I. Financial Distress and Banks' Communication Policy in Crisis Times

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Abstract

This paper analyzes banks' communication policies in crisis times and the role of imperfect information in enhancing banks' financial distress. If banks differ in their exposure to dubious assets, fragile banks may claim to be sound only in order to manipulate investors' expectations. Then sound banks must pay a larger interest rate than in a perfect information set-up. A stronger sanction for false information would improve the situation of the low-risk banks but would deteriorate the situation of the high-risk banks. The total effect on the economy-wide frequency of default of credit institutions is ambiguous. It can be shown that, in some cases, the optimal sanction is lower than the sanction that rules out any manipulatory behavior.

Keywords: financial distress, financial crisis, banks, disclosure, transparency

JEL Classification: E44, G21, D82

1. Introduction

One major factor of uncertainty during the 2007-2009 financial crisis was the exposure of banks' balance sheets to hard-to-value assets such as Mortgage Backed Securities (MBSs) or Collateral Debt Obligations (CDOs) originated by US mortgage and financial institutions heavily involved in subprime lending.[1] Although these "toxic securities" were in general *made in USA*, many European banks appeared to have massively invested in such assets.

In general, banks and financial institutions perpetrate a tradition of opacity (Morgan, 2002). In particular, during the last crisis, they were extremely reluctant to disclose their true exposure to these hard-to-value assets such as the CDOs. For instance, in November 2007 the French bank *Société Générale* declared to have little exposure to

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[1] January 2007 marked the sharp increase in delinquency rates on sub-prime loans (Borio, 2008).

high-risk US MBSs and CDOs; yet in January 2008 they wrote down as much as 1.2 billion euros related to such investment (WSJ, 22.01.08), and another 2.6 billions euros in May 2008 (WSJ, 14.05.08). At *Bearn Sterns*, the CEO declared two weeks before the bank's collapse that "we don't see any pressure on our liquidity, let alone a liquidity crisis" (WSJ, 19.03.07). On September 10, 2008, one day after the executive of *Lehman Brothers* calculated that the firm needs at least 3 billion US dollars in fresh capital, they assured investors on a conference call that the bank needed no capital at all (WSJ, 07.10.08). Such a lack of transparency brought about a generalized shortage of trust that can be measured, for instance, by the wedge between interest rates in the unsecured interbank credit market and the secured central bank short-term lending. This indicator reached a peak of two percentage points in the aftermath of *Lehman Brothers*' collapse (September 2008), to slide down in early 2009.

Quite recently (April 2009), policymakers all around the world tried to figure out what regulation could help avoiding the next financial crisis. Many reform proposals build on the widely held belief according to which "honesty is the best policy"; in particular, many policymakers argue that more transparency could only improve the functioning of the financial sector and its resilience to shocks. For instance, Jean-Claude Trichet, the ECB President, declared in October 2007:

> "In any case, we need more transparency. The illustration that what we have in front of our eyes as regards the functioning of commercial papers, asset-backed commercial papers in particular, is clearly that we presently pay a high price for the lack of transparency. And the same in the interbank money market, as I said".[2]

When leaders of developed or big emerging economies met in London on April 2, 2009 for a G-20 Summit aiming at reforming the financial system such as to avoid further similar crises, enhancing transparency turned out as a key recommendation.[3]

During the 2007-2009 crisis, policymakers also brought direct support to commercial banks by pushing down the cost of their short-term borrowing form the central bank. In the US, the Fed slashed the target rate from 5.25% to almost zero between August 2007 and January 2008; it also agreed on lending money against a wider range of collateral, including investment-grade MBS. The ECB begun to cut down the main interest rate in October 15, 2008, in a coordinated move with the other major central banks, bringing it down from 4.25% to 1.5 % in March 2009.

This paper aims at analyzing the impact of imperfect information on the risk of bank default in crisis times, as well as banks' communication strategy during a financial crisis. In the model, there are two types of banks that differ in their exposure to dubious assets. Private investors, called to lend to short-term funds to banks during the crisis, are assumed to have only imperfect information about the true exposure of a given bank. Bank managers can send either honest or misleading signals. In particular, the manager of a fragile bank (i.e., with high exposure to risky assets) may

[2] Jean-Claude Trichet, "ECB Introductory statement swith Q&A", 10.09.2007, http://www.ecb.int/ press/ pressconf/ 2007 / html/ is070906.en.html.

[3] See www.g20.org for main working documents and the final declaration.

want to claim that their exposure is small, in order to benefit of better financing terms until "the storm is over". If generalized, this strategy is harmful for solid banks that have no means to signal themselves and must borrow at a higher interest rate than in a perfect information set-up. The model builds on our early analysis of communication policy as pertaining to the corporate sector (Besancenot and Vranceanu, 2009), yet the banking sector model features additional complexity due to non-linear relationships.

An increase in the sanction for dishonest communication comes with two antagonistic effects: on the one hand, since there are fewer liars in the economy, the interest rate required by investors to finance low risk institutions should decline and their frequency of defaults should diminish. On the other hand, managers who honestly announce that their bank has a high exposure to risky assets will have to pay a larger interest rate, and their frequency of defaults should increase. The theoretical analysis points out that the two effects tend to offset each other. We perform several numerical simulations in order to find out which is the dominant one. It turns out that in some cases the sanction that drives to zero the number of dishonest managers can be socially inefficient: a lower sanction would bring about a smaller number of bank defaults. In a related paper, Cordella and Yeyati (1996) have shown that if banks have no complete control over their risk exposure, the presence of uniformed investors may reduce the risk of bank failures. The model can also show the impact on defaults of a reduction in the interest rate on borrowed funds from the central bank.

A substantial literature on corporate financial distress has emphasized that the image clients and suppliers have about a company plays an important role in determining its actual financial stance. More precisely, if creditors start having doubts about the financial position of a company, they may ask for a higher risk premium, which represents an indirect cost for the firm (e.g., Altman, 1984; Wruck, 1990; Andrade and Kaplan, 1998). To avoid this additional strain, in difficult times the manager may well communicate on better than actual performances only to get more favorable contracting terms and push down these indirect costs. Our analysis can also be connected to traditional studies in the financial market micro-structure where accounting information is shown to have a bearing on a firm valuation (e.g., Diamond and Verrecchia, 1991; Baiman and Verrecchia, 1996; Bushman *et al*., 1996). The specific nature of information asymmetries and regulation of the banking sector were analyzed by Aghion, Bolton and Fries (1998), or Freixas and Jorgé (2007).

Inter alia, the going financial crisis has put an end to the myth of risk-sharing through widespread recourse to securitization. It turned out that securitization actually increased the risk of contagion and shock propagation between interconnected players, which, in turn, brought about a dramatic risk of systemic failure of the financial system (Brunnermeier, 2009). It is beyond the scope of this paper to address this extremely important question; for sure, in presence of mechanisms of transmitting shocks from one bank to another, additional strain on every individual bank – such as described in our paper – would amplify the systemic risk.[4]

[4] See for instance the classical paper by Rochet and Tirole (1996) on bank systemic risk originated in interbank lending.

The paper is organized as following. The next section introduces the main assumptions. The section 3 presents the equilibrium of the model. We work out several numerical simulations in section 4. The last section presents the conclusion.

2. The main assumptions

We recall that the model is developed to analyze banks' disclosure decisions once that the crisis is unwinding. The composition of the assets portfolio is given, the banker cannot "get rid" of the high risk securities. The proportion of central bank funding is also determined by the central bank (CB). The model is cast as a game between investors – who must lend money to a financial institution, and the manager of the latter, who decides on the communication policy with the aim at maximizing the survival chances of his company. There are two types of financial institutions. The *H*-type institution has a high exposure to risky assets; the *L*-type has a low exposure. Let *q* be the frequency of *L*-type, low-risk banks in total population of banks.

Investors know the distribution of types, but do not know the type of each institution. The manager knows the true exposure of his institution and must issue a signal before he raises funds.

More in detail, the balance sheet of a typical financial institution has the simplified form:

Table 1

Simplified balance sheet of a commercial bank

Assets	Liabilities
$1-\alpha^j$, Risk-free assets, bearing interest R_b	$1-\beta$, Central Bank funds, bearing interest k
α^j, Risky assets, bearing interest ρ	β, Private funds, bearing interest i^a

The total market value of the bank is normalized to one. Then α^j can be interpreted as the proportion of risky assets in total assets, $1-\alpha^j$ being the proportion of risk-free assets. Banks of *H*-type have a proportion of risky assets α^H, banks of *L*-type have a proportion α^L, with $\alpha^H > \alpha^L$. Let R_b be the interest rate on the risk-free assets of the bank, and let ρ be the interest rate on risky assets.

On the liabilities side, $1-\beta$ is the proportion of funds borrowed from the central bank at a pre-determined interest rate k and β is the proportion of funds that the institution must raise in the private market at a market-determined interest rate i^a. Private debt is subordinated to central bank debt.

The interest rate on private funds depends on the investors beliefs about the type of the bank, and these beliefs depend on the manager's announcement a. More precisely, the manager can state that the bank has a high exposure to risk, so the announcement is a=*h* or a low exposure, that is a=*l*.

At the end of the game, a proportion τ of the risky assets will default (completely, their residual value is zero). The proportion τ is a random variable on the support $[0,1]$; the p.d.f. is denoted by $f(\tau)$ and the c.d.f. will be denoted by $F(\tau)$.

The **sequence of decisions** is the following:

- At time t=1, Nature chooses the type of bank $j \in \{L, H\}$ with α^j the share of risky assets in total assets.
- At time t=2, the bank's manager announces the type of the bank, $a \in \{l, h\}$. He is honest if $a = j$, and dishonest if $a \neq j$.
- At time t=3, given a, investors ask an interest rate i^a to lend money to the bank (short term).
- At time t=4, the shock τ is realized, and, depending on its true exposure α^j and its liabilities, the bank defaults or not. In the case of default, the liar must pay a fine θ . The game is over.

The default condition

A bank of type j defaults when the shock τ is realized if, given the announcement a (and thus i^a), its liabilities exceed its assets. This can happen if the proportion of default on risky assets exceeds a critical threshold $\hat{\tau}^{ja}$. More precisely, we can write that default occurs if:

$$(1-\alpha^j)(1+R_b)+\alpha^j(1-\tau)(1+\rho) < \beta(1+i^a)+(1-\beta)(1+k)$$
$$\Leftrightarrow \tau > \hat{\tau}^{ja} \equiv \frac{\alpha^j(\rho - R_b) + \left[R_b - \beta i^a - (1-\beta)k\right]}{\alpha^j(1+\rho)}. \tag{1}$$

We notice that default can happen only if $\hat{\tau}^{ja} < 1$, which is tantamount to $\left[R_b - \beta i^a - (1-\beta)k\right] < \alpha^j(1+R_b) \Leftrightarrow \alpha^j > \frac{R_b - \beta i^a - (1-\beta)k}{(1+R_b)}$.

A negative term $\frac{R_b - \beta i^a - (1-\beta)k}{(1+R_b)}$ is not a realistic assumption. Indeed, in such a case, “very sound” banks that have no exposure to risky assets (α^L=0) would be in a situation of default just because the interest rate they have to pay to private investors (i^j) is too big. In equilibrium, only high-risk banks would participate to the market (adverse selection), and the problem would become trivial.

Therefore in the following we focus on situations where the term $\frac{R_b - \beta i^a - (1-\beta)k}{(1+R_b)}$ is strictly positive, $\forall a \in \{l,h\}$. This requires that i^a should be relatively small (in turn, this is possible if the interest rate on risk-free assets available to private investors is relatively small).

In this case, if we write $\hat{\tau}^{ja}(\alpha^j) = \frac{(\rho - R_b)}{(1+\rho)} + \frac{\left[R_b - \beta i^a - (1-\beta)k\right]}{\alpha^j (1+\rho)}$, this is a decreasing function in α^j, $\frac{\partial \hat{\tau}^{ja}(\alpha^j)}{\partial \alpha^j} = -\frac{\left[R_b - \beta i^a - (1-\beta)k\right]}{\left(\alpha^j\right)^2 (1+\rho)} < 0$. We also notice that $\frac{(\rho - R_b)}{(1+\rho)} < 1$.

The default probability of a bank can be written as:

$$Pr[\tau > \hat{\tau}^{ja}] = 1 - F(\hat{\tau}^{ja}). \tag{2}$$

This probability of default increases with α^j : $\frac{d\,Pr[\tau > \hat{\tau}^{ja}]}{d\alpha^j} = -f(\hat{\tau}^{ja})\left(\frac{\partial \hat{\tau}^{ja}}{\partial \alpha^j}\right) > 0.$

In case of the bank's default, investors, who have invested the amount β, get the residual value $(1-\alpha^j)(1+R_b) + \alpha^j(1-\tau)(1+\rho) - (1-\beta)(1+k)$. If the bank does not default, investors get $\beta(1+i^a)$.

If the bank defaults ($\tau > \hat{\tau}^{ja}$), the profit is zero; if the bank does not default ($\tau \le \hat{\tau}^{ja}$), it makes a profit that depends on the actual τ:

$$\Pi(\tau \mid j,a) = \left[(1-\alpha^j)(1+R_b) + \alpha^j(1-\tau)(1+\rho)\right] - \left[\beta(1+i^a) + (1-\beta)(1+k)\right].$$

Hence the bank's expected profit is thus $\int_0^{\hat{\tau}^{ja}} \Pi(\tau \mid j,a)\,dF(\tau)$.

The managers' payoff. Managers are assumed to be risk-neutral. To keep the model as simple as possible, we will assume that the manager aims at maximizing chances that his company survives during a temporary crisis; more specifically, the payoff of a manager of a *j*-type bank who announces a is proportional to the survival probability $\Pr[\tau < \hat{\tau}^{ja}]$.[5] In addition, if the company defaults and the manger has issued a false signal, he will bear a fine θ.

We thus write the manager's payoff as:

$$Z(a \mid j) = Pr[\tau < \hat{\tau}^{ja}] - \mathbf{1}_{j \ne a}\, Pr[\tau > \hat{\tau}^{ja}]\theta. \tag{3}$$

where the factor $\mathbf{1}_{j \ne a}$ takes the value 0 if $j = a$ and 1 if $j \ne a$.

3. Equilibrium of the game

A Nash equilibrium of this game is a situation where managers chose the optimal communication policy given investors' beliefs, and investors beliefs are correct given managers' optimal policies.

3.1 The bank manager's strategy and investors' beliefs

A bank manager's strategy is defined as the optimal announcement conditional upon

[5] Many senior executives, in general at the head of the fixed-income branches, loose their jobs during the 2007-2009 crisis. After *Citigroup* reported a huge loss in the third quarter of 2008, its CEO had to resign and so did the CEO of *Merrill Lynch*.

his type. Formally, it can be represented by a function a=a(j), with $j \in \{L,H\}$. In this particular game, the manager's strategy is written as:

$$a(j) = \begin{cases} l, & \text{for } j = L \\ \mu l + (1-\mu)h, \text{ with } \mu \in [0,1], & \text{for } j = H \end{cases}. \quad (4)$$

where μ is the probability that a liar is running a H-type bank (he thus announces l).

Notice that a manager at the head of a low-risk bank has no incentive to claim that the bank has a high exposure to risky assets, if else he must pay a bigger interest rate to private investors and chances that his firm defaults increase. They will always tell the truth $(a = l)$. To the contrary, managers at the head of H-type banks might claim that their bank is of the L-type $(a = l)$ in order to manipulate investors' expectations and benefit from a lower interest rate. Thus, they can push down the risk of default, but have to bear a larger expected fine if caught. There can also be managers running H-type banks that honestly announce their type, $(a = h)$.

Given the managerial strategy, investors' beliefs can be represented by the probability of the manager announcing l contingent upon the type of the bank:

$$\Theta = \begin{cases} Pr[l \mid H] = \mu, \text{ where } \mu \in [0,1] \\ Pr[l \mid L] = 1 \end{cases}, \quad (5)$$

It can be shown that this game presents a *separating equilibrium* where each type of bank has a specific communication policy, more precisely $a(L) = l$ and $a(H) = h$, a *pooling equilibrium* where all banks adopt the same communication policy, more precisely $a(j) = l, \forall j$ and a *hybrid equilibrium* where a fraction μ of the managers at the head of H-type banks announce l (lie) and the rest of them announce h (are honest); managers of the L-type banks always announce l. In the following, we will focus on this hybrid equilibrium ($\mu \in]0,1[$), given that the pooling and the separating situations appear to be special cases that correspond to $\mu = 1$ and respectively $\mu = 0$.

3.2. Interest rates

Private investors are risk neutral. They have access to risk-free assets bearing an interest R . We assume that in a world with trade frictions banks have better risk-free opportunities than private agents, so $R < R_b$.

a)If the manager announces $a = h,$ then the bank must be H . With risk neutral investors, the interest rate i^h is implicitly defined by the zero trade-off condition:

$$\beta(1+R) = \begin{cases} \beta(1+i^h), \text{if } \tau \le \hat{\tau}^{Hh} \\ (1-\alpha^H)(1+R_b) + \alpha^H(1-\tau)(1+\rho) - (1-\beta)(1+k), \text{if } \tau > \hat{\tau}^{Hh} \end{cases} \quad (6)$$

which is equivalent to:

$$1+R=(1+i^{h})\int_0^{\hat{\tau}^{Hh}} dF(\tau)+\beta^{-1}\begin{bmatrix}(1-\alpha^{H})(1+R_b)-\\(1-\beta)(1+k)\end{bmatrix}\int_{\hat{\tau}^{Hh}}^{1} dF(\tau)+ \\ +\beta^{-1}\alpha^{H}(1+\rho)\int_{\hat{\tau}^{Hh}}^{1}(1-\tau)dF(\tau), \tag{7}$$

where, according to equation (1),

$$\hat{\tau}^{Hh}=\frac{\alpha^{H}(\rho-R_b)+\lfloor R_b-\beta i^{h}-(1-\beta)k\rfloor}{\alpha^{H}(1+\rho)}. \tag{8}$$

We notice that for a given c.d.f. $F()$, Eq.(7) can be solved for i^{h}. The latter is independent of θ ; it depends on k.

b) If the manager announces $a=l$, the bank can be either H with $Pr[H\mid l]$ or L with $Pr[L\mid l]=1-Pr[H\mid l]$. The interest rate i^{l} is implicitly defined by the zero trade-off condition:

$$\beta(1+R)=\begin{cases}\text{with } Pr[H\mid l]\begin{cases}\beta(1+i^{l}), \text{if } \tau\le\hat{\tau}^{Hl}\\(1-\alpha^{H})(1+R_b)+\alpha^{H}(1-\tau)(1+\rho)-(1-\beta)(1+k), \text{if } \tau>\hat{\tau}^{Hl}\end{cases}\\ \text{with } Pr[L\mid l]\begin{cases}\beta(1+i^{l}), \text{if } \tau\le\hat{\tau}^{Ll}\\(1-\alpha^{L})(1+R_b)+\alpha^{L}(1-\tau)(1+\rho)-(1-\beta)(1+k), \text{if } \tau>\hat{\tau}^{Ll}\end{cases}\end{cases} \tag{9.}$$

which, with additional notation $S^{H}=\lfloor(1-\alpha^{H})(1+R_b)-(1-\beta)(1+k)\rfloor$ and $S^{L}=\lfloor(1-\alpha^{L})(1+R_b)-(1-\beta)(1+k)\rfloor$ is equivalent to:

$$1+R=Pr[H\mid l]\left\{(1+i^{l})\int_0^{\hat{\tau}^{Hl}} dF(\tau)+\beta^{-1}S^{H}\int_{\hat{\tau}^{Hl}}^{1} dF(\tau)+\beta^{-1}\alpha^{H}(1+\rho)\int_{\hat{\tau}^{Hl}}^{1}(1-\tau)dF(\tau)\right\}+ \\ +Pr[L\mid l]\left\{(1+i^{l})\int_0^{\hat{\tau}^{Ll}} dF(\tau)+\beta^{-1}S^{L}\int_{\hat{\tau}^{Ll}}^{1} dF(\tau)+\beta^{-1}\alpha^{L}(1+\rho)\int_{\hat{\tau}^{Ll}}^{1}(1-\tau)dF(\tau)\right\}, \tag{10}$$

with:

$$\hat{\tau}^{Hl}=\frac{\alpha^{H}(\rho-R_b)+\lfloor R_b-\beta i^{l}-(1-\beta)k\rfloor}{\alpha^{H}(1+\rho)}, \tag{11}$$

and

$$\hat{\tau}^{Ll}=\frac{\alpha^{L}(\rho-R_b)+\lfloor R_b-\beta i^{l}-(1-\beta)k\rfloor}{\alpha^{L}(1+\rho)}. \tag{12}$$

We notice that for a given c.d.f. $F()$, the former equation becomes a relationship between the interest rate i^{l} and $Pr[H\mid l]$, that is: $\Phi(i^{l},Pr[H\mid l])=C$.

3.3. The indifference condition

As already mentioned, we assume that the managers' payoff is proportional to chances that the bank survives, and there is a sanction θ for liars when their bank defaults. So, for an honest manager, we have:

$$Z(h \mid H) = Pr[\tau < \hat{\tau}^{hH}] \quad (13)$$

and for a liar:

$$Z(l \mid H) = Pr[\tau < \hat{\tau}^{lH}] - \theta Pr[\tau > \hat{\tau}^{lH}]. \quad (14)$$

The **indifference condition** $Z(h \mid H) = Z(l \mid H)$ allows us to determine the interest rate i^l for which the manager is indifferent between policies h or l.

$$\begin{aligned}
&Z(h \mid H) = Z(l \mid H) \\
&Pr[\tau < \hat{\tau}^{Hh}] = Pr[\tau < \hat{\tau}^{Hl}] - \theta Pr[\tau > \hat{\tau}^{Hl}] \\
&F(\hat{\tau}^{Hh}) = F(\hat{\tau}^{Hl}) - \theta\left[1 - F(\hat{\tau}^{Hl})\right] \\
&F(\hat{\tau}^{Hl}) - F(\hat{\tau}^{Hh}) = \theta\left[1 - F(\hat{\tau}^{Hl})\right] \quad (15)
\end{aligned}$$

As $\hat{\tau}^{Hl} = \hat{\tau}^{Hl}(i^l)$ and $\hat{\tau}^{Hh} = \hat{\tau}^{Hh}(i^h)$, the last equation determines i^l with respect to i^h.

It can be shown that $i^l < i^h$. For so doing, we assume that $i^l > i^h$. Then $\hat{\tau}^{Hl} < \hat{\tau}^{Hh}$, and $F(\hat{\tau}^{Hl}) < F(\hat{\tau}^{Hh})$. We have $F(\hat{\tau}^{Hl}) - F(\hat{\tau}^{Hh}) < 0$, while $\theta\left[1 - F(\hat{\tau}^{Hl})\right] > 0$, which is false. The opposite is true: $i^l < i^h$ and, also $F(\hat{\tau}^{Hl}) > F(\hat{\tau}^{Hh})$.

The direct consequence is that the *H*-type bank has an incentive to claim that it is of *L*-type in order to benefit of the more advantageous borrowing terms.

We can show now that, in the hybrid equilibrium, an increase in the sanction pushes down the interest rate of the banks that announce l, that is $di^l / d\theta < 0$.

For so doing, we recall that i^h is independent on i^l, thus $\frac{\partial \hat{\tau}^{Hh}}{\partial i^l} = 0$. We also know that $\hat{\tau}^{Hl} = \frac{\alpha^H(\rho - R_b) + \left[R_b - \beta i^l - (1-\beta)k\right]}{\alpha^H(1+\rho)}$; hence, $\frac{\partial \hat{\tau}^{Hl}}{\partial i^l} = -\frac{\beta}{\alpha^H(1+\rho)} < 0$.

The total differentiation of the indifference condition (Eq. 15) allows us to determine the co-movements between the equilibrium i^l and the sanction θ:

$$0 = f(\hat{\tau}^{Hl})\frac{\partial \hat{\tau}^{Hl}}{\partial i^l} di^l - d\theta\left[1 - F(\hat{\tau}^{Hl})\right] + \theta f(\hat{\tau}^{Hl})\frac{\partial \hat{\tau}^{Hl}}{\partial i^l} di^l$$

$$\Leftrightarrow d\theta\left[1 - F(\hat{\tau}^{Hl})\right] = (1+\theta)\frac{\partial \hat{\tau}^{Hl}}{\partial i^l} f(\hat{\tau}^{Hl}) di^l$$

$$\Leftrightarrow \frac{di^l}{d\theta} = \frac{1 - F(\hat{\tau}^{Hl})}{f(\hat{\tau}^{Hl})(1+\theta)} \frac{1}{\partial \hat{\tau}^{Hl} / \partial i^l} = -\frac{1 - F(\hat{\tau}^{Hl})}{f(\hat{\tau}^{Hl})} \frac{\alpha^H(1+\rho)}{\beta(1+\theta)} < 0$$

In turn, as $d\hat{\tau}^{jl} / di^{l} < 0,$ we get $d\hat{\tau}^{jl} / d\theta > 0$: when the sanction increases, the probability of default decreases for all banks that announced l.

$$\frac{d\hat{\tau}^{jl}}{d\theta} = \frac{\partial\hat{\tau}^{jl}}{\partial i^{l}} \frac{di^{l}}{d\theta} = \frac{\beta}{\alpha^{j}(1+\rho)} \left[\frac{1-F(\hat{\tau}^{Hl})}{f(\hat{\tau}^{Hl})} \frac{\alpha^{H}(1+\rho)}{\beta(1+\theta)} \right] = \left(\frac{\alpha^{H}}{\alpha^{j}} \right) \frac{1-F(\hat{\tau}^{Hl})}{(1+\theta)f(\hat{\tau}^{Hl})} > 0$$

For instance, with a uniform p.d.f. where $\tau \in [0,1]$, the condition $Z(h \mid H) = Z(l \mid H)$ implies:

$$\frac{\alpha^{H}(\rho - R_b) + \left[R_b - \beta i^{h} - (1-\beta)k\right]}{\alpha^{H}(1+\rho)} = \frac{\alpha^{H}(\rho - R_b) + \left[R_b - \beta i^{l} - (1-\beta)k\right]}{\alpha^{H}(1+\rho)}$$
$$-\theta\left[1 - \frac{\alpha^{H}(\rho - R_b) + \left[R_b - \beta i^{l} - (1-\beta)k\right]}{\alpha^{H}(1+\rho)}\right]$$
$$\Leftrightarrow i^{l} = i^{h} - \theta\beta^{-1}\left\{\alpha^{H}(1+R_b) + \left[R_b - \beta i^{l} - (1-\beta)k\right]\right\}$$

with $i^{l} < i^{h}$ and $di^{l} / d\theta < 0$:

$$\frac{di^{l}}{d\theta} = -\beta^{-1}\left\{\alpha^{H}(1+R_b) + \left[R_b - \beta i^{l} - (1-\beta)k\right]\right\} < 0. \tag{17}$$

3.4. Solution and policy implications

We have obtained a system of three equations (Eq. (7), Eq. (10), Eq. (15)) and three unknowns: i^{h}, i^{l} and $Pr[H \mid l]$. To solve the model, we remark that the no trade-of condition when the bank announces *h* (Eq. 7) allows us to determine i^{h} and the indifference condition (Eq.15) allows us to determine i^{l} as a function of the various exogenous variables and i^{h}. Then, for a given i^{l} and i^{h}, the no trade-off condition Eq. (10) determines the probability $Pr[H \mid l]$.

Once that we obtain $Pr[H \mid l]$, we can determine μ, the frequency of liars. Indeed, according to Bayes rule we know that:

$$Pr[H \mid l] = \frac{Pr[l \mid H]\, Pr[H]}{Pr[l \mid H]\, Pr[H] + Pr[l \mid L]\, Pr[L]} = \frac{\mu(1-q)}{\mu(1-q)+q}. \tag{18}$$

So:

$$\mu = \frac{q\, Pr[H \mid l]}{(1-q)(1-Pr[H \mid l])}. \tag{19}$$

In the corner situations $\mu = 1$ ($\mu = 0$), the pooling (respectively separating) equilibrium prevails; if $\mu \in]0,1[$, managers running high risk banks play a mixed strategy, the hybrid equilibrium prevails.

In order to study the consequences of various policies we need an aggregate objective for the government. One main policy objective of many governments during the 2007-2009 financial turmoil was to prevent banks from massive default. Indeed, several banks in the UK (*Northern Rock*), Germany (*IKW*, *Hypo Real Estate*), Belgium

(*Dexia*), or the United States (*Citigroup*) were actually saved from bankruptcy through massive inflows of public money. It seems thus reasonable to consider that during this crisis the frequency of defaulting banks is a good proxy for of the governments' payoff function.

Our model allows to analyze how the overall frequency of defaults varies when policymakers change either the sanction for liars (transparency) θ or the cost of borrowed resource k. Policies aiming at directly reducing the risk of home owner default might also be analyzed as a leftward shift of the distribution $f(\tau)$.[6]

Let us denote by V *the frequency of defaulting banks in the total population of banks* (since the number of bank has been normalized to one, the frequency and the number of defaults is equivalent). The set of defaulting banks include defaults of L-banks and defaults of H-banks, knowing that a proportion μ of the latter have declared that they are of the L-type. Formally, the expression of V is:

$$\begin{aligned} V &= q\,Pr[\tau > \hat{\tau}^{Ll}] + (1-q)\left\{\mu\,Pr[\tau > \hat{\tau}^{Hl}] + (1-\mu)Pr[\tau > \hat{\tau}^{Hh}]\right\} \\ &= q[1-F(\hat{\tau}^{Ll})] + (1-q)\left\{\mu[1-F(\hat{\tau}^{Hl})] + (1-\mu)[1-F(\hat{\tau}^{Hh})]\right\} \end{aligned} \tag{20}$$

- Variations in k (the borrowing cost).

We can now study the impact on V of variations in k.

$$\begin{aligned} \frac{dV}{dk} &= -qf(\hat{\tau}^{Ll})\frac{d\hat{\tau}^{Ll}}{dk} + (1-q)\left\{\frac{d\mu}{dk}[1-F(\hat{\tau}^{Hl})] - \mu f(\hat{\tau}^{Hl})\frac{d\hat{\tau}^{Hl}}{dk} - \frac{d\mu}{dk}[1-F(\hat{\tau}^{Hh})] - (1-\mu)f(\hat{\tau}^{Hh})\frac{d\hat{\tau}^{Hh}}{dk}\right\} = \\ &= -qf(\hat{\tau}^{Ll})\frac{d\hat{\tau}^{Ll}}{dk} + (1-q)\left\{\frac{d\mu}{dk}[F(\hat{\tau}^{Hh}) - F(\hat{\tau}^{Hl})] - \mu f(\hat{\tau}^{Hl})\frac{d\hat{\tau}^{Hl}}{dk} - (1-\mu)f(\hat{\tau}^{Hh})\frac{d\hat{\tau}^{Hh}}{dk}\right\} \end{aligned} \tag{21}$$

with $F(\hat{\tau}^{Hh}) - F(\hat{\tau}^{Hl}) < 0.$ When the cost of borrowing from the central bank increases, the interest rate i^l increases too. We have therefore $\frac{d\hat{\tau}^{Ll}}{dk} < 0$ and $\frac{d\hat{\tau}^{Hl}}{dk} < 0$, the risk of default increases for both banks. If $\frac{d\mu}{dk} > 0,$ the outcome is $\frac{dV}{dk} > 0.$

- Variations in θ (the sanction level).

If the sanction θ goes up, more managers at the head of *H*-type banks honestly state that their bank is h; they are charged the large interest rate i^h and their chances of default increase sharply. On the other hand, if there are less liars, the value of the signal l improves, and the interest rate i^l goes down; managers who announce l have better chances to survive (all the *L* banks and the remaining liars *H*). Since the two effects tend to offset each others, the overall effect is ambiguous.

[6] In December 2007 the Bush Administration worked out an emergency plan aiming to switch subprime borrowers to more sustainable loans. Similar measures were adopted by the Obama Administration in January 2009.

$$\begin{aligned}\frac{dV}{d\theta} &= -qf(\hat{\tau}^{Ll})\frac{d\hat{\tau}^{Ll}}{d\theta} + (1-q)\left\{\frac{d\mu}{d\theta}[1-F(\hat{\tau}^{Hl})] - \mu f(\hat{\tau}^{Hl})\frac{d\hat{\tau}^{Hl}}{d\theta} - \frac{d\mu}{d\theta}[1-F(\hat{\tau}^{Hh})]\right\} \\ &= -qf(\hat{\tau}^{Ll})\frac{d\hat{\tau}^{Ll}}{d\theta} + (1-q)\left\{\frac{d\mu}{d\theta}[F(\hat{\tau}^{Hh}) - F(\hat{\tau}^{Hl})] - \mu f(\hat{\tau}^{Hl})\frac{d\hat{\tau}^{Hl}}{d\theta}\right\}\end{aligned} \quad (22)$$

with $F(\hat{\tau}^{Hh}) - F(\hat{\tau}^{Hl}) < 0,\quad \frac{d\hat{\tau}^{Ll}}{d\theta} > 0,\quad \frac{d\hat{\tau}^{Hh}}{d\theta} > 0$ and $\frac{d\mu}{d\theta} < 0.$

From a policy point a view, the former result is interesting insofar as is shows that, depending on the strength of the two effects, transparency can bring about more or less defaults. More intuition about this result can be provided by means of a numerical simulation.

4. The numerical simulation

The model can be solved numerically for a specific p.d.f. $f(\tau)$. We choose a uniform distribution on the interval $[0,\ 1/3]$. With this upper bound, no more than 1/3 of the risky assets of a bank can default. The other parameters are: interest rates $R = 0.02$, $R_b = 0.05$, $k = 0.04$, $\delta = 0.15$; the proportion of central bank funding, $(1-\beta) = 0.05$; the proportions of risky assets, $\alpha^H = 0.25$, $\alpha^L = 0.10$; and the frequency of highly exposed banks $q = 1/3$. We allow the sanction to vary between $\theta = [0.035, 0.046]$ with a step of 0.001.[7]

We obtain $i^h = 0.04085$. As expected, when the sanction increases, the low interest rate i^l and the frequency of liars μ both decline. Recall that for $\mu = 0$ the separating equilibrium is reached, there are no more liars.

[7]The Maple program used to solve this problem can be provided on request.

Figure 1

The low interest rate i^l with respect to the sanction θ

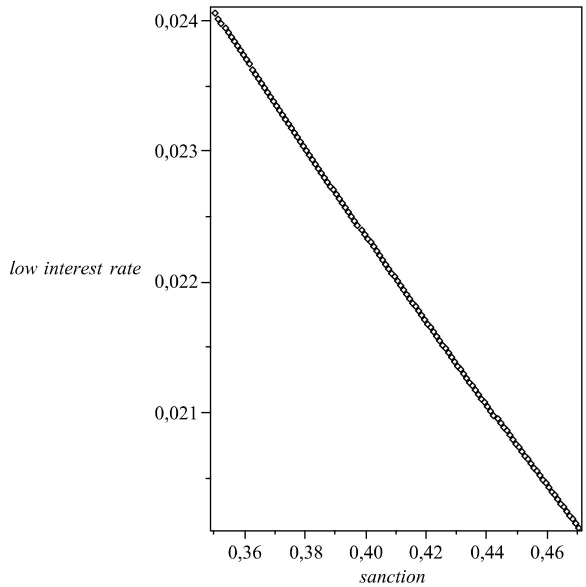


Figure 2

The frequency of liars q with respect to the sanction θ

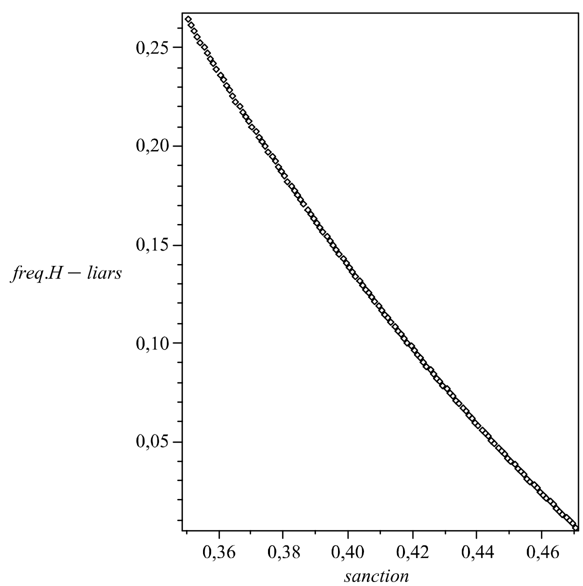


Figure 3 shows the impact of a rising sanction on the overall frequency of defaults. In a first step, a higher sanction brings about a reduction in the frequency of defaults. The positive effect that comes with an improvement in the value of the l signal and the lower i^l offsets the increasing frequency of banks which declare to be of the $H-$type (and are thus subject to a higher probability of default). However, in our simulation, there is a critical sanction ($\theta = 0.45$) above which the latter negative effect takes over the positive effect. If the policymaker pushes the sanction up to the point where the frequency of liars becomes zero, the overall frequency of default is larger than if some lies were tolerated.

Figure 3

Frequency of defaults *V* with respect to the sanction θ, for *k*=0.04

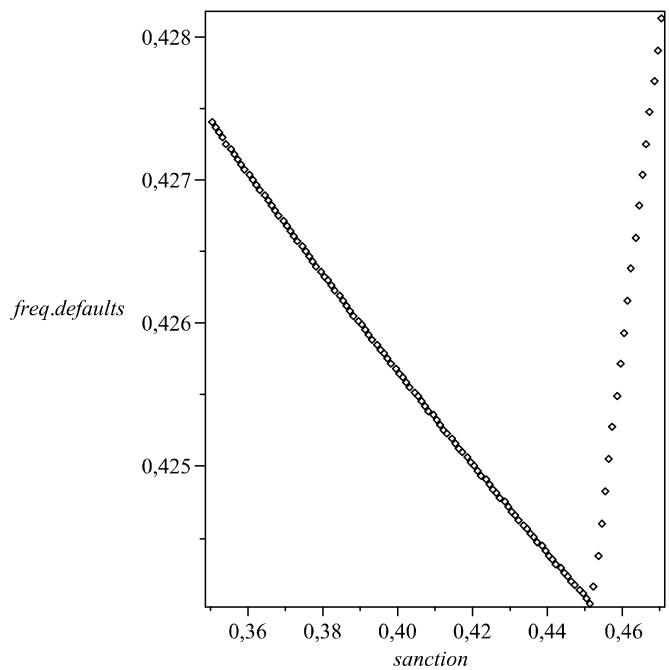
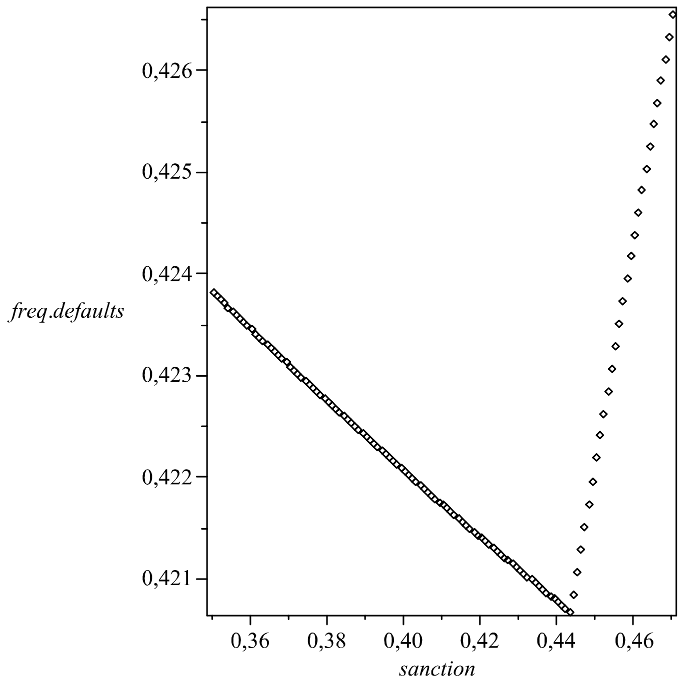


Figure 4 shows the consequences on the former relationship from reducing the interest rate of central bank funds (k) by 1/4 percentage point, from 0.04 to 0.0375.

As expected, the overall frequency of defaults V declines for all θ ; the optimal sanction is also lower for a lower k .

Figure 4

Impact of a lower *k* on the frequency of defaults



As long as the actual sanction for fraudulent disclosure is lower than the optimal sanction, increasing the sanction θ or reducing the repo rate k brings about similar effects in terms of reducing the frequency of defaults. Yet, if policymakers are uncertain whether the actual sanction is to the left or to the right of the critical level, policymakers who want to take no risk should reduce the repo rate.

5. Conclusions

The 2007-2009 financial crisis that developed on the foundations of the US subprime turmoil recalled with strength the role of trust and honesty in the good functioning of financial markets. This paper has analyzed from a theoretical perspective the banks' communication strategy during such a financial crisis. It emphasizes the impact of a manager's communication policy on the financial distress of his bank and showed that a dose of uncertainty can contribute, in some cases, to improve social welfare.

It has been shown that when investors have only imperfect information about the banks' true exposure to risky assets, some fragile bank may claim that they are strong only to manipulate investors' expectations. As the latter do figure out this strategy, they ask for a larger interest rate that penalizes the genuine solid banks. A policy of increasing the sanction on dishonest managers may help reducing the frequency of defaults up to a point. If the sanction is too strong and the frequency of liars too small, losses from further tightening the sanction can offset the benefits, since more fragile banks are pushed to unveil their true situation and are subject to a larger risk of default.

A reduction in the repo interest rate at which the central bank provides funding to all banks appears to be a more efficient policy, at least in the short run. In a long run perspective other considerations, such as moral hazard or inflation risks should be brought into the picture.

Our results should not be interpreted as a plea against additional transparency in financial markets. The analysis pertains to managing information during a crisis. We argued that in such difficult times, full transparency might not be needed. But in normal times, transparency is what we need the most to avoid further crises.

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