



Banking and Transparency: Is More Information Always Better?

Nicole Allenspach

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Banking and Transparency: Is More Information Always Better?

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Abstract

This paper shows that transparency in banking can be harmful from a social planner's point of view. According to our model, enhancing transparency above a certain level may lead to the inefficient liquidation of a bank. The reason lies in the nature of a standard deposit contract: its payoff scheme has limited upside gains (cap) but leaves the depositor with the downside risk. Accordingly, depositors will not take into account possible future upside gains of the bank when deciding whether or not to withdraw their deposits. Our result points towards a trade-off the regulator faces: while enhancing transparency may be useful to reduce incentives for excessive risk-taking (moral hazard), it may also increase the risk of inefficient bank runs.

Keywords: banking, transparency, financial stability, bank run

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1 Introduction

Since the Asian crisis in 1998, calls for enhancing transparency in the banking sector have been prompted regularly. The outburst of the subprime mortgage crisis in mid-2007 has reignited an interest in transparency as some banks have been severely criticized for not disclosing all relevant information. Accordingly, one of the lessons often drawn from this crisis is that banks have to become more transparent to the markets.¹ In other words, transparency is generally regarded as being beneficial in enhancing both the efficiency and the stability of banks and a financial system as a whole.

However, the actual impact of enhancing transparency may be less evident in the case of banks. Banks do in fact exist because of inefficiencies. They solve the information asymmetry between lenders and borrowers and are therefore opaque by definition. Hence, due to the existence of market distortions, disclosing information² to the market may be less beneficial as often claimed or may—under certain circumstances—even worsen the overall outcome.³ Furman and Stiglitz (1998) argue that greater transparency could have severely aggravated the savings and loans crisis in the United States as many banks would have had to shut down, cut their lending to a significant extent or receive substantial equity injections. Similarly, De Grauwe (2008) points out that transparency is not a panacea to prevent financial crises and may sometimes even be counterproductive.

The aim of this paper is to contribute to the discussion on transparency in banking by pointing out a possible drawback of information disclosure to the market. It is thereby important to note that the paper does not intend to carry out a balanced analysis of possibly beneficial and harmful effects of transparency but rather to provide an example where being transparent might not always be optimal. In a simple model where the bank's investment portfolio is solely exposed to exogenous risk factors such as macroeconomic shocks or a stock market crash, we show that enhancing transparency over a certain level may lead to the inefficient liquidation of a bank. The basic idea behind this is as follows: A bank may temporarily be threatened by a shock but the institution's overall outlook is still positive. Disclosing information on that bank while

¹See, e.g., Financial Stability Forum (2008).

²Disclosing information does not necessarily imply transparency as, e.g., it does not automatically ensure that the information disclosed is also received and correctly understood by the market. Nevertheless, in what follows, these expressions are used interchangeably.

³According to the theory of the second best: When there is more than one imperfection in an economy, removing one of them need not improve welfare.

in trouble may lead depositors to run a bank with a positive net present value. At this stage, allowing for some degree of intransparency—or in some cases even complete intransparency—may keep depositors from running the bank and may thus prevent the inefficient liquidation of this bank.

The reason for this inefficient liquidation lies in the very nature of deposit contracts: the payoff scheme of a standard deposit contract has limited upside gains (cap) but leaves the depositor with the downside risk. Accordingly, depositors do not take into account possible future upside gains of the bank when deciding whether to run the bank or not. Although assumed to be risk neutral, they act as if they were risk averse.⁴ Inefficient bank runs are often related to the phenomenon of depositor coordination failure.⁵ We show that inefficient liquidation might also occur in the absence of a coordination problem.

There exists a vast literature on various aspects of information disclosure. This literature, however, is not bank-specific.⁶ Banks and the banking system as a whole are fundamentally different from other sectors. First, the part of debt finance is much higher at banks than at other firms. The incentives of debtholders differ from those of equityholders. Second, banks are fragile and subject to bank runs and banking crises as they finance long-term investments with short-term debt. And lastly, the banking sector is highly regulated compared to other sectors of the economy. Results from the general information disclosure literature might thus not necessarily be applied to banks. Moreover, there might be some topics that are only (or especially) relevant for the analysis of information disclosure in a banking context.

An increasing number of papers concentrate on transparency issues in the context of banks. There are several theoretical papers that study the effect of transparency on bank stability via market discipline. These papers address the issue of moral hazard in banking, i.e., the banks' incentive for excessive risk taking. Transparency may prevent banks from excessive risk taking and may thus improve their stability by fostering market discipline: providing enough information allows creditors to force the

⁴This is the counterpart to the literature on moral hazard in banking where banks do not take into account possible downside risks due to limited liability. Although assumed to be risk neutral, banks behave as if they were risk loving. Their incentive for excessive risk-taking may result in the *inefficient continuation* of a bank. In our analysis, however, moral hazard is not an issue as banks are exposed to exogenous risk factors only.

⁵There is an extensive literature starting with Diamond and Dybvig (1983) that relates inefficient liquidation to the phenomenon of depositor coordination failure.

⁶For an overview on the theoretical strand of this literature, see Verrecchia (2001); an overview on empirical disclosure literature is provided in Healy and Palepu (2001).

banks to choose the appropriate risk level. The papers thereby concentrate on the depositors' investment decision as a channel for market discipline. The consensus is that transparency indeed reduces risk as it enables depositors to demand adequate compensation—i.e., deposit rates—for given risk-levels. Examples of this literature are Boot and Schmeits (2000), Hyttinen and Takalo (2002, 2004) and Cordella and Yeyati (1998). Some of these papers also account for factors that might dilute the beneficial effect of transparency on bank stability. Hyttinen and Takalo (2002) show how deposit insurance and costs associated with information disclosure reduce, offset or even overcompensate the otherwise beneficial effect of enhanced transparency on the banks' stability.

Recent policy initiatives that call for enhancing transparency in banking—such as Pillar 3 of the new Basel Capital Accord (Basel II)—are also based on the same argument that market discipline can be strengthened—and therefore banks' excessive risk taking reduced—by greater disclosure. Also from a supervisory perspective, there seems to be much consensus that, in the context where banks control their risk, enhancing transparency may be beneficial at best—in that transparency may force banks to behave more prudently—and simply irrelevant⁷ at worst.

As mentioned above, this paper concentrates on the impact of transparency when banks are not able to control their risk exposure. In other words: in contrast to the above mentioned papers, moral hazard is not an issue. In an extension of their model, Cordella and Yeyati (1998) additionally study the impact of disclosure on the ex ante probability of bank failures in the case where the bank's risk level evolves according to exogenous risk factors. In this case, bank transparency reduces bank stability as investors demand higher funding compensation which aggravates the banks' situation. The setup in our paper differs from this exogenous risk version of the Cordella and Yeyati model in the following sense. First, while Cordella and Yeyati compare the polar cases of complete transparency versus complete intransparency, we allow for interior solutions. In doing so, we are able to show how the optimal transparency level varies with the components that determine the exogenous risk. Second, we explicitly model a standard deposit contract. And third, while Cordella and Yeyati focus on the relation between transparency and the funding terms, we concentrate additionally on its

⁷Irrelevant in the sense that although all relevant information is disclosed to the market, market discipline does not work. For an example where market discipline may actually lead to an increase in risk, see Blum (2002) .

impact on the depositor’s withdrawal decision. In other words, possible consequences of transparency are analyzed in a bank run model.

The impact of transparency might not be the same for individual banks and for the banking sector as a whole. In a bank run model with two banks, Chen and Hasan (2006) show that enhancing transparency of one bank may reduce depositor welfare as it increases the chance of a (inefficient) contagious run on the other bank. Hence, as in our model, enhancing transparency may cause inefficient bank runs. In contrast to our model, however, the result is driven by depositor coordination failure.

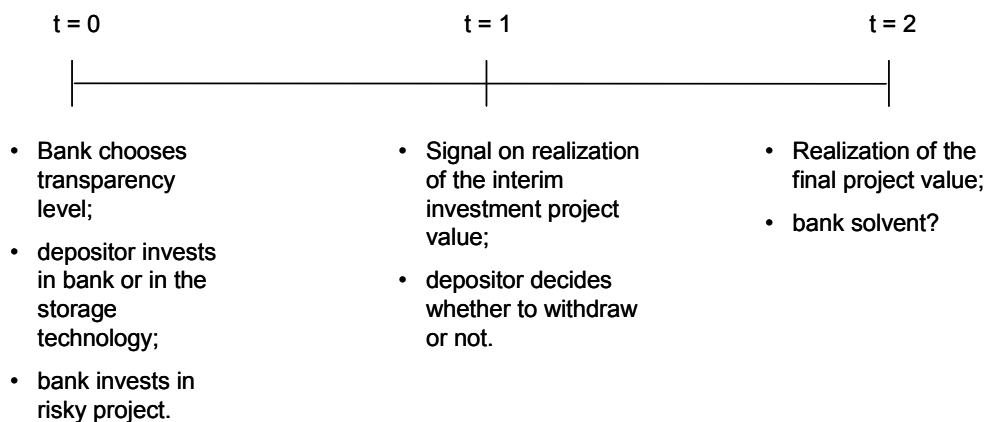
In a similar model, Chen and Hasan (2008) illustrate how transparency—the precision of a public signal on bank assets—and depositors’ expectation concerning the revelation of the public signal determine whether information-based bank runs improve depositor welfare. If the signal is precise, information-based bank runs are beneficial as they allow the efficient liquidation of a bank. If the signal is noisy, however, bank runs will reduce depositor welfare. In this setup, panic runs—i.e., bank runs where depositors’ expectations about the bank fundamentals have not changed—may occur. These runs are triggered by changes in depositors’ expectation about the actual revelation of the signal.

The paper is organized as follows. Section 2 describes the setup of the model. The solutions to the depositor’s investment and withdrawing decisions and the optimal choice of the bank’s transparency level are presented in section 3. Section 4 discusses possible extensions of the model and section 5 concludes.

2 The Setup

The optimal transparency decision is analyzed within the framework of a dynamic game of incomplete information. The setup of the model reflects a situation where a bank is hit by a shock, may thus temporarily fall into a stress situation and faces the threat of depositors withdrawing their funds. The outlook of the bank’s investment project is, however, favorable. In other words, even in the case where the bank’s investment project is hit by a negative shock, its net present value is still positive. The following subsections describe (i) the agents, their action choices, and the timing of the game, (ii) the (exogenously given) distribution of the bank’s investment project value and the corresponding payoffs for the agents, and (iii) the information structure and the precise definition of bank transparency.

Figure 1: TIMELINE



2.1 Economy, Agents and Timeline

The economy consists of a bank and a depositor. Both are risk neutral. We assume that the bank is completely financed by a deposit which is normalized to unity. The bank invests the deposit in a risky long-term investment project of which the project value distribution is exogenously given. This project yields a random *interim* investment project value \tilde{V}_1 at the interim stage and a random *final* investment project value \tilde{V}_2 at the final stage (cf. Section 2.2). At the interim stage, the bank has to disclose information to the market—i.e., to the depositor—on the realization of the interim project value. The bank’s action choice is its decision on the transparency level v with respect to the information disclosed. We assume limited liability.

The depositor is thought of as representing a group of large informed investors. Small, uninformed depositors are irrelevant in our context since this group is not expected to exert any form of market discipline.⁸ There is no deposit insurance. The representative depositor with endowment 1 has two action choices. First, he decides whether to invest his endowment in the bank at the gross deposit rate $R^D \geq 1$ or to use the storage technology at the safe gross return of 1. Once invested in the bank, he decides—second—whether to withdraw his deposit or to leave it in the bank. It is assumed that the depositor’s withdrawing decision is not contractable.

The depositor decides whether to withdraw or not based on a signal s^i on the

⁸Note also that only one depositor is needed in our model, as coordination between depositors is not an issue.

realization i of the interim project value he receives. The signal can be interpreted as a financial statement the bank publishes in response to the realization of the shock. The transparency level v initially chosen by the bank defines the *precision* of this signal (cf. Section 2.3). The transparency level v and the investment project value distribution are common knowledge. The realization of the interim project value, however, is not observable to the depositor.

Figure 1 presents the timeline of the model. There are three periods: 0, 1, 2. In $t = 0$, the bank chooses its level of transparency v , the depositor decides whether to invest its endowment in the bank or to use the storage technology. If he invests in the bank, the bank invests these funds in a risky long-term project.

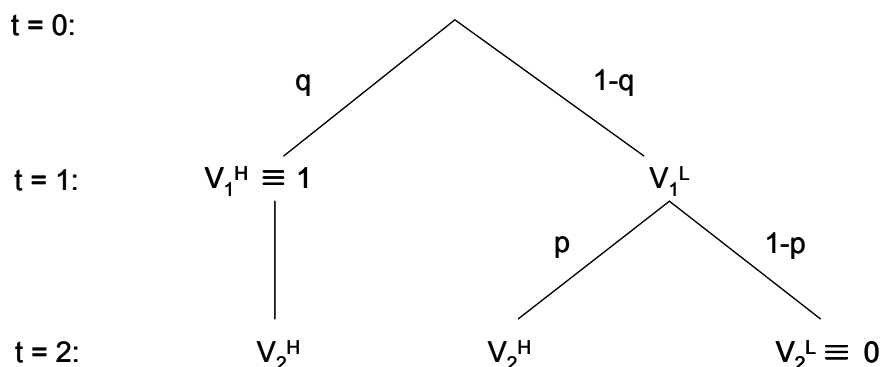
At the interim stage $t = 1$, the depositor receives a signal on the realization of the random interim project value. Based on this signal, he decides whether to withdraw his deposits or not. If he withdraws, the bank is closed early. Otherwise, the bank continues to operate until $t = 2$. In $t = 2$, the final project value materializes. The bank is closed and it pays back the (gross) deposit rate to the depositor in the case of solvency.

2.2 Investment Project Value Distribution and Payoffs

The investment project value distribution is summarized in figure 2. At the interim stage $t = 1$, the interim project value \tilde{V}_1 materializes. The project yields a *high* interim value $V_1^H \geq 1$ with probability q and a *low* value $V_1^L < 1$ with probability $(1 - q)$. As the bank's total liabilities amount to 1, the bank is liquid in the case of V_1^H but becomes (temporarily) illiquid in the case of V_1^L . For notational and computational simplicity, V_1^H is set equal to 1. If the depositor decides to withdraw in $t = 1$, he receives either 1 (if $\tilde{V}_1 = V_1^H \equiv 1$) or V_1^L (if $\tilde{V}_1 = V_1^L$); the bank gets nothing. Otherwise, the bank continues to operate until $t = 2$.

In $t = 2$, the investment project ends and the final project value \tilde{V}_2 materializes. The distribution of the investment project's final value depends on the state in $t = 1$. If, at the interim stage $t = 1$, a high interim value has occurred, the project yields a *high* final project value $V_2^H > 1$ with probability 1. If a low interim value has materialized, however, V_2^H will only be achieved with probability p . With probability $(1 - p)$, the investment project yields a *low* value $V_2^L < V_1^L$. For notational and computational

Figure 2: INVESTMENT PROJECT VALUE DISTRIBUTION



simplicity, V_2^L is set equal to zero.⁹ It is assumed that $p \leq q$. In other words: the probability of success from the first technology is equal to or higher than the probability of success from the second technology. The bank remains solvent if V_2^H is realized and is insolvent otherwise. In other words:

$$V_2^H \geq R^D > 1 > V_1^L > 0 \quad (1)$$

We assume that the expected investment project value is higher than or equal to the value from the alternative option, the storage technology:

$$qV_2^H + (1 - q)pV_2^H \geq 1 \quad (2)$$

Inequality (2) is a necessary condition for the existence of the bank: if the sure payoff from using the storage technology is higher than the expected payoff from investing in the risky project, a bank would not exist. We further assume that—given a low project value in $t = 1$ —the expected final investment project value from continuing the investment project is higher than the value from stopping the project and closing the bank in $t = 1$:

$$pV_2^H \geq V_1^L \quad (3)$$

Inequality (3) implies that the case of efficient liquidation of a bank is ruled out in this model by assumption.¹⁰

⁹The results do not change qualitatively due to the simplifications with respect to V_1^H und V_2^L .

¹⁰For a model where bank runs are efficient, see, e.g., Allen and Gale (1998). Chen and Hasan (2006) analyze the relation between transparency of banks and the efficiency of bank runs.

Lastly, we assume that—given a low project value in $t = 1$ —the depositor’s payoff from withdrawing in the bad state is equal or greater than the expected payoff from not withdrawing in the bad state:

$$V_1^L \geq pR^D \quad (4)$$

Inequality (4) is assumed to restrict the attention to only those cases where there is a conflict of interest between the bank and the depositor. If inequality (4) did not hold, the depositor would have no incentive at all to withdraw its deposits.

In the solvency case, the depositor receives his promised deposit rate R^D , while the bank gets the difference between the final investment project value V_2^H and the deposit rate R^D . If the bank becomes insolvent in $t = 2$, however, neither the bank nor the depositor receives anything. The distribution of the bank’s and the depositor’s payoffs—conditional on the realization of the bank’s investment project values and the depositor’s withdrawal decision—are summarized in Table 1 and Table 2.

Table 1: Payoff structure if bank is closed in period 1

	Realization of \tilde{V}_1 :	
	$V_1^H \equiv 1$	V_1^L
Bank:	0	0
Depositor:	1	V_1^L

Table 2: Payoff structure if bank operates until period 2

	Realization of \tilde{V}_2 :	
	V_2^H	$V_2^L \equiv 0$
Bank:	$V_2^H - R^D$	0
Depositor:	R^D	0

2.3 Information Structure and Transparency

While the investment project value distribution is common knowledge, the realization of the interim project value is not observable by the depositor. However, in $t = 1$, the bank has to disclose information on the state of the bank to the market. At the interim stage, thus, the depositor receives a signal s^i on the realization i of the interim project value \tilde{V}_1 , where s^H is pointing to a high interim project value V_1^H and s^L to

a low interim project value V_1^L . Given that the distribution of the final project value \tilde{V}_2 is related to the realization of the interim project value \tilde{V}_1 , the signal serves as an indicator of the probability that the bank remains solvent in $t = 2$.

The level of transparency initially chosen by the bank is defined as the *precision* of the signal. Concretely, transparency is defined as the conditional probability of signal s^i given the realization i of the random interim project value \tilde{V}_1 :

$$\begin{aligned} v &= \text{prob} [s^i | V_1^i], \quad i = L, H \\ (1 - v) &= \text{prob} [s^j | V_1^j], \quad i = L, H; \quad j = L, H; \quad i \neq j \end{aligned} \tag{5}$$

with $v \in [0.5, 1]$. The more transparent the bank, the more precise is the signal on the actual state of the investment project in $t = 1$. Or, in other words: the higher the transparency level, the higher the probability that the depositor receives the correct signal.¹¹ If the transparency level v is set to 0.5, the signal does not contain any new information compared to the information available in $t = 0$. This corresponds to the case of *complete intransparency*. If $v = 1$, then the signal reflects the realization of the interim project value perfectly, i.e., there is *complete transparency*.

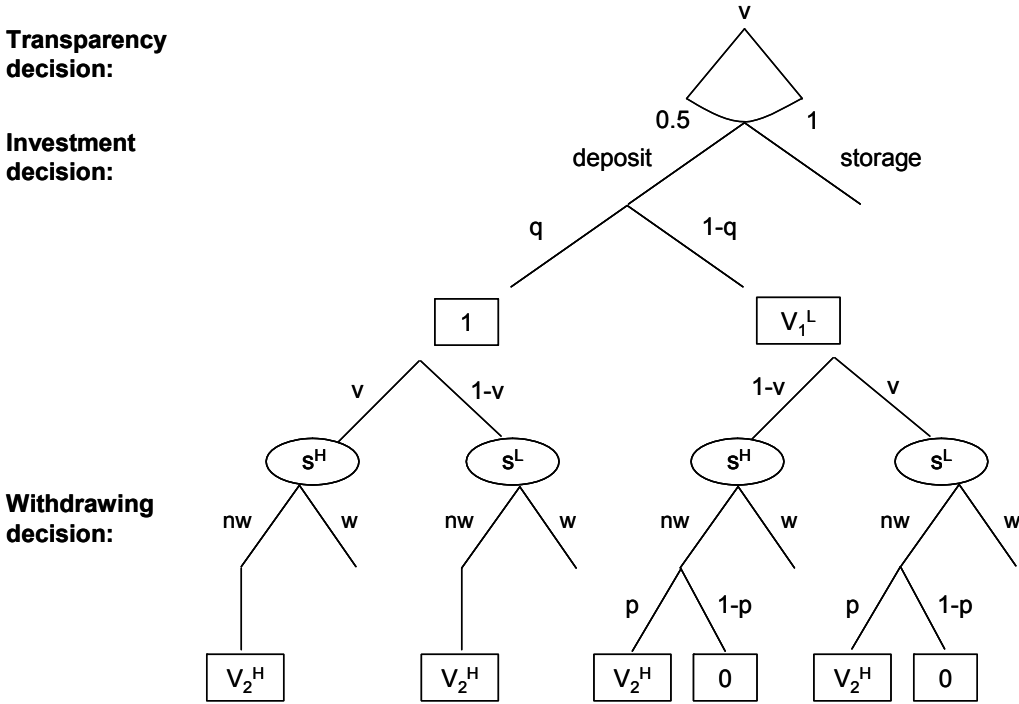
Enhancing transparency, however, is costly for the bank. We assume a convex cost function $c(v)$ with the following properties:

$$\begin{aligned} c(0.5) &= 0, \\ c'(v) &\geq 0, \quad c''(v) > 0, \quad c'(0.5) = 0, \quad c'(1) = \infty \end{aligned} \tag{6}$$

Costs may arise because the bank has to produce comprehensive information on its financial performance—the state of the investment project in $t = 1$ —and to disclose it to the depositor. Moreover, costs may also arise because the bank and/or the investment have to be (re-)organized such as to become transparent. It is assumed that the higher the transparency level, the more costly it gets to enhance transparency further. Figure 3 summarizes the game described in Section 2.

¹¹As the recent crisis has shown, there exists various ways to make it hard for investors to get a clear picture of the actual situation of a bank. Examples are disclosing only partial information or “hiding” the relevant pieces of information within a bulk of irrelevant figures.

Figure 3: GAME TREE



3 The Game and Its Equilibria

As a reference point to the Perfect Bayesian Equilibrium to be derived for the game according to figure 3, the first-best allocation of the model is presented first. A first-best allocation is characterized by the lack of inefficiencies arising, e.g., from incentive problems or imperfect information. Hence, the representation of the model in the first-best world reduces to the project value distribution given in figure 2. The corresponding first-best allocation is presented in proposition 1.

Proposition 1 *The first-best allocation is characterized by (i) the investment in the project takes place in $t = 0$ and (ii) the project is not liquidated in $t = 1$.*

Not investing in the project as well as early liquidation of the project is inefficient.

Proof. By assumptions (2) and (3), the expected investment project value is always—i.e., at any stage in the game—higher or equal than the payoff from the alternative option. ■

The following sections derive the solution to the game as described by figure 3 taking into account imperfect information and the agents' incentive compatible behavior.

The game has to be solved by backward induction. We start with the depositor's withdrawing decision in $t = 1$. Based on this result, we turn to the depositor's investment decision in $t = 0$. Finally, we analyze the optimal bank transparency decision.

3.1 The Depositor's Withdrawing Decision

After being hit by a shock in $t = 1$, the bank has to disclose information on its actual situation. Based on this information—i.e., the signal s^i on the realization i of the interim project value \tilde{V}_1 —the depositor has to decide whether to withdraw his funds or to leave them in the bank. According to the two possible outcomes of the signal, we distinguish between two cases.¹²

Case 1: If a *low* signal is observed in $t = 1$, the depositor *withdraws* if the expected payoff from withdrawing

$$\begin{aligned} E [P^D(w) | s^L] &= \text{prob} [V_1^L | s^L] \cdot V_1^L + \text{prob} [V_1^H | s^L] \cdot 1 \\ &= \frac{(1-q)v}{(1-q)v + q(1-v)} V_1^L + \frac{q(1-v)}{(1-q)v + q(1-v)} \end{aligned} \quad (7)$$

is greater than or equal to the expected payoff from not withdrawing

$$\begin{aligned} E [P^D(nw) | s^L] &= \text{prob} [V_1^L | s^L] \cdot pR^D + \text{prob} [V_1^H | s^L] \cdot R^D \\ &= \frac{(1-q)v}{(1-q)v + q(1-v)} pR^D + \frac{q(1-v)}{(1-q)v + q(1-v)} \cdot R^D \end{aligned} \quad (8)$$

Thus, the depositor *withdraws* in the case of a *low* signal if

$$\frac{(1-q)(V_1^L - pR^D)}{q(R^D - 1)} \geq \frac{1-v}{v} \quad (9)$$

Case 2: If a *high* signal is observed in $t = 1$, the depositor does *not* withdraw if the expected payoff from not withdrawing

$$\begin{aligned} E [P^D(nw) | s^H] &= \text{prob} [V_1^H | s^H] \cdot R^D + \text{prob} [V_1^L | s^H] \cdot pR^D \\ &= \frac{qv}{qv + (1-q)(1-v)} R^D + \frac{(1-q)(1-v)}{qv + (1-q)(1-v)} pR^D \end{aligned} \quad (10)$$

¹²The derivation of the conditional probabilities of the good and the bad state given a high or a low signal is presented in section 3.2.

is greater than or equal to the expected payoff from withdrawing

$$\begin{aligned} E [P^D(w) | s^H] &= \text{prob} [V_1^H | s^H] \cdot 1 + \text{prob} [V_1^L | s^H] \cdot V_1^L \\ &= \frac{qv}{qv + (1-q)(1-v)} + \frac{(1-q)(1-v)}{qv + (1-q)(1-v)} V_1^L \end{aligned} \quad (11)$$

Thus, the depositor does *not* withdraw in the case of a *high* signal if

$$\frac{(1-q)(V_1^L - pR^D)}{q(R^D - 1)} \leq \frac{v}{1-v} \quad (12)$$

In what follows, we assume that inequalities (9) and (12) hold, i.e., we assume

$$\frac{(1-v)}{v} \leq \frac{(1-q)(V_1^L - pR^D)}{q(R^D - 1)} \leq \frac{v}{(1-v)} \quad \forall v \in (0.5, 1] \quad (13)$$

Under assumption (13), the depositor *withdraws* after receiving a *low* signal and does *not* withdraw after receiving a *high* signal. This allows us to concentrate on those cases where the information disclosed to the depositor—and therefore also the bank’s transparency choice—has an influence on the depositor’s decision to withdraw. In other words: assumption (13) describes the conditions under which the signal transmits valuable information. If this assumption did not hold, the *a priori* information on expected payoffs would completely dominate and the signal would be worthless. Inequality (13), however, is only assumed to hold for $v > 0.5$. In the case of complete intransparency, i.e., for $v = 0.5$, the signal does not contain any new information compared to the information available in $t = 0$. Hence, the depositor will not withdraw provided that investing in $t = 0$ has been preferred to using the storage technology (cf. Section 3.2).

The inequalities in assumption (13) relate transparency to the depositor’s payoff distribution. The fraction in the middle relates (i) the depositor’s *expected excess payoff from withdrawing* over not withdrawing in the *bad* state weighted by the (prior) probability of being in the *bad* state (nominator) to (ii) the depositor’s *expected excess payoff from not withdrawing* over withdrawing in the *good* state weighted by the (prior) probability of being in the *good* state (denominator). Comparing these two weighted expected excess payoffs can be interpreted as assessing the opportunity costs arising from choosing the wrong action. The higher the precision of the signal, i.e., the higher the transparency level v , the more these expected excess payoffs are allowed to differ

while still fulfilling condition (13): If—for example—the depositor receives a low signal s^L and is almost sure that a low interim project value V_1^L has materialized—i.e., v is almost 1—he will withdraw even if the prior information on the excess payoffs are in favour of not withdrawing. Concretely, he will withdraw even if $q(R^D - 1)$ —the weighted expected excess payoff from not withdrawing over withdrawing in the good state—is much higher than $(1 - q)(V_1^L - pR^D)$ —the weighted expected excess payoff from withdrawing over not withdrawing in the bad state.

Under condition (13), the depositor always withdraws when he observes a signal indicating that the fundamentals of the bank are weak. Compared to the efficient allocation as outlined in proposition 1, however, this solution is inefficient. The efficient solution would only be achieved if either not withdrawing was the dominant strategy¹³ or the optimal bank transparency choice would always be complete intransparency (i.e., $v^* = 0.5$), independent of the bank’s risk profile. However, not withdrawing as a dominant strategy is ruled out by assumption (13) and complete intransparency might but does not necessarily have to be optimal (see section 3.3).

3.2 The Depositor’s Investment Decision

Based on the transparency level chosen and the interest rate offered by the bank in $t = 0$, the depositor decides whether to invest his endowment of 1 in the bank or to use the storage technology. The depositor invests in the bank if his expected payoff from investing in the bank, $E [P^D]$, is greater than or equal to the payoff from storing, where

$$E [P^D] = E [P^D | s^H] \cdot \text{prob}(s^H) + E [P^D | s^L] \cdot \text{prob}(s^L) \quad (14)$$

The depositor’s expected payoff from investing, $E [P^D]$, is the sum of (i) his expected payoff given that a *high* signal is observed, $E [P^D | s^H]$, weighted by the probability of observing a *high* signal, $\text{prob}(s^H)$, and (ii) his expected payoff given that a *low* signal is observed, $E [P^D | s^L]$, weighted by the probability of observing a *low* signal, $\text{prob}(s^L)$. The probability of observing signal s^i is given by

$$\text{prob}(s^i) = \text{prob}(s^i | V_1^i) \cdot \text{prob}(V_1^i) + \text{prob}(s^i | V_1^j) \cdot \text{prob}(V_1^j) \quad (15)$$

¹³I.e., if the depositor’s payoff distribution was such that even when receiving a bad signal, the depositor decides not to withdraw.

Thus:

$$\text{prob}(s^H) = qv + (1 - q)(1 - v) \quad (16)$$

$$\text{prob}(s^L) = (1 - q)v + q(1 - v) \quad (17)$$

We next turn to the depositor's expected payoffs conditional on the signal observed. Under assumption (13), the depositor withdraws after observing a low signal and does not withdraw after observing a high signal. The depositor's expected payoff conditional on observing s^L (s^H)— $E [P^D | s^L]$ ($E [P^D | s^H]$)—is thus the sum of (i) the payoff from withdrawing (not withdrawing) in the bad (good) state weighted by the conditional probability of being in the bad (good) state and (ii) the payoff from withdrawing (not withdrawing) in the good (bad) state weighted by the conditional probability of being in the good (bad) state:

$$E [P^D | s^L] = \text{prob}(V_1^L | s^L) \cdot V_1^L + \text{prob}(1 | s^L) \cdot 1 \quad (18)$$

$$E [P^D | s^H] = \text{prob}(1 | s^H) \cdot R^D + \text{prob}(V_1^L | s^H) \cdot pR^D \quad (19)$$

The conditional probabilities of the bad and good state, respectively, are given by

$$\text{prob}(V_1^L | s^L) = \frac{\text{prob}(V_1^L \cup s^L)}{\text{prob}(s^L)} = \frac{(1 - q)v}{(1 - q)v + q(1 - v)} \quad (20)$$

$$\text{prob}(V_1^L | s^H) = \frac{\text{prob}(V_1^L \cup s^H)}{\text{prob}(s^H)} = \frac{(1 - q)(1 - v)}{qv + (1 - q)(1 - v)} \quad (21)$$

$$\text{prob}(1 | s^L) = \frac{\text{prob}(1 \cup s^L)}{\text{prob}(s^L)} = \frac{q(1 - v)}{(1 - q)v + q(1 - v)} \quad (22)$$

$$\text{prob}(1 | s^H) = \frac{\text{prob}(1 \cup s^H)}{\text{prob}(s^H)} = \frac{qv}{qv + (1 - q)(1 - v)} \quad (23)$$

Taking equations (15) to (23) together yields

$$E [P^D] = qvR^D + (1 - q)(1 - v)pR^D + (1 - q)vV_1^L + q(1 - v) \quad (24)$$

The depositor invests in the bank if the expected payoff from investing is greater than or equal to the (sure) payoff from the storage technology, i.e., if

$$qvR^D + (1 - q)(1 - v)pR^D + (1 - q)vV_1^L + q(1 - v) \geq 1 \quad (25)$$

or

$$R^D \geq \frac{1 - (1 - q)vV_1^L - q(1 - v)}{qv + (1 - q)p(1 - v)} \equiv R_{crit}^D(v) \quad (26)$$

$R_{crit}^D(v)$ (henceforth R_{crit}^D) is the critical value for the deposit rate. It represents the lower threshold for the deposit rate to which the depositor is indifferent between investing in the bank and using the storage technology. In other words, inequality (26) represents the depositor's participation constraint. The level of R_{crit}^D is a function of the parameters describing the investment project value distribution—i.e., the bank's risk profile—and the transparency level chosen by the bank. As will be shown in section 3.4, this level is strictly decreasing with the project value distribution parameters. Moreover, the critical deposit rate is also negatively related to the transparency level v . The less transparent the bank, the more the bank has to pay to the depositor to attract funding. Hence, while increasing transparency is costly as assumed in equation (6), it also reduces a component in the bank's overall cost function, namely the funding costs.

Proposition 2 *The critical value for the deposit rate, R_{crit}^D , is strictly decreasing with the transparency level v .*

Proof. Differentiating the critical value for the deposit rate, R_{crit}^D , with respect to the transparency level v yields:

$$\frac{\partial R_{crit}^D}{\partial v} = \frac{(1 - q) [p - q - (1 - q)pV_1^L]}{[qv + (1 - q)p(1 - v)]^2} < 0 \quad (27)$$

which is negative given that $V_1^L < 1$ and $p \leq q$ by assumption. ¹⁴ ■

3.3 The Optimal Decision on the Transparency Level

We next turn to the bank's decision on the optimal transparency level v . The higher the transparency level v , the higher the precision of the signal s^i on the realization i of the interim investment project value \tilde{V}_1 . The bank chooses the level of transparency

¹⁴The assumption $p \leq q$ is a *sufficient* but not a necessary condition to ensure that the critical value of the deposit rate R_{crit}^D is decreasing with the transparency level v .

that maximizes its expected payoff, $E [P^B(v)]$, subject to the depositor's participation constraint (inequality 26)¹⁵:

$$\begin{aligned} \max E [P^B(v)] &= qv (V_2^H - R^D) & (28) \\ &+(1-q)(1-v)p (V_2^H - R^D) \\ &-c(v) \end{aligned}$$

$$\text{s.t. } R^D \geq \frac{1 - (1-q)vV_1^L - q(1-v)}{qv + (1-q)p(1-v)} \quad (29)$$

The first line in equation (28) describes the bank's expected payoff in the *good* state while the second line represents the bank's expected payoff in the *bad* state. The third line corresponds to the (direct) costs associated with the level of transparency as characterized in equation (6).

Since the depositor's participation constraint holds as an equality, it can be inserted into the bank's expected payoff function. Hence, the bank's maximization problem can be restated as:

$$\begin{aligned} \max E [P^B(v)] &= qvV_2^H + (1-q)(1-v)pV_2^H & (30) \\ &+(1-q)vV_1^L + q(1-v) - 1 \\ &-c(v) \end{aligned}$$

The corresponding first-order condition (FOC) is given by:

$$\frac{\partial E [P^B(v)]}{\partial v} = q(V_2^H - 1) - (1-q)(pV_2^H - V_1^L) - c'(v) \quad (31)$$

The FOC relates the *expected marginal project value* of an additional unit of transparency—the first term in equation (31)—to the *expected marginal costs*—the last two terms in equation (31). The expected marginal costs of an additional unit of transparency consist of two components: The *direct* marginal costs—represented by the last term in equation (31) and stemming from the transparency cost function as characterized in equation (6)—and the *indirect* marginal costs.

¹⁵Note that although the setup of the maximization problem corresponds to the one of a monopoly bank, the result with respect to the optimal transparency level does not change if the banking sector was assumed to be competitive. As will be shown below, the solution to the bank's maximization problem is identical to the socially optimal level of transparency. In other words: the market structure in this setup is irrelevant with respect to the solution for the optimal transparency level. It would only affect the distribution of the surplus.

Proposition 3 *If the expected marginal project value of an additional unit of transparency is equal to or lower than the expected indirect marginal costs, i.e., if*

$$q(V_2^H - 1) \leq (1 - q)(pV_2^H - V_1^L) \quad (32)$$

then the optimal level of transparency is $v^ = 0.5$, i.e., complete intransparency.*

If, however, the expected marginal project value of an additional unit of transparency is greater than the expected indirect marginal costs—i.e., inequality (32) does not hold—an interior solution exists for the optimal transparency level v^ .*

Proof. If inequality (32) holds, the FOC in equation (31) is negative. Hence, the optimal transparency level is the lowest possible one which corresponds to $v^* = 0.5$, the case of complete intransparency.

If, however, inequality (32) does not hold, the FOC becomes positive under complete intransparency ($v = 0.5$):

$$\frac{\partial E [P^B(v)]}{\partial v}(0.5) = q(V_2^H - 1) - (1 - q)(pV_2^H - V_1^L) > 0 \quad (33)$$

It is thus no longer optimal to choose complete intransparency, but a certain positive level of transparency. Complete transparency is, however, also not optimal as the bank's expected payoff function is concave:

$$\frac{\partial^2 E [P^B(v)]}{\partial v^2} = -c''(v) < 0 \quad (34)$$

Hence: If inequality (32) does not hold, there exists an interior solution for the transparency level v . The exact solution v^* depends on the values for the parameters describing the investment project value distribution. ■

Ignoring the direct costs for the moment, inequality (32) represents the trade-off the bank faces with respect to the transparency level. Roughly speaking, both sides of inequality (32) can be interpreted as opportunity costs of liquidating, either in the good (left hand side) or in the bad (right hand side) state. The trade-off with respect to transparency is best illustrated by the project value distribution tree (figure 2). The left hand side of inequality (32), the expected marginal project value, corresponds to the left branch of this tree. Precisely, it corresponds to the difference between the

project value from continuing and the project value from liquidating in the good state, weighted by the probability of being in the good state. In the case of the good state, the bank prefers transparency to intransparency. In other words, the bank wants the signal to reflect the correct state of the bank to prevent the depositor from withdrawing.

If the bad state has materialized, however, intransparency is preferred to transparency to prevent an inefficient bank run. This preference is reflected in the right hand side of inequality (32) which corresponds to the right branch of the project value distribution tree (figure 2). It is the difference between the project value from continuing and the project value from liquidating in the bad state, weighted by the probability of being in the bad state.

The higher the expected project value difference in the bad compared to the one in the good state, the higher the opportunity costs of liquidating in the bad compared to the ones in the good state, and therefore the lower the transparency level chosen by the bank. In the case where the expected project value difference in the bad state (right hand side of inequality (32)), is higher than the one in the good state (left hand side of inequality (32)), the bank chooses complete intransparency, i.e., $v^* = 0.5$. In the opposite case, the bank chooses a positive level of transparency of which the exact level depends on the direct costs as well as on the bank's risk profile parameters.

Inequality (32) is more likely to be satisfied (i) the *lower* the probability q of a high interim project value, (ii) the *higher* the probability p of achieving the high final project value despite a low interim value and (iii) the *lower* the value of the low interim project value V_1^L . The *lower* q and V_1^L are and the *higher* p is, the more dominant the indirect marginal costs become compared to the marginal expected project value of an additional unit of transparency, i.e., the more dominant the right hand side of the project value distribution tree (figure 2) becomes.

So far, we have derived the optimal solution for the transparency level from the bank's point of view. However, calls for enhancing transparency in the banking sector are based on the assumption that banks are reluctant to disclose information to investors and depositors and that bank transparency might therefore be too low compared to its socially optimal level. Would social welfare be enhanced in this setup by increasing the transparency level above the bank's optimal solution?

Proposition 4 *In this setup, deviating from the bank's solution for the transparency level is not socially optimal. Enhancing transparency above the level chosen by the bank*

decreases social welfare.

Proof. The socially optimal transparency level v_{SW}^* is the level that maximizes expected social welfare:

$$\begin{aligned} \max E[SW(v)] &= qvV_2^H + q(1-v) \\ &+ (1-q)(1-v)pV_2^H + (1-q)vV_1^L \\ &- c(v) \end{aligned} \tag{35}$$

As the corresponding FOC

$$\frac{\partial E[SW(v)]}{\partial v} = q(V_2^H - 1) - (1-q)(pV_2^H - V_1^L) - c'(v)$$

coincides with the FOC from the bank's maximization problem (equation (31)), the socially optimal transparency level v_{SW}^* equals the bank's optimal transparency level v^* . Hence: deviating from the bank's solution for the transparency level decreases social welfare in this setup. ■

According to proposition 4, enhancing transparency above the bank's solution for the transparency level is not socially optimal in this setup.¹⁶

To summarize, enhancing transparency has the following three effects: On the positive side, enhancing the transparency level v *decreases* the probability of an (inefficient) bank run in the case of a *high* signal (reflected by the first term in equation (31)). On the negative side, however, an increase in the transparency level *increases* (i) the probability of an (inefficient) bank run in the case of a low signal (reflected by the second term in equation (31)) as well as (ii) the direct costs of transparency (reflected by the last term in equation (31)).

3.4 Comparative Statics Analysis

In what follows, we assume that inequality (32) does not hold. In other words, we assume that the expected marginal project value of an additional unit of transparency *exceeds* the latter's expected indirect marginal costs. The aim here is to analyze how the optimal solution for the transparency level v^* and the critical value for the deposit

¹⁶Note that in this setup, many issues inherently linked to banking and transparency are ignored. Section 4 provides a discussion of some of these issues.

rate R_{crit}^D vary with the parameters describing the bank's risk profile.¹⁷ In fact, both variables are a function of these parameters. Both values vary with the probability q of a high interim project value and the probability p of a high final project value given a low interim value.¹⁸

Proposition 5 *If inequality (32) does not hold, the optimal transparency level v^* is strictly increasing in the probability q of a high interim project value and strictly decreasing in the probability p of a high final project value given a low interim value has materialized in $t = 1$.*

Proof. Define a function $F(v^*, q)$ and a function $G(v^*, p)$ such that

$$F(v^*, q) \equiv \frac{\partial E [\tilde{V}_2(v)]}{\partial v} = 0 \quad (36)$$

and

$$G(v^*, p) \equiv \frac{\partial E [\tilde{V}_2(v)]}{\partial v} = 0 \quad (37)$$

Taking the total differential of $F(v^*, q)$ and $G(v^*, p)$ yields:

$$\frac{\partial F}{\partial v} dv^* + \frac{\partial F}{\partial q} dq = 0 \quad (38)$$

$$\frac{\partial G}{\partial v} dv^* + \frac{\partial G}{\partial p} dp = 0 \quad (39)$$

or

$$\frac{dv^*}{dq} = -\frac{\frac{\partial F}{\partial q}}{\frac{\partial F}{\partial v}} \quad (40)$$

$$\frac{dv^*}{dp} = -\frac{\frac{\partial G}{\partial p}}{\frac{\partial G}{\partial v}} \quad (41)$$

According to equations (40) and (41), we obtain the influence of a unit change in q and p on the optimal transparency level v^* by calculating the partial derivatives of

¹⁷If inequality (32) does not hold, the optimal transparency level is complete intransparency, regardless of the bank's risk parameters.

¹⁸In addition to the risk distribution parameters, the critical value for the deposit rate R_{crit}^D is also a function of the transparency level v (see proposition 2).

the functions $F(v^*, q)$ and $G(v^*, p)$. We have

$$\frac{\partial F}{\partial v} = -c''(v) < 0 \quad (42)$$

$$\frac{\partial F}{\partial q} = V_2^H - 1 + pV_2^H - V_1^L > 0 \quad (43)$$

where $\frac{\partial F}{\partial q} > 0$ given that $V_1^L \leq pV_2^H$ by assumption (3),

and

$$\frac{\partial G}{\partial v} = -c''(v) < 0 \quad (44)$$

$$\frac{\partial G}{\partial p} = -(1 - q)V_2^H < 0 \quad (45)$$

Hence: an increase in the probability q of a high interim project value is associated with an increase in the optimal transparency level v^* , i.e., $\frac{dv^*}{dq} > 0$. An increase in the probability p of a high final project value—given a low interim value has materialized in $t = 1$ —is, however, associated with a decrease in the optimal transparency level v^* , i.e., $\frac{dv^*}{dp} < 0$. ■

Proposition 5 states that—for a sufficiently small level of the low interim project value V_1^L as is assumed in inequality (3)—the higher the probability q of a high investment project value in $t = 1$, the higher the optimal transparency level v^* chosen by the bank. The more likely it is that the bank will be in the good state in $t = 1$, the more willing the bank shows in $t = 0$ to disclose the actual state in $t = 1$ in order to avoid a run. The condition on the low interim project value V_1^L (inequality (3)) is a sufficient but not a necessary condition to assure that in $t = 1$, the expected payoff from continuing is higher than the payoff from liquidating.¹⁹ If the low interim project value is too high, then the *probability* q of a high interim project value does not play a role anymore.

¹⁹The necessary condition to assure that $\frac{\partial F}{\partial q} > 0$ is:

$$1 + V_1^L < V_2^H + pV_2^H$$

The left-hand side of the above inequality is the expected payoff from liquidating while the right-hand side corresponds to the expected payoff from continuing.

Proposition 5 also states that the higher the probability p of a high final project value—given a low interim value in $t = 1$ —the lower the optimal transparency level v^* the bank chooses. The higher this probability p , the higher the expected payoff from continuing becomes compared to the payoff from liquidating in $t = 1$. Given that a low interim return has materialized in $t = 1$, however, continuing becomes more likely the lower the level of transparency.

Proposition 6 *The critical value for the deposit rate, R_{crit}^D , is strictly decreasing with (i) the probability q of a high interim project value, and (ii) the probability p of a high final project value V_2^H given a low interim value in $t = 1$.*

Proof. Differentiating the critical value for the deposit rate, R_{crit}^D , with respect to (i) the probability q of a high interim project value, and (ii) the probability p of a high final project value V_2^H given a low interim value in $t = 1$ yields:

$$\frac{\partial R_{crit}^D}{\partial q} = \frac{v [vV_1^L + p(1 - v) - 1]}{[qv + (1 - q)p(1 - v)]^2} < 0 \quad (46)$$

$$\frac{\partial R_{crit}^D}{\partial p} = \frac{(1 - q)(1 - v) [(1 - q)vV_1^L + q(1 - v) - 1]}{[qv + (1 - q)p(1 - v)]^2} < 0 \quad (47)$$

which are both negative given that $v \in [0.5, 1]$ and $p \in [0, 1]$ by definition and $V_1^L < 1$ by assumption. ■

Proposition 6 states that the critical value for the deposit rate is negatively related to the probabilities of a high interim project value, q , and a high final project value p given a low interim value. The higher these probabilities, the higher the probability that the bank will remain solvent and the depositor will actually receive the promised repayment in $t = 2$, and therefore the lower the repayment the bank has to promise to get the depositor investing in the bank.

4 Discussion

This section addresses robustness issues and possible extensions of the model presented in the previous sections.

First, the result in our model is driven by the characteristics of the deposit contract. The payoff scheme of the deposit contract prevents the implementation of the first-best

solution. To minimize the probability of a bank run, the optimal solution in our model is to allow for some degree of intransparency. However, inefficient bank runs could also be ruled out by allowing for renegotiation. The bank could—in principle—renegotiate the deposit contract in the case of a bad state at the interim stage by offering a higher deposit rate. In other words, the bank could compensate the depositor for the risk from leaving the deposit in the bank until the end of the game, despite the bank’s bad state in the interim period. If this were possible, no run would occur in our model. However, renegotiation is not observed in practice and we therefore think that a standard deposit contract promising a fixed return and no possibility for renegotiation is a reasonable assumption.

Similarly, the bank could also offer a state-contingent deposit contract to avoid a bank run. In other words, the bank could offer a deposit rate contingent on the state of the bank at the interim period and the corresponding signal observed, respectively. However, while there exist deposit rates indexed to variables reflecting general economic conditions, there are—to our knowledge—no deposit rates related to the future risk profile of a bank.

Second, the model could also be extended to take into account—and assess the impact of—other possibilities than avoiding or minimizing the probability of a bank run to prevent the early liquidation of the investment project. For example, the bank could be given the opportunity of raising money from central banks and interbank markets in case a bank run occurs. Alternatively, the bank could buy an insurance in advance which would guarantee liquidity in case of depositor withdrawals.²⁰

Third, as already indicated in the introduction, our model is clearly biased towards intransparency. Potentially beneficial effects of transparency are ignored. A first of these potentially beneficial effects is the role of transparency in disciplining banks. By forcing banks to disclose relevant information to the market—so the intention of various policy initiatives such as Pillar 3 of the new Basel Capital Accord—investors may be able to discipline the banks’ risk taking behavior. In our model, this potentially beneficial role of transparency in disciplining banks is ruled out by assuming that the bank’s risk profile is completely determined by *exogenous* factors. The bank in our model cannot choose its risk level. While this might appear a very strong assumption at first, the recent turmoil in financial markets showed that even banks that have not been directly exposed to the troubled markets suffered from the overall loss of

²⁰The author thanks an anonymous referee for raising these points.

confidence. Thus, there are circumstances that are out of the control of the banks and thus can affect also the most prudent institutions.

Another potentially beneficial effect of transparency is related to the fact that bank runs may also be *efficient*. On the one hand, bank runs may be efficient in that they serve as a mean to discipline banks. On the other hand, the liquidation of an inefficient bank also reduces the costs associated with an inefficient continuation of banks, e.g., costs due to the fact that banks have an incentive for gambling for resurrection when they are in trouble. Enhancing transparency may increase the probability that efficient bank runs indeed occur. Our model completely ignores the possibility of efficient bank runs. Bank runs in this setup are inefficient by assumption.²¹

Lastly, transparency in our setup is defined in the sense that information is disclosed to the market. It is important to emphasize that we do not analyze the case of information disclosed to the regulator. This is a further interesting topic to analyze.

5 Conclusion

This paper analyzes the optimal choice of a bank's transparency level in a simple model where the bank's investment portfolio is completely exposed to exogenous risk factors. Transparency is defined as the precision of a signal on the bank's state at the interim stage. At this interim stage, the bank might fall into a stress situation. Nevertheless, the bank's outlook is assumed to be favorable. We show that—in this setup—disclosing transparent information on the interim state of a bank might be harmful. In our model, enhancing transparency above a certain level may lead to the inefficient liquidation of a bank. The reason for this inefficient liquidation lies in the the payoff scheme of a standard deposit contract: this payoff scheme is limited above. Accordingly, depositors do not take into account possible future upside gains of the bank when deciding if they run the bank or not. Although assumed to be risk neutral, they act as if they were risk averse. Allowing for some degree of intransparency—or in some cases even complete intransparency—may keep depositors from running the bank and may thus avoid the inefficient liquidation of the bank.

The optimal degree of transparency in this model is determined so as to maximize the probability that the bank continues to operate until the end of the game. Given that the bank is completely exposed to exogenous risk factors that materialize in either

²¹See Chen and Hasan (2006) for a model with both efficient and inefficient bank runs.

a good or a bad state at the interim stage, the bank faces a trade-off with respect to the transparency level: while in the case of the good state, transparency is preferred to intransparency, the contrary holds when the bad state occurs. In other words, the optimal transparency level varies with the parameters describing the bank's risk profile. The *higher* the probability that the bank is in a good state at the interim stage, the *higher* the optimal degree of transparency. However, the *higher* the bank's probability of remaining solvent in the end despite an unfavorable situation at the interim stage, the *lower* the optimal transparency level for a given relation between the probability of a good interim state and the (conditional) probability of remaining solvent in the end. An increase in these two probabilities increases the expected payoff from continuing compared to the expected payoff from liquidating the bank. The "continuing" outcome becomes more likely with a high transparency level in the good state and a low transparency level in the bad state at the interim stage.

Given the sometimes rather uncritical call for imposing transparency requirements on banks and on other financial institutions, this paper contributes to the discussion by emphasizing possible drawbacks of such policy initiatives. In doing so, it questions the unambiguous beneficial role of transparency in banking and calls for a more balanced discussion of this issue: "Transparency, like sunlight, needs to be looked at carefully."²²

²²The Economist, 2009.

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