Government Guarantees, Transparency, and Bank Risk-taking*

Preliminary

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Abstract

We present a model of bank risk taking and government guarantees. Levered banks take excessive risk as their actions are not fully priced at the margin by debt holders. The impact of government guarantees on bank risk taking depends critically on the portion of bank investors that can observe bank behavior and hence price debt at the margin. Greater guarantees increase risk taking (moral hazard) when these informed investors hold a sufficiently large fraction of liabilities. But, otherwise, they reduce risk taking by increasing the profits of the bank (franchise value effect). The results extend to the case in which information disclosure and thus the portion of informed investor is endogenous but costly. The model also shows that when bank capital is endogenous, public guarantees lead unequivocally to an increase in bank leverage and an associated increase in risk taking. This points to a complex relationship between prudential policy and the institutional framework governing bank resolution and bailouts. In particular, the balance between the moral hazard and the franchise value effects depends on the allowed degree of bank leverage, in addition to the intermediation margins and the severity of agency problems.

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1 Introduction

The bailouts of banks and other financial intermediaries during the Global Financial Crisis led to a regulatory backlash focused on limiting future public intervention in support of the financial sector. In particular, the post-crisis regulatory debate has centered on how to eliminate too-big-too-fail subsidies and reduce the moral hazard associated with implicit or explicit government guarantees. With these objectives in mind, regulatory reforms have typically introduced new and higher hurdles for government support to banks during crises. Cases in point can be seen in the new restrictions on Federal Reserve Bank actions written into Dodd-Frank, or in the recently introduced bail-in requirements in the EU.

The primary rationale underpinning these reforms is that bailouts are inequitable and that the expectation of public support affects the behavior of bankers. In particular, part of the argument is that public guarantees prevent the correct pricing of risk by market participants. This induces inefficiently reckless behavior by bankers who become less concerned about risk taking since their actions are not reflected in their costs of financing. Removing the expectation of bailouts is then expected to restore market discipline and thus prevent banks from taking socially excessive risk.

Yet, the notion that the expectation of bailouts and other forms of public guarantees lead to greater moral hazard relies on the assumption that banks are transparent and investors can price risk at the margin correctly, or that a bailout is likely to benefit shareholders/managers in addition to creditors/depositors. Put differently, the assumption is that, absent government guarantees, implicit or explicit, competitive forces will be able to discipline bank behavior early enough to prevent excessive risk taking, hence reducing the probability of financial crises.

In contrast, when banks are sufficiently opaque, or when the pricing of liabilities cannot easily incorporate risk taking in interim periods (i.e., after the debt has been issued), a public insurance scheme can improve banks' incentives by reducing the cost of liabilities. While guarantees make the pricing of debt insensitive to risk, they also reduce the promised interest rate that banks must offer their investors and depositors. Since bankers (or bank shareholders) are residual claimants on the returns from loans on their portfolios, a reduced cost of funding increases a bank's payoff conditional on success. This greater payoff increases the bank's incentives to monitor its loans in order to guarantee repayment. Equivalently, it induces the bank to choose safer portfolios than what would be individually optimal with higher deposit and bond rates. Thus, public guarantees can curb rather than exacerbate banks' risk-shifting tendencies.

It is important to note, however, that the force described above improves the bank's incentives only when a large portion of the bank's liabilities is already insensitive to risk at the margin. If all the bank's liabilities reflected the bank's risk choices at the margin, then risk taking would be fully internalized and there would be no additional incentive effect stemming from the reduced pricing of debt and deposits that comes with government guarantees.

A second important distinction is between the bailout of bondholders and that of shareholders/managers (that is, agents that have full control over a bank's risk taking activity). The effects discussed above pertain to the bailout of bondholders and depositors. In contrast, insuring an informed party (shareholders/managers) against a risk over which it has full control can only lead to worse incentives. Consistently, in this model, the promise or expectation of bailing out shareholders has an unequivocally detrimental impact on bank risk taking, irrespectively of the weight of shareholder claims in a bank's liability structure.

Also note that saying that a bank's risk is "priced at the margin" is not the same as saying that a bank portfolio is correctly priced in equilibrium. In the latter case, investors form conjectures about a bank's behavior and price its liabilities accordingly. The bank takes the cost of its liabilities as given when it makes its risk taking choices. And, in equilibrium, deposit rates and yields on debt correctly reflect the bank's risk taking decisions. In the former case, the cost of a bank's liabilities is a function of its risk taking, and the bank takes it directly into account when it makes its choices.

Empirical evidence on whether investors can price bank risk correctly (and in particular, at the margin) is at best mixed. On the one hand, there is solid evidence that depositors and other security holders are able to identify banks that are at risk of failure, either by running or by demanding higher interest rates. On the other, this does not necessarily imply that depositors are able to discipline effectively bank managers' behavior ex ante. Indeed, there is similarly solid evidence that events (such as regulatory audits) in which details about bank holdings are suddenly revealed lead to sharp repricing of banks liabilities (see Section 8, for a survey of the literature and discussion).

We extend our model along two dimensions. First, we allow banks to exert some control over the fraction of their liabilities that is priced at the margin. Think about this as banks being able to make a (costly) investment in transparency/disclosure. Under these conditions, bailouts may entail an additional form of moral hazard by reducing the benefits (to the bank) of transparency, they will lead the banks to be more opaque, which everything else equal will tend to increase their risk taking. Yet, even with this additional source of moral hazard, we show that if the cost of information disclosure is sufficiently high, the net effect of bailouts may still be reduced risk taking.

The second extension deals with leverage. In our model, capital is costly (there is an equity premium) and observable; and investors use it to infer a bank's risk taking behavior (higher capital means less risk). When allowed to choose their level of leverage, banks will choose capital as to balance its higher cost with its benefit in reducing the cost of debt and deposits in equilibrium. Under these conditions, the expectation of a bailout will reduce the benefits of capital and, hence, increase leverage. This, in turn, will unequivocally increase risk taking. This points to an important interaction between bailout policies and capital regulation. For intermediaries subject to capital requirements, our results with exogenous capital apply and the effects of bailout on risk taking depend on the proportion of liabilities priced at the margin. For the rest, the expectation of bailouts leads to greater leverage and more excess risk taking.

Finally a couple of caveats. First, most of the issues are present in all sectors of the economy. Large non-financial corporations are often opaque and investors may have difficulty in pricing their risk at the margin. At the same time, they are some time considered systemic and have been bailed out in the past. It follows that, to some extent, the model could apply beyond the financial sector. Yet, there are obvious reasons to focus primarily on banks. First, the size and frequency of bailouts (and the explicit guarantees) for the financial sector do not find a counterpart in other industries. Second, by the very nature of their business, banks and other financial intermediaries find it easier than non-financial firms to modify their risk profile on a short-term basis. It is, then, likely more difficult for investors to price their risk at the margin (see Morgan, 2002). Finally, as a consequence, the post-crisis reform debate has primarily focused on measures addressing issues related to the bailout of banks.

Second, in this paper, we abstract from the issue of whether a bank is systemic or not. This is obviously a relevant issue when deciding whether or not to bailout an institution. However, the issue is somewhat orthogonal to the point we are making in this paper. Most papers examine the trade-off between the ex-post aggregate welfare benefits from bailing out a systemic bank in a crisis and the inefficiencies (the increased risk taking) associated with the expectation or promise of such action. Here we are interested in under what conditions such promise indeed lead to increased inefficiency. That said, it is worth noting that, in a related model (modified to admit contagion), the promise of bailout for systemic institutions may improve the incentives of banks subject to the risk of contagion (see Dell'Ariccia and Ratnovski, 2013), providing an additional counterbalance to standard moral hazard effects.

The paper relates to the literature on bailouts, deposit insurance, and moral hazard in banking. Our model extends the simple framework used in Cordella and Levy Yeyati (2002), Dell'Ariccia and Marquez (2006), Allen, Carletti, and Marquez (2011), and Dell'Ariccia, Laeven, and Marquez (2014), where banks face quadratic monitoring costs, are protected by limited liabilities, and only repay depositors when the project succeed. In addition, we allow for part of a bank's debt liabilities to be priced at the margin and we consider government guarantees. The idea that insurance can have a pro-incentive effect is studied in Cordella and Levy-Yeyati (2003) and Dell'Ariccia and Ratvnoski (2013). However, in both these papers insurance is provided against risks outside the control of the bank (macroeconomic risk in the first case, and contagion risk in the second). The mechanism at work in our paper is then more akin to the effect of lower deposit rates explored in Matutes and Vives (2000) and Hellman, Murdoch, and Stiglitz (2005). There a deposit rate ceiling or deposit insurance increase a bank's charter value an hence reduce agency problems.

The paper contributes to the policy debate on bank resolution and intervention. Most of the narrative of the post-crisis reform effort has been on making crisis resolution more equitable and in avoiding creating conditions conducive to moral hazard. From that standpoint, a trade-off emerges between the need to minimize the macroeconomic effects of bank distress ex post (including through generous bailouts) and avoiding policies that distort bank ex-ante risk-taking incentives. Here, we focus on what conditions that have to be in place for such trade-off to exist; in the process we identify an important relationship between capital regulation and bank resolution policies.

The paper is organized as follow: Section 2 presents a stylized model of bank risk taking highlighting these forces. We then examine how the expectations of public bailouts interact with bank leverage and the intermediation margins, to determine risk taking. Sections 3 and 4 explore under what conditions bailouts can improve rather than worsen a bank's risk profile, for the case where the fraction of liabilities with risk priced at the margin is exogenously specified or is endogenously determined, respectively. Section 5 presents a brief discussion of additional effects that may arise if government guarantees (in the form of a possible bailout) also have the potential to benefit shareholders. Section 6 examines the case with endogenous bank leverage and discusses the role of capital regulation. Section 7 presents illustrative numerical simulations of the model.

Section 8 summarizes the evidence on debtholder discipline and bank risk taking. Finally, Section 9 concludes.

2 A model of bank risk taking

Consider a risk-neutral, profit-maximizing bank with a loan portfolio of size 1. The portfolio is financed by equity, k, and a mass $1-k$ of debt (bonds and deposits). Risk-neutral debt holders will invest in the bank as long as they are compensated for risk (i.e., as long as they break even relative to the risk free rate). Further, we assume that a fraction θ of debt holders is able to observe the true riskiness of the bank's portfolio, which, in turn, depends on the bank's monitoring efforts; consequently, they can price bank risk at the margin. The rest either cannot observe risk taking or cannot easily condition the pricing on the actual, realized degree of risk, and hence it will price debt based on the expected riskiness. These latter investors must break even in equilibrium, but they do not adjust the pricing of their claims to the bank's marginal portfolio choices.[1] Finally, we assume, that, with probability γ, the government will intervene in case of bank failure and bail out debt holders. One alternative interpretation is that a fraction γ of debt is protected by government guarantees such as deposit insurance, so that γ can be viewed as caps on the amount of deposits that are insured.

In our model, we assume that the bank is protected by limited liability and it repays depositors only when successful. If the bank fails, the bank's owners/managers lose the invested capital. More precisely, we assume that the portfolio of the bank returns R with probability $q \in [0,1]$ and zero otherwise, where q is the bank's choice of monitoring effort, which entails a cost $\frac{1}{2}cq^2$. Note that one can write an essentially identical model based on project screening/portfolio allocation.[2] Denoting by $\overline{r}$ the risk free rate, by r_D the gross interest rate on bank debt, and by $r_E \geq 1$ the opportunity cost of equity, the bank's expected profits can be written as:

$$\Pi = q\left(R - \gamma(1-k)\overline{r} - (1-\gamma)\left(\theta\frac{\overline{r}}{q} + (1-\theta)\,r_D\right)(1-k)\right) - r_E k - \frac{1}{2}cq^2 - \frac{1}{2}\varphi\theta^2. \qquad (1)$$

[1] This is equivalent to saying that for the fraction θ of debt holders, bank portfolio risk is contractible, so that the pricing of their debt claim can be made contingent on the bank's choice of risk. Instead, for other debt holders, the pricing of their claims cannot be made explicitly contingent on the bank's chosen level of risk, even if the risk is correctly priced in equilibrium.

[2] Equivalently, the framework can be seen as a portfolio choice problem for the bank: the bank chooses a portfolio on the efficient frontier that repays $R - \frac{c}{2}q$ with probability q, and thus must trade off greater returns with greater risk.

The first term reflects the bank's limited liability, which implies that the bank only repays debt holders (bond holders and depositors) when its project succeeds, which occurs with probability q. The cost of bank debt is a weighted average of interest rates that reflects the assumptions above: given the expectation of government bailout of debt holders, γ, investors put the same weight on the risk free rate. Yet, with probability $1-\gamma$ debt is subject to default and needs to be priced accordingly. A fraction θ is priced in a way that perfectly reflects the bank's actual risk taking at the margin, $(\frac{\overline{r}}{q})$, with the remaining portion, $1-\theta$, reflecting the expected risk taking $r_D = \frac{\overline{r}}{E[q]}$. The required return to equity, r_E, is taken here as exogenous - all that matters for our purposes is that $r_E \geq 1$.[3]

3 Equilibrium with a exogenous priced-at-the-margin liabilities

For the moment, assume that θ, the fraction of debt that is correctly priced at the margin, is exogenously given. Differentiating (1) with respect to q, the first order condition of the bank's problem can be written as

$$\frac{\partial \Pi}{\partial q} = R - cq - (1-k)(\overline{r}\gamma + r_D(1-\gamma)(1-\theta)) = 0, \tag{2}$$

so that

$$\widehat{q} = \frac{R - \gamma(1-k)\overline{r} - r_D\,(1-\gamma)\,(1-\theta)\,(1-k)}{c}, \tag{3}$$

where

$$r_D = \frac{\overline{r}}{E[q]}. \tag{4}$$

First, note from (3) that a bank funded entirely with equity (thus without an agency problem) would choose $\widetilde{q} = \frac{R}{c}$, which hence represents the socially optimal monitoring effort. It is also immediate from (3) that generally we will have $\widehat{q} < \widetilde{q}$. Second, the bank's monitoring effort, $\widehat{q}$, is increasing in its gross return R and its capitalization, as is common in models that incorporate a moral hazard on the bank's side. Note further, however, that $\widehat{q}$ is also increasing in θ: the greater the fraction of liabilities the price of which is risk-sensitive, the more discipline is imposed on the bank through this channel. This effect represents the depositor discipline channel discussed above, which leads the bank to exert more effort and choose a safer portfolio. Finally, note that whether

[3] Since investors are all risk neutral, there is no risk premium associated with equity and hence r_E need not be affected by leverage changes within the bank. Nevertheless, r_E may be strictly greater than 1 to the extent that banks face difficulties in raising capital due to asymmetric information, issuance costs, dilution of existing shareholders, etc.

$\widehat{q}$ is increasing or decreasing in γ, the fraction of deposits that are insured, depends on how large θ is. To see this, note that $\frac{\partial \widehat{q}}{\partial \gamma} = \frac{(-\overline{r}+r_D(1-\theta))(1-k)}{c}$. For θ large and close to 1, the bank's level of monitoring $\widehat{q}$ is increasing in γ, while the opposite is true for θ close to 0. We discuss this issue further below given it represents one of the main aspects of the paper.

We now impose rational expectations, that is, $E[q] = \widehat{q}$, and use (3) and (4) to explicitly characterize the equilibrium values (denoted by an asterisk) of monitoring effort and the interest rate on debt (i.e., deposits):

$$q^* = \frac{R-(1-k)\overline{r}\gamma + \sqrt{(R-(1-k)\overline{r}\gamma)^2 - 4c\overline{r}(1-k)(1-\gamma)(1-\theta)}}{2c}; \tag{5}$$

$$r_D^* = \frac{\overline{r}}{q^*}. \tag{6}$$

To ensure the existence of an internal solution, $q^* \in (0,1)$, we further assume that[4]

$$c \in \left(R, \frac{(R-\overline{r})^2}{4\overline{r}}\right), \tag{A.1}$$

and, for the interval to be non empty, that[5]

$$R > \overline{r}(3+\sqrt{2}). \tag{A.2}$$

Having computed the equilibrium values for the monitoring effort and the debt rate, we are now in a position to study how changes in the institutional setting affect the bank's risk taking incentives. Since, in our framework, the bank tends to take on excessive risk because is a levered institution, which operates under limited liability and partial pricing at the margin, an increase in equity necessarily makes the bank more prudent. Similarly, an increase in the fraction θ of the risk sensitive non-insured debt also increases the equilibrium monitoring effort of the bank. In both cases, the force at work is greater market discipline through a larger share of the bank liabilities priced at the margin. Put differently, the bank's behavior will reflect more directly on its cost of funding.

In contrast, the effect of an increase in the probability of bailout has an ambiguous effect on bank risk taking. On the one hand, it increases bank profits conditional on success by reducing the average interest rate on debt; this makes the bank more prudent. On the other, it reduces the

[4] The first condition ensures that $q^* > 1$; the second that the radicand in (5) and (6) is positive, and thus that a rational expectations equilibrium exists.

[5] This condition is, of course, a sufficient one.

weight of debt priced at the margin, thus, diminishing the bank's incentive to "behave" to reduce the cost of its funding.

In order to better understand the different forces in action, we study the link between government guarantees on the bank's liabilities and risk taking incentives depending on how large the fraction of the bank's debt is risk sensitive. More precisely, we can show that:

Proposition 1 *An increase in the share of debt liabilities covered by guarantees, γ, decreases the bank's monitoring effort q if, and only if, the fraction θ of risk sensitive uninsured deposits is large enough.*

Proof. See Appendix. ■

The proposition establishes that offering a guarantee on deposits and/or debt as a way of increasing the bank's return conditional on project success leads to greater moral hazard and more risk taking only when a significant portion of the bank's liabilities is priced at the margin. In other words, when most debt is priced in a way that reflects the bank's risk taking decisions, we have the classic moral hazard result: increases in government guarantees reduce the bank's incentives to monitor since it makes the interest it has to pay on debt less sensitive to its risk-taking decisions.

Conversely, when most of the bank's liabilities earn a return that is fixed relative to the bank's risk choices (even if they are correctly priced in equilibrium), providing greater government guarantees, such as by increasing limits in the deposit insurance ceiling or extending coverage to uninsured debtholders, is a way of improving incentives for the bank to exert effort since it raises the margin between its payoff conditional on success and its repayment to depositors, thus making it more willing to exert more effort in monitoring. The overall effect of government guarantees on bank's monitoring effort is thus dependent on the fraction of debt that is priced at the margin. The proposition also highlights that the "mortal sin" that has been ascribed to the introduction of deposit insurance, namely greater moral hazard, is highly dependent on the fact that, in the absence, of deposit insurance bank creditors can price their claims in a way that is responsive and reacts to the bank's risk choices. Otherwise, even if these claims are priced correctly to reflect risk taking, offering a government guarantee does not introduce a distortion, and indeed it helps alleviate moral hazard problems stemming from limited liability.

Given much of the recent discussion concerning the role of bank capital in controlling risk taking and absorbing losses when those materialize, it is useful to study how the degree of capitalization affects a bank's optimal reaction to greater deposit insurance coverage. Since the focus here is on controlling risk taking that may be induced by the introduction of a government guarantee, we consider the case where $\theta = 1$, so that the distortion in favor of great risk taking induced by deposit insurance is maximized. Given the equilibrium level of monitoring q^* specified in (5), for $\theta = 1$, that is when all depositors price risk correctly at the margin, we have $q^* = \frac{R-(1-k)\bar{r}\gamma}{c}$, so that increases in γ clearly decrease monitoring, or in other words lead to more risk taking: $\frac{dq^*}{d\gamma} = \frac{-(1-k)\bar{r}}{c} < 0$.

Consider now an increase in bank capital k. This will have two effects. First, more bank capital will reduce risk-taking, by increasing the bankers' "skin in the game", $\frac{dq^*}{dk} > 0$. Second, it will have the following marginal effect: $\frac{d^2q^*}{dkd\gamma} = \frac{\bar{r}}{c} > 0$. In other words, an increase in k attenuates the effect of an increase in γ, and helps control the moral hazard problem induced by the introduction of deposit insurance. It bears emphasizing, however, that capital is only needed to play this role when large guarantees, such as greater a comprehensive deposit insurance, lead bank to take on too much risk. Instead, when θ, the fraction of uninsured deposits that price risk at the margin, is lower, deposit insurance leads to better incentives for the bank and thus to lower risk taking, so that there is no need to use capital to provide a countervailing effect.

Other instruments: it is useful to note that the effects identified here, which stem from "pricing at the margin" of debt instruments, are distinct from other mechanisms, which have also been recently proposed as effective ways to reduce bank risk taking and protect other claimholders at the bank. A salient example is the use of contingent convertible bonds–"cocos"–that has been much discussed recently, and which has been touted as an effective way of dealing with undercapitalized banks that may need additional capital exactly when they are in a downturn, having amassed losses (or potential losses) that reduced its capitalization. In our model, introducing cocos would have little effect unless the bond part of the coco, to be repaid in "good times," when the bank's project is successful (i.e., with probability q), has an interest rate which itself prices the bank's risk correctly at the margin. If the interest rate is fixed up-front however, as for the fraction $1 - \theta$ of uninsured debt in our base model, then the same risk taking incentives as above arise. In the bad state, when the bank's projects fail to pay off, the cocos would convert into equity, but since the bank is defaulting anyway in that case, such conversion would also have no incentive effects.[6]

This discussion suggests that the use of such instruments as cocos may be particularly valuable

[6] It would, however, reduce the burden on the deposit insurance fund, but would have little to no effect on ex ante risk taking by the bank.

when the primary purpose of capital is create a buffer that acts as a first backstop against losses. But, in order to be useful when the primary concern is bank moral hazard, cocos are subject to the same conditions as standard bonds: they need to be priced at the margin. When this does not happen, the solution may require increasing the payoff of the bank in the good states of the world, rather than decreasing it in the bad states.

4 Endogenous information disclosure

In the previous section, we assumed that an exogenous fraction θ of uninsured debt was priced at the margin. However, given its importance, a bank may like to exert some control over this fraction, if at all possible. In that case, the existence of government guarantees is likely to affect also this aspect of a bank's behavior. For instance, if debt pricing relies on information disclosure and information disclosure is costly, government guarantees will reduce the benefits (to the bank) from disclosure. Put differently, when information disclosure is endogenous, a greater probability of bailouts may entail an additional form of moral hazard. In this section, we examine this issue.

We allow the bank to choose θ by paying a cost $\frac{1}{2}\varphi\theta^2$ before deciding on the monitoring effort q. One may therefore interpret θ as the degree of transparency of the bank's balance sheet, with greater transparency being more costly for the bank. θ may also represent the fraction of debt to which the bank agrees to offer pricing that is risk sensitive, and thus is contingent on how much risk is actually chosen.

Note that it need not be that the bank faces an actual cost associated with transparency, but rather that more transparent investments may earn it lower returns than those the bank could earn by investing in more specialized but also more opaque projects.[7]

Solving by backward induction, the problem of the bank can be written as:

$$\max_{\theta}\Pi = q^* \left(R - \gamma(1-k)\overline{r} - (1-\gamma)\left(\theta\frac{\overline{r}}{q^*} + (1-\theta)\,r_D\right)(1-k)\right) - r_E k - \frac{1}{2}cq^{*2} - \frac{1}{2}\varphi\theta^2, \quad (7)$$

where q^* is given by expression (5). Such a set-up allows us to study how an increase in the cost of transparency φ affects the relation between the degree of government guarantees and bank's monitoring effort.

[7] One could also imagine that investors/depositors can make investments in information acquisition about the bank, or in monitoring the bank, and such decisions may well interact with the bank's decision of how much transparent to make its balance sheet. We abstract from such considerations here in order to focus purely on the bank's incentives to both disclose and monitor its portfolio.

Now consider the following Lemma

Lemma 1 *The individually optimal proportion of debt liabilities priced at the margin, $\widehat{\theta}$, is decreasing in the degree of government guarantees, γ.*

Proof. See Appendix. ■

This lemma establishes that once the fraction θ of liabilities priced at the margin is under the control of the bank, the promise of government guarantees entails an additional moral hazard problem. Since, in our setup, information disclosure is costly, banks will choose a lower level of disclosure when the benefits associated with pricing risk at the margin are reduced. Indeed, it is immediate that when $\gamma = 1$, the first order conditions from (7) will imply $\widehat{\theta} = 0$. Note, however, that this does not mean that with θ endogenous an increase in government guarantees always implies an increase in bank risk taking (a decline in q^*). As for the case with θ exogenous, the effect of greater guarantees on risk taking will depend on the balance of their moral hazard effect (now including their impact on $\widehat{\theta}$) and their "charter value" effect. We demonstrate this in the following proposition.

Proposition 2 *There exists a $\overline{\varphi}$ such that for $\varphi > \overline{\varphi}$ a bank's monitoring effort is always increasing in in the degree of government guarantees, γ.*

Proof. See Appendix ■

The proposition establishes that more generous government guarantees (e.g., comprehensive deposit insurance) decrease bank monitoring and lead to more risk taking, as has often been argued, only when the cost of disclosure, or transparency, is relatively low. The intuition is similar to that for Proposition 1: when the cost of transparency φ is low, the bank will optimally choose to disclose a lot of information, implying that θ will be high. In that case, as shown in Proposition 1, increases in γ will lead to a reduction in monitoring effort by the bank. Conversely, when φ is relatively high, the bank finds disclosure too onerous and will choose a low level of transparency θ. In that case, increasing government guarantees is good for incentives and leads the bank to exert more monitoring effort. Put differently, since there is little pricing at the margin anyway, the promise of bailout does not entail much moral hazard and the value effect through bank profitability prevails.

The threshold level of the cost of transparency below which risk taking increases in γ can be solved for explicitly, and is given by

$$\overline{\varphi} \equiv \frac{c\overline{r}^2 \left(1-k\right)^2}{\left(c-R+(1-k)\overline{r}\right)\left(R-2(1-k)\overline{r}\right)}. \tag{8}$$

It is useful to study how the threshold $\overline{\varphi}$ varies with different characteristics of the market, such as the level of capital for a bank, the marginal cost of bank effort/reduced risk taking, or the risk free rate that represents debt holders opportunity cost for lending to the bank. We state the comparative statics of the threshold $\overline{\varphi}$ as the following corollary, which follows directly from differentiating (8) with respect to the c, k, and $\overline{r}$:

Corollary 1 *Comparative statics: The threshold level of the cost of transparency to the bank, $\overline{\varphi}$, is:*

1. *Decreasing in the bank's marginal cost of monitoring, c:*

$$\frac{\partial\overline{\varphi}}{\partial c} = -\frac{\overline{r}^2 \left(1-k\right)^2 \left(R-(1-k)\overline{r}\right)}{\left(c-R+(1-k)\overline{r}\right)^2 \left(R-2(1-k)\overline{r}\right)} < 0; \tag{9}$$

2. *Decreasing in the bank's degree of capitalization, k:*

$$\frac{\partial\overline{\varphi}}{\partial k} = -c\overline{r}^2 \left(1-k\right) \frac{(1-k)\overline{r} + 2\left(R-(1-k)\overline{r}\right)\left(c-R\right)}{\left(\left(c-R+(1-k)\overline{r}\right)\left(R-2(1-k)\overline{r}\right)\right)^2} < 0; \tag{10}$$

3. *Increasing in the risk free rate, $\overline{r}$:*

$$\frac{\partial\overline{\varphi}}{\partial \overline{r}} = c\overline{r} \left(1-k\right)^2 \frac{(1-k)\overline{r}R + 2\left(R-(1-k)\overline{r}\right)\left(c-R\right)}{\left(\left(c-R+(1-k)\overline{r}\right)\left(R-2(1-k)\overline{r}\right)\right)^2} > 0. \tag{11}$$

From (9), it follows that the condition for government guarantees to reduce the riskiness of the bank's portfolio get less stringent when agency problems become more severe (the cost of bank monitoring c increases). This reflects that when effort by the bank to control risk taking is more costly, in equilibrium, the bank will wish to exert less effort and take more risk, all things equal. As a result, there is greater value in aligning the bank's incentives with what is socially beneficial, which here translates into a lower threshold value $\overline{\varphi}$ above which government guarantees help reduce rather than increase risk taking.

The second part of the corollary, reflected in (10), implies that[8] the higher bank capital is, the

[8] Remember that from (A.1), $c > R$.

more likely it is that guarantees such as deposit insurance reduce risk taking incentives. The intuition here is that θ^* is decreasing in k, as the benefits from disclosure decrease with the proportion of liabilities that is priced at the margin (with and without disclosure). This means that, for higher values of k, the decrease in θ caused by higher guarantees is smaller (and thus the moral hazard effect is also smaller).

Finally, the third part of the corollary, equation (11), implies that a reduction in the cost of liabilities makes guarantees less appealing from a risk-taking perspective. The reason is that for very low interest rates, moral hazard is necessarily limited and there is little benefit from disclosing information. Put together, these comparative statics illustrate how changes in various characteristics of the markets affect the likelihood that a government guarantee will be beneficial rather than detrimental with respect to bank risk, and the associated systemic problems that are beyond the scope of this paper.

5 Insuring debt versus bailing out shareholders

In our analysis so far, we have focused on government guarantees that benefit debt holders (e.g., depositors) but do not extend to shareholders. The primary reason for doing so has been to narrow our analysis to the debate concerning how policies like deposit insurance or the extension of guarantees to other (subordinated) bondholders may distort bank incentives and lead to increased risk taking by attenuating the channel of "debtholder discipline." In practice, however, concerns have also been voiced that government intervention to provide funds to investors may also accrue to the benefit of shareholders, bailing them out along with depositors when the bank suffers losses. For instance, by preventing a bank from going into liquidation, a rescue package may preserve its long term charter value. Essentially, the concern is that often rescue packages end up leaving significant "crumbs on the table" for banks' shareholders and management.

Such a bailout can be easily incorporated into the current framework and it is easy to show that this kind of component of a rescue package is unequivocally bad for incentives.

Consider the case where shareholders/managers also obtain some benefit whenever government guarantees protect debt holders and depositors. This means that in default states there is the same probability γ that shareholders will receive a payoff A. For instance, a bailout may allow bank shareholders to recover a fraction of their equity, so that $A = \alpha r_E k$, with $\alpha \leq 1$. In that case, profits are

$$\Pi = q\left(R - \gamma(1-k)r^* - (1-\gamma)\left(\theta\frac{r^*}{q} + (1-\theta)\,r_D\right)(1-k)\right) + (1-q)\,\gamma A - r_E k - \frac{1}{2}cq^2 - \frac{1}{2}\varphi\theta^2.$$

Maximizing this then gives us

$$\widehat{q} = \frac{R - \gamma(1-k)r^* - \gamma A - r_D\,(1-\gamma)\,(1-\theta)\,(1-k)}{c},$$

and, as usual, after imposing $r_D = \frac{r^*}{E[\widehat{q}]}$, we get

$$\widehat{q}\,(k) = \frac{1}{2c}\left(R - \gamma(1-k)r^* - \gamma A + \sqrt{(R-\gamma(1-k)r^*)^2 - 4cr^*\,(1-\gamma)\,(1-\theta)\,(1-k)}\right). \quad (12)$$

Equation (12) clearly shows that bailing out management/shareholders is bad for incentives, for any $\gamma > 0$. Note, however, that if government guarantees can't easily be targeted to depositors/debtholders only (so it is more like a bailout for political reasons rather than a pure guarantee on deposits), then there are two offsetting effects: the bailout probability γ reduces r_D, which is good for incentives, but increases the payoff to shareholders in the default state, which is bad for incentives. If A is small, then the pro incentive effect will still dominate, whereas if A is large, the guarantee the moral hazard effect will.

The result in this section is not surprising: A bailout of shareholders/managers amount to insuring the informed party against a risk that it fully controls.[9] The implication is that rescue packages should be designed in a way that minimizes this effect (with small A). Provisions to wipe out existing shareholders and replace a bank's top management and board following a bailout would go in this direction.

6 Endogenous leverage

So far, we have treated the bank's liability structure (its debt/equity mix) as exogenous. In this section, we relax that assumption and consider how government guarantees affect a bank's leverage. We add to the model an initial stage in which banks choose their level of capital, k, which is then observed by debtholders/depositors. Then, capital functions as a commitment device. Since k is observable, it informs debtholders/depositors' expectations about a bank's risk taking and debt

[9] This is different from what happens when public guarantees insure banks against risks that they cannot control. In that case, strengthening the charter value of a bank can be beneficial for incentives (see Cordella and Levy-Yeyati, 2003, and Dell'Ariccia and Ratvnoski, 2015).

is priced accordingly. Formally, $r_D = \frac{r^*}{E[\widehat{q}|k]}$; and since $\widehat{q}$ decreases with leverage, higher capital implies a lower interest rate on uninsured debt liabilities. This effect is countered by the fact that, as in most of the literature, we assume that capital is expensive (that is it requires a premium over debt). Formally, assume that there is risk-adjusted constant equity premium so that $r_E = \frac{\overline{r}+\xi}{q}$. For simplicity, in this section, we will treat the proportion of debt priced at the margin, θ, as exogenous. Expected profits can be written as:

$$\Pi = q\left(R - \gamma(1-k)\overline{r} - (1-\gamma)\left(\theta\frac{\overline{r}}{q} + (1-\theta)\, r_D\right)(1-k) - k\frac{\overline{r}+\xi}{q}\right) - \frac{1}{2}cq^2.$$

We solve the model by backward induction. The second stage remains identical to what we discussed in section 3. The equilibrium values of q and r_D can be expressed as a function of k as in equations 5 and 6; from which it is immediate that $\frac{\partial q^*}{\partial k} > 0$ and $\frac{\partial r_D^*}{\partial k} < 0$. If we substitute these equilibrium values into the expected profits expression and take the first order conditions with respect to k, we obtain:

$$\frac{d\Pi}{dk} = \frac{\partial \Pi}{\partial k} + \frac{\partial \Pi}{\partial q}\frac{\partial q}{\partial k} + \frac{\partial \Pi}{\partial r_D}\frac{\partial r_D}{\partial k} = \frac{\partial \Pi}{\partial k} + \frac{\partial \Pi}{\partial r_D}\frac{\partial r_D}{\partial k} = 0, \tag{13}$$

where $\frac{\partial \Pi}{\partial q}\frac{\partial q}{\partial k} = 0$ from the envelope theorem. After some plumbing, this can be written as

$$\frac{d\Pi}{dk} = -\left(1-q\right)\gamma\overline{r} - \xi + \frac{\partial q}{\partial k}\left(R - \gamma(1-k)\overline{r} - cq\right) = 0 \tag{14}$$

the solution to this equation gives $\widehat{k}$. We can now state the following result.

Proposition 3 *An increase in the share of debt liabilities priced at the margin, θ, decreases a bank's individually optimal level of capital, $\widehat{k}$.*

Proof. See Appendix. ■

The intuition for this result is straightforward. In this model capital is costly, but it provides the bank with a commitment/signalling device that the bank will behave "prudently". More capital increases a bank's equilibrium monitoring, since shareholders price risk at the margin. Formally, a higher k means higher $E[\widehat{q}|k]$, and thus a lower cost of debt. As θ increases a greater portion of the mass $1-k$ of debtholders also price risk at the margin, reducing the pro monitoring effect of replacing debt with equity. Put differently, since a larger portion of debtholders/depositors observes $\widehat{q}$ directly, the benefit from being able to affect $E[\widehat{q}|k]$ decreases. Indeed, note that for $\theta = 1$, the bank obtains no benefit from holding capital and the model only admits a corner solution with $\widehat{k} = 0$.

Government guarantees have a similar effect, although for slightly different reasons.

Proposition 4 *An increase in the share of debt liabilities covered by guarantees, γ, decreases a bank's individually optimal level of capital, $\widehat{k}$.*

Proof. See Appendix. ■

The proposition establishes that, irrespectively of the portion of debt liabilities priced at the margin, an increase in government guarantees will lead banks to increase leverage (decrease k). The intuition for this result is similar to that for the result above. The benefit to the bank from holding more capital is that by increasing the expected probability of bank solvency, $E[\widehat{q}|k]$, it reduces the rate paid on liabilities that are not priced at the margin, r_D. More government guarantees imply that a larger proportion of those liabilities pays the fixed risk-free rate independently from the level of bank capital. And thus reduce the incentive to hold capital.

The question that arises from this proposition is whether the impact of bailout expectations on bank leverage is sufficiently strong to imply an unequivocal net effect on bank risk taking. remember that, in this model, more levered banks take more risk, since limited liability is at the core of our agency problem. Indeed, it is immediate from equation 3 that, for any $\theta < 1$, $\frac{\partial \widehat{q}}{\partial k} > 0$.

Claim 1 *When a bank's capital, $\widehat{k}$, is endogenous, an increase in the share of debt liabilities covered by guarantees, γ, unequivocally decreases the bank's monitoring effort $\widehat{q}$.*

Proof. See Appendix ■

This result means that when leverage is endogenous, more pervasive guarantees always lead to higher risk taking. Essentially, the additional channel of bank leverage tilts the balance of the effects against bank monitoring.

The findings in this section have important implications as they highlight the relationship between prudential regulation and resolutions policies. First, note that when bank leverage is constrained by capital (or leverage) requirements, the result here apply only to the extent that banks hold capital well in excess of regulation. Once the constraint binds, the relevant framework is that with exogenous k. It follows that by imposing higher capital requirements regulators can extend the region for which bailouts improve bank incentives. At the same time, this means that the promise of bailouts is more detrimental to incentives for unregulated financial intermediaries.

Second (and possibly more relevant in practice), the result that the individually optimal capital is decreasing in the probability of bailout suggests that banks will have greater incentives to circumvent capital regulation when bailout policies become more generous. In contrast, when the expectation of bailouts is low (such as, for instance, for hedge funds) intermediaries will tend to operate with lower levels of leverage.

7 A numerical example

In this section, we present numerical simulations of the model. Our purpose is threefold. First, we want to provide an intuitive graphical illustration of the effects identified in the analysis. Second, we could not provide an analytical solution for the result (in Section 6) that, when capital in endogenous, bank monitoring, q, is unequivocally decreasing in the expectation of a government bailout, γ. Here, we show that this result holds for a broad range of parameters. Finally, most of our analysis relies on internal solutions for our main variables of interest, q^*, θ^*, and k^*. And the example serves to demonstrate that there is a broad set of parameter values for which such solutions indeed exist.

In the simulations, we set the risk free rate $\overline{r} = 1$, we assume an equity premium of 50 bps ($r_E = 1.05$), a capital requirement $k = 15\%$ (in the baseline scenario). As per the other parameters, we assume that (A.1) and (A.2) hold, and we set $R = 7$, $c = 10$, and $\phi = 1$.

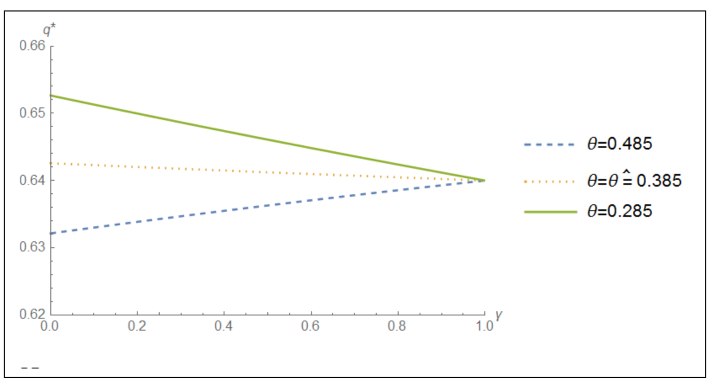

Figure 1: Bank optimal monitoring, q^*, as a function of γ.

Using this parametrization,[10] Figure 1 illustrates Proposition 1. The equilibrium probability of loan

[10] We decided to keep the model simple and thus we did not introduce additional parameters, to be able to work

repayment q^* is plotted as a function of the share γ of debt liabilities covered by guarantees, for different values of θ, the fraction of risk sensitive uninsured deposits. According to the proposition, a bailout guarantee decreases monitoring effort only if the fraction of risk sensitive uninsured deposit is large enough. In our parametrization, the threshold value is 38.5%.

Next, following the discussion in Section 4, we endogenize information disclosure and allow the bank to choose (at a cost $\frac{1}{2}\phi\theta^2$) the fraction of debt that is priced at the margin. As proved in Lemma 2, Figure 2 shows that it is indeed the case that the fraction of debt that the bank decides to price at the margin decreases with the share of guaranteed liabilities. When the latter tends to one, there is no more scope for market discipline and thus for bank to invest in disclosure. Interestingly, Figure 2 suggests that capital requirements and optimal disclosure are strategic substitutes. The higher the capital requirement, the higher is bank self discipline and this necessarily reduces the appeal of disclosure as a means to enhance market discipline.

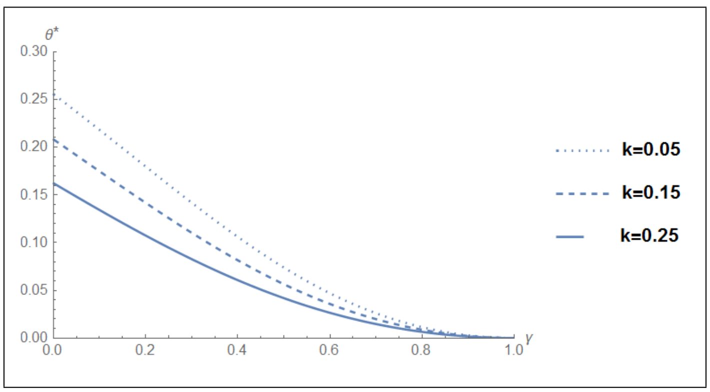

Figure 2: Optimal disclosure, θ^*, as a function of γ.

The fact that an increase in the share of insured liabilities reduces the bank's incentive to rely on market discipline, however, does not mean that it necessarily increases risk taking incentives. Again, one should look both at the moral hazard and at the charter value effects. As proved in Proposition 2, Figure 3 shows that, if the cost of disclosure, ϕ, is high, and thus market discipline is costly for the bank, then it is more likely that the charter value effects dominates and that guarantees discipline bank behavior. Instead, when the cost of disclosure is low, starting from low levels of γ, a further increase in the share of guaranteed liabilities increases risk taking. This, up to a point where the level of market discipline becomes so low that the charter value effect again

with more realistic rate of returns, which we could have done easily. Hence, the simulations have to be interpreted only qualitatively.

dominates (locally).

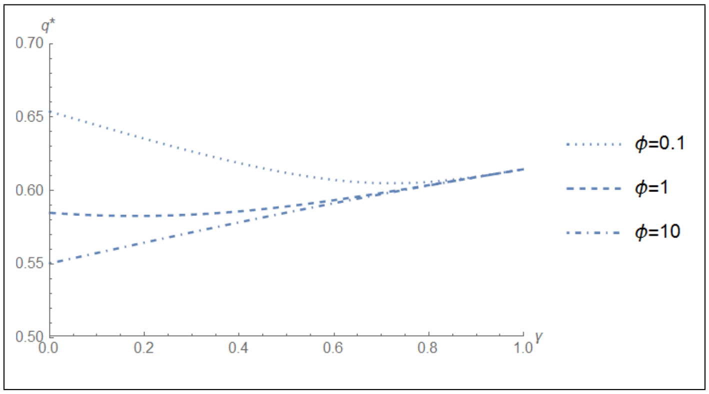

Figure 3: Bank optimal monitoring, q^*, as a function of γ, with θ endogenous.

Finally, when we endogenize bank leverage (keeping disclosure exogenous, as in Figure 1), we find, see Figure 4, that an increase in the share θ of debt liabilities priced at the margin (from 28.5% to 48.5%) decreases the bank's optimal level of capital; and so does an increase in the share of debt liabilities covered by the guarantee. Notice that, here, the decrease in the level of capital is bounded below by the minimal capital ratio $k = 15\%$, which, interestingly enough, becomes binding the earlier, the higher is the share of deposits priced at the margin. Again, this confirms our previous finding that self discipline, enabled by lower leverage, and market discipline enabled by a larger share of liabilities priced at the margin, are strategic substitutes.

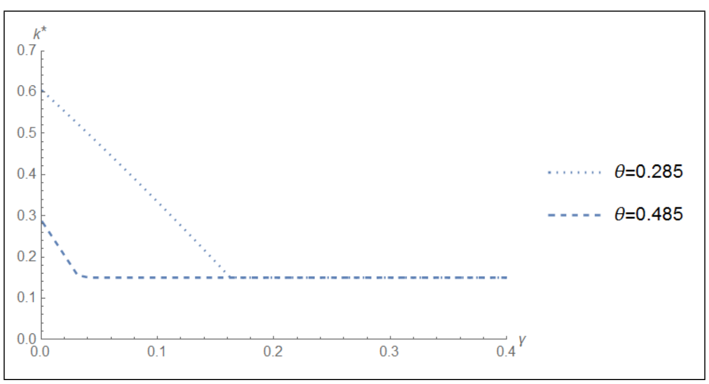

Figure 4: Optimal bank capitalization, k^*, as a function of γ.

Last, but not least, Figure 5 illustrates the effects of an increase in the share of guaranteed liabilities on bank risk taking when capital is exogenous. In this case, the moral hazard effect necessarily dominates as guarantees further discourage the bank to hold capital. However, when capital requirements become binding, and at some point they do, we are back to the situation described in Figure 1, where, the effect of the expectation of a bailout on bank risk taking incentives depends on the effectiveness of market discipline, measured by the share of deposits priced at the margin.

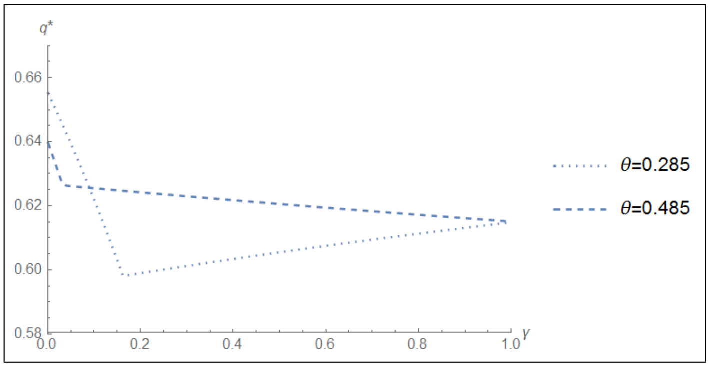

Figure 5: Bank optimal monitoring effort, q^*, when capital k is endogenous.

8 Our results and the existing empirical evidence

The main message of our model is a very simple one: a necessary condition for government guarantees, such as deposit insurance, to hinder market discipline is that debtholders actually be able/willing to exert such a discipline. If not,[11] the subsidy embedded in the guarantees should induce banks to select safer portfolios by increasing the bank's return conditional on success, thus making it more of a residual claimant and aligning its incentives with value maximization. To understand whether the first effect–moral hazard–or the second one–the value effect–of government guarantees is more likely to prevail in a specific situation, one should form a view on the extent to which debtholders are actually able to discipline banks. Ultimately, this is an empirical question which has been investigated quite extensively in the recent banking literature.

Were we asked to summarize this literature in one line, we would say that the evidence that depositors and other security holders are able to identify banks that are at risk of failure, either by running or by demanding higher interest rates, is pretty solid (for the US, among others, see Baer and Brewer, 1986, Goldberg and Hudgins, 1996, Calomiris and Wilson, 1998, Flannery and Sorescu, 1996; for Argentina, Chile and Mexico, see Martinez Peria and Schmukler, 2001).

Yet, the fact that depositors tend to leave troubled banks and/or demand higher risk premia

[11] Min (2015) provides a comprehensive discussion of market discipline and its failures.

when a bank is in distress does not necessarily imply that depositors are able to discipline effectively bank managers' behavior. This important point was raised first by Bliss and Flannery (2001), who distinguish between the monitoring and the influence aspect of market discipline. When they refer to (market) monitoring, they point to investors' ability to understand the financial condition of a firm; when they refer to (market) influence they point to investors' ability to affect managerial actions and, ultimately, to align them with their own interests. With this important distinction in mind, they then look at a panel of large US bank holding companies, those for which one expects market discipline to hold, and they find scant evidence of investors' influence.

Actually, the distinction between the monitoring and the influencing aspect of market discipline can be better understood as a distinction between ex-post and ex-ante discipline (Bliss, 2004). Ex-post discipline comes as a response to a managerial action, such as the withdrawal of deposits from a bank in a situation of financial distress; ex-ante discipline, instead, constrains managers' action by making it costly to act in a way that is not aligned with (in our case) debtholders' objectives. In our model, when depositors observe the bank's portfolio choice, risk is priced directly in the deposit rate and we have ex-ante discipline; when risk is non observable or, for various reasons, not contractible, discipline is necessarily ex-post. Such a distinction is very useful when interpreting some of the recent financial crises.

Stephanou (2010), for instance, looks at the price of different instruments issued by some of the banks more exposed to mortgage instruments (Citigroup, Bear Stearns, and Lehman Brothers) in the period preceding the explosion of the sub-prime crisis in the US. His main finding is that the prices of these instruments only began to decline (vis-à-vis a market benchmark) in the second half of 2007, and went deep south only after Bearn Stearns' collapse. In other words, the market started to price in exposure to risky asset well after banks undertook such investments. In addition, he also found that prices of CDS and equities reacted much quicker and stronger than those of subordinated or senior debt–Lehman Brothers' senior debt remained close to par until just before the bank failed–raising serious doubts about debtholders' ability to exert market discipline. Mispricing of risk is clearly not only a US phenomenon. Beirne and Fratzcher (2013) show that, prior to the Eurozone crisis, economic fundamentals were very poor predictors of sovereign risk, thus hinting again at lack of bondholders' influence.

The distinction between ex-ante and ex-post discipline is thus critical to understand how the presence of government guarantees affects risk taking incentives. For instance, if depositor can exert ex-post, but not ex-ante discipline, there is no reason to question the credibility of the deposit guarantee schemes to reconcile Martinez Peria and Schmuckler's (2001) contrasting findings that depositors do discipline banks in trouble–by withdrawing deposits or demanding higher interest rates–but that the presence of a deposit insurance scheme does not diminish the extent of market discipline.

In addition, when looking at the empirical literature, it is important to keep in mind that even if government guarantees, such as deposit insurance schemes, may decrease market discipline (see, for instance, Demirgüç-Kunt and Huizinga, 2004, for cross-country evidence, and Hadad et al., 2011 for the case of Indonesia), this does not imply that they increase bank risk-taking incentives per se. Indeed, in our model, with the exception of the limit case in which θ–the fraction of risk sensitive uninsured deposits–is equal to zero, government guarantees do create moral hazard; however, they also create a countervailing value effect; which of the two effects is more likely to prevail depends, ultimately, on depositors' ability/willingness to monitor banks' behavior effectively.

It is also important to notice that information disclosure is not enough to guarantee market discipline. Freixas and Laux (2012) argue that the latter requires that information effectively reaches the market and is adequately processed and used. In their view, in the period that preceded the global financial crisis, the lack of market discipline was not the consequence of insufficient disclosure but of market participants' lack of incentives to process it.

With such distinctions clear in mind, we are now in a position to look at the recent literature on the effects of government guarantees on bank risk taking behavior. Not surprising, this evidence is mixed, too. In Germany, Gropp et al. (2014) show that the unanticipated removal of saving banks' government guarantees, because of a court decision, led to a reduction in credit risk; Dam and Koetter (2012), using political factors to identify the causal effect of bank bailouts on risk taking, also find economically significant positive effects. Conversely, looking at the bailout of distressed banks, Berger et al. (2016a) find that capital support was conducive to a reduction both in lending and in risk taking.

There is also a large and growing literature trying to ascertain whether the Troubled Asset Relief Program (TARP) in the US was successful in reducing systemic risk by providing, among other things, an "upside" to banks, or whether it increased risk taking incentive because of the moral hazard it generated. Again, the evidence is mixed: Duchin and Sosyura (2014) show that bailed-out banks tend to be riskier, even if such an increase in risk may not be perceived by regulators;[12] Schenk and Thornton (2016), instead, indicate that TARP bailouts are likely to increase risk-taking in "weak" institutions (low charter values and high leverage) and to decrease it in "strong" institutions (high charter values and low leverage). Finally, using a diff-in-diff strategy, Berger et al. (2016b) also show that TARP contributed to the reduction in systemic risk and that such a reduction has been stronger for larger, safer banks, in states with better economic situations.

The crisis also offered natural experiments to look into the pricing behavior of bank investors. Data on banks' sovereign debt holdings disaggregated by bond issuer are not generally available. However, the EBA released detailed bank-level information when it announced the results of its stress tests. And evidence suggests that this had an impact on banks' CDS spreads. The table below (from Dell'Ariccia et al. 2016) shows that banks that were found to hold larger amounts of distress sovereign bonds on their balance sheets experienced a sharper increase in CDS spreads and drop in stock returns. This evidence is not consistent with the notion that investors price risk at the margin; in particular, since the stress tests revealed new information about bank holding, but little news about the underlying quality of those securities.

Impact of banks' exposure to government debt on stock and CDS market performance

	(1)	(2)	(3)	(4)	(5)
	Banks' stock market returns			Banks' CDS spreads	
Sovereign CDS*Domestic sovereign exposure	-1.664***	-1.782***	-1.690***	0.159***	0.115***
	(0.396)	(0.425)	(0.401)	(0.062)	(0.047)
Domestic sovereign exposure (% assets)	-0.009		0.003	0.443*	0.596***
	(0.038)		(0.040)	(0.266)	(0.183)
Sovereign CDS	-0.177***	-0.182***	-0.186***	0.041***	
	(0.035)	(0.037)	(0.035)	(0.005)	
Bank FE	Yes		Yes	Yes	Yes
Country FE	Yes	Yes		Yes	
Year				Yes	
Year-month FE	Yes				
Bank-year-month FE		Yes			
Country-year-month FE			Yes		Yes
Number of countries	12	12	12	5	5
Number of banks	33	33	33	29	29
Observations	1,468	1,468	1,468	1,849	1,849
R-squared	0.234	0.305	0.273	0.60	0.66

Notes: In columns 1-3 the dependent variable is the bank's stock market return and the sample contains 33 domestic banks from 12 euro area countries. The data are pooled over EBA stress test release periods, where each period includes the day of data release and the subsequent 10 trading days, during Mar 2010-Dec 2013. Regressions are run at the bank-trading day level. "Domestic exposure" is the ratio of the bank's total holdings of domestic sovereign bonds to the bank's total assets. "Sovereign CDS" is the log-difference of daily CDS spreads on a 5-year government bond. In columns 4-5 the dependent variable is the bank's CDS spread and the sample includes 29 domestic banks in Greece, Ireland, Italy, Portugal, and Spain. Regressions are run at the bank-month level. The time period is Aug 2007-Jun 2013. "Sovereign CDS" is the maximum CDS spread on a 10-year sovereign bond during the month. "Domestic exposure" is the ratio of the bank's total holdings of domestic sovereign bonds to the bank's total assets (divided by 1000). A constant term is included (coefficient not shown). Standard errors clustered at the bank level appear in parentheses, where *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level. Sources: ECB Individual MFI Balance Sheet Statistics, European Banking Authority, Bankscope, Bloomberg, SNL Financial, and Datastream.

Table 1

[12] Because it occurs in the same asset classes and thus does not affect the CAR.

9 Discussion and conclusions (preliminary)

This paper reexamines the theoretical relationship between the expectation of a government bailout of bank debtholders (depositors and bondholders) and bank risk taking. After the Global Financial Crises, the regulatory policy debate has centered on how to make financial institutions safer and more resilient to shocks. Within that debate, the classical argument that explicit (typically deposit insurance) or implicit (typically the expectation of a public bailout of bondholders) government guarantees on bank liabilities entail a moral hazard effect that increase bank risk taking has played a prominent role. Yet, this argument critically relies on debtholders' and depositors' ability to price bank risk taking at the margin. Put differently, it requires the cost of bank liabilities to reflect changes in bank behavior. In contrast, absent this ability, the presence of government guarantees improves bank incentives by reducing the cost of their liabilities and hence increasing their charter value.

The simple model in this paper highlights these effects. It shows that when the proportion of bank debt-holders that can price risk at the margin is sufficiently high, the classical moral hazard argument holds. But when it is relatively low, the charter value effect dominates. The model also shows that when banks can choose (at some cost) how much information to disclose and, hence, the proportion of liabilities priced at the margin, government guarantees entail an additional form of moral hazard. They tend to reduce the degree of disclosure. This tilts the balance in favor of the classical moral hazard effect. Yet, when the cost of disclosure is sufficiently high, the charter value effect still prevails. The model also finds that the balance between the moral hazard and charter value effects is likely to vary across banks and with economic conditions. In particular, the likelihood that bank guarantees increase risk taking is higher for less capitalized banks, when intermediation margins are higher, and when agency problems are less severe.

Finally, the model shows that when bank capital is endogenous, public guarantees may lead to an increase in bank leverage and an associated increase in risk taking. Again, an additional form of moral hazard. In that context, the model suggests that there is complex relationship between prudential policy and the institutional framework governing bank resolution and bailouts. Effective capital regulation and limits on leverage may avoid some of the negative effects of government guarantees and bailout expectations and increase the policy space on that front. This also means that government guarantees are much more problematic for institutions without leverage regulation.

The model of course has limitations. First, a multi-period could provide a more complex view of information disclosure. For instance, over time, investors could infer a bank's portfolio position from its profitability and price its debt accordingly. Yet, as long as banks where able to adjust their portfolio "often enough", absent information disclosure, investors would not be able to price risk at the margin (exactly as in our one-period model). From this perspective, our parameter capturing the proportion of a bank's liabilities that are priced at the margin could be reinterpreted in a multiperiod setting to capture the portion of a bank portfolio that cannot be easily readjusted.

Recent regulatory reforms have aimed at minimizing the exposure of taxpayers to losses stemming from public interventions into banking systems and reducing the implicit subsidies associated with too-big-too-fail. New regulation has significantly increased banks' loss absorption capacity by raising minimum capital requirements and imposing additional buffers on systemic institutions. More critically (from this paper's standpoint) reforms have aimed at tying the government's hands in case of a crisis. In the US, the Dodd-Frank act included norms aimed at curbing the authorities ability to inject public money into troubled financial institutions. In the EU, the recently implemented BRRD (Bank Resolution and Recovery Directive) requires a bail-in of junior and subordinated debt of at least 8 percent of a bank's total liabilities before public funds can be used.

These restrictions aim primarily at protecting taxpayers money, but were also informed, at least in part, by the desire to contain moral hazard associated with the expectation of government assistance. In light of the findings in this paper, whether or not these measures will succeed in the latter objective depends on the degree with which bank risk is priced at the margin. From this standpoint, as discussed in the previous section, the empirical evidence on the matter is mixed. The paper also suggests that post-crisis reforms by reducing bank leverage have already reduced the moral hazard concerns associated with the expectation of government assistance, and have created policy space for more "generous" guarantees.

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10 Appendix. Proofs

10.1 Proposition 1.

Proof. Differentiating (5) with respect to γ, we have that

$$\frac{\partial q^*}{\partial \gamma} = \frac{(1-k)\overline{r}}{2c\Phi}(-R + (1-k)\overline{r}\gamma + 2c(1-\theta) - \Phi), \tag{15}$$

with $\Phi \equiv \sqrt{(R - \gamma(1-k)r)^2 - 4cr(1-\gamma)(1-\theta)(1-k)} \geq 0$. At $\theta = 0$,

$$(-R + (1-k)\overline{r}\gamma + 2c(1-\theta) - \Phi) = 2c(1-q^*)$$

which is positive when parameters are such that q admits an internal solution so that (15) is always positive. At $\theta = 1$, (A.1), instead, implies that (15) is always negative. Thus, to complete the proof, is enough to show that $\frac{\partial^2 q^*}{\partial\theta\partial\gamma} < 0$. Differentiating (15) with respect to γ, we obtain:

$$\frac{\partial^2 q^*}{\partial\theta\partial\gamma} = \frac{-(1-k)\overline{r}\Psi}{\left((R - \gamma(1-k)\overline{r})^2 - 4c\overline{r}(1-k)(1-\theta)(1-\gamma)\right)^{\frac{3}{2}}}, \tag{16}$$

with

$$\Psi \equiv (R - (1-k)\overline{r})(R - (1-k)\overline{r}\gamma) - 2c\overline{r}(1-\gamma)(1-k)(1-\theta). \tag{17}$$

To show that $\frac{\partial^2 q^*}{\partial\theta\partial\gamma} < 0$, it is enough to show that $\Psi > 0$. Since Ψ is a linear function of γ, to prove that it is positive for any γ, it is enough to show that it is positive at $\gamma = 0$, and $\gamma = 1$ (for any k and θ). When $\gamma = 0$, we have that

$$\Psi = R(R - (1-k)r) - 2c\overline{r}(1-k)(1-\theta). \tag{18}$$

Since (18) is an increasing function of k and θ, if we know that if it is positive at $k = 0$ and $\theta = 0$, then it is positive for all k and θ. We thus have that

$$\Psi\,|_{\gamma=0;\theta=0} = R^2 - Rr - 2c\overline{r} > 0$$

However since from (A.1), we know that $R < c$ a sufficient condition for the inequality to hold is that

$$R^2 - 3\overline{r}c > 0$$

or

$$c < \frac{R^2}{3\overline{r}},$$

which is always satisfied if (A.1) holds. This in turn implies that a single $\widehat{\theta} \in (0,1)$ exists such that $\frac{\partial q^*}{\partial \gamma} > 0$, if $\theta < \widehat{\theta}$; and $\frac{\partial q^*}{\partial \gamma} < 0$, if $\theta > \widehat{\theta}$. ■

10.2 Lemma 1

Proof. Define

$$H = \frac{d\Pi}{d\theta} = (1-\theta)\frac{\overline{r}^2(1-\gamma)^2(1-k)^2}{q\sqrt{(R-\gamma(1-k)\overline{r})^2 - 4c\overline{r}(1-\gamma)(1-\theta)(1-k)}} - \theta\varphi. \tag{19}$$

Note that

$$\frac{d\theta}{d\gamma} = -\frac{\frac{dH}{d\gamma}}{\frac{dH}{d\theta}},$$

where $\frac{dH}{d\theta} < 0$ from the second order conditions. Then, we have that $\frac{d\theta}{d\gamma}$ will have the same sign as $\frac{dH}{d\gamma}$. We can write:

$$\frac{dH}{d\gamma} = -(1-\theta)r^2(1-\gamma)(1-k)^2\frac{2A + \frac{\partial A}{\partial\gamma}(1-\gamma)}{A^2}$$

where $A = q\sqrt{(R-\gamma(1-k)\overline{r})^2 - 4c\overline{r}(1-\gamma)(1-\theta)(1-k)}$. Now:

$$\frac{\partial A}{\partial \gamma} = -qr(1-k)\frac{R - r\gamma(1-k) - 2c(1-\theta)}{\sqrt{(R-\gamma(1-k)r)^2 - 4cr(1-\gamma)(1-\theta)(1-k)}}$$

which after substituting gives us

$$\frac{dH}{d\gamma} = -(1-\theta)r^2(1-\gamma)(1-k)^2\frac{\frac{2q^2\left((R-\gamma(1-k)r)^2-4cr(1-\gamma)(1-\theta)(1-k)\right)}{A} - \frac{q^2r(1-k)(1-\gamma)(R-r\gamma(1-k)-2c(1-\theta))}{A}}{A^2}$$

So $\frac{dH}{d\gamma}$ will have the opposite sign of

$$B = \frac{2q^2\left((R-\gamma(1-k)r)^2 - 4cr(1-\gamma)(1-\theta)(1-k)\right)}{A} - \frac{q^2r(1-k)(1-\gamma)(R-r\gamma(1-k)-2c(1-\theta))}{A}$$

we can rewrite

$$\frac{BA}{q^2} = (R-\gamma(1-k)r)^2 - 4cr(1-\gamma)(1-\theta)(1-k) + (R-(1-k)r)(R-r(1-k)\gamma) - 2cr(1-\gamma)(1-\theta)(1-k)$$

The first term is just $A^2/q > 0$. A sufficient condition for the second term to be positive is that

$R > 2r$; which is always verified from our other restrictions. It follows that $B > 0$ and that $\frac{dH}{d\gamma} < 0$. Which in turn implies that $\frac{d\theta}{d\gamma} < 0$. ■

10.3 Proposition 2

Proof. From (5), we have that

$$q^* \mid_{\gamma=0} \equiv q_0^* = \frac{1}{2c}(R + \sqrt{R^2 - 4c\overline{r}(1-k)(1-\theta)}, \tag{20}$$

$$q^* \mid_{\gamma=1} \equiv q_1^* = \frac{R - (1-k)\overline{r}}{c}, \tag{21}$$

Let's now define $\overline{\theta}$ as the value of θ such that $q_0^* = q_1^*$, or

$$\frac{1}{2c}\left(R + \sqrt{R^2 - 4c\overline{r}\left(1-\theta\right)\left(1-k\right)}\right) = \frac{R - (1-k)\overline{r}}{c}, \tag{22}$$

which gives

$$\overline{\theta} = 1 - \frac{R - (1-k)\overline{r}}{c} = 1 - q_1^*. \tag{23}$$

The first order condition of (7) with respect to θ can be written as

$$\frac{d\Pi}{d\theta} = (1-\theta)\frac{\overline{r}^2\left(1-\gamma\right)^2\left(1-k\right)^2}{q^*\sqrt{\left(R - \gamma(1-k)\overline{r}\right)^2 - 4c\overline{r}\left(1-\gamma\right)\left(1-\theta\right)\left(1-k\right)}} - \theta\varphi = 0, \tag{24}$$

and, using (5):

$$\frac{d\Pi}{d\theta} = (1-\theta)\frac{\overline{r}^2\left(1-\gamma\right)^2\left(1-k\right)^2}{q^*(2cq^* - R + (1-k)\overline{r}\gamma)} - \theta\varphi = 0. \tag{25}$$

When $\gamma = 0$, the expression becomes:

$$\frac{d\Pi}{d\theta} = (1-\theta)\frac{\overline{r}^2\left(1-k\right)^2}{q_0^*(2cq^* - R)} - \theta\varphi = 0. \tag{26}$$

If now we substitute $\overline{\theta}$ from (23) into (26), we obtain:

$$\frac{d\Pi}{d\theta} = q_1^*\frac{\overline{r}^2\left(1-k\right)^2}{q_0^*(2cq^* - R)} - (1-q_1^*)\varphi = 0. \tag{27}$$

However, at $\theta = \overline{\theta}$, $q_0^* = q_1^* = \frac{R-(1-k)r}{c}$ so that we can rewrite (27) as

$$\frac{d\Pi}{d\theta} = \frac{\overline{r}^2\left(1-k\right)^2}{(2cq^* - R)} - \left(\frac{c - R + (1-k)\overline{r}}{c}\right)\varphi = 0; \tag{28}$$

Solving for φ, we obtain

$$\overline{\varphi} = \frac{c\overline{r}^2 (1-k)^2}{(c - R + (1-k)\overline{r})(R - 2(1-k)\overline{r})}.$$

Notice that, by construction, $\overline{\varphi}$ is the cost of transparency such that, after having chosen θ optimally, the bank chooses the same portfolio riskiness when its deposit are fully insured ($\gamma = 1$) and when they are not ($\gamma = 0$). The fact that $\frac{\partial q^*}{\partial \theta} > 0$ and, from (23), $\frac{\partial \overline{\theta}}{\partial \varphi} > 0$ implies that $q_0^* > q_1^* \Longleftrightarrow \varphi < \overline{\varphi}$. [TO BE COMPLETED] ■

10.4 Proposition 3

Proof. From 5, it is immediate that $\frac{\partial q}{\partial k} > 0$ (k enters always with a positive sign, actually two negative signs) and $\frac{\partial^2 q}{\partial k \partial \theta} < 0$. It follows that

$$\frac{d\widehat{k}}{d\theta} = -\frac{\frac{\partial^2 \Pi}{\partial k \partial \theta}}{\frac{\partial^2 \Pi}{\partial k^2}} < 0$$

since $\frac{d^2 \Pi}{dk^2} < 0$ from the second order conditions. Note that for $\theta = 1$, we have

$$\frac{d\Pi}{dk} = -\left(1 - \frac{R - (1-k)\overline{r}\gamma}{c}\right)\gamma\overline{r} - \xi < 0, \text{ for all } k$$

and the first order conditions for k can never be satisfied. Then, the model will only admit a corner solution with $\widehat{k} = 0$. ■

10.5 Proposition 4

Proof. From 14, we have that $\frac{\partial^2 \Pi}{\partial k \partial \gamma} < 0$, which, together with the second order conditions with respect to k, implies that

$$\frac{d\widehat{k}}{d\gamma} = -\frac{\frac{\partial^2 \Pi}{\partial k \partial \gamma}}{\frac{\partial^2 \Pi}{\partial k^2}} < 0,$$

that is as government guarantees increase, banks find it optimal to reduce their capitalization (increase their leverage). ■

10.6 Claim 1

Proof. Numerical simulations for a broad range of parameters support this claim.

[BEGINNING OF AN ANALYTICAL PROOF]

The first order conditions with respect to k are

$$\frac{d\Pi}{dk} = -\left(1-q\right)\gamma\overline{r} - \xi + \frac{\partial q}{\partial k}\left(R - \gamma(1-k)\overline{r} - cq\right) = 0 \tag{29}$$

This has to be satisfied as an identity in equilibrium: $\frac{\partial\Pi}{\partial k} \equiv 0$ for any value of γ at the equilibrium choice of k. Now consider the following derivative:

$$\begin{aligned}\frac{d\left(\frac{\partial\Pi}{\partial k}\right)}{d\gamma} &= \frac{d\left(-\left(1-q\right)\gamma\overline{r} - \xi + \frac{\partial q}{\partial k}\left(R - \gamma(1-k)\overline{r} - cq\right)\right)}{d\gamma} = \\ &-\left(1-q\right)\overline{r} + \frac{\partial q}{\partial\gamma}\gamma\overline{r} + \frac{\partial^2 q}{\partial k\partial\gamma}\left(R - \gamma(1-k)\overline{r} - cq\right) + \frac{\partial q}{\partial k}\left(-(1-k)\overline{r} - c\frac{\partial q}{\partial\gamma}\right)\end{aligned}$$

Given that $\frac{d\Pi}{dk}$ is identically equal to zero, this expression must also be equal to zero

$$\begin{aligned}&-\left(1-q\right)\overline{r} + \frac{\partial q}{\partial\gamma}\left(\gamma\overline{r} - c\frac{\partial q}{\partial k}\right) + \frac{\partial^2 q}{\partial k\partial\gamma}\left(R - \gamma(1-k)\overline{r} - cq\right) - \frac{\partial q}{\partial k}(1-k)\overline{r} \\ &= -\left(1-q\right)\overline{r} + \frac{\partial q}{\partial\gamma}\gamma\overline{r} + \frac{\partial^2 q}{\partial k\partial\gamma}\left(R - \gamma(1-k)\overline{r} - cq\right) + \frac{\partial q}{\partial k}\left(-(1-k)\overline{r} - c\frac{\partial q}{\partial\gamma}\right)\end{aligned}$$

■