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Bailouts and Systemic Insurance

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Abstract

We revisit the link between bailouts and bank risk taking. The expectation of government support to failing banks creates moral hazard—increases bank risk taking. However, when a bank's success depends on both its effort and the overall stability of the banking system, a government's commitment to shield banks from contagion may increase their incentives to invest prudently and so reduce bank risk taking. This systemic insurance effect will be relatively more important when bailout rents are low and the risk of contagion (upon a bank failure) is high. The optimal policy may then be not to try to avoid bailouts, 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 risk realizations to the taxpayer. So the 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 expected 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. While banks have some control over direct exposures, the indirect links are largely beyond an individual bank's control. 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 initial results: banks take more risk when other banks take more risk, because risk taking of other banks increases the threat of contagion.[1]

Under these circumstances, when the government commits to stem the systemic effects of bank failure, it 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 that increases banks' incentives to monitor loans (this is similar to the effect identified for macro shocks by Cordella and Levy-Yeyati, 2003, and to that of IMF lending to sovereigns in Corsetti et al., 2006). The promise of bailout removes a risk outside the control of a bank and increases its return to monitoring. Going back to our risky flight parable, how would your choice of meal change if you had a parachute?

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 the quality of their own portfolio. The risk of contagion is exogenous to individual banks (it cannot be managed or diversified), 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 to two inefficiencies. First, banks are protected by limited liability and informational asymmetries prevent investors from pricing risk at the margin. As a result, in equilibrium banks will 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 externality, this exogenous source of risk reduces the private return to portfolio monitoring/screening. Bank increase idiosyncratic risk, increasing also the contagion externality.

[1] While we focus on the risk that a bank failure imposes on other banks, other papers have focused on the 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).

Capital requirements cannot fully correct this problem: even a bank fully funded by capital will take excessive risk when exposed to risk externalities.

Against this background, government intervention in support of failing banks has two opposite effects on incentives. It exacerbates the moral hazard problem stemming from limited liability, but reduces the externality problem associated with contagion. The extent of moral hazard depends on the rents that the government leaves to bailed out banks, while the importance of the "systemic insurance" effect 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 and better *ex ante* outcomes.

The "systemic insurance" effects continue to be present when we allow banks to correlate their investments. The threat of contagion may induce banks to excessively correlate their portfolios, because contagion discourages strategies that pay off when other banks fail (Acharya and Yorulmazer, 2007). Such correlation may be undesirable for a number of reasons – inefficient distribution of credit in the economy, lower bank profits, or an increased probability of simultaneous bank failures (which are socially costly; Acharya, 2009). We show that the expectations of government support may reduce banks' incentives to correlate their investments by decreasing the risk of contagion.

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 weak banks and high probability of contagion) with well-designed bank resolution rules (which minimize bailout rents). Second, we focus on *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. Third, and most critically, we assume that the government is able to commit to a given bailout strategy. In a richer model with potential time inconsistencies in the government reaction function, outcomes may be more complex. In particular, banks may find it optimal to take correlated risks if they believe that bailouts will be more likely when many of them fail simultaneously (Farhi and Tirole, 2012). We discuss this later.

Several recent papers have explored the effects of expected government support on bank risk taking (Acharya and Yorulmazer, 2007 and 2008a; Diamond and Rajan, 2009; Farhi and Tirole, 2012). In these papers, bailouts increase risk taking and generate a strategic complementarity among banks when the probability of bailouts increases with the share of the banking system that is in distress. We add to that literature by introducing a risk externality in the form of an undiversifiable contagion risk. This risk externality creates an additional strategic complementarity in risk taking, one that does not result from government policy. In contrast to the existing literature, by preventing contagion, bailouts can reduce the strategic externalities and bank risk taking.

The paper relates to the literature on government intervention as a means of preventing contagion (Freixas et al., 2000; Allen and Gale, 2001; Diamond and Rajan, 2005). The observation that by removing exogenous risk the government can improve banks' monitoring incentives was first made by Cordella and Levy-Yeyati (2003), in the context of macroeconomic shocks. Our model builds on their work by making these shocks endogenous to the banking system, thus offering a link between individual bank risk taking and systemic risk.[2]

The rest of the paper is structured as follows. Section 2 discusses stylized facts on contagion and bailouts, which we use as a foundation for our analysis. Section 3 presents the model of bank risk taking and bailouts. Section 4 extends the model to the case of correlated risks. Section 5 concludes.

2 Stylized Facts on Contagion and Bailouts

The model relies on two key assumptions. One is that an individual bank cannot fully manage or diversify the risk of being affected by contagion. The other is that government support shields healthy banks from contagion, but leaves rents to failing ones. In this section, we discuss these assumptions in the context of the existing literature.

[2] 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.

Contagion. The literature highlights three channels of contagion. One is macro contagion, where a failure of a bank worsens macroeconomic fundamentals, which can lead to failures of 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). The final channel is fire sales by distressed banks, which lower asset prices and affect balance sheet constraints of other banks, pushing them to sell at a loss too. Fire sales can affect asset markets (Lorenzoni, 2008; Korinek, 2011) or, in the form of freezes, bank funding markets (Caballero and Krishnamurthy, 2003; Diamond and Rajan, 2005).

Note that it is impossible for an individual bank, operating in a modern banking system, to fully protect itself from contagion. This feature is most immediate for macro contagion. But the same holds to some extent for counterparty risks. First, a bank always needs to maintain some counterparty exposures (e.g. interbank deposits which support the payments system and allow banks to manage liquidity), and these exposures may have to be with certain banks (major "money center" banks). Second, 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).[3] Similarly, while some fire sale risks can be reduced, others cannot, e.g. exposures to wholesale funding markets for banks that face a shortage of deposits.

Consistent with this view, we focus on the component of contagion risk that banks cannot manage or diversify (we call it simply, contagion risk). In the model, the risk of contagion results from two factors. The first is endogenous individual bank risk taking. The second is the probability of contagion given a bank's failure. In practice, this conditional probability is determined by the stage of the business cycle, the average strength of the banking system, or the overall design of the financial system – all of which are of interest but outside of an individual bank's control. Accordingly, given the focus of this paper and to keep the model tractable, we model the probability of contagion given a bank's failure as an exogenous parameter.

Bailout rents. 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)

[3] Also, some interbank exposures may be economically beneficial because they provide market discipline (Rochet and Tirole, 1996).

takeovers by the government. During the 2008 crisis, however, support also came through "macro" measures, such as exceptionally accommodating fiscal and monetary policies (Laeven and Valencia, 2010).

Most often, government support leaves "bailout rents" to the incumbent shareholders (and other stakeholders) of distressed banks. When the government lacks legal tools to take over a bank of 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, so shareholders benefit from a bailout. Bailout rents generate moral hazard: they protect shareholders from downside risk realizations, and hence increase their risk taking incentives.[4] 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 another 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.[5] 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 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

[4] Bailouts can leave rents to bank managers and creditors too, in which case they increase also their risk taking incentives. Our stylized model abstracts from effects on bank managers and creditors.

[5] 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.

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 4).

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 α that (absent government intervention) the other bank's portfolio will also become non-performing, independently of the other bank's monitoring. The risk of contagion cannot be managed or diversified (see Section 2).

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 of bank monitoring choices and showing that the risk of contagion reduces bank monitoring. We can write the expected profits of bank i as:

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

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. Also there, $(R-(1-k_i)\,r_D)$ is the payoff to shareholders in case of success, and $-cq_i^2/2$ is the cost of effort.

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

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

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

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

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 classical moral hazard. Banks are protected by limited liability and their risk taking cannot be priced at the margin. Being levered, they will tend to take on too much risk relative to what is socially optimal. The second inefficiency (the focus of this paper) is the externality associated with contagion, represented by α. 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* $\widehat{q}$ *is decreasing in the probability of contagion given failure,* α*:* $d\widehat{q}/d\alpha < 0$*, and increasing in banks' capital:* $d\widehat{q}/dk > 0$

In particular, $\widehat{q} = 0$ for $\alpha = 1$ (maximum contagion risk), and $\widehat{q} = \frac{1}{c}\left(R - r_D\left(1-k\right)\right)$ 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 $\left(R - r_D\left(1-k_i\right)\right)$ 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, $\alpha(1-\widehat{q})$) 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 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 risk taking in other banks. (We discuss the role of 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 θ. The value of θ is known in advance.[6] 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.[7] A lower δ represents a better ability by the government to make intervention targeted (i.e. not benefitting shareholders of failing banks). The game tree with government intervention is shown in Figure 2.

Under these assumptions the expected profits of bank i become:

$$E(\Pi_i) = \left(q_i\left(1-(1-q_j)(1-\theta)\alpha\right) + (1-q_i)\,\theta\delta\right)\left(R-(1-k)\,r_D\right) - \frac{c}{2}q_i^2. \tag{4}$$

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

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

$$\widehat{q_i} = \frac{\left(1-(1-q_j)(1-\theta)\alpha - \theta\delta\right)\left(R-(1-k)\,r_D\right)}{c}. \tag{5}$$

From (5) it is immediate that:

$$\frac{\partial\widehat{q_i}}{\partial\theta} = \frac{\alpha\,(1-q_j)-\delta}{c}\left(R-(1-k)\,r_D\right). \tag{6}$$

[6] The fact that θ 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.

[7] 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 still hold. Moreover, such policy would reduce moral hazard and tilt the balance more in favor of the "insurance" effect.

That is, for a given monitoring effort by bank j, the change in the probability of bailout θ 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 (that is when the probability of contagion given failure is larger and/or when bank j is perceived as riskier). The second channel (the second term in the numerator) is the classical moral hazard effect. The expectation of retaining a share of profits δ in case of failure and bailout reduces the bank's incentives to monitor its loan portfolio. This effect is stronger when the bailout rents are larger (higher δ).

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

$$\widehat{q}(\theta) = \frac{(1-\alpha(1-\theta)-\theta\delta)(R-(1-k)r_D)}{c-\alpha(1-\theta)(R-(1-k)r_D)} \tag{7}$$

We can now state the following proposition:

Proposition 1 *For $\delta < 1$, 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: $\frac{d\widehat{q}(\theta)}{d\theta} > 0$, and for $\alpha < \alpha^*$, the opposite occurs: $\frac{d\widehat{q}(\theta)}{d\theta} < 0$.*

Proposition 1 is the key result of our paper. It establishes the "systemic insurance" effect of bailouts. In states of the world 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 showed that government intervention may, under certain conditions, reduce excess bank risk taking that arises due to contagion. It is important to observe that this type of excess risk taking cannot be reduced simply through higher bank capital (which would have been a more traditional policy). The reason is that this risk taking is driven not by leverage but by an externality across banks which bank capital does not directly affect. Indeed, the level of monitoring where banks internalize the contagion externality is obtained by maximizing (1) with respect to $q_i = q_j$ jointly (assuming symmetrical k_i):

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

It is easy to see that $q^* > \widehat{q}$ for any k.

Moreover, the externality-driven excess risk taking in fact increases under higher capital:

$$\frac{d\left(q^* - \widehat{q}\right)}{dk} > 0 \text{ and } \frac{d\left(q^*/\widehat{q}\right)}{dk} > 0 \tag{9}$$

The intuition is that banks with higher capital are idiosyncratically safer (prefer higher monitoring) and so are more averse to an exogenous source of risk. Contagion is more costly for the shareholders of well-capitalized banks.

This does not mean that in this model capital does not serve a purpose. On the contrary, the existence of risk externalities reinforces 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 capital will also improve incentives at other banks by reducing the risk of contagion. Indeed, it is easy to show that $\frac{d\widehat{q}_i}{dk_j} > 0$.

3.4 The Case with Distressed Banks

As discussed above, the risk of contagion introduces a strategic complementarity in risk taking: when a bank believes that other banks are taking great risks, it has 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. In this model, this translated into lower q.

For instance, assume bank j has suffered losses that have depleted its capital. From equation (5), it is immediate that a lower k_j leads to a lower q_j. Alternatively, one could think about a shock that has decreased the profitability of the bank's portfolio in case of success (a lower R), with similar results. From equation (5), it is immediate that the presence of such "zombie" banks reduces screening incentives for healthy ones. 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 $\frac{\partial \widehat{q_i}}{\partial \theta}$ is more likely to be positive when the risk of contagion, $\alpha\left(1-q_j\right)$, is greater. And this is the case when q_j is smaller, for example because k_j and/or R_j are smaller.

4 A Model with Correlated Risks

The previous section showed that bailouts may improve bank incentives by protecting them from a source of risk outside their control. In this section we study how the risk of contagion and expectations of a government bailout affect bank incentives to correlate credit risk.

Consider a slightly modified version of our model. 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 choose the same effort, $q_i = q_j$, they succeed or fail simultaneously. (In our model, $q_i = q_j$ always holds in equilibrium, because we focus on symmetric banks.) And when, out of equilibrium, banks choose different effort, for example, $q_i > q_j$, bank i's portfolio performs in all states of the world in which bank j's portfolio does. This makes the conditional *probability*(i is successful$|j$ is successful) $= 1$ for $q_i \geq q_j$ and $= q_i/q_j$ for $q_i < q_j$.

Note that when banks succeed or fail simultaneously, they are not subject to the risk of contagion. Indeed, contagion has a meaningful effect on bank profits only when one banks succeeds while another fails (so that the distress of a failing bank is passed through to an otherwise sound bank). But when banks succeed or fail simultaneously, contagion is irrelevant.[8]

When banks lend to the same sector, competition for the same pool of loan opportunities reduces their return in case of success by a measure H.[9] 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 using cheap talk.) Banks lend to different sectors when indifferent. After choosing sectors, banks choose monitoring efforts simultaneously as in the main model.

4.1 Contagion and Correlated Risks

As usual, we solve the game by backward induction. 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 (identical to (1)) is:

$$E(\Pi_i) = q_i\,(1 - \alpha\,(1 - q_j))\,V - \frac{c}{2} q_i^2, \tag{10}$$

the effort in the Nash equilibrium (identical to (3)) is:

$$\hat{q} = \frac{(1-\alpha)\,V}{c - \alpha V}, \tag{11}$$

and equilibrium profits when bank investment strategies are uncorrelated (obtained by substituting (10) into (11)) are:

$$E(\widehat{\Pi}_U) = \frac{c}{2}\left(\frac{(1-\alpha)\,V}{c-\alpha V}\right)^2. \tag{12}$$

[8] 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 we were to introduce this effect, 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.

[9] 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.

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:

$$E(\Pi_i | q_i \leq q_j) = q_i(V - H) - \frac{c}{2}q_i^2. \tag{13}$$

Note two differences with (10). First, there is no term $-\alpha(1 - q_j)$ in the probability of success: when banks lend to the same sector, they succeed or fail together, so there is no risk of contagion. This increases incentives to correlate bank risks. Second, there is an additional term $-H$ in the payoff in case of success, reflecting a more difficult lending environment when banks focus on the same sector. This reduces incentives to correlate risks.

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

$$E(\Pi_i | q_i > q_j) = q_i(1 - \alpha(q_i - q_j))(V - H) - \frac{c}{2}q_i^2. \tag{14}$$

Lemma 2 *Under (13) and (14), the game admits a continuum of symmetric Nash equilibria in bank monitoring effort:*

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

Of these, the equilibrium with the highest $\widehat{q}$ is Pareto-dominant and can be implemented by cheap talk.

Proof. In Appendix A. ■

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

$$q_i = q_j = \hat{q} = \frac{V - H}{c}. \tag{15}$$

This obtains profits when bank investment strategies are correlated:

$$E(\widehat{\Pi}_C) = \frac{c}{2}\left(\frac{V-H}{c}\right)^2. \tag{16}$$

Bank i is indifferent between the two sectors when $E(\widehat{\Pi}_U) = E(\widehat{\Pi}_C)$, that is for:

$$\widetilde{H} = \frac{\alpha V\,(c - V)}{c - \alpha V}. \tag{17}$$

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 externality stemming from contagion makes correlated investment strategies – 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 which, in turn, leads to greater risk taking. Note that this fits nicely with experience of credit booms, such as for instance the subprime mortgage boom that preceded the recent crisis. (Beyond the scope of this model, as a larger share of the banking system invests in a certain class of assets, contagion risk increases. Then, other banks have higher incentives to shift their portfolios to the same class of assets. This leads directly to further risk tasking and increases the impact of the eventual bust.)

4.2 Effects of Bailouts

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

When banks lend to different sectors, the model is again identical to that in the previous section. The profit function (identical to (4)) is:

$$E(\Pi_i) = (q_i\,(1 - (1 - q_j)\,(1 - \theta)\alpha) + (1 - q_i)\,\theta\delta)\,V - \frac{c}{2}q_i^2, \tag{18}$$

and the effort in the Nash equilibrium (identical to (7)) is:

$$\widehat{q}\,(\theta) = \frac{(1 - \alpha\,(1 - \theta) - \theta\delta)\,V}{c - \alpha\,(1 - \theta)\,V}. \tag{19}$$

Substituting (18) into (19) obtains equilibrium profits:

$$E(\widehat{\Pi}_U|\theta) = \left(\frac{(1 - \alpha\,(1 - \theta) - \theta\delta)\,V}{c - \alpha\,(1 - \theta)\,V}\right)^2 \frac{c}{2} + \theta\delta V. \tag{20}$$

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

$$E(\Pi_i | q_i \leq q_j) = (q_i + \delta\theta\,(1 - q_i))\,(V - H) - \frac{c}{2} q_2^2, \quad (21)$$

and for $q_i > q_j$ is:

$$E(\Pi_i | q_i > q_j) = (q_i(1 - \alpha(1-\theta)(q_i - q_j)) + \delta\theta\,(1 - q_i))\,(V - H) - \frac{c}{2} q_i^2 \quad (22)$$

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

$$q_i = q_j = \hat{q} = \frac{(1 - \delta\theta)\,(V - H)}{c}. \quad (23)$$

Note that 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:

$$E(\widehat{\Pi}_C | \theta) = \frac{(1 - \delta\theta)^2\,(V - H)^2}{2c} + \delta\theta(V - H). \quad (24)$$

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

$$\left(\frac{(1 - \alpha\,(1 - \theta) - \theta\delta)\,V}{c - \alpha\,(1 - \theta)\,V}\right)^2 \frac{c}{2} + \theta\delta V = \frac{(1 - \delta\theta)^2\,(V - H)^2}{2c} + \delta\theta(V - H), \quad (25)$$

which gives the threshold $\tilde{H}$: 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 θ. The following proposition summarizes:

Proposition 2 *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 2 is our second main result. It shows that whenever a government intervention has a positive impact on bank risk taking, it also reduces banks' incentives to correlate their risks by lending to the same sector.

Note that Proposition 2 offers 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 (δ 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 (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.

5 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.

The model is open to extensions and interpretations. One could rewrite the model in the context of banks' short-termist behavior that was prevalent in the run-up to the recent crisis. Indeed, the concept of "insufficient monitoring" can be interpreted as 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 sytem 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 question 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 caution that the recent initiatives that create impediments to timely and targeted intervention may in effect destabilize financial system. First, they would make the financial system more unstable in the run-up to and during crises, when banks would respond to the risk of contagion by neglecting monitoring and/or by correlating risk with unstable banks. Second, reducing scope for timely, targeted interventions 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 a 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.

A Proof of Lemma 2.

We intend to show that under (13) and (14), the game admits a continuum of symmetric equilibria:

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

For $q_j = \widehat{q} \in \left[\frac{(1-\alpha)(V-H)}{c}, \frac{V-H}{c} \right]$, 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 $\widehat{q} = \frac{(V-H)}{c}$, i.e. $\widehat{q} \in \frac{(V-H)}{c}$ Pareto-dominates all the other equilibria. QED.

B Proof of Proposition 2.

Define:

$$Z \equiv E(\widehat{\Pi}_U|\theta) - E(\widehat{\Pi}_C|\theta). \tag{26}$$

Then:

$$\frac{d\widetilde{H}}{d\theta} = -\frac{\frac{\partial Z}{\partial \theta}}{\frac{\partial Z}{\partial H}}. \tag{27}$$

Substitute (20) and (24) into (26) to obtain:

$$Z = \left(\frac{(1-\alpha(1-\theta)-\theta\delta)V}{c-\alpha(1-\theta)V}\right)^2 \frac{c}{2} - \frac{(1-\delta\theta)^2(V-H)^2}{2c} + \delta\theta H, \tag{28}$$

which immediately yields:

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

and

$$\frac{\partial Z}{\partial \theta} = c(1-\alpha(1-\theta)-\theta\delta)V^2 \frac{\alpha(c-V)-\delta(c-\alpha V)}{(c-\alpha(1-\theta)V)^3} + \frac{2\delta(1-\delta\theta)(V-H)^2}{2c} + \delta H. \tag{29}$$

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 $\frac{d\widetilde{H}}{d\theta} < 0$. QED.

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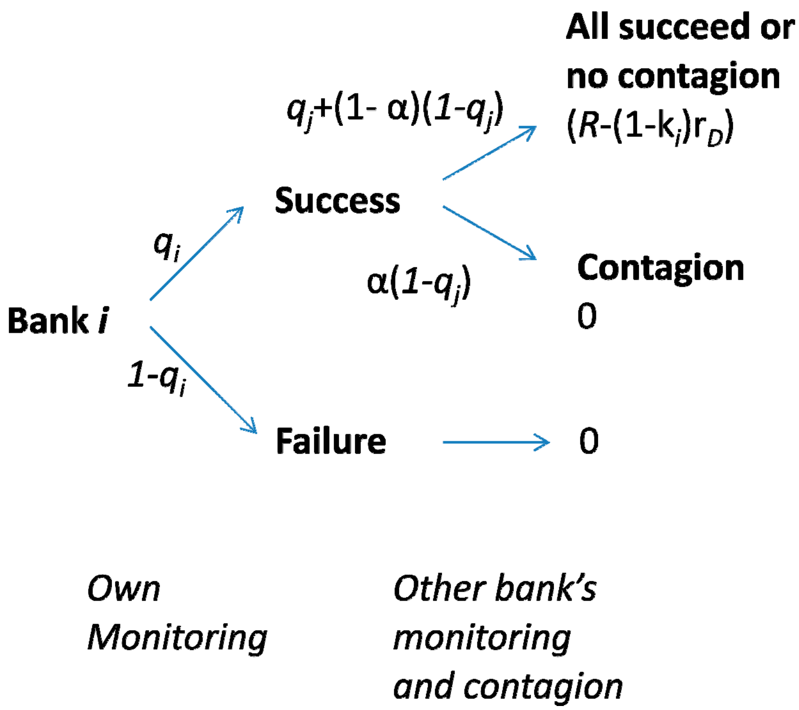
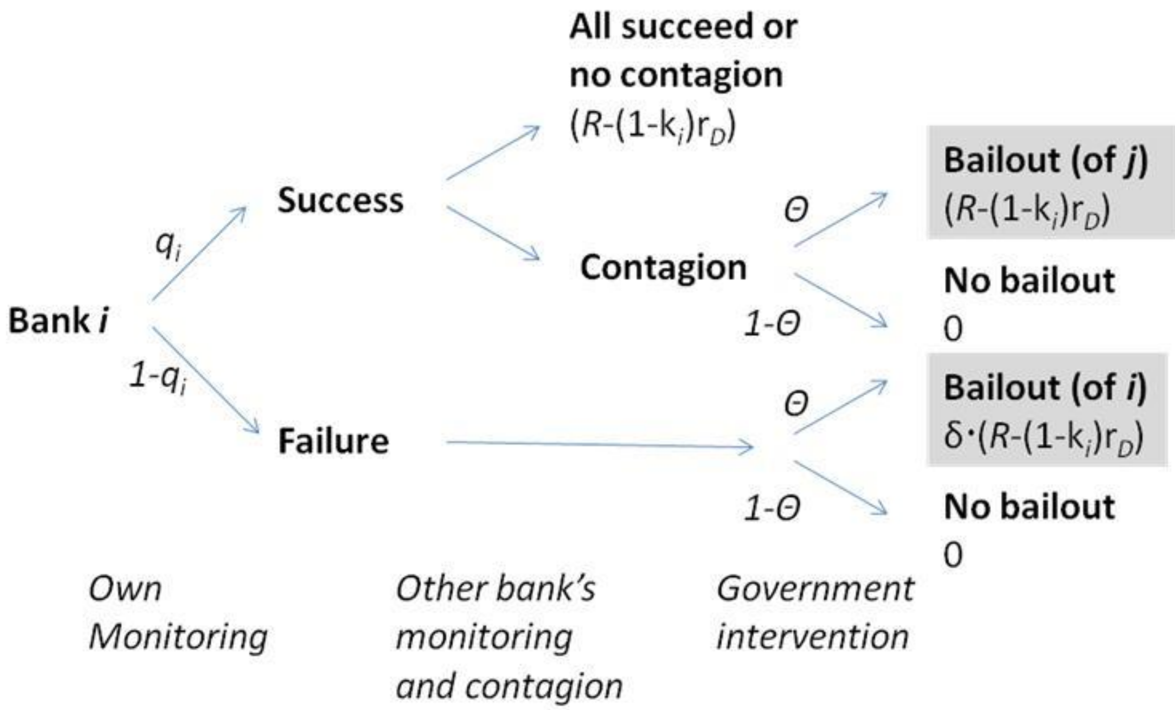
Figure 1. Game tree: the effects of contagion.



The Figure shows payoffs of bank *i* depending on the realizations of its own and bank *j*'s monitoring effort, and the intensity of contagion.

Figure 2: Game tree: the effects of government intervention



The Figure shows payoffs of bank *i* depending on the realizations of its own and bank *j*'s monitoring effort, the intensity of contagion, and the presence of government intervention.