the expectation operator in the latter, since the bank whose payoff is represented in (4) does not know X. Comparing (2) and (3), the best strategy of an informed bank is obviously to choose *liq* if $L > X$ and *res* otherwise. At equilibrium, therefore, for either bank,

$$\alpha_i(X) = \begin{cases} 1 & \text{if } X < L, \\ 0 & \text{if } X \geq L. \end{cases} \tag{5}$$

Note that this coincides with the socially optimal decision. To derive the best response of an ill informed bank, define $Z = \max[X, L]$. This is the total

[2] While this section describes a simultaneous game, we introduce a sequence in section 6. The equilibrium concept is Perfect Bayesian Equilibrium, namely, a belief system and a strategy profile such that beliefs are based upon the equilibrium strategies and are constructed using Bayes' rule whenever possible, and strategies obey the criterion of sequential rationality.

return that would accrue from an unsuccessful project if banks were perfectly informed at date 1 and took the appropriate decision. The expected value is

$$\overline{Z} \equiv E(Z) = F(L)L + (1 - F(L))E(X \mid X \geq L). \tag{6}$$

Substituting in (4) and using (5), the payoff from *res* for an ill informed bank can then be rewritten as

$$u_i(res, \alpha_j \mid \phi) = \frac{1}{2}\left\{(1-\theta)\left[\alpha_j(\phi)L + (1-\alpha(\phi))\,\overline{X}\right] + \theta\overline{Z}\right\}. \tag{7}$$

Comparing (2) and (7), bank i's best response, when ill informed, depends on the other bank's strategy when the latter is also ill informed and on the likelihood of poor information. The expression in (7) is increasing in θ since $\overline{Z} > L > \overline{X}$. Accordingly, if θ is sufficiently large, it is best to play *res* and rely on the other bank to make the appropriate decision. Conversely, if θ is close to zero, the best move is to play *liq*. The expression in (7) is also increasing in $\alpha_j(\phi)$. The greater the probability that the other bank plays *liq* when ill informed, the safer it is to play *res* when one is also ill informed since the probability of a "wrong" rescheduling decision is smaller.

Proposition 1 *At equilibrium, for $\beta = 1/2$, well informed banks take the sociallyoptimal decisions. Ill informed ones always reschedule their loan if*

$$\theta \geq \widehat{\theta} \equiv \frac{L - \overline{X}}{\overline{Z} - \overline{X}}. \tag{8}$$

When $\theta < \widehat{\theta}$, there are two equilibria. In equilibrium M, ill informed banks play a mixed strategy, rescheduling with the strictly positive probability

$$1 - \alpha_i(\phi) = \frac{\theta}{1-\theta}\left(\frac{\overline{Z} - L}{L - \overline{X}}\right), \quad i = 1, 2. \tag{9}$$

In equilibrium P, the banks play pure strategies: one always reschedules, the other always liquidates.

The essence of the result is that banks sometimes rely on others to take the appropriate decision (proofs are henceforth in the Appendix). The gamble, from the prespective of an ill informed bank, is that the other lender may have more precise information. When this is sufficiently likely (i.e., $\theta \geq \widehat{\theta}$), each bank, when ill informed, completely disregards its own unfavorable information and relies fully on the other bank to be better informed. In fact, "temporizing" through a rescheduling decision is then a dominant strategy—see the proof. When the likelihood of the other bank being well informed is small ($\theta < \widehat{\theta}$), there are two possibilities. In the pure strategy equilibrium P, one bank is passive and "delegates" to the other lender the liquidation versus rescheduling decision. In turn, the lender in charge always liquidates when ill informed, completely discounting the possibility that the other bank may have obtained favorable information. In the symmetric strategy equilibrium M, an ill informed bank is indifferent between rescheduling or filing to liquidate. The greater the likelihood that the other bank is well informed, the larger the probability of rescheduling, i.e., of delegating the decision to the other lender. The next section discusses the extent of the inefficiencies characterizing these equilibria.

4 Inefficiency

Inefficiency compared to the first-best with shared information is not surprising. Still, it is of interest to explore how the nature and extent of the inefficiency is affected by the amount of information in the system. Moreover, while the perfect sharing of information represents an obvious benchmark, we also ask whether the equilibria can be improved upon even though information is not shared. Let B denote the facial value of the loan (i.e., $B = 1+\rho$ where ρ is the rate of interest on the debt contract). By assumption, R is sufficiently large for $R > B$ to obtain. Let $\overline{Y}$ denote the total amount that the lenders (both banks together) expect to recuperate from an unsuccessful project—i.e., one that will not be completed at date 1. Recall that a project is successful with probability γ. In a perfectly competitive credit market, banks earn zero ex ante expected profits so that B satisfies

$$1 = \gamma B + (1-\gamma)\overline{Y}.$$

The larger $\overline{Y}$, the smaller B (equivalently, the smaller ρ). We measure inefficiency by how small $\overline{Y}$ is. In terms of the lenders' strategies, the amount recuperated on average is

$$\begin{aligned} \overline{Y}(\theta) &= \theta^2\overline{Z} + \theta(1-\theta)\left[\widehat{\alpha}_2 L + (1-\widehat{\alpha}_2)\,\overline{Z}\right] + (1-\theta)\theta\left[\widehat{\alpha}_1 L + (1-\widehat{\alpha}_1)\,\overline{Z}\right] \\ &\quad + (1-\theta)^2\left[(1-(1-\widehat{\alpha}_1)(1-\widehat{\alpha}_2))\,L + (1-\widehat{\alpha}_1)(1-\widehat{\alpha}_2)\overline{X}\right], \quad (10) \end{aligned}$$

where $\widehat{\alpha}_i$ is the strategy $\alpha_i(\phi)$ when ill informed. Each bank is assumed to play the socially optimal—and equilibrium—strategy when well informed. The derivation of (10) is straightforward. The total expected return $\overline{Z}$ is obtained when both banks are well informed or when only one is, which occurs with probability $2\theta(1-\theta)$, and the other reschedules. When both banks are ill informed, the total return from an unsuccessful project is L if at least one bank liquidates, otherwise it is on average $\overline{X}$. In a first best with perfectly aggregated information, the amount expected to be recuperated is

$$\overline{Y}^*(\theta) = (1-\theta)^2\,L + \left(1-(1-\theta)^2\right)\overline{Z}. \quad (11)$$

When information is shared, $\overline{Z}$ is expected to be recuperated if at least one of the lenders is informed, hence with probability $1-(1-\theta)^2$. When none is informed, the project is appropriately liquidated. Denote the equilibrium outcome by $\overline{Y}^e(\theta)$. From proposition 1, when $\theta \geq \widehat{\theta}$,

$$\overline{Y}^e(\theta) = \overline{Y}_{II}(\theta) \equiv (1-\theta)^2\,\overline{X} + \left(1-(1-\theta)^2\right)\overline{Z}. \quad (12)$$

The subscript in the middle expression emphasizes that in equilibrium both lenders always reschedule; that is, we set $\widehat{\alpha}_1 = \widehat{\alpha}_2 = 0$ in (10). When $\theta < \widehat{\theta}$, the outcome depends on which equilibrium we pick. In the pure strategy equilibrium, one banks always reschedules when ill informed and the other always liquidates. Hence,

$$\overline{Y}^e(\theta) = \overline{Y}_P(\theta) \equiv (1-\theta)L + \theta\overline{Z}. \tag{13}$$

In the mixed strategy equilibrium, both lenders play the same strategy and

$$\begin{aligned}\overline{Y}^e(\theta) &= \overline{Y}_M(\theta) \equiv \theta^2\overline{Z} + 2\theta(1-\theta)\left[\widehat{\alpha}L + (1-\widehat{\alpha})\,\overline{Z}\right] \\ &\quad + (1-\theta)^2\left[\left(1-(1-\widehat{\alpha})^2\right)L + (1-\widehat{\alpha})^2\,\overline{X}\right],\end{aligned} \tag{14}$$

where $\widehat{\alpha}$ is the optimal strategy $\alpha(\phi)$ defined in proposition 1. Comparing with the first-best amount in (11), $\overline{Y}^e(\theta) \leq \overline{Y}^*(\theta)$ with strict inequality when $\theta \in (0,1)$. There is maximum waste of information when the probability that individual banks are well informed is neither too large nor too small. When the information is on average either very good (θ close to unity) or very bad (θ close to zero), the social loss from the non sharing of information is negligible. Relying on the other bank to be well informed has no social cost if indeed the other bank is very likely to be informed. Conversely, when the likelihood is small, at least one bank will almost be certain to liquidate—this is the bank "in charge" in equilibrium P or both banks in equilibrium M, since $\alpha(\phi)$ in (9) then approaches unity. Consider now the nature of the inefficiency. When $\theta \geq \widehat{\theta}$, ill informed banks always reschedule. Rescheduling may therefore occur even though both banks have unfavorable—albeit imprecise—information. Compared to the first best, the problem is therefore too much rescheduling. By contrast, when $\theta < \widehat{\theta}$, inefficient rescheduling never occurs in the pure strategy equilibrium, but there is inefficient liquidation. The bank "in charge" may then liquidate even though the other lender observed $X \geq L$. In the mixed strategy equilibrium, both types of inefficiencies occur. Which of these two equilibria is socially preferable? In the proof of the next proposition, we show that the pure strategy equilibrium is socially preferable, i.e., $\overline{Y}_P(\theta) > \overline{Y}_M(\theta)$ for $\theta \in (0, \widehat{\theta})$. A more general question is whether a Pareto improvement could be achieved by imposing rescheduling strategies on banks, subject to the constraint that they are consistent with the banks'private information. Second-best optimal strategies potentially differ from the equilibrium ones only in the event that banks are ill informed. To characterize the socially optimal strategies, it is therefore sufficient to choose $\widehat{\alpha}_1$ and $\widehat{\alpha}_2$ in (10) so as to maximize $\overline{Y}(\theta)$.

Proposition 2 *The following strategies are second-best optimal, subject to the constraint that lenders cannot credibly share information: if* $\theta \geq \widehat{\theta}$, $\alpha_1 = \alpha_2 = 0$*; if* $\theta < \widehat{\theta}$, $\alpha_1 = 1$ *and* $\alpha_2 = 0$ *or* $\alpha_1 = 0$ *and* $\alpha_2 = 1$*.*

Proof. See the Appendix.

The result is surprising. When lenders obtain information that cannot be shared and if the likelihood of information is sufficiently high ($\theta \geq \widehat{\theta}$), there is indeed excessive rescheduling compared to the ideal of perfectly aggregated information. However, given the constraint that information cannot be shared, rescheduling decisions are socially optimal in a second-best sense. Put differently, in equilibrium, there is not excessive reliance on others being well informed. For instance, the outcome would be worse if ill informed banks always acted myopically, liquidating on the basis of the imprecise but unfavorable information ϕ.[3] When $\theta < \widehat{\theta}$, the pure strategy equilibrium is second-best efficient. It is socially efficient for the bank "in charge" to act myopically—at the risk of inefficient liquidation—and for one bank to fully rely on the other lender's decision. Inefficient rescheduling in a second-best sense therefore only arises in the mixed strategy equilibrium, which requires a sufficiently small probability of banks being well informed.

5 Herding

Our results bear some similarity with so-called herding phenomena. However, the mechanism leading to a "wrong" outcome with herding is of a very

[3] We would then have $\overline{Y}(\theta) = (1-\theta^2)L + \theta^2\overline{Z}$, which is easily seen to be less than $\overline{Y}_{II}(\theta)$ when $\theta \geq \widehat{\theta}$.

different nature. Herding (see for instance Banerjee 1992) occurs when players who receive private signals *observe* the actions taken by other players and update accordingly. In such a setup, the first player, so to speak, can determine a cascade of optimal deviations from the actions dictated by the private signals, even when the information owned by all players, if merged, would point towards a superior solution. In our case, observing other players' actions is inessential. An ill informed bank knows that, if it reschedules, its mistake can be corrected by the better informed lender, when there is one, but not if it liquidates. This suffices to gamble against information that is unfavorable but poor. Indeed, modifying our set-up so as to introduce a sequence of moves has no effect on the results. Suppose one bank, say bank 1, moves first. Denote its strategy by $\widehat{\alpha}_1(\cdot)$ where the dot refers to the bank's private information. Bank 2 moves after observing the action of bank 1. Its strategy is described by $\widehat{\alpha}_2(liq, \cdot)$ and $\widehat{\alpha}_2(res, \cdot)$, where again the dot is the bank's private information and where *liq* and *res* refer to bank 1's action. We have the following result.

Proposition 3 *Let $\alpha_1(\cdot)$ and $\alpha_2(\cdot)$ be equilibrium strategies of the simultaneous game, where the argument is ϕ or the realization of $\widetilde{X}$. Then $\widehat{\alpha}_1(\cdot) = \alpha_1(\cdot)$ and $\widehat{\alpha}_2(liq, \cdot) = 1$, $\widehat{\alpha}_2(res, \cdot) = \alpha_2(\cdot)$ are equilibrium strategies of the sequential game where bank 1's play of res or liq is observed by bank 2.*

Proof. See the Appendix.Bank 2 is now better informed than when moves

are simultaneous, but the outcome is not improved. The intuition is that bank 2's action matters only when bank 1 plays *res*, as in the simultaneous game. If bank 2 is well informed, it chooses the socially efficient action, again as in the simultaneous game. In one class of equilibria, an ill informed bank 2 replicates *res* because the play of *res* by bank 1 represents "good news".[4]

[4]Rescheduling by bank 1 is good news if θ is large, since the possibility that the bank rescheduled even though ill informed is then small. It is also good news if θ is small and bank 1 plays *res* only when well informed.

Thus, an ill informed bank 2 plays *res* when its decision matters. For bank 1, the play of *res* therefore has the same expected payoff as in the simultaneous game.

6 Extensions

To complete the analysis, we briefly explore the case where the first-mover advantage in liquidation is non negligible (we restrict the discussion to the simultaneous game). Recall that, if it is the only one to liquidate, a bank gets the payoff $L\beta$ while the other lender gets $(1-\beta)L$, where $\beta \in (\frac{1}{2}, 1)$. Compared to the equilibrium where β is arbitrarily close to one half, a larger value has two effects. First, well informed banks will now inefficiently liquidate unless their information is sufficiently favorable. Secondly, ill informed banks liquidate more often. Both effects reinforce one another. To see this, let X'_β denote the equilibrium cutoff such that an informed bank reschedules when observing $X \geq X'_\beta$.. From a social point of view, rescheduling should take place when $X > L$. However, with β greater than one half, an informed bank will now liquidate if X is sufficiently close to L. One reason is the possibility of gaining the first-mover advantage should the other lender reschedule. Another is that rescheduling is now dangerous as the other lender might liquidate because he is ill informed. The payoff then would be $(1-\beta)L$ rather than $L/2$ as in section 3. At the same time, an ill informed bank will anticipate that the other lender, if informed, will be less prone to rescheduling. The strategy of an ill informed bank will therefore also change and lean more towards liquidation. At the extreme, if β is large enough, the advantage from liquidating is so large that it becomes a dominant strategy, whatever the signal received. Otherwise, when the value of β is not too large, equilibrium strategies are similar to those already studied, except for the inefficient liquidation when at least one bank is well informed and the fact that inefficient rescheduling takes place less often when both banks are ill informed. In other words, the first-mover advantage in liquidation remedies some of the excess rescheduling, but at the cost of excessive liquidations. The frequency of inefficient liquidation increases with X'_β. Let $\alpha_\beta(\phi)$ denote the probability of liquidation by an ill informed lender, as a function of β. The threshold triggering rescheduling for a well informed bank is then (all derivations are in the Appendix)

$$X'_\beta = L\frac{2\beta - \alpha_\beta(\phi)(1-\theta)}{1-\alpha_\beta(\phi)(1-\theta)}. \tag{15}$$

Clearly, $X'_\beta > L$ for $\beta > 1/2$ with the threshold tending to L, the socially efficient cutoff, when β tends to one half.. As in section 3, an ill informed bank always reschedules if the probability of the other bank being well informed is sufficiently large. Specifically, $\alpha_\beta(\phi)$ equals zero if

$$\theta \geq \widehat{\theta}_\beta \equiv \frac{2\beta L - \overline{X}}{\left[F(2\beta L)L + (1-F(2\beta L))\, E\left(X \mid X \geq 2\beta L\right) - \overline{X}\right]}, \tag{16}$$

where it is easily verified that $\widehat{\theta}_\beta$ is increasing in β. When $\theta < \widehat{\theta}_\beta$ but assuming it is not too small, an ill informed bank randomizes, rescheduling with probability

$$1-\alpha_\beta(\phi) = \frac{\theta\left[E(X \mid X \geq X'_\beta) - L\right](1-F(X'_\beta)) - L(2\beta-1)}{(L-\bar{X})(1-\theta)}. \tag{17}$$

It is easily shown that $\alpha_\beta(\phi)$ is larger than the corresponding value in proposition 1. Note also that (17) holds only if θ is not too small, otherwise the expression becomes negative since $\beta > 1/2$. Therefore, if θ is sufficiently small, the equilibrium is in pure strategies with $\alpha_\beta(\phi) = 1$. This is a further contrast with the equilibrium in section 3.

7 Concluding comments

The notion that excessive lending may result in loan arrangements is not new, where excessive lending may take different meanings according to the context. Financing projects that have negative expected present value may result in adverse selection setups (De Meza and Webb (1987), or providing loans that allow managers to pursue inefficient projects in the future (Hart and Moore (1995), are just two examples. but overlending may also result from imperfect bankruptcy procedures that give too much protection to borrowers. Similarly, inefficient monitoring may hamper the ability to make the efficient financing decisions. Our idea is that inefficiencies may arise at the rescheduling stage because lenders may rationally decide to disregard a bad signal received. We stress how excessive rescheduling may result so that *ex-post*, if the information possessed by all lenders was revealed, it could be verified that all lenders had bad news and all lenders decided to reschedule. However, as we have shown, in the same game, if some or all lenders receive the good and precise signal, too much liquidation obtains. Recall, indeed, that rescheduling by an ill informed lender is not always a pure strategy, and randomization may occur: then, because a well informed lender knows that the other can be ill informed and liquidate instead of refinancing a good project, he will also liquidate, avoiding the risk of being last in a liquidation procedure. Therefore, *ex-post*, it may appear that too much or too little liquidation has occurred with respect to the social optimum, according to how the information has been disseminated in the system. Our argument bears some similarity with studies of so-called herding phenomena but, as argued in section 5 above, the similarity is only apparent: in our game the results do not impinge upon a player observing the ations of other players. However, introducing a sequence of observable moves does not change our equilbria, as shown above. An ill informed bank, due to the liquidation isnstitute, knows that its mistake can be corrected by the better informed one, if there is one. This suffices to gamble against the information received. In reality liquidation is a drastic decision only if the creditor rights are highly protected and repossession of the debtor assets is swift and frictionless. Obviously, this is not so in most industrialized countries and maybe even less so in less developed ones. Prevailing codes ensure that the debtor rights are preserved under liquidation, or that debtors can appeal to special protection institutes like Chapter 11 in the U.S., somewhat based on the idea that liquidation of viable firms may occur due to market imperfections. This is clearly not the place to resume the rich debate on the design of optimal creditors' rights protection, liquidation and bankruptcy. We point out, however, that the liquidation value, L, should summarize the expected payment by a lender, given the prevailing legislation and efficiency of legal system. Another instance of players not making use of the information in their possession can be found in Brandenburger and Polak (1996), where firms' managers maximize the value of the firms' share by taking actions that they would take if they had no different information from the market participants. There, managers that take suboptimal choices have superior information. The finance literature also deals with various kinds of inefficient management that tries to please analysts (see for instance Degeorge, Patel and Zeckhauser 1999 and 2005 and the references therein).

Appendix

Proof of proposition 1: From (2) and (7)**,** when ill informed, bank i plays *res* if

$$(1-\theta)\left[\alpha_j(\phi)L + (1-\alpha_j(\phi))\,\overline{X}\right] + \theta\overline{Z} \geq L. \tag{18}$$

Consider first the case where $\theta \geq \widehat{\theta}$ as defined in the proposition. The above condition is then satisfied with $\alpha_j(\phi) = 0$. Moreover, the left-hand side of (18) is increasing in $\alpha_j(\phi)$ because $L > \overline{X}$. Hence, the condition holds for all $\alpha_j(\phi)$, which means that *res* is a dominant strategy **for bank** i. This proves the first part of the proposition. When $\theta < \widehat{\theta}$, condition (18) does not hold if $\alpha_j(\phi) = 0$. The best response to the pure strategy *res* is therefore the pure strategy *liq.* Now, (18) is satisfied as a strict inequality if $\alpha_j(\phi) = 1$ (since $\overline{Z} > L$ and given $\theta > 0$). Thus, *res* is itself the best response to *liq*, proving equilibrium P. From **this last** argument, when $0 < \theta < \widehat{\theta}$, there exists $\alpha_j(\phi) \in (0,1)$ such that (18) holds as an equality. Solving for $\alpha_j(\phi)$ yields (9) and proves equilibrium M. ■

Proof of proposition 2: We first show that $\overline{Y}_P(\theta) \geq \overline{Y}_M(\theta)$ with strict inequality for $\theta \in (0, \widehat{\theta})$, where the expressions are as defined in (13) and (14). From (9), substitute for $\widehat{\alpha} = \alpha(\phi)$ in (14), yielding

$$\overline{Y}_M(\theta) = L + \frac{\theta^2(\overline{Z} - L)(\overline{Z} - \overline{X})}{(L - \overline{X})}.$$

Define

$$h(\theta) \equiv \overline{Y}^e(\widehat{\theta}) - \overline{Y}_I(\theta) = \left[L + \frac{\theta^2(\overline{Z} - L)(\overline{Z} - \overline{X})}{(L - \overline{X})}\right] - \left[(1-\theta)L + \theta\overline{Z}\right].$$

The function $h(\theta)$ is a quadratic, with roots at $\theta = 0$ and $\theta = \widehat{\theta} = (L - \overline{X})/(\overline{Z} - \overline{X})$, and it is strictly convex, hence $h(\theta) < 0$ when $\theta \in (0, \widehat{\theta})$. The optimal α_1 and α_2 maximize $\overline{Y}(\theta)$ in (**??**). Let μ_i be the multiplier associated with the constrant $\alpha_i \leq 1$ and ν_i the multiplier associated with $\alpha_i \geq 0$, $i = 1, 2$. The Lagrangean is

$$\mathcal{L} = \overline{Y}(\theta) + \mu_1(1 - \alpha_1) + \nu_1\alpha_1 + \mu_2(1 - \alpha_2) + \nu_2\alpha_2.$$

The necessary conditions for a maximum are the first-order conditions

$$\partial\mathcal{L}/\partial\alpha_1 = (1-\theta)[(1-\theta)(L-\overline{X})(1-\alpha_2) - \theta(\overline{Z}-L)] - \mu_1 + \nu_1 = 0, \quad (19)$$
$$\partial\mathcal{L}/\partial\alpha_2 = (1-\theta)[(1-\theta)(L-\overline{X})(1-\alpha_1) - \theta(\overline{Z}-L)] - \mu_2 + \nu_2 = 0, \quad (20)$$

together with complentary slackness and non-negativity of the multipliers,

$$\mu_i(1 - \alpha_i) = \nu_i\alpha_i = 0,\ \mu_i \geq 0,\ \nu_i \geq 0,\ i = 1, 2. \quad (21)$$

When $\theta \geq \widehat{\theta}$, $(1-\theta)(L - \overline{X})(1 - \alpha_i) - \theta(\overline{Z} - L) < 0$ for all α_i. Hence, there is onlyone solution to (19), (20) and (21) and it involves $\nu_i > 0$, implying $\alpha_i = 0$, $i = 1, 2$. When $\theta < \widehat{\theta}$, the first term on the right-hand side of

(19) and (20) is zero if $\alpha_1 = \alpha_2 = \alpha(\phi)$, where the latter is as defined in (9). Together with $\mu_i = \nu_i = 0$, $i = 1, 2$, this therefore constitutes one solution to the set of necessary conditions. It corresponds to equilibrium M. Another possibility is the corner solution defined by $\alpha_1 = 1$ and $\alpha_2 = 0$. Since $(1-\theta)(L - \overline{X}) - \theta(\overline{Z} - L) > 0$ for $\theta < \widehat{\theta}$, $\alpha_2 = 0$ in (19) implies $\mu_1 > 0$ and therefore $\alpha_1 = 1$. In (20), $\alpha_1 = 1$ implies $\nu_2 > 0$, hence $\alpha_2 = 0$. The corner solution corresponds to equilibrium P. From the above result, $\theta \in (0, \widehat{\theta})$ implies $\overline{Y}_P(\theta) > \overline{Y}_M(\theta)$. The maximization problem is therefore solved by the corner solution. ■

Proof of proposition 3: When bank 1 chooses *liq*, bank 2 cannot affect the outcome and it is therefore a best response to also choose *liq*, hence $\widehat{\alpha}_2(liq, \cdot) = 1$. Obviously, $\widehat{\alpha}_1(X) = \widehat{\alpha}_2(res, X) = \alpha(X)$, i.e., well informed banks choose the socially efficient action (when their action matters). Thus, we need only discuss $\widehat{\alpha}_1(\phi)$ and $\widehat{\alpha}_2(res, \phi)$. In the simultaneous game (and given that the other bank behaves efficiently when well informed), bank 2 weakly prefers *res* to *liq* if

$$(1-\theta)\left[\alpha_1 L + (1-\alpha_1))\overline{X}\right] + \theta\overline{Z} \geq L, \tag{22}$$

where α_1 is short-hand for $\alpha_1(\phi)$. In the sequential game, after the play of *res* by bank 1, *res* is weakly preferred to *liq* by bank 2 if

$$\frac{\theta(1-F(L))E(X \mid X \geq L) + (1-\theta)(1-\alpha_1)\overline{X}}{\theta(1-F(L)) + (1-\theta)(1-\alpha_1)} \geq L, \tag{23}$$

where α_1 is short-hand for $\widehat{\alpha}_1(\phi)$. The left-hand side is (twice) the expected payoff from playing *res*, given that bank 2 observed ϕ and the play of *res* by bank 1 (the probability of the latter is the numerator of the expression). Now, from (6), substitute for $\overline{Z}$ in (22), which then writes as

$$(1-\theta) \tag{24}$$

It is easily checked that (23) and (24) are in fact equivalent. Thus, $\widehat{\alpha}_1(\phi) = \alpha_1(\phi)$ implies $\widehat{\alpha}_2(res, \phi) = \alpha_2(\phi)$ as best response. We now show the converse. In the sequential game, when ill informed, bank 1 weakly prefers *res* to *liq* if

$$(1-\theta)\left[\alpha_2 L + (1-\alpha_2))\,\overline{X}\right] + \theta\overline{Z} \geq L, \tag{25}$$

where α_2 is short-hand for $\widehat{\alpha}_2(res, \phi)$. The condition is the same in the simultaneous game, but with α_2 short-hand for $\alpha_2(\phi)$. It follows that $\widehat{\alpha}_2(res, \phi) = \alpha_2(\phi)$ implies $\widehat{\alpha}_1(\phi) = \alpha_1(\phi)$, thereby concluding the proof. ■

Proofs of the statements in section 6: We first derive the formula for X'_β in (15). We write $\alpha_\beta = \alpha_\beta(\phi)$ for short. If a well informed bank plays *res* after observing $X \geq X'_\beta$, its expected payoff is $\theta\left(\frac{X}{2}\right) + (1-\theta)\left[\alpha_\beta(1-\beta)L + (1-\alpha_\beta)\frac{X}{2}\right]$, given that the other lender will also play *res* if informed. If the bank plays *liq*, the expected payoff is $(L\beta)\left((1-\theta)(1-\alpha_\beta)+\theta\right)+ \frac{L}{2}(1-\theta)\alpha_\beta$. For X'_β to define a cutoff point, the two payoffs must be equal at $X = X'_\beta$, which leads to (15).

To prove (16), set $\alpha_\beta = 0$ in (15) so that $X'_\beta = 2\beta L$. If it plays *res,* an ill informed bank gets

$$u(res, \alpha \,|\, \phi) =$$
$$\theta\left\{(1-F(2\beta L))\,\frac{E(X \mid X \geq 2\beta L)}{2} + F(2\beta L)(1-\beta)L\right\} + (1-\theta)\frac{\overline{X}}{2}.$$

If it plays *liq*, the expected payoff is

$$u(liq, \alpha \,|\, \phi) = \theta\left\{(1-F(2\beta L))\,\beta L + F(2\beta L)\frac{L}{2}\right\} + (1-\theta)\beta L.$$

One easily checks that $u(res, \alpha \,|\, \phi) \geq u(liq, \alpha \,|\, \phi)$ is equivalent to $\theta \geq \widehat{\theta}_\beta$ as defined in (16). Note that $\widehat{\theta}_\beta < 1$ only if β is not too large, which is implicitly assumed here.

To prove (17), assume $\theta < \widehat{\theta}_\beta$ and write π for the belief that an ill informed bank assigns to the event that the other lender plays *res*. At equilibrium, $\pi = \theta(1-F(X'_\beta)) + (1-\theta)(1-\alpha_\beta)$. For an ill informed bank, the payoff from *liq* is therefore

$$\pi\,(\beta L) + (1-\pi)\frac{L}{2}.$$

The payoff from *res* is

$$\pi\left(\frac{\theta(1-F(X'_\beta))}{\pi}\frac{E(X\mid X\geq X'_\beta)}{2}+\frac{(1-\theta)(1-\alpha_\beta)}{\pi}\frac{\bar{X}}{2}\right)+(1-\pi)(1-\beta)L.$$

Substituting for π and setting the two payoffs equal to one another leads to (17). Note that the equality is consistent with $\alpha_\beta(\phi)<1$ only if θ is not too small.

Finally, we prove that $\alpha_\beta(\phi)>\alpha(\phi)$, where the latter is as defined in proposition 1. From (15) and (17), $X'_\beta=L$ and $\alpha_\beta(\phi)=\alpha(\phi)$ when $\beta=1/2$. Now, from (17), $\alpha_\beta(\phi)$ is increasing in β. It is also increasing in X'_β since

$$\frac{\partial\alpha_\beta(\phi)}{\partial X'_\beta}=\frac{f(X'_\beta)\left(X'_\beta-L\right)}{(1-\theta)(L-\overline{X})}$$

and $X'_\beta>L$ when $\beta>1/2$. The two results together imply $\alpha_\beta(\phi)>\alpha(\phi)$ as claimed.

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