

# Bailouts and Systemic Insurance\*

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## Abstract

We revisit the link between bailouts and bank risk taking. Bailout expectations create moral hazard – increase bank risk taking. However, when a bank’s success depends on both its effort and the overall stability of the banking system, bailouts that shield banks from contagion may increase their incentives to invest prudently and so reduce bank risk taking. This systemic insurance effect is more important when bailout rents are low while contagion risk is high. The optimal policy may then be not to make bailouts difficult, but to make them “effective”: associated with lower rents.

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# 1 Introduction

In the recent crisis, governments in several countries provided massive support to distressed financial institutions (directly through exceptional liquidity and capital support, and indirectly through unprecedented fiscal and monetary expansions). The literature accepts that such support was essential to prevent a financial sector meltdown, which would have had devastating effects on the real economy. However it is also forceful in pointing out that, in the long run, government support to banks carries significant moral hazard costs. When banks expect to be supported in a crisis, they take more risk, because shareholders, managers, and other stakeholders believe they can shift negative realizations to the taxpayer. So expectations of support increase the probability of bank failures that governments want to avoid in the first place (Acharya and Yorulmazer, 2007; Diamond and Rajan, 2009; Farhi and Tirole, 2012).

This paper highlights that when there are risks beyond the control of individual banks, such as the risk of contagion, the expectation of government support, while creating moral hazard, also entails a virtuous “systemic insurance” effect on bank risk taking. The reason is that bailouts protect banks against contagion, removing an exogenous source of risk, and this may increase bank incentives to monitor loans. The interaction between the moral hazard and systemic insurance effects of bailouts is the focus of this paper.

The risk of contagion is one of the reasons that makes banks special. While a car company going bankrupt is an opportunity for its competitors, a bank going bankrupt is a potential threat to the industry, especially when the failing bank is large. Banks are exposed to each other directly through the interbank market, and indirectly through the real economy and financial markets. The threat of contagion affects bank incentives. The key mechanism that we consider in this paper is that when a bank can fail due to exogenous circumstances, it does not invest as much to protect itself from idiosyncratic risk. Indeed, would you watch your cholesterol intake while eating on a plane that is likely to crash? Or save money for retirement when living in a war zone? Moreover, making the threat of contagion endogenous to the risk choices of all banks generates a strategic complementarity that amplifies its immediate impact: banks take more risk when other banks take more risk, because risk taking by other banks increases the threat of contagion.<sup>1</sup>

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<sup>1</sup>While we focus on the risk that a bank’s failure imposes on other banks, other papers have focused on the

Under these circumstances, a government’s commitment to support failing banks has two effects on bank incentives. The first is the classical *moral hazard* effect described in much of the literature. The second is a *systemic insurance* effect: a bailout reduces the risk of being affected by contagion, which increases a bank’s return to activities that reduce idiosyncratic risk (monitoring loans, screening borrowers, etc.). Going back to our risky flight parable, how would your choice of meal change if you had a parachute? We show that the extent of moral hazard depends on the rents that the government leaves to bailed out banks, while the importance of “systemic insurance” depends on the probability of contagion. Thus, there are parameter values – low bailout rents and a high risk of contagion – for which the promise of government intervention leads to lower bank risk taking and better outcomes.

Formally, we develop a model of financial intermediation where banks use deposits (or debt) and their own capital to fund a portfolio of risky loans. The bank portfolio is subject to two sources of risk. The first is idiosyncratic and under the control of the bank. Think about this risk as dependent on the quality of a bank’s borrowers, which the bank can control through costly monitoring or screening. The second source of risk is contagion. Think about this, for example, as a form of macro risk. When a bank of systemic importance fails, it has negative effects on the real economy, possibly triggering a recession. A deep enough recession can lead even the best borrowers into trouble and, as a consequence, can cause the failure of other banks independently of how carefully they monitor their portfolio or screen their loan applicants. The risk of contagion is largely exogenous to individual banks (when the cost of reducing a bank’s exposure to contagion is high). But it is endogenous to the financial system as a whole, since it depends on risk taking by all banks.

These two sources of risk are associated with two inefficiencies. First, limited liability and informational asymmetries prevent investors from pricing bank risk taking at the margin. As a result, in equilibrium banks take excessive idiosyncratic risk. As in other models, this problem can be ameliorated through capital requirements. The second inefficiency stems from externalities. When individual banks do not take into account the effect of their risk taking on other banks, they take too much risk relative to the coordinated solution. And since banks are also affected by the

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potential benefits for competing banks that can buy assets of a distressed institution at firesale prices, possibly with government support to the buyer (Perotti and Suarez, 2002, Acharya and Yorulmazer, 2008a).

externality, this exogenous source of risk reduces the private return to portfolio monitoring, pushing them to take even more risk. We show that capital requirements cannot fully correct this problem: even a bank fully funded by capital will take excessive risk when exposed to risk externalities. (Still, capital plays an important role, because by affecting a bank's behavior it influences the threat of contagion in the banking system.) In contrast, a bailout that prevents contagion can directly correct this externality when it leaves sufficiently small rents to failing banks.

In an extension (Section 4) we endogenize a bank's exposure to contagion risks by allowing it to invest resources (at a cost) to protect itself from the failure of other banks. In this extended setup, bailouts entail an additional moral hazard dimension. Banks reduce their efforts to protect themselves from contagion in response to anticipated bailouts. Obviously, this additional element works against the systemic insurance effect. However we show that when a bank's cost of protecting itself against contagion is sufficiently high, its equilibrium exposure to contagion becomes inelastic in the probability of a bailout, and the result that the systemic insurance effect may dominate moral hazard persists. We also show that our result holds when banks can correlate their risks, and when banks are asymmetric so that contagion spreads from a distressed systemic bank to the rest of the system.

It is important to interpret our results with caution. First, they should not be seen as downplaying the moral hazard implications of bailouts. Rather, we argue that such implications have to be balanced with systemic insurance effects. Systemic insurance may be important for some, but not all parameter values. The best illustration for the case where systemic insurance effects might dominate would be a financial system on the brink of the crisis (with risky banks and a high probability of contagion) with well-designed bank resolution rules (which minimize bailout rents).

Second, we focus on the *ex ante* effects of policies. *Ex post* considerations may be different and depend e.g. on the difference between the economic costs of bank bankruptcy and that of the use of public funds. In a richer model, when the government is not able to commit to a given bailout strategy, *ex post* considerations could lead to time inconsistencies in the government reaction function and more complex outcomes. In particular, banks may find it optimal to take correlated risks if they believe that bailouts are more likely when many of them fail simultaneously (Farhi and Tirole, 2012). We discuss how these issues play in our model in Section 5.

Several papers have argued that bailout expectations create moral hazard and can increase bank risk taking (recent examples include: Acharya and Yorulmazer, 2007 and 2008a; Diamond and Rajan, 2009; Farhi and Tirole, 2012). Such moral hazard effects are present in our model too. (Indeed, our models allows for bank moral hazard along two dimensions: idiosyncratic risk taking and the effort to reduce exposure to contagion). We add to that literature by introducing a risk externality associated with contagion. We highlight that bailouts can prevent contagion and reduce risk externalities across banks. This may have a positive strategic effect on bank monitoring choices, leading banks to reduce their risk taking.

Our paper relates to the literature on government intervention as a means to prevent contagion (Freixas et al., 2000; Allen and Gale, 2001; Diamond and Rajan, 2005). The observation that bailouts can remove exogenous risk and improve banks' monitoring incentives was made by Cordella and Levy-Yeyati (2003) in the context of exogenous macroeconomic shocks.<sup>2</sup> In this paper, we focus on endogenous systemic risk driven by the strategic interaction of individual bank risk choices. This offers a much richer framework and allows us to study questions such as the relative effectiveness of bank capital vs. bailout commitments in reducing systemic risk, the relative effectiveness of bailout policies in stable vs. distressed banking systems, and the impact of bailouts on the banks' incentives to protect themselves from contagion, and to correlate their risk.

The rest of the paper is structured as follows. Section 2 provides background for contagion and bailouts. Section 3 presents the model of bank risk taking and bailouts. Section 4 allows banks to affect their exposure to contagion. Section 5 discusses correlated risks. Section 6 concludes.

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<sup>2</sup>Corsetti et al., 2006, made a similar observation for IMF lending to sovereigns. Also, Orszag and Stiglitz (2002) use the creation of fire departments as a parable to describe how risk taking incentives are affected by externalities and public policy. In their model (like here), individuals do not take into account the effects of fireproof houses on reducing the risk of fire damage to their neighbors' homes, and invest too little in fire safety. The introduction of a fire department reduces the risk of a fire, but further worsens individual incentives, as it reduces the probability that a fire spreads from one house to another. To extend their parable, our paper is more about condo buildings rather than single-family houses. If the rest of the building burns down and collapses, a condo owner gets little benefit from having fireproofed her own apartment. Then, the introduction of a fire department makes individual safety measures more valuable as it reduces the probability of total meltdown.

## 2 Background: Contagion and Bailouts

The model incorporates two key observations. One is that banks are affected by the risk of contagion, and reducing this exposure is costly from the perspective of an individual bank. The other is that government support shields healthy banks from contagion, but leaves rents to failing ones.

**Contagion.** The literature highlights a number of channels of interbank contagion. One is macro contagion, where a failure of a bank worsens macroeconomic fundamentals, weakening other banks (Goldstein and Pauzner, 2004; Acharya and Yorulmazer, 2008b; Bebchuk and Goldstein, 2011). Another is counterparty risk from interbank exposures (Allen and Gale, 2000; Freixas et al., 2000). Yet another channel is fire sales by distressed banks, which depress asset prices and affect balance sheet constraints of other banks, pushing them to sell at a loss too (Lorenzoni, 2008; Korinek, 2011). Contagion can also spread through a squeeze in bank funding markets (Caballero and Krishnamurthy, 2003; Diamond and Rajan, 2005; Morrison and White, 2013).

In the benchmark model of Section 3 we assume that the risk of contagion is exogenous – an individual bank cannot affect it. In Section 4 we allow banks to reduce their exposure to contagion at a cost. The fact that protecting a bank against contagion is difficult or costly seems indisputable. Protecting against macro contagion, to the extent that this is at all possible, would require banks to restrict its borrower base to customers with the smallest cyclical exposures. Some counterparty risks are inherent to bank activities, as banks need to participate in the payments system and manage liquidity. Moreover, some exposures may have to be with certain (“money center”) banks, restricting the banks’ ability to manage counterparty risks.<sup>3</sup> Reducing exposure to fire sale risk may require banks to adjust their investment or liquidity management strategies. To restrict wholesale funding market exposures, banks may need to constrain the volumes of lending to those that can be supported by insured deposits alone.

**Bailouts.** We use the term “bailout” to describe any government support to distressed banks. In practice, such support is often direct: capital or liquidity injections, and (partial) takeovers by the

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<sup>3</sup>Also, even if a bank cuts its own exposure to a risky counterparty, it cannot be sure that its idiosyncratically safe counterparties have done the same (Acemoglu et al., 2012; Caballero and Simsec, 2013). Further, some interbank exposures may be economically beneficial because they provide market discipline (Rochet and Tirole, 1996).

government. During the 2008 crisis, however, support also came through “macro” measures, such as exceptionally accommodating fiscal and monetary policies (Laeven and Valencia, 2010). We assume that bailouts prevent contagion. Indeed, the prevention of contagion has featured prominently in the narrative justifying exceptional policy measures during the crisis.

Most often, however, government support also leaves “bailout rents” to incumbent shareholders (and other stakeholders) of distressed banks. When the government lacks legal tools to take over a bank or force it to issue new shares, incumbent shareholders retain claims on future bank income. This future income would have been zero if the bank had failed, the bailout makes it positive, to the benefit of shareholders. Bailout rents generate moral hazard: they protect shareholders from downside risk realizations, and hence increase their risk taking incentives.<sup>4</sup> The size of bailout rents is affected by the design of the intervention. For example, a strong resolution framework can help contain bailout rents (e.g. in the U.S. for banks resolved under the FDIC Improvement Act of 1991, where, as a rule, most shareholder value is wiped out). In contrast, macro measures may leave banks larger bailout rents than direct interventions. The size of bailout rents is a key parameter of our model.

### 3 A Model of Bank Risk Taking and Bailouts

Consider two identical risk-neutral and profit-maximizing banks. Each bank  $i$  has a loan portfolio of size 1. The portfolio is financed by equity,  $k_i$ , and deposits (or debt),  $1 - k_i$ . The gross interest rate on deposits is  $r_D$  and, for simplicity, not risk-sensitive thanks to deposit insurance.<sup>5</sup> Banks are protected by limited liability and repay depositors only when successful. If they fail, bank owners lose the invested capital. We largely base our model on the framework used in Dell’Ariccia and Marquez (2006), Allen et al. (2012), and Dell’Ariccia et al. (2013).

Loan portfolios are exposed to two sources of risk. The first is idiosyncratic risk. The portfolio of bank  $i$  returns  $R$  with probability  $q_i$  and zero otherwise, where  $q_i$  is the bank’s choice of monitoring

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<sup>4</sup>When bailouts leave rents to bank managers and creditors, they increase also their risk taking incentives. Our stylized model abstracts from effects on bank managers and creditors.

<sup>5</sup>In the absence of deposit insurance, the deposit rate would be risk-sensitive and reflect depositors’ expectations on bank solvency. This would strengthen our results on the “systemic insurance” effect of bailouts. The promise of a bailout would reduce the deposit rate and increase bank profits in case of success, which would make the positive effects of bailouts on bank monitoring larger.

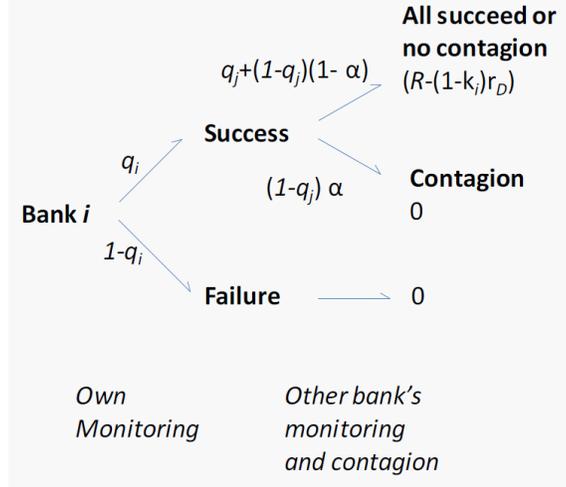


Figure 1: The game tree.

effort, which entails a cost  $\frac{1}{2}cq_i^2$ . We assume that  $c > (R - (1 - k_i)r_D) > 0$ ; this ensures that the model has an internal solution. For now, we assume that idiosyncratic risks are uncorrelated across banks; we discuss the case where banks can correlate their portfolio risks in Section 5.

The second source of risk – and the key feature of the model – is contagion. We assume that when one bank fails, there is a probability  $\alpha$  that (absent government intervention) the other bank’s portfolio will also become non-performing, independently of the other bank’s monitoring. In this section we treat  $\alpha$  as fixed, to showcase our results most directly. In Section 4 we allow banks to reduce their exposure to contagion at a cost, making  $\alpha$  an endogenous choice variable, and verify under what conditions our results continue to hold.

Banks choose their monitoring effort simultaneously and cannot observe each other’s choices. The game tree is shown in Figure 1.

### 3.1 Contagion and Risk Taking

We start by deriving the Nash equilibrium for the banks’ monitoring choices and showing that the risk of contagion reduces bank monitoring. We can write the expected profits of bank  $i$  as (for simplicity, throughout the paper, we omit the cost of equity):

$$E(\Pi_i) = q_i (1 - \alpha(1 - q_j)) (R - (1 - k_i)r_D) - \frac{c}{2}q_i^2. \tag{1}$$

On the right hand side,  $q_i(1 - \alpha(1 - q_j))$  is the probability that the bank's portfolio will be performing:  $q_i$  is the probability of the portfolio's idiosyncratic success, which can be reduced by the probability  $\alpha(1 - q_j)$  of contagion. The second term in brackets,  $(R - (1 - k_i)r_D)$ , is the payoff to shareholders in case of success, and  $-cq_i^2/2$  is monitoring effort cost.

From the first order conditions of (1) with respect to  $q_i$ , we obtain the reaction function:

$$\hat{q}_i = \frac{1 - \alpha(1 - q_j)}{c} (R - (1 - k_i)r_D). \quad (2)$$

And, imposing symmetry on (2), we obtain the symmetric Nash equilibrium:

$$\hat{q} = \frac{(1 - \alpha)(R - (1 - k)r_D)}{c - \alpha(R - (1 - k)r_D)} \quad (3)$$

From (3) it is immediate to see that the model entails two sources of inefficiency. The first, represented by the term  $-(1 - k)r_D$ , is classic moral hazard. Banks are protected by limited liability and their risk taking cannot be priced at the margin. Being levered, they tend to take on too much risk relative to what is socially optimal. Put differently, banks do not take into account the losses that their failure would impose on their creditors. The second inefficiency (the focus of this paper) is the externality associated with contagion, represented by  $\alpha$ . The undiversifiable risk of contagion reduces a bank's incentives to monitor its loans. Both sources of inefficiency lead to excessive risk taking by banks.

More formally, we can state the following result:

**Lemma 1** *The equilibrium monitoring effort of banks  $\hat{q}$  is decreasing in the probability of contagion given failure,  $\alpha$ :  $d\hat{q}/d\alpha < 0$ , and increasing in banks' capital:  $d\hat{q}/dk > 0$*

In particular,  $\hat{q} = 0$  for  $\alpha = 1$  (maximum contagion risk), and  $\hat{q} = \frac{1}{c}(R - r_D(1 - k))$  for  $\alpha = 0$  (no contagion risk). The externality associated with contagion lowers a bank's incentives to reduce its own idiosyncratic risk. This is because the risk of contagion reduces the payoff to monitoring: relative to the no-contagion case, for a given monitoring effort, the probability that a bank  $i$  receives the positive payoff  $(R - r_D(1 - k_i))$  is reduced by  $\alpha(1 - q_j)$ . The bank then adjusts its monitoring effort to equalize its marginal cost to a lower expected marginal revenue.

The risk of contagion (in equilibrium,  $\alpha(1-\hat{q})$ ) is exogenous to each bank but endogenous to the financial system. As a result, in equilibrium, the banking system will bear an inefficiently high level of risk. This stems from two different, but connected effects. First, a bank does not internalize the positive effect that its monitoring has on another bank’s expected profits, leading to a too low level of monitoring (as for any classic externality). The second effect stems from strategic interaction. As the private return to monitoring depends positively on the other bank’s monitoring effort, each bank reduces its monitoring effort further than if it were the only one facing the externality.

Capital maintains its classical “skin-in-the-game” role and reduces moral hazard effects stemming from limited liability. In addition, because of the complementarity in risk taking associated with contagion, it acquires a new dimension: by reducing risk taking at the bank level, it reduces contagion and hence risk taking in other banks. (We discuss the role of bank capital and how it interacts with risk externalities in Section 3.3)

### 3.2 Effects of Bailouts

Now consider the case when the government can support failing banks. Formally, assume that the government intervenes in a failing bank with probability  $\theta$ . The value of  $\theta$  is known in advance.<sup>6</sup> A government intervention has two effects. First, it prevents contagion: allows the other bank to survive intact and realize the full value of its profits. Second, it leaves some “bailout rents” to the failing bank (absence of bailout rents would reinforce our results). We model bailout rents by assuming that the bank gets to keep a share  $\delta < 1$  of the profits it could have made if it were idiosyncratically successful. A lower  $\delta$  represents a better ability by the government to make its intervention targeted (i.e. not benefitting shareholders of failing banks). The game tree with government intervention is shown in Figure 2.

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<sup>6</sup>The fact that  $\theta$  can take values between 0 and 1 captures the notion that the government’s exact reaction function may not be public knowledge, or more likely that it is not certain that, even in the case of intervention, default and contagion can be avoided. Also, note that here we assume that government needs to intervene before observing whether a failure is actually contagious. Under a “more efficient” bailout policy of only intervening after contagion is observed were available, our results would be even stronger. Such conditional policy would reduce moral hazard and tilt the balance more in favor of the “insurance” effect.

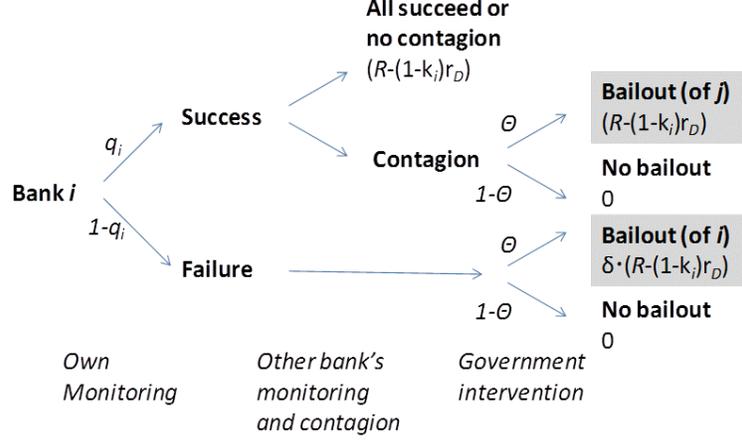


Figure 2: The game tree with bailouts.

Under these assumptions the expected profits of bank  $i$  become:

$$E(\Pi_i) = (q_i (1 - (1 - q_j) (1 - \theta)\alpha) + (1 - q_i) \theta \delta) (R - (1 - k_i) r_D) - \frac{c}{2} q_i^2. \quad (4)$$

Equation (4) has two extra elements relative to the case without intervention (equation (1)). First, the probability of contagion becomes  $(1 - q_j) (1 - \theta)\alpha$ , because, with probability  $\theta$ , bank  $j$  is bailed out. Second, also with probability  $\theta$ , bank  $i$  preserves a share of profits  $\delta$  when it would have idiosyncratically failed without government intervention.

From the first order conditions of (4) with respect to  $q_i$  we obtain the reaction function:

$$\hat{q}_i = \frac{(1 - (1 - q_j) (1 - \theta)\alpha - \theta \delta) (R - (1 - k_i) r_D)}{c}. \quad (5)$$

From (5) it is immediate that:

$$\frac{\partial \hat{q}_i}{\partial \theta} = \frac{\alpha (1 - q_j) - \delta}{c} (R - (1 - k_i) r_D). \quad (6)$$

That is, for a given monitoring effort by bank  $j$ , the change in the probability of bailout  $\theta$  affects bank  $i$ 's monitoring through two channels. The first channel (the first term in the numerator) is the positive effect of systemic insurance: bailouts reduce the threat of contagion, increasing the bank's incentives to monitor. This effect is stronger when the threat of contagion,  $\alpha (1 - q_j)$ , is

greater (when the probability of contagion given failure is larger and/or when bank  $j$  is riskier). The second channel (the second term in the numerator) is the classical moral hazard effect. The expectation that a bailout will allow shareholders to retain a share of profits  $\delta$  in case of failure reduces the bank's incentives to monitor its loan portfolio. This effect is stronger when the bailout rents are larger (higher  $\delta$ ).

Imposing symmetry on (5), we obtain the Nash equilibrium:

$$\hat{q}(\theta) = \frac{(1 - \alpha(1 - \theta) - \theta\delta)(R - (1 - k)r_D)}{c - \alpha(1 - \theta)(R - (1 - k)r_D)}. \quad (7)$$

We can now state the following proposition:

**Proposition 1** *For any  $\delta < 1$ , there exists  $\alpha^* = \frac{c\delta}{c - (1 - \delta)(R - (1 - k)r_D)}$ ,  $\frac{d\alpha^*}{d\delta} > 0$ , such that for  $\alpha > \alpha^*$ , equilibrium monitoring increases with the probability of government intervention:  $\frac{d\hat{q}(\theta)}{d\theta} > 0$ , and for  $\alpha < \alpha^*$ , the opposite occurs:  $\frac{d\hat{q}(\theta)}{d\theta} < 0$ .*

Proposition 1 is one key result of our paper. It establishes the “systemic insurance” effect of bailouts. In an environment where the probability of contagion given failure is high, while the rents associated with government support are low, insuring the banking system against contagion can increase monitoring incentives. This result stems from the two countervailing effects described above. A higher probability of bailout increases moral hazard since it leaves rents on the table for failing banks. But, at the same time, it corrects for the externality stemming from the threat of contagion, protecting banks from a risk that they cannot control. When the threat of contagion given failure is high, while the rents left to a failing bank are small, the second, “systemic insurance” effect prevails.

### 3.3 The Role of Bank Capital

We have shown that government intervention may, under certain conditions, reduce excess bank risk taking that arises from contagion risk. It is important to observe that this type of excess risk taking cannot be eliminated simply through higher bank capital (which would have been a more traditional policy). The reason is that such risk taking is driven not by leverage but by an

externality across banks which bank capital does not directly affect (things would be more complex if a bank's capital determined its exposure to contagion risk). Indeed, the level of monitoring where banks internalize the contagion externality is obtained by maximizing the joint profit of two banks (1) (assuming symmetrical  $k_i$ ):

$$q^* = \frac{(1 - \alpha)(R - r_D(1 - k))}{c - 2\alpha(R - r_D(1 - k))}. \quad (8)$$

From (3) and (8) it is easy to see that  $q^* > \hat{q}$  for any  $k$ . Moreover, the externality-driven excess risk taking increases under higher capital:

$$\frac{d(q^* - \hat{q})}{dk} > 0 \quad \text{and} \quad \frac{d(q^*/\hat{q})}{dk} > 0. \quad (9)$$

The intuition is as follows. Higher capital reduces bank risk taking. But banks with higher capital are also more averse to an exogenous source of risk. (Contagion risk is costlier for the shareholders of well-capitalized banks.) While higher capital makes the financial system safer, banks start preferring an even safer financial system, and the wedge between socially optimal and private bank risk choices in the presence of contagion increases.

The fact that capital cannot eliminate the contagion externality does not mean it does not serve a purpose in this model. On the contrary, risk externalities reinforce the rationale for capital regulation to reduce moral hazard. In addition to the traditional “skin-in-the-game” effect on individual bank's risk taking, an increase in a bank's capital will also improve incentives at other banks by reducing the risk of contagion. Indeed, it is easy to show that  $d\hat{q}_i/dk_j > 0$ .

### 3.4 Distressed Banks

As discussed above, the risk of contagion introduces a strategic complementarity in risk taking: when a bank believes that other banks are acting imprudently, it has greater incentives to do the same. This magnifies the systemic consequences of allowing distressed banks to continue to operate. Distressed institutions have incentives to gamble for resurrection. For instance, assume bank  $j$  has suffered losses that have depleted its capital. (Alternatively, one could think about a shock that

has decreased the bank’s returns in case of success  $R$ , with similar results.) From equation (5), it is immediate that a lower  $k_j$  leads to a lower  $q_j$ . Also from (5), a lower  $q_j$  leads to a lower  $q_i$ , i.e. the presence of “zombie” banks reduces screening incentives also for healthy banks. Essentially, distressed banks impose negative externalities *ax-ante*: by taking greater risks they increase the threat of contagion and reduce the returns to monitoring of otherwise healthy banks, pushing them to take more risk too.

These are exactly the circumstances under which the promise of a bailout is more likely to improve screening incentives (at healthy banks). From equation (6), we know that  $\partial \widehat{q}_i / \partial \theta$  is more likely to be positive when the risk of contagion,  $\alpha(1 - q_j)$ , is greater. From Proposition 1,  $d\alpha^* / dk > 0$ , suggesting that for lower levels of capital, the range of parameter values for which a bailout improves incentives, is wider.<sup>7</sup>

## 4 Endogenous Exposure to Contagion Risk

So far we have treated the probability of contagion given bank failure,  $\alpha$ , as exogenous. In this Section we allow banks to affect their exposure to contagion at a cost. Making contagion risk endogenous to bank choices creates an additional dimension of moral hazard: banks protect themselves less against contagion in response to anticipated bailouts. In principle this works against our result, and when such moral hazard is severe the systemic insurance effect may never be able to dominate it. However we find that when the bank’s cost of reducing the probability of contagion is sufficiently high, the bank’s equilibrium choice of exposure to contagion becomes relatively inelastic in the expected probability of a bailout, and the result that systemic insurance effect dominates moral hazard for sufficiently “effective” (with low rents) bailouts continues to hold.

### 4.1 Contagion and Risk Taking

Assume that banks can control their exposure to contagion. Formally, each bank can choose the probability,  $\alpha_i$ , of suffering contagion in case of the other bank’s failure. However, reducing this

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<sup>7</sup>Bailouts may also help weaker financial systems more when such systems have a higher probability of contagion  $\alpha$ . The next Section verifies that less capitalized banks tend to protect themselves against contagion less, leading to higher  $\alpha$ .

risk comes at a cost,  $\frac{1}{2}(1 - \alpha_i)^2 \xi$ . For brevity, let  $V$  denote a bank's profits in case of success  $V = (R - (1 - k)r_D)$ . We assume that the cost parameters  $c$  and  $\xi$  are such that they entail an interior solution:

$$V < \xi < \frac{V^2}{c - V}, \quad (10)$$

which implies  $V < c < 2V$ .<sup>8</sup>

Based on the modified assumptions above, the profit function (1) becomes:

$$E(\Pi_i) = q_i(1 - \alpha_i(1 - q_j))V - \frac{1}{2}cq_i^2 - \frac{1}{2}(1 - \alpha_i)^2 \xi. \quad (11)$$

We solve for the banks' choice of  $q_i$  and  $\alpha_i$  in stages, as if the bank chose  $q_i$  in stage one and  $\alpha_i$  in stage two. This is equivalent to a simultaneous choice of  $q_i$  and  $\alpha_i$  by each bank, because  $\alpha_i$  is not strategic (does not affect the payoff to bank  $j$  beyond its effect on  $q_i$ ).

Solving by backwards induction, the bank  $i$ 's first order condition with respect to  $\alpha_i$  gives:

$$\alpha_i(q_i, q_j) = 1 - \frac{q_i(1 - q_j)V}{\xi}. \quad (12)$$

The bank  $i$ 's chosen exposure to contagion is lower when the anticipated risk of another bank  $q_j$  is higher and the cost of insuring against contagion  $\xi$  is lower. Replacing (12) into the profit function (11) and taking the first order condition with respect to  $q_i$  gives:

$$q_i = \frac{q_j V}{c - \frac{1}{\xi}(1 - q_j)^2 V^2}. \quad (13)$$

Note that  $\frac{dq_i}{dq_j} > 0$ : as in the baseline model, there is strategic complementarity in bank risk taking.

The response function (13) supports two symmetric equilibria. One is  $q = q_0 = 0$ , corresponding to  $\alpha = \alpha_0 = 1$  (from (12)). The other is:

$$q = q_1 = 1 - \frac{\sqrt{\xi(c - V)}}{V},$$

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<sup>8</sup>Arguably, there may be a region where reducing exposure to contagion is not costly. In that region banks will always choose to reduce such exposure. Thus, the relevant region is one where further reductions are costly.

corresponding to  $\alpha = \alpha_1 = \frac{c}{V} - \sqrt{\frac{c-V}{\xi}}$ . From (10),  $0 < q_1 < 1$  and  $0 < \alpha_1 < 1$ , representing an interior solution. Observe that the  $q_i = q_1$  equilibrium (with positive profits) Pareto-dominates the  $q = q_0$  equilibrium (with zero profits). We focus on the  $q_i = q_1$  equilibrium in the analysis that follows.<sup>9</sup>

## 4.2 Effects of Bailouts

Now consider the case with government bailouts. Similar to (4), the profit function (11) becomes:

$$E(\Pi_i) = (q_i(1 - (1 - q_j)(1 - \theta)\alpha) + (1 - q_i)\theta\delta)V - \frac{c}{2}q_i^2 - \frac{1}{2}(1 - \alpha)^2\xi. \quad (14)$$

The first order condition with respect to  $\alpha_i$  gives:

$$\alpha(q_i, q_j) = 1 - \frac{q_i(1 - q_j)(1 - \theta)V}{\xi}. \quad (15)$$

Observe that bailout expectations,  $\theta$ , reduce the bank's incentives to limit contagion, resulting in a higher  $\alpha_i$  for given  $q_i$  and  $q_j$ . This is an additional moral hazard effect of bailouts, present when banks can affect their exposure to contagion. Replacing (15) into (14) and taking the first order condition with respect to  $q_i$  we get:

$$q_i = \frac{(1 - \theta\delta - (1 - \theta)(1 - q_j))V}{c - \frac{1}{\xi}(1 - \theta)^2(1 - q_j)^2V^2}. \quad (16)$$

Interestingly,  $q_i = q_j = 0$  is no longer an equilibrium when  $\theta > 0$ . Imposing symmetry on (16) gives:

$$q = \frac{(1 - \theta\delta - (1 - \theta)(1 - q))V}{c - \frac{1}{\xi}(1 - \theta)^2(1 - q)^2V^2}. \quad (17)$$

We are interested in  $dq/d\theta$ , and how it is affected by cost parameters  $\delta$  and  $\xi$ . One can demonstrate the following result:

**Proposition 2** *There exist a sufficiently low  $\delta$  and a sufficiently high  $\xi$  such that  $dq/d\theta > 0$ .*

<sup>9</sup>One can verify that the second order condition is satisfied for  $q_i = q_1$  and that the corner solution  $q_i = 1$  is not an equilibrium. (The third symmetric equilibrium of (13),  $q_2 = 1 + \sqrt{\xi(c - V)}/V$ , is larger than 1, so we disregard it.)

**Proof.** See Appendix. ■

Proposition 2 shows that there exist parameter values such that the systemic insurance effect of bailouts dominates the two moral hazard effects – the effect on bank monitoring related to bailout rents and the effect on the bank’s choice of exposure to contagion. Specifically, this holds when moral hazard effects are limited. That is when bailout rents are sufficiently low (as in Proposition 1), while the costs of protecting against contagion are sufficiently high, making the bank’s choice of exposure to contagion inelastic in the probability of a bailout.

## 5 Correlated Risks

So far, we have assumed that banks’ idiosyncratic risks were uncorrelated. In this section we extend the model to examine the effects of bailouts when banks can correlate their risk with that of other banks. The literature suggests that the correlation of risk across banks is a major prudential concern, since joint failures of banks are socially costly (Acharya, 2009; Acharya et al., 2012).

The literature typically approaches the link between bailouts and risk correlation by assuming that the government is more likely to intervene when multiple banks fail together. Then, banks want to correlate their risks in order to maximize the probability of a joint failure, which would trigger a bailout and protect banks from downside risk realizations (Acharya and Yorulmazer, 2007; Farhi and Tirole, 2012).

We introduce into this analysis the possibility of contagion. We start from the observation that contagion by itself already creates incentives for banks to correlate their portfolios. Banks want to succeed or fail together, if they believe that the failure of other banks would expose them to the risk of contagion, which would negate the benefits of their idiosyncratic success (cf. Acharya and Yorulmazer, 2008b). Going back to our risky flight: for given probabilities of having a heart attack and crashing with a plane, would not you rather have the two happen at the same time? We proceed to show that, by protecting banks against contagion, bailouts may reduce banks’ incentives to correlate their risks.

## 5.1 Contagion and Correlated Risks

Consider a slightly modified version of our benchmark model of Section 3. As before, consider two ex-ante identical banks. But assume that there are two sectors in the economy. Each bank can lend to only one sector. And the two banks can coordinate on lending to the same or different sectors. When banks lend to different sectors the model is identical to that in the previous section: idiosyncratic risk realizations are independently distributed, and banks are exposed to an undiversifiable contagion risk. When banks lend to the same sector, their idiosyncratic risks are correlated. Formally, when banks have the same effort,  $q_i = q_j$ , they succeed or fail simultaneously. (Efforts will be equal in equilibrium for symmetric banks.) And when, out of equilibrium, banks choose different effort levels, the bank with the higher effort succeeds in all states of the world in which the bank with the lower effort does. This makes the conditional probability that bank  $i$  is successful when bank  $j$  is successful equal to: 1 for  $q_i \geq q_j$ , and  $q_i/q_j$  for  $q_i < q_j$ .

Note that when banks' idiosyncratic risks are fully correlated, banks are *de facto* not subject to the risk of contagion. Indeed, contagion has a meaningful effect on bank profits only when one bank's idiosyncratic realization is positive and the other is negative (so that the distress of a failing bank can be passed through to an otherwise sound bank). But when individual risks strike simultaneously, contagion is irrelevant.<sup>10</sup>

We assume that when banks lend to the same sector, competition for the same pool of lending opportunities reduces their return in case of success by a measure  $H$ .<sup>11</sup> Banks move in a sequential fashion with regard to their choice of sectors. (This ensures that there are no coordination failures; the results are the same when banks move simultaneously but can coordinate their choices.) Banks lend to different sectors when indifferent. After choosing sectors, banks choose monitoring efforts simultaneously as in the main model.

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<sup>10</sup>In practice, it may be that the probability of contagion increases with the correlation of idiosyncratic risks. For instance, contagion may be stronger when banks invest in the same or similar sectors, but do not achieve the full correlation of returns, so as to make contagion risk irrelevant. By focusing on full correlation, our model abstracts from this issue. If such effects were present, the results in this section would depend on the functional form of the relationship between the correlation of idiosyncratic risks with the risk of contagion.

<sup>11</sup>This can result from funding more marginal projects and from compressed margins due to increased competition for the same borrowers. For our analysis the two sources of decreased profitability are equivalent. From an aggregate welfare standpoint, however, the first would be a net loss, while the second would be just a transfer and may actually be welfare improving if it reduces oligopolistic rents.

As usual, we solve the game by backward induction. Recall that we denote the bank's payoff in case of success as  $V = (R - (1 - k_i) r_D)$ . Assume without loss of generality that bank  $j$  chooses the sector first. Consider the maximization problem for bank  $i$ . If it chooses to lend to a sector different from bank  $j$ , it will remain exposed to contagion and equations are identical to those in the previous section. The profit function is (1), the Nash equilibrium effort is (3), and substituting (1) into (3) obtains equilibrium profits:

$$E(\widehat{\Pi}_U) = \frac{c}{2} \left( \frac{(1 - \alpha)V}{c - \alpha V} \right)^2. \quad (18)$$

If, instead, bank  $i$  lends to the same sector as bank  $j$ , the profit function for  $q_i \leq q_j$  (this includes the case  $q_i = q_j$ , which we will show to hold in equilibrium) becomes:

$$E(\Pi_i | q_i \leq q_j) = q_i(V - H) - \frac{c}{2} q_i^2. \quad (19)$$

Note two differences with (1). First, there is no term  $-\alpha(1 - q_j)$  in the probability of success: when banks lend to the same sector, they idiosyncratically succeed or fail together, so there is no risk of contagion. So contagion risk increases incentives to correlate bank risks. Second, there is an additional term  $-H$  in the payoff in case of success, reflecting a less profitable lending environment when banks focus on the same sector. This reduces incentives to correlate risks.

For  $q_i > q_j$ , the profit function is:

$$E(\Pi_i | q_i > q_j) = (q_i - \alpha(q_i - q_j))(V - H) - \frac{c}{2} q_i^2. \quad (20)$$

**Lemma 2** *Conditional on banks lending to the same sector, the monitoring effort game admits a continuum of symmetric Nash equilibria:*

$$q_i = q_j = \widehat{q} \in \left[ \frac{(1 - \alpha)(V - H)}{c}, \frac{V - H}{c} \right].$$

*Of these, the equilibrium with the highest  $\widehat{q}$  is Pareto-dominant.*

**Proof.** In Appendix A. ■

In what follows, we focus on the Pareto-dominant Nash equilibrium of bank monitoring effort:

$$q_i = q_j = \hat{q} = \frac{V - H}{c}. \quad (21)$$

So, when banks lend to the same sector their expected profits are:

$$E(\hat{\Pi}_C) = \frac{c}{2} \left( \frac{V - H}{c} \right)^2. \quad (22)$$

Bank  $i$  is indifferent between the two sectors when  $E(\hat{\Pi}_U) = E(\hat{\Pi}_C)$ , corresponding to (from (18) and (22)):

$$\tilde{H} = \frac{\alpha V (c - V)}{c - \alpha V}. \quad (23)$$

In equilibrium, banks lend to different sectors for  $H \geq \tilde{H}$ , and to the same sector for  $H < \tilde{H}$ . Note that  $\partial \tilde{H} / \partial \alpha > 0$ : the contagion externality makes the correlation of risks – lending to the same sector – more attractive.

When contagion risks are severe, banks herd in their choice of assets (in our model, the choice of sector that they lend to) and are willing to accept lower margins in case of success. This, in turn, leads to greater risk taking.

## 5.2 Effects of Bailouts

Now consider the case when, similarly to the main model, the government commits to support any failing bank with probability  $\theta$ .

When banks lend to different sectors, the model is again identical to that in the previous section. The profit function is (4), the Nash equilibrium effort is (7), and substituting (4) into (7) obtains equilibrium profits:

$$E(\hat{\Pi}_U | \theta) = \left( \frac{(1 - \alpha(1 - \theta) - \theta\delta)V}{c - \alpha(1 - \theta)V} \right)^2 \frac{c}{2} + \theta\delta V. \quad (24)$$

In contrast, when banks lend to the same sector, the profit function for bank  $i$  for  $q_i \leq q_j$  is:

$$E(\Pi_i | q_i \leq q_j) = (q_i + \delta\theta(1 - q_i))(V - H) - \frac{c}{2}q_i^2, \quad (25)$$

and for  $q_i > q_j$  is:

$$E(\Pi_i | q_i > q_j) = (q_i - \alpha(1 - \theta)(q_i - q_j)) + \delta\theta(1 - q_i)(V - H) - \frac{c}{2}q_i^2 \quad (26)$$

Similar to Lemma 1, the Pareto-dominant Nash equilibrium of bank monitoring effort is:

$$q_i = q_j = \hat{q} = \frac{(1 - \delta\theta)(V - H)}{c}. \quad (27)$$

Since there is no contagion risk when banks lend to the same sector, the promise of a bailout has an unequivocally detrimental effect on monitoring.

The equilibrium profits are:

$$E(\hat{\Pi}_C | \theta) = \frac{(1 - \delta\theta)^2 (V - H)^2}{2c} + \delta\theta(V - H). \quad (28)$$

The bank  $i$  is indifferent between the two sectors for  $E(\hat{\Pi}_U | \theta) = E(\hat{\Pi}_C | \theta)$ :

$$\left( \frac{(1 - \alpha(1 - \theta) - \theta\delta)V}{c - \alpha(1 - \theta)V} \right)^2 \frac{c}{2} + \theta\delta V = \frac{(1 - \delta\theta)^2 (V - H)^2}{2c} + \delta\theta(V - H), \quad (29)$$

which gives the threshold  $\tilde{H} > 0$ . In equilibrium, banks lend to different sectors for  $H \geq \tilde{H}$ , and to the same sector for  $H < \tilde{H}$ .

We can now study how  $\tilde{H}$  is affected by a change in  $\theta$ .

**Proposition 3** For  $\delta < 1$  and  $\alpha > \alpha^* = \frac{c\delta}{c - (1 - \delta)(R - (1 - k)r_D)}$  (same as in Proposition 1), a higher probability of government support reduces banks' incentives to invest in the same sector:  $\frac{d\tilde{H}(\theta)}{d\theta} < 0$ .

**Proof.** In Appendix B. ■

Proposition 3 shows that when contagion pushes banks to correlate risk, government intervention reduces their incentives to do so whenever it has a positive impact on bank risk taking. Note that this is a sufficient condition, but not a necessary one (i.e., the range of parameter values for which bailouts reduce the correlation of bank risks can be wider). The intuition is as follows. Abstracting from the effects of bailouts on effort – holding  $q$  exogenous – makes  $d\tilde{H}(\theta)/d\theta < 0$  hold always.

When  $q$  is endogenous, bailouts affect effort. Recall that bailouts always reduce effort when banks correlate their risk. When bailouts increase effort in the uncorrelated sector ( $\alpha > \alpha^*$ ), this makes the uncorrelated sector more attractive, so  $d\tilde{H}(\theta)/d\theta < 0$  again holds (this is the Proposition 2). But when bailouts reduce effort in the uncorrelated sector too ( $\alpha < \alpha^*$ ), and that effect is substantial ( $\delta$  is high),  $d\tilde{H}(\theta)/d\theta < 0$  may not hold.

The results in this section rely on the implicit assumption that any announced bailout policy is credible. In practice, governments may have a greater incentive to intervene when several banks fail at the same time (Acharya and Yorulmazer, 2007; Farhi and Tirole, 2012). Our model is too stylized to examine this type of time inconsistency (one would need to model explicitly the reaction function of the authorities, including the cost of intervention). Yet, in reduced form, this would imply that the bailout expectations are higher when banks are in the correlated sector. If this effect is strong enough, and bailout rents are sufficiently high, government intervention may only have the effect of increasing bank incentives to correlate risks. And, as a result, it will unequivocally lead to greater risk taking.

At the same time, when bailouts are *ex ante* optimal in our model, time inconsistency would imply that the government promises a bailout *ex ante* but reneges by not bailing out a bank that fails alone *ex post*. The government, in effect, would intervene too little. This contrasts with the common view that the government is likely to intervene too much (as in Acharya and Yorulmazer, 2007, and Farhi and Tirole, 2012). Of course one can suggest economic reasons for too little intervention *ex post* (e.g. a high cost of public funds), but these reasons are less powerful for low bailout rents (and hence costs) – the same parameter that makes a bailout optimal in the first place. So the time inconsistency arguments are less pertinent to our analysis than to other models of bailouts.

## 6 Conclusions

This paper revisits the link between bailouts and bank risk taking. It is accepted that bailouts have a moral hazard effect that encourages risk taking. However, we also show that when there are risk externalities across banks, this effect coexists with an opposite one: bailouts protect prudent

banks against contagion. This encourages monitoring and reduces bank risk taking. On net, a government's commitment to save systemic banks when the threat of contagion is high may reduce risk taking by all banks even when bailouts leave banks some (modest) rents.

We show that the systemic insurance effect of bailouts may dominate even when banks can affect their exposure to contagion conditional on the cost of doing so being sufficiently high. And that a similar systemic insurance effect exists with regard to the correlation of risk across banks.

The model is open to extensions and interpretations. The concept of "insufficient monitoring" can be interpreted as a variety of business practices that generate short-term return at expense of higher long-term risk: fee- and volume-based banking, lending with teaser rates, or the use of cheaper but unstable short-term funding. Our analysis shows that banks will have more incentives to engage in short-termist strategies when they are exposed to contagion risk that affects their long-term returns, especially if other banks are also engaging in such strategies. The model can also be rewritten to study spillovers in international contagion. For example, it would suggest that countries with debt overhang have low incentives to implement macroeconomic adjustment programs if they are subject to contagion from other countries with similar problems. A joint approach to such countries would be preferable.

The model approaches the issue of contagion in a reduced-form fashion. Future work could explore how the structure of the banking system affects the probability of contagious failures in the context of endogenous risk taking. For instance, what is the relationship between bank concentration or competition and risk taking and the risk of contagion? How does this affect the relationship between bailout policies and risk taking incentives? We leave these questions for future research.

The results in our paper offer policy implications relevant to the current bank resolution and crisis management debates. In particular, the results suggest that regulation that creates impediments to timely and targeted intervention (with the objective of reducing moral hazard) may at times back fire. First, to the extent that contagion is a serious concern for banks, it may reduce their incentives to reduce idiosyncratic risk taking. Second, by reducing the scope for timely, targeted interventions it may leave governments with no *ex-post* options but to undertake more macro, less targeted bailouts, which leave greater rents to failing banks and hence are more distortive. The model suggests that a more promising policy direction is to focus on the efficiency of

interventions: creating legal and practical conditions where interventions in distressed banks can be undertaken easily but “effectively”: leaving bank shareholders (and other stakeholders) as little rents as possible.

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## A Proof of Proposition 2.

We intend to show that for a sufficiently low  $\delta$  and a sufficiently high  $\xi$ ,  $dq/d\theta > 0$ .

To sign  $dq/d\theta$ , use the implicit function theorem. Rewrite (17) as

$$Z = cq - \frac{q}{\xi} (1 - \theta)^2 (1 - q)^2 V^2 - (1 - \theta\delta - (1 - \theta)(1 - q)) V = 0, \quad (30)$$

and recall that  $\frac{dq}{d\theta} = -\frac{\partial Z}{\partial \theta} / \frac{\partial Z}{\partial q}$ . Now sign the two latter terms separately.

Start with  $dZ/d\theta$ . Differentiating (30) and arranging the terms, we obtain:

$$\frac{\partial Z}{\partial \theta} = (1 - q) \left( 2q(1 - q)(1 - \theta) \frac{V}{\xi} + \left( \frac{\delta}{(1 - q)} - 1 \right) \right) V. \quad (31)$$

Note that  $\partial Z/\partial \theta < 0$  for  $\delta = 0$ , since  $V/\xi < 1$  (from (10)) and  $q(1 - q) < \frac{1}{4}$ . And, by continuity, there exists a neighborhood of sufficiently small  $\delta$  such that  $\partial Z/\partial \theta < 0$  holds there too.

Now consider  $dZ/dq$ . Again, differentiating (30) and arranging the terms, we obtain:

$$\frac{\partial Z}{\partial q} = c - V(1 - \theta) \left( 1 + \frac{(1 - 3q)(1 - q)(1 - \theta)V}{\xi} \right). \quad (32)$$

Note that for  $\xi = \frac{V^2}{c - V}$  (the maximum  $\xi$  that satisfies restriction (10)):

$$\left. \frac{\partial Z}{\partial q} \right|_{\xi = \frac{V^2}{c - V}} = (c - V)(1 - \theta)^2 q(4 - 3q) + \theta V + (c - V)\theta(2 - \theta) > 0. \quad (33)$$

And, by continuity, there exists a neighborhood of sufficiently high  $\xi$  (but such that  $\xi < \frac{V^2}{c - V}$ ) such that  $\partial Z/\partial \theta > 0$  holds there too.

Therefore, for a sufficiently low  $\delta$  and a sufficiently high  $\xi$ ,  $\frac{\partial Z}{\partial \theta} < 0$  and  $\frac{\partial Z}{\partial q} > 0$ , making  $dq/d\theta > 0$ . ■

## B Proof of Lemma 2.

We intend to show that under (19) and (20), the game admits a continuum of symmetric equilibria:

$$q_i = q_j = \hat{q} \in \left[ \frac{(1-\alpha)(V-H)}{c}, \frac{V-H}{c} \right].$$

For  $q_j = \hat{q} \in \left[ \frac{(1-\alpha)(V-H)}{c}, \frac{V-H}{c} \right]$ , a deviation  $q_i > q_j$  is not profitable, since the marginal cost,  $cq_i$ , greater than the marginal expected revenue  $(1-\alpha)(V-H)$  (since in those states of the world bank  $j$  always fails). A deviation  $q_i < q_j$ , is not profitable, since its marginal cost, again  $cq_i$ , is smaller than the marginal expected revenue,  $V-H$  (in those states of the world bank  $i$  is not exposed to contagion since  $q_i < q_j$ ). By the same argument there cannot be any asymmetric equilibrium with  $q_i$  or  $q_j$  in the range  $\left[ \frac{(1-\alpha)(V-H)}{c}, \frac{V-H}{c} \right]$ .

It is left to show that no equilibrium exists with  $q_i$  and  $q_j$  outside of the range  $\left[ \frac{(1-\alpha)(V-H)}{c}, \frac{V-H}{c} \right]$ . Assume  $q_j > \frac{V-H}{c}$ . The best response for bank  $i$  is  $q_i = \frac{V-H}{c}$  (since for  $q_i < q_j$ , expected profits are  $q_i(V-H) - \frac{c}{2}q_i^2$ ). And, as shown above, for any  $q_i > q_j$ , the marginal cost would exceed the marginal expected revenue. For  $q_i = \frac{V-H}{c}$ , the best response is  $q_j = \frac{V-H}{c}$ . So there cannot be an equilibrium with  $q_i$  or  $q_j$  greater than  $\frac{V-H}{c}$ .

Now consider  $q_j < \frac{(1-\alpha)(V-H)}{c}$ . The best response for bank  $i$  is  $q_i = \frac{(1-\alpha)(V-H)}{c}$ , since for  $q_i > q_j$ , the expected marginal revenue is  $(1-\alpha)(V-H)$ . But the best response to  $q_i = \frac{(1-\alpha)(V-H)}{c}$  is  $q_j = \frac{(1-\alpha)(V-H)}{c}$ . So there cannot be an equilibrium with  $q_i$  or  $q_j$  smaller than  $\frac{(1-\alpha)(V-H)}{c}$ .

Finally, note that since in all symmetric equilibria for this game expected profits can be written as  $q_i(V-H) - \frac{c}{2}q_i^2$ . They are maximized for the symmetric equilibrium  $\hat{q} = \frac{(V-H)}{c}$ , i.e.  $\hat{q} \in \frac{(V-H)}{c}$  Pareto-dominates all the other equilibria. ■

## C Proof of Proposition 3.

Define:

$$Z \equiv E(\widehat{\Pi}_U|\theta) - E(\widehat{\Pi}_C|\theta). \quad (34)$$

Then:

$$\frac{d\tilde{H}}{d\theta} = -\frac{\frac{\partial Z}{\partial \theta}}{\frac{\partial Z}{\partial H}}. \quad (35)$$

Substitute (24) and (28) into (34) to obtain:

$$Z = \left( \frac{(1 - \alpha(1 - \theta) - \theta\delta)V}{c - \alpha(1 - \theta)V} \right)^2 \frac{c}{2} - \frac{(1 - \delta\theta)^2(V - H)^2}{2c} + \delta\theta H, \quad (36)$$

which immediately yields:

$$\frac{\partial Z}{\partial H} = \frac{2(1 - \delta\theta)^2(V - H)}{2c} + \delta\theta > 0$$

and

$$\frac{\partial Z}{\partial \theta} = c(1 - \alpha(1 - \theta) - \theta\delta)V^2 \frac{\alpha(c - V) - \delta(c - \alpha V)}{(c - \alpha(1 - \theta)V)^3} + \frac{2\delta(1 - \delta\theta)(V - H)^2}{2c} + \delta H. \quad (37)$$

Note that all multipliers are positive, except  $\alpha(c - V) - \delta(c - \alpha V)$ . Recall that we consider  $\alpha > \frac{c\delta}{c - (1 - \delta)(R - (1 - k)r_D)}$ . Rewrite the term as:

$$\begin{aligned} \alpha(c - V) - \delta(c - \alpha V) &= \alpha(c - V(1 - \delta)) - c\delta \\ &> \frac{c\delta}{c - (1 - \delta)V} (c - V(1 - \delta)) - c\delta = 0. \end{aligned}$$

So all terms are positive:  $\frac{\partial Z}{\partial \theta} > 0$ , making  $\frac{d\tilde{H}}{d\theta} < 0$ . ■