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Too many to fail - How bonus taxation prevents gambling for bailouts

Michael Hilmer*

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Abstract

Using a simple symmetric principal-agent model of two banks, this paper studies the effects of both bailouts and bonus taxes on risk taking and managerial compensation. In contrast to existing literature, we assume financial institutions to be systemic only on a collective basis, implying support only if they collectively fail. This too-many-to-fail assumption generates incentives for herding and collective moral hazard. If banks can anticipate bailouts, they can coordinate on equilibrium where they collectively incentivize higher risk-taking. A bonus tax can prevent this market failure, even if it is implemented unilaterally: proper bonus taxation reduces risk-taking of the taxed bank and, consequentially, rules out the equilibrium with high risk-taking of both banks. In preventing market failure due to banks collective moral hazard, bonus taxation reestablishes market discipline.

Keywords: Bonus Tax; Executive Compensation; Bailout; Systemic Risk, Too Many To Fail; Collective Moral Hazard

JEL Codes: H24; J3; M52; G38; D62

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1 Introduction

In the recent financial crisis, some important observations about the characteristics of the financial market, its players, contagion effects and policymakers' response could be made. Governments and central banks have been faced with troubled banks and a challenging tradeoff: should they allow bank insolvencies, which would lead to contagion effects and thus to enormous welfare losses, or should they rescue them and let the public pay for the losses. In addition, while banks were rescued using huge sums of money from the taxpayer, the public debated about high compensation payments considered to be unfair, especially in banking industries. Policymakers included this item in their discussions and partly responded by reforming the tax treatment of managerial compensation, e.g. by imposing bonus taxes.

This paper combines three aspects from the financial crisis: a) the systemic risk of financial institutions that are not systemic individually but on a collective basis, b) high compensation payments to bankers, and c) bonus taxation. By analyzing these aspects in a principal-agent model of two banks, the paper presents effects of a) bailouts and b) bonus taxation on managerial incentives and risk taking. In this model, if agents have to be incentivized to select a project only when its success probability is high enough, then anticipated bailout increases risk-taking. Moreover, we show how bonus taxation reduces overall risk taking. While leading politicians emphasized the necessity of a coordinated approach with all major economies implementing the tax at a global level¹, the results suggest that also unilateral bonus taxation eliminates an equilibrium with high risk taking and causes positive external effects on other countries.

There are two main opportunities for banks to become systemic: on the one hand, banks may be large and thereby systemic on an individual level, i.e. they are "too big to fail". On the other hand, banks may be too small to be too-big-to-fail, but strongly interconnected and thereby systemic collectively, i.e. "too many to fail". While the first opportunity has already been studied in the literature, this paper focuses on the latter opportunity. We assume that only simultaneously failing banks receive a bailout. A single failing bank is not going to be bailed out.

¹See "For Global Finance, Global Regulation" (Gordon Brown and Nicolas Sarkozy, Wall Street Journal 2009, Dec 9): "[...] action that must be taken must be at a global level. No one territory can be expected to or be able to act on its own."

In the last decades, financial markets have integrated more and more, and in this move also cross-border banking increased.² Degryse et. al (2010) have shown, that this increase in cross-border banking also caused an increase of financial contagion by banks. For policymakers, this is relevant when it comes to the decision whether or not to bail out failing banks. Irrespective of size, the more interconnected a bank is, the more systemic it is. This is especially the case, if banks can increase the likelihood of a bailout by correlating their investments. In the extreme, both are either successful, or fail simultaneously, thereby exerting higher pressure on the regulator for a bailout. For the possible future regulator, this leads to the uncomfortable situation where he would like to prevent banks' incentive to coordinate, but cannot credibly commit to a no bailout-clause.³

Another issue in the public debate were high compensation payments and its taxation. From an economic point of view, asymmetric information calls for bonus payments in order to incentivize the agent to act in the principal's interest. Nevertheless, it has been considered as unfair that bankers receive high bonus payments in times in which taxpayers have to bear the costs of their decisions. In response to that, several countries introduced a surtax on managerial bonuses. For the fiscal year 2009-2010, the UK introduced a 50% bank payroll tax which was levied on bonus payments for bankers higher than 25.000 GBP (UK Finance Act 2010, Schedule 1). Likewise, other countries raised bonus taxes for banks supported by the government: in 2011, Ireland introduced a 90% tax, while the US House of Representatives approved such a 90% tax already in March 2009.⁴

The results of the model propose the following: If banks can anticipate bailouts, market discipline weakens in terms that banks incentivize their bankers to take on higher risk. In a situation without bonus taxation, banks foresee that they are systemic in a herd and thus can coordinate on an equilibrium with high risk taking, taking advantage of the systemic risk they collectively cause. If, on the other hand, bankers' bonuses are taxed properly, then the taxed banker requests a higher gross bonus payment to be compensated for the additional tax burden. Thereby incentives for risk taking become more expensive such that a proper

²For an analysis of cross-border banking in Europe see Allen et. al (2011).

³See Acharya and Yorulmazer (2007) for an explanation of the differences between too-big-to-fail and too-many-to-fail and an analysis of time-inconsistency in bank closure policies.

⁴See "Ireland to reintroduce 90% bank bonus tax" (guardian.co.uk 2011, Jan 26) and "Bonus Tax Heads to Senate After House Passes 90% Levy" (bloomberg.com 2009, Mar 20).

bonus tax can circumvent excessive risk taking in equilibrium. Moreover, for the equilibrium with excessive risk taking to break down, it is sufficient if only one manager is subject to a bonus tax. Then, bonus taxation reestablishes market discipline as it prevents market failure due to banks' collective moral hazard.

2 Related Literature

With respect to literature, this paper belongs to several strands of literature. In terms of methodology, it is related to the literature on executive compensation and especially to the literature on delegated expertise. This literature in large parts focuses on efficient or optimal contracting by using agency theory.⁵ There, a firm owner has to incentivize a manager to act in his interest but is exposed to an information asymmetry, which may lead to shirking or moral hazard by the manager. In standard models of the agency literature (see Jensen and Meckling, 1976, Holmström, 1979, and Grossman and Hart, 1983, among others), agents typically are assumed to exert effort in order to increase (the probability of high) profits. As they dislike effort and effort is not directly observable by the principal, an agency problem arises.

In the literature on delegated expertise, in general, a delegated expert can acquire superior information about a random state of nature and then take a decision based on this information. The principal can only observe the outcome, but does not know on which information the agent's decision was based. Thereby a conflict of interest is created. In contrast to literature, this paper abstracts from costs to acquire superior information, but assumes that the agent already has this expertise.⁶ Thereby it is closest related to Lambert (1986), as the agent subsequent does not receive a noisy signal on the success probability of projects, but can observe the actual success probabilities. Given this knowledge, the agent

⁵Another perception on executive compensation is the managerial power approach, mainly brought forward by Bebchuk et al. (2002), Bebchuk and Fried (2003) and Bebchuk and Fried (2004). In contrast to efficient-contracting, they believe in powerful, rent-seeking agent that are able to influence their own pay. For an overview on the contributions in both strands of literature see Frydman and Jenter (2010) and Murphy (2013).

⁶Existing papers differ in their assumptions on costs of information. Some assume information costs to be fixed (Lambert (1986), Gromb and Martimort (2007), Core and Qian (2002)), while in others agents can take continuous effort that improves information quality (Malcomson (2009), Feess and Walzl (2004), Barron and Waddell (2003)). Crémer and Khalil (1992) assume that the agent can acquire information already before signing the contract, but show that the optimal contract will abstain from incentives to invest in information.

decides whether or not to invest in a risky project.⁷ Thus, the contract must provide sufficient incentives to circumvent moral hazard in deciding upon an investment. For optimal contracts, Palomino and Prat (2003) have shown that a bonus contract best aligns interests between principal and agent, when the agent's task is the selection of a portfolio of risky financial assets. In contrast to other models, there the agent does not have to acquire additional information, but has to incur costs in order to be able to invest in a risky project at all.

A second strand of literature this paper belongs to, is the literature on systemic risk due to a too-many-to-fail problem. While Brown and Dinc (2009) affirm with their empirical findings the relevance of the too-many-to-fail problem, Acharya and Yorulmazer (2007) and Acharya (2009) show with their models banks' incentives to herd and to correlate their bank assets and returns, especially when they are small in size. Thereby, banks increase both economy-wide aggregate risk and the likelihood that many banks fail together. Acharya and Yorulmazer (2007) account for the time-inconsistency in bank closure policies, while Acharya (2009) suggests implementation of regulation at a collective level where banks are required to hold greater capital against general risk than against specific risk. Farhi and Tirole (2012) investigate, that anticipated bailouts also lead to high levels of short-term debt, high leverage and wide-scale maturity mismatch and thus to collective moral hazard. As a result, they claim optimal policy intervention as a reduction of interest rates and the use of direct transfers only when a large fraction of banks is affected by a crisis.

For bonus taxes, effects have been studied empirically and theoretically.⁸ Von Ehrlich and Radulescu (2012) empirically analyze the effects of the UK bank payroll tax on compensation payments. Their findings suggest that the bonus tax caused a reduction in bonus payments of 40%. However, this reduction was accompanied by an one-to-one increase in other pay components not subject to the tax. Altogether, the bonus tax did not affect overall compensation. Theoretically,

⁷With respect to the choice set for the agent's decision, different assumptions are made in the literature. While, alike in this paper, in Core and Qian (2002), Barron and Waddell (2003), Feess and Walzl (2004) and Gromb and Martimort (2007) the agent only decides upon investing or not, Lambert (1986), Demski and Sappington (1987) and Malcomson (2009) allow for different actions to take or projects to choose from.

⁸A review on literature analyzing systemic externalities of bank failures is provided by Wagner (2010). For a broader analysis of proposed and discussed tax measures on the financial sector, e.g. a Financial Transactions Tax, see Shackelford et al. (2010), Keen (2011a) and Devereux (2011). Brunnermeier et al. (2009) state principles of financial regulation.

effects of bonus taxation have been studied mainly in principal-agent models. Assuming a risk-averse agent, Dietl et al. (2013) analyze how a bonus tax affects the composition of compensation payments and executives' incentives to exert effort. Effects in their model depend on agent's degree of risk aversion and the variance in firm value. By extending the agent's choice set - next to effort - to risk taking, Grossmann et al. (2012) observe an effect opposed to ours. They find that a bonus tax induces the agent to reduce effort and to increase risk-taking as the agent's marginal cost of risk decreases more than his marginal revenue. The compensation structure shifts towards a fixed salary. A comparison of different kinds of bonus taxation has been done by Hilmer (2013). The paper shows that a bonus tax and limited deductibility of bonus payments from the corporate income tax have similar distortionary effects in reducing effort and net bonuses and thereby reduce welfare. In contrast to bonus taxation, welfare even can be increased by paying a subsidy for bonus payments. Radulescu (2012) studies the effects of a bonus tax in a two-country framework with endogenous or exogenous reservation wages. In her model, an unilateral bonus tax leads to a decline in effort, while incidence mainly falls on the firm's shareholders. Results are largely similar when she allows for an endogenous reservation wage, but depend on the strength of the negative reaction of the reservation wage to the bonus tax. Thanassoulis (2012) emphasizes the negative externality of competition. He finds that remuneration is increasing when banks compete for the best teams of bankers. In turn, higher remuneration also drives up expected costs of bankruptcy of competing banks.

Besley and Ghatak (2013) model bonus taxation in presence of the externality of bailouts due to a too-big-to-fail problem and analyze a situation with three groups of citizens: consumers, financial intermediaries and financial sector workers. They find that a situation with bailout guarantees and without bonus taxation is inefficient and inequitable. Moreover, a bonus tax, above and beyond standard progressive income taxation, can correct the distortion in financial sector workers' effort and risk-taking a bailout causes.⁹

This paper contributes to the literature, as it analyzes the effects of anticipated bailouts on bonus payments and risk taking and their reactions to a bonus tax.

⁹Keen (2011b) does not model bonus taxes, but also addresses the problem of taxing or regulating banks under presence of systemic risk. He finds, that corrective taxation requires a progressive tax on the bank's borrowing. Tax policy can be further supported by minimum capital requirements.

Literature has dealt with this problem for systemic risks due to too-big-to-fail¹⁰, but there is not yet research on the effects of bonus taxation due to a too-many-to-fail problem. As too-big-to-fail only covers large banks and already is in place if only one bank fails, the too-many-to-fail analysis is a meaningful extension which includes smaller banks and collective moral hazard into the analysis. This is especially interesting, when fiscal jurisdiction only covers a subset of banks such that regulation can not capture all banks collectively. For this analysis, the model is restricted at times in a way that makes it possible to examine the effects of bonus taxation that only addresses one bank.

In the following section, we introduce the general model and derive benchmark results with only one bank. In section 4, the model will be extended towards two banks, where the agents of both banks simultaneously decide on project implementation while they anticipate a bailout if banks fail simultaneously. Section 5 illustrates, how a bonus tax leads to reduced risk taking, both when imposed on one manager only or on both managers. Section 6 concludes.

3 One Bank - Benchmark

Model

The model specification is as follows: There is one risk-neutral shareholder (principal) who delegates the task of implementing a project to a risk-neutral manager (agent). This is done by offering a take-it-or-leave-it contract to the manager, whose payoff is subject to a limited liability constraint and who has an exogenous outside option $\underline{u} \geq 0$. If the manager accepts the contract, he decides whether or not to invest into a risky project R . One could think of project R as a possible investment in subprime mortgages. If he decides against project R , no further costs arise for the manager and investment will take place in a safe asset S . Asset S generates a payoff $s \geq 0$ in any state of the world, e.g. $Pr(s | S) = 1$. In case the manager wants to invest in R , he faces fixed costs $C > 0$ for imple-

¹⁰Hakenes and Schnabel (2013) show how bonuses change when bailouts can be anticipated. Similar to this model, an anticipated bailout increases bonuses and risk-taking in their analysis. In contrast to this model, Hakenes and Schnabel (2013), alike Besley and Ghatak (2013), study the too-big-to-fail problem. In addition, they do not analyze the effects of bonus taxation.

menting the project.¹¹ Once implemented R , there exist three states of the world with corresponding returns $r_H > s \geq 0 > -r_L$ and their respective probabilities $Pr(r_H) = p_i$, $Pr(s | R) = q$ and $Pr(-r_L) = (1 - p_i - q)$. As $p_i \in (0, 1)$ and $q \in (0, 1)$, each return is realized with some probability. This implies a first informational advantage of the manager vis-à-vis the principal: ex post only realizations r_H , s and r_L are observable, respectively, but not the agent's actual investment. As the payoff s can occur with or without implementing R , the principal can not perfectly infer whether the agent has implemented the risky project or not.

In addition, it is assumed that there is a second source of information asymmetry between the principal and the manager which regards the profitability of the risky project R . While the manager (as an expert) before contract signing knows the actual success probability p_i , the principal only knows the distribution of possible success probabilities p_i .¹² Thus, information asymmetry accrues as the principal can not observe on which information the manager based his decision on project implementation. For the principal, this problem is especially severe if R is profitable for some probabilities p_i , while it is not profitable for other probabilities p_i . To analyze this problem and for simplicity, we assume that there exist two different probabilities p_i (with $i \in \{l, h\}$) that the project yields the high return r_H : $p_l < p_h$. When nature draws the possible probabilities p_l and p_h before the contracting stage, both the principal and the manager learn about them. In contrast to the principal, the manager not only learns the set of possible probabilities $\{p_l, p_h\}$ and their respective likelihood of occurrence, he also receives a perfect signal about the actual success probability - either p_l or p_h - before the take-it-or-leave-it contract is offered to him. For the likelihoods of occurrence, it is assumed that the high success probability p_h occurs with probability $\gamma \in (0, 1)$, while the low success probability p_l appears with probability $(1 - \gamma)$. Finally, if the agent accepts the contract, he chooses whether to implement R at a cost C or not. Afterwards, returns are realized and payments are made.

¹¹For simplicity, we assumed costs for investment into S to be zero. Nevertheless, results do not change qualitatively if we allow for costs of the safe asset $C_S > 0$, as long as $C > C_S$.

¹²Following Lambert (1986), an agent can also acquire superior information by investing in knowledge after contract signing. As the focus here are compensation payments and taxation rather than the agent's information acquisition, the assumption of the agent's ex ante superior information simplyfies the analysis, but is not crucial.

Compensation Payments

The principal needs a compensation structure that provides incentives for the agent to make an appropriate decision on the basis of his superior information. Thus, as compensation for the task of operating the company and implementing the investment project, the manager is offered a state-contingent wage. This pays a fixed wage A if the outcome is $(-r_L)$, a wage Y if the outcome is s , and a bonus additionally to the fixed wage A if the outcome is r_H . For the bonus, the principal remits $b \geq 0$ as a fraction of payoff r_H , which yields a total payment of $(A + br_H)$ if the outcome is r_H . As the principal makes losses when the outcome is $(-r_L)$, he has no means to credibly commit to a fixed wage $A > 0$. As the manager is constrained by limited liability, this implies $A = 0$.¹³ Similarly, the principal is financially not able to pay $Y > s$. At the same time, it will not be optimal for him to pay $Y > \underline{u}$. In this case, either suboptimal rent payments to the agent would be necessary, or the agent would always choose S rather than R .¹⁴ At the end, s and \underline{u} mainly have effects on the profitability of the safe asset S , which depends on whether $s \leq \underline{u}$ or $s \geq \underline{u}$, and thereby set a payoff threshold for the risky project. For the sake of simplicity, we assume $s = \underline{u} = 0$ and refer to the safe project S as “no project”.¹⁵ This assumption immediately implies $Y = 0$.

In expectation, the manager’s compensation EC when implementing the risky project amounts to $EC = p_i br_H$ while he faces costs C for this task. By assumption, the agent maximizes his expected net compensation with respect to his choice of accepting the contract or not and with respect to his investment choice. Without further costs (e.g. for effort), the manager is faced with a tradeoff on the extensive margin rather than on the intensive margin (e.g. between marginal expected bonus and marginal effort costs).¹⁶ As he knows the probabilities p_i and

¹³Even if the principal receives a bailout r_L , he has no means to pay $A > 0$. But even if he had, a bonus would still be necessary to incentivize the agent to implement R only for such probabilities p_i for which it is profitable in expectation. Otherwise, the manager would, protected by his limited liability, also implement projects that harm the principal.

¹⁴If $Y > \underline{u}$, the agent shirks and never implements R unless the principal increases b . This leads to rent payments to the manager. For all remaining $0 \leq Y \leq \min\{s, \underline{u}\}$, both principal and manager are indifferent in absence of bonus taxation. With bonus taxation, Y optimally satisfies $Y = \min\{s, \underline{u}\}$.

¹⁵This simplification has no qualitative implications for the analysis of too-many-to-fail policies and bonus taxation. Rather, it has a level effect on the principal’s expected payoff for both S and R (as the principal does not have to compensate the manager for \underline{u}) and a constant effect on the tradeoff between implementing R rather than S (depending on the difference $(s - \underline{u})$).

¹⁶This paper abstracts from effort choices as the focus shall be on the effects of bonus taxation

q and as $\underline{u} = 0$, he will accept any contract for which his expected compensation equals or exceeds implementation costs C , and reject the contract for expected payments below.

As the agent's expected net-compensation $p_i b r_h$ is linear in p_i , there exists a threshold \hat{p} which determines whether or not to accept the contract. For all $p_i < \hat{p}$, the environment to invest into the risky project is too unsafe. In expectation, the high (low) cash flow r_H (r_L) emerges too seldom (often) in order to yield an expected compensation higher than C . For the opposite case of $p > \hat{p}$, the probability of the high (low) cash flow r_H (r_L) is large (small) enough to outperform C . In summary, the agent will reject the contract whenever $p_i < \hat{p}$, and accept the contract for all $p_i \geq \hat{p}$ (being indifferent for $p_i = \hat{p}$).

Following the arguments above, the threshold \hat{p} is characterized by a binding Participation Constraint given the bonus payment b by the principal:

$$\hat{p} = \frac{C}{b r_H}. \quad (1)$$

Optimization Problem Principal

Taking the agent's optimality condition (1) into account, the principal in the first stage chooses a bonus parameter b which maximizes his expected payoff EP . The principal has no knowledge about the success probability p_i , but knows all possible probabilities $\{p_l, p_h\}$ and their likelihood to occur. His maximization problem then is:

$$\begin{aligned} \max_b & [(1 - \gamma) (p_l (1 - b) r_H + (1 - p_l - q) (-r_L)) + \gamma (p_h (1 - b) r_H + (1 - p_h - q) (-r_L))] (2) \\ \text{s.t.} & \\ & p_i b r_H \geq C \end{aligned} \quad (3)$$

As explained, equation (3) shows the agent's Participation Constraint (PC), which the principal has to consider. It states that the agent will only accept the

on the implementation of risky projects (in contrast to distortions of managerial effort). For the effects of a bonus tax on managerial effort, it shall be referred to existing studies as Radulescu (2012), Dietl et al. (2013) or Hilmer (2013).

principal's take-it-or-leave-it offer if his expected compensation at least remunerates him for the exogenous costs $C \in R^+$ of implementing the risky project.¹⁷ For the Principal, it is clearly optimal to choose a bonus payment which makes the agent's Optimality Condition (1) binding for the lowest probability p_i^* for which he wants to implement the risky project, thus $\hat{p} \in \{p_l, p_h\}$ and $b^* \in \left\{ \frac{C}{p_h r_H}, \frac{C}{p_l r_H} \right\}$.

Corollary 1. *Assume that a principal wants the manager to implement the risky project R only if he received a signal $p_i = p_h$, thus $\hat{p} = p_h$. Then, optimal compensation is given by $b_h = \frac{C}{p_h r_H}$.*

Consider a situation, where the principal may want to implement R only for the high success probability p_h . If he pays a bonus $b < \frac{C}{p_h r_H}$, the manager rejects the principal's contract offer both when he observes p_l or p_h . Thus, R will not be implemented for the success probability p_h even if desired by the principal. If, on the other hand, the principal offers a bonus $b > \frac{C}{p_h r_H}$, he pays a higher bonus than needed to incentivize the manager to accept the contract for a signal p_h . This unnecessary high bonus leaves a rent to the manager, lowers the principal's payoff, and therefore can not be optimal for him.

Corollary 2. *Assume that a principal wants the manager to implement the risky project R both for signals $p_i = p_l$ and $p_i = p_h$, thus $\hat{p} = p_l$. Then, optimal compensation is given by $b_l = \frac{C}{p_l r_H}$.*

The same argument as above applies if the principal wants to implement R for both p_l and p_h . For bonuses $b < \frac{C}{p_l r_H}$, the manager would reject the contract, while $b > \frac{C}{p_l r_H}$ implies an inefficient high bonus. Thus, the principal only pays bonuses $b^* \in \left\{ \frac{C}{p_h r_H}, \frac{C}{p_l r_H} \right\}$. For the first one, the agent accepts the contract only for a signal p_h , while he accepts the contract for signals p_h and p_l if he receives the latter (steeper) bonus.

Equilibrium

In order to determine the optimal investment strategy, the principal compares the two different possible expected payoffs EP_l and EP_h when incentivizing $\hat{p} = p_l$

¹⁷Note: an Incentive Compatibility Constraint (ICC) is not necessary for this maximization problem. As $\underline{u} = 0$, $Y = 0$ and $C > 0$, the ICC for implementing R rather than S (given by $(p_i b r_H + qY - C \geq Y)$) is fulfilled whenever the PC $(p b r_H + qY - C \geq \underline{u})$ is fulfilled.

or $\hat{p} = p_h$ with each other. Substituting the respective optimal compensation schemes from Corollaries 1 and 2 into the expected payoff (2), we get:

$$EP_l = (1 - \gamma) [p_l r_H - C - (1 - p_l - q) r_L] + \gamma \left[p_h r_H - \frac{p_h}{p_l} C - (1 - p_h - q) r_L \right] \quad (4)$$

$$EP_h = 0 + \gamma [p_h r_H - C - (1 - p_h - q) r_L] \quad (5)$$

Equation (4) denotes the principal's expected payoff EP_l if he incentivizes the manager to accept the contract for all $p_i \geq \hat{p} = p_l$. For the manager to accept the contract for p_l , the principal has to pay a bonus $b_l = \frac{C}{p_l r_H}$. As for p_l the success probability is low compared to p_h , the principal has to give a high share b in order to compensate the manager for his implementation costs C . Due to the fact that b stays constant, but the success probability is higher for p_h , the manager in expectation gets compensated for C if the signal is p_l , but earns a rent $\left(\frac{p_h}{p_l} - 1\right) C$ if the signal p_h . In return, the principal increases his probability of investing into the risky project (i.e. that the manager accepts the contract and implements R), thereby increasing the chance (risk) to earn r_H (lose r_L).

If the principal on the other hand only incentivizes acceptance of the high probability p_h (equation (5)), he pays a bonus $b_h = \frac{C}{p_h r_H}$ which in expectation perfectly compensates the agent for the implementation costs C if the actual success probability is p_h . By that, the agent will not accept the contract for p_l and the principal earns 0 with probability $(1 - \gamma)$.

Lemma 1. *Suppose that $p_l < \frac{C}{r_H}$. Then, there exists a unique equilibrium (b^*, \hat{p}^*) where the principal chooses to offer a bonus rate $b^* = b_h = \frac{C}{p_h r_H}$ if and only if*

$$p_h \geq \frac{C + (1 - q) r_L}{r_H + r_L} \equiv \hat{p}^*. \quad (6)$$

The agent accepts the contract and implements the risky project for all $p_h \geq \hat{p}^$. Otherwise, no contract will be signed.*

Proof. Directly follows from a comparison of equations (4) and (5). If $p_l < \frac{u}{r_H}$, it follows $EP_l < EP_h$. $EP_h \geq 0$ if and only if $p_h \geq \frac{C + (1 - q) r_L}{r_H + r_L}$. \square

As explained above, the principal is faced with a tradeoff: he can either pay

a rent to the agent, thereby increasing the chance (risk) to earn r_H (lose r_L), or he can choose to implement the risky project only for $p_i = p_h$, thereby avoid rent payments, but also abandon possible additional profits. In order to induce an agency problem with respect to project choice, we assume that the lower success probability p_l is too small to generate a positive payoff in expectation. Thus, it will be assumed that $p_l < \frac{C}{r_H}$ from which follows $EP_h > EP_l \forall \gamma$.¹⁸ Consequently, as the principal maximizes expected payoff, he offers a bonus b_h to the agent, who will only accept the contract if $p_i = p_h$. For the principal, this is only profitable if the success probability p_h is high enough, i.e. $p_h \geq \frac{C+(1-q)r_L}{r_H+r_L}$ as he only then earns an expected payoff $EP_h \geq 0$.¹⁹

4 Two Banks

Extending the model towards a framework with two banks $k \in \{1, 2\}$ (with Principal k and Agent k) allows to analyze the impact of a “too many to fail” problem. The banks are assumed to be symmetric with an identical principal-agent structure and similar decision structures with respect to the risky project. Thus, all moves as the take-it-or-leave-it contract offer and the decision on project implementation take place simultaneously and are therefore not observable by the other bank. Strategic choices available for each bank and possible project returns on the other hand are common knowledge. This is especially the case as banks are assumed to have the identical project R available to invest in. By this assumption, risks are perfectly correlated for both banks: if both invested into R , either both are successful, or both fail. Up to that point, nothing changed with respect to bank’s strategic choices or expected payoffs vis-à-vis the one-bank case. This changes when introducing a “too many to fail” problem, as banks’ losses in case of a crisis possibly are carried over by a bailout. For banks, this implies a modification regarding project implementation choices: next to individual choices,

¹⁸Without assuming $p_l < \frac{u}{r_H}$, the principal may want to incentivize also the probability p_l . He could pay a fixed wage $A = \frac{C}{1-q}$ and $b = 0$ and the agent would accept the contract for all p_i without having an agency problem in the project choice occurring. With bonus taxation, this is the only case where the restriction on $A = 0$ makes a qualitative difference.

¹⁹In fact, the results of Lemma 1 hold already if $\gamma \left(\frac{p_h}{p_l} - 1 \right) C > (1 - \gamma) (p_l r_H - C - (1 - p_l - q) r_L)$. By that, the principal’s increase in expected payoff by implementing p_l and p_h rather than only p_h , i.e. $(1 - \gamma) (p_l r_H - C - (1 - p_l - q) r_L)$, is smaller than the additional expected incentive costs of a rent to the agent, i.e. $\gamma \left(\frac{p_h}{p_l} - 1 \right) C$.

collective risk choices are important to increase the likelihood of a bailout.

The “too many to fail” problem

Assume the government can decide whether it grants financial support to financially distressed banks.²⁰ Thereby, it is faced with a tradeoff between gains of a bailout (corresponds to welfare costs associated to bank insolvencies) and the cost associated to this action. From a welfare perspective, it will be optimal for the government to bail out banks only if the gains of a bailout are not less than its costs. Assume that both costs and gains depend, next to money involved, on the number of banks failed (with $n \subseteq k$ being the number of banks failed). Thus, it is assumed that society can stand one failing bank without high welfare losses, but cannot sustain financial markets if two (or more) banks fail at the same time. While banks are not systemic on an individual basis, they are systemic on a collective basis, yielding a too-many-to-fail problem if more than one bank fail:

Definition 1. If a too-many-to-fail problem is present, government chooses to bail out banks whenever their bankruptcy becomes a systemic risk. In contrast to a too-big-to-fail problem, this is only the case if more than one bank fail at the same time, i.e. for $n > 1$. In this case, the government takes over banks’ losses from the risky project.

In deciding whether a bailout is beneficial, the government compares the costs of a bailout to the gains of rescuing failing banks. Assume costs and gains of bailouts follow functions $C(n, r_L)$ and $G(n, r_L)$, respectively. If only one bank invests into the risky project and fails, costs and gains of supporting the bank are $C(1, r_L)$ and $G(1, r_L)$, respectively. As society can stand one failing bank without high welfare losses, a single failing bank does not spread systemic risk in the financial system and thus $G(1, r_L) \not\geq C(1, r_L)$. As a result, a single bank will not be bailed out if it invested in subprime mortgages and failed. If however both banks invest into the subprime mortgages at the same time, then also both only fail together as risks are perfectly correlated. In this case, costs and gains of bailouts are $C(2, r_L)$ and $G(2, r_L)$, respectively. Due to the systemic risk inherent in a collective bankruptcy of more than one bank, it will be optimal for

²⁰Next to a direct cash-payment to failed banks, a bailout also can be interpreted as various institutions granting financial support to financially distressed banks, e.g. non-standard measures by the ECB or the Troubled Asset Relief Program (TARP) of the US government.

the government to grant financial support to both banks as $G(2, r_L) > C(2, r_L)$.

Equilibrium with anticipated bailouts

Expecting a future bailout as defined above, either because of communication thereof or by anticipating the unjustifiable welfare losses a breakup of the financial system would cause, banks may change their bonus payments and risk taking in equilibrium. Let us assume for a moment, that both banks take the same decision and therefore either both fail, or none.²¹ Then, the principal again (as in (4) and (5)) compares expected payoffs with each other to determine the optimal cutoff probability p_i^B , this time taking into account that the bank does not have to bear losses in the bad state. Thus, $r_L = 0$:

$$EP_l^B = (1 - \gamma)[p_l r_H - C] + \gamma \left[p_h r_H - \frac{p_h}{p_l} C \right] \quad (7)$$

$$EP_h^B = \gamma[p_h r_H - C] \quad (8)$$

Comparing (7) and (8), the principal has to take two decisions: first, he has to prove which cutoff probability p_i^B in expectation yields a higher payoff, and whether in expectation he can reckon with positive payoffs at all for the respective cutoff probability $\hat{p}^B = p_l$ or $\hat{p}^B = p_h$. As before, a bank again will never choose to incentivize the manager to accept the contract for the low success probability p_l as, due to $p_l r_H < \underline{u}$, $EP_h > EP_l \forall \gamma$. Therefore, the relevant question for the principal is whether he should incentivize the agent to accept the contract and to implement the project for the success probability p_h . If the principal wants to implement the project only for p_h , he still has to pay a bonus $b_h = \frac{C}{p_h r_H}$. However, taking the principal's downside of the risky project by granting a bailout, his expected payoff increases for all EP_i^B . Ceteris paribus, the project in expectation yields a nonnegative payoff EP_h^B already if $p_h \geq \frac{C}{r_H} := \hat{p}^B$. Thus, implementation of the risky project becomes profitable also for success probabilities $p_h < \hat{p}^*$, i.e. for success probabilities for which the project in absence of a bailout would yield a negative expected payoff to the principal.

²¹As banks are symmetric in any aspect, this “assumption” will be a result in the two (symmetric) pure strategy equilibria illustrated in Lemma 3.

Lemma 2. *In absence of bailout policy, project implementation is profitable for the principal only for success probabilities $p_h \in \overline{P}_h$, $\overline{P}_h \equiv [\hat{p}^*, 1)$. If there is a bailout, project implementation becomes profitable also for success probabilities $p_h \in \underline{P}_h$, $\underline{P}_h \equiv [\hat{p}^B, \hat{p}^*)$.*

Let us focus on success probabilities $p_h \in \underline{P}_h$. Whether there is a bailout at all depends upon the other bank's decision, as by Definition 1 banks only receive a bailout if they collectively fail. Therefore, for success probabilities $p_h \in \underline{P}_h$, it is only profitable to implement the project if also the other bank implements the project. If bank 2 does not implement the project, the project yields a negative expected payoff for bank 1. Thus, each bank has two strategic choices with respect to the offered incentive payments for the manager, depending on the other bank's action: either, it will choose to pay a bonus according to Corollary 1 that optimally incentivizes the manager to implement the project ("I") for a signal p_h , or the bank does not offer an appropriate bonus, the manager will reject the contract and thus the project is not going to be implemented ("N"). For success probabilities $p_h \in \underline{P}_h$, this gives us four combinations: (I, I), (I, N), (N, I) and (N, N). Fig. 1 summarises the expected net-payoffs of both banks for the four combinations, provided that the government makes its decision as described in Definition 1 and that both banks choose their incentive pay optimally. In each cell the left entry refers to bank 1 and the right entry to bank 2.

Figure 1: Expected net-payoff for principal of bank 1 resp. 2, if banks receive a bailout if both fail at the same time.

<div><div>1</div><div>2</div></div>		N	I
N	<div><div><div><div></div></div></div><div><div>0</div></div></div>	<div><div><div></div></div><div>0</div></div>	$EP_h(\underline{p_h}) < 0$
I	<div><div><div><div></div></div></div><div><div>$EP_h(\underline{p_h}) < 0$</div></div></div>	<div><div><div></div></div><div>0</div></div>	<div><div><div><div></div></div></div><div><div>$EP_h^B(\underline{p_h}) > 0$</div></div></div>

The payoff table shows two patterns, that result in two (symmetric) pure strategy Nash Equilibria for success probabilities $p_h \in \underline{P}_h$:

Lemma 3. *Suppose that $p_l < \frac{C}{r_H}$ and banks receive a bailout according to Definition 1. Then, for success probabilities $p_h \in \underline{P}_h$, there exist two (symmetric) pure strategy equilibria where both principals either*

1. *refrain from project implementation and do not offer a contract to the manager,*
2. *or implement the project by offering a bonus rate $b_h = \frac{C}{p_h r_H}$.*

The pure strategy Nash Equilibrium with project implementation is payoff dominant compared to refraining from implementation.

Proof. Banks' mutual best responses are “do not offer contract (N) if other bank does not offer contract (N)” and “offer bonus b_h (I) if the other bank offers b_h (I)”. As $EP_h^B(\underline{P}_h) > 0$, the latter equilibrium is payoff dominant compared to a payoff zero. \square

In the first case, suppose bank 1 refrains from the project and does not incentivize the manager to implement the project for $p_h \in \underline{P}_h$. By Definition 1, irrespectively of bank 2's action, there will not be a bailout. If bank 2 implements the project anyway, it risks to fail as a single, non-systemic bank and therefore does not receive a bailout. By that, bank 2 has to bear possible losses itself and earn expected payoff according to equation (5). But, as stated in Lemma 1, project implementation without bailout is only profitable if $p_h \geq \hat{p}^*$, i.e. $p_h \in \overline{P}_h$. Thus, the best response by bank 2 is to refrain from the project as well and earn zero profit.

In the second case, assume bank 1 wants to implement the project for $p_h \in \underline{P}_h$ and offers a bonus $b_h = \frac{C}{p_h r_H}$ that will be accepted by the agent. In this case, bank 2 can be sure to receive a bailout if it implements the project as well and fails. Both banks together are collectively systemic and will be rescued. Knowing this, investments become profitable also for lower success probabilities $p_h \in \underline{P}_h$ (as $EP_h^B \geq 0$ for $p_h \geq \frac{C}{r_H}$). Thus, the best response by bank 2 to higher risk taking by bank 1 is to also increase risk taking by offering a contract for $p_h \in \underline{P}_h$ as well. In contrast to the one-bank case, the bank now neglects the expected costs of failing as those are going to be socialized. The anticipated bailout provides an externality to the bank such that it takes more risk than it would do on an individual basis.

Welfare implications of collective Moral Hazard

Whether an increase in risk taking is desirable or not depends on its welfare implications and thus on assumptions on the welfare function and the success probabilities p_i . As this paper focuses on efficiency concerns rather than redistribution, also welfare is assumed to be maximal when efficiency is maximal. Thereby, an efficient outcome is assumed to be in place, if the principal would have implemented it also in a first best world in absence of any externalities (e.g. bailout) and information asymmetries (e.g. non-observability of the actual success probability by the principal).

In absence of an agency problem, an optimal compensation scheme for the principal pays the manager his implementation costs C whenever he implements the risky project and zero if he does not. For these compensation costs, the principal wants to implement the project as long as his expected payoff equals or exceeds his own outside option, i.e. $p_i r_H - (1 - p_i - q) r_L - C \geq 0$.

Definition 2. An investment decision is efficient if and only if $p_i \geq \frac{C+(1-q)r_L}{r_H+r_L} \equiv \hat{p}^{opt}$.

Comparing the cutoff levels with information asymmetry \hat{p}^* and with distorted risk taking due to an anticipated bailout \hat{p}^B to the efficient investment decision defined above, the following has been shown:

Proposition 1. *Suppose banks are aware of the potential systemic risk they collectively can cause and thus can expect a bailout if they jointly fail. Then, they can coordinate on an equilibrium where both take on higher risk than the socially desirable level they would decide upon on an individual level.*

Proof. Directly follows from Lemma 1 - 3. As $\hat{p}^B < \hat{p}^{opt}$, a cutoff \hat{p}^B for p_h is socially not desirable, whereas $\hat{p}^* = \hat{p}^{opt}$ is. \square

A comparison between Lemma 1, 2 and 3 demonstrates, how banks change their project implementation decision, and by that risk taking, when they are systemic on a collective basis and hence can anticipate bailouts. While the presence of information asymmetry between principal and agent does not cause welfare effects (as $\hat{p}^* = \hat{p}^{opt}$) and thus project implementation is only profitable for success probabilities $p_h \geq \frac{C+(1-q)r_L}{r_H+r_L}$, the presence of a too-many-to-fail bailout policy does cause such effects. As Lemma 2 shows, when banks can anticipate that they will

be rescued if they failed, both principals increase their expected payoff by increasing risk taking. Project implementation becomes profitable already for success probabilities $p_h \geq \frac{C}{r_H}$ (with $\frac{C}{r_H} < \frac{C+(1-q)r_L}{r_H+r_L}$). Thus, they are willing to implement projects with success probabilities lower than the socially desired level $\hat{p}^B < \hat{p}^{opt}$. This is due to the fact that the principal has to bear a real risk and losses of $-r_L < 0$ when there is no bailout, while he will not suffer losses when there is a bailout. Thus, the principal will accept risky projects also for lower success probabilities for which he would not incentivize the manager in absence of a bailout. As a bailout will only be executed if two banks fail at the same time, Lemma 3 highlights that higher risk taking is indeed an equilibrium if banks anticipate the bailout policy. Moreover, this equilibrium is payoff dominant compared to the equilibrium where both banks refrain from implementing the project and stay with their outside option for $p_h \in \underline{P}_h$. Thus, when anticipating bailouts due to a too-many-to-fail systemic risk, banks can coordinate on a socially undesirable equilibrium where both increase their risk taking by implementing risky projects also for lower success probabilities.

5 Bonus Taxation

To analyze the welfare effects of a bonus tax under existence of too-many-to-fail bailout policies, an additional stage will be introduced into the model: before the take-it-or-leave-it contract is offered to the manager, the government can implement a bonus tax. Introducing this, bonus payments become subject to a bonus tax, $t_b \in [0; 1)$, which has to be paid by the managers. Therefore, from gross compensation $p_i b r_h$, managers only receive expected net-compensation payments of $p_i (1 - t_b) b r_h < p_i b r_h$ if they accept the contract.

Effects of a tax on managers' bonuses

Assume that the government introduced a bonus tax for bonus payments to the manager. As the manager now has to bear the additional tax burden, also his optimal threshold level \hat{p} changes to:

$$\hat{p}^t = \frac{C}{(1 - t_b) b^t r_H}. \quad (9)$$

For a given bonus b , a bonus tax will lead to an increased threshold level \hat{p}^t for the minimum success probability for which the manager accepts the contract. Or, if the principal wants to incentivize a given threshold level \hat{p} , the bonus payment b^t to the manager has to be increased in a way, that the manager is fully compensated for the bonus tax. In either way, a bonus tax in expectation is associated with higher costs for the principal, either in terms of lost expected profits due to a higher threshold probability, or in terms of higher compensation payments.

Again, banks can expect a future bailout as denoted in section 4 when both banks take the same actions. In addition, the principal now takes into account the associated costs from the bonus tax when deciding upon the optimal threshold probability \hat{p}^t . Thereby, expected payoffs (7) and (8) for the different threshold levels p_l and p_h change to EP_l^t and EP_h^t :

$$EP_l^t = (1 - \gamma) \left[p_l r_H - \frac{C}{(1 - t_b)} \right] + \gamma \left[p_h r_H - \frac{p_h}{p_l} \frac{C}{(1 - t_b)} \right] \quad (10)$$

$$EP_h^t = \gamma \left[p_h r_H - \frac{C}{(1 - t_b)} \right] \quad (11)$$

As seen in section 4, an expected bailout influences possible additional profits by eliminating the risk of loosing r_L . The newly introduced bonus tax on the other hand affects the costs of incentive payments. While net incentive payments to the agent stay constant, the principal's costs of incentive payments increase the higher the bonus tax is. Therefore, it becomes more and more expensive to incentivize the agent to accept the contract.

Whether or not a bonus tax can reverse the principals distorted risk taking of $p_h \in \underline{P}_h \cup \overline{P}_h$ in presence of bailouts back to the benchmark threshold $p_h \in \overline{P}_h$, depends upon the extent to which bonuses are taxed. In order that it is profitable for the principal to incentivize the manager to implement the project solely for $p_h \in \overline{P}_h$, the cutoff probability under taxation \hat{p}^t must equal the optimal cutoff probability \hat{p}^* defined in Lemma 1. For the bonus tax to be effective in reversing the threshold for the success probability in spite of bailouts to the benchmark, the proper tax rate is given by $t_b = \frac{r_L((1-q)r_H - C)}{r_H((1-q)r_L + C)}$.

Lemma 4. *A bonus tax $t_b^* = \frac{r_L((1-q)r_H - C)}{r_H((1-q)r_L + C)}$ is effective in reversing the threshold probability from $\hat{p}^B = \frac{C}{r_H}$ back to $\hat{p}^t = \hat{p}^* = \frac{C + (1-q)r_L}{r_H + r_L}$. Thereby, the bonus tax exactly balances the externality a bailout entails and thus reduces bank's incentives*

for risk taking to the socially desired level.

When a bonus tax according to Lemma 4 is introduced, incentives change for both principals compared to section 4. For any bonus payment they need in order to incentivize the manager to act in their best interest, principals now bear costs of $\frac{b}{1-t_b}$ rather than only b . This increases costs and makes projects (intendedly) unattractive which are profitable without bonus tax. As Lemma 4 describes, whenever banks coordinate on the payoff dominant equilibrium with collective Moral Hazard, the optimal bonus tax t_b^* exactly balances the externality a bailout entails. If $t_b < t_b^*$, it is still attractive for banks to invest into the risky project when it is not desirable from a social welfare point of view, i.e. $\hat{p}^t < \hat{p}^{opt}$. On the other hand, if $t_b > t_b^*$, the bonus tax is set too high and thereby prevents socially optimal risk taking. In this case, banks will incentivize too little risk taking as necessary incentive payments are too expensive, i.e. $\hat{p}^* < \hat{p}^t$. Only for a tax rate t_b^* , the cutoff probability for the risky project to be profitable under collective Moral Hazard \hat{p}^t coincides with the socially optimal cutoff probability \hat{p}^{opt} . Therefore, only for t_b^* , the bonus tax exactly balances the externality a bailout entails.

Nevertheless, project profitability in big parts still depends on the expectation of a bailout. In a similar fashion as in the case without bonus tax, banks have comparable best responses as in Lemma 3 to strategies of the other bank. As thresholds have changed due to the bonus tax, it is optimal to offer the following contracts to the agent:

Lemma 5. *Suppose that $p_l < \frac{C}{r_H}$, banks receive a bailout according to Definition 1 and the government introduces a bonus tax $t_b = t_b^*$. Then,*

1. *for $p_h < \hat{p}^t$ banks will not implement the risky project anymore.*
2. *for $p_h \in [\hat{p}^t, \hat{p}_2^t)$ there exist two (symmetric) pure strategy equilibria (N, N) and (I, I) , where both principals either refrain from project implementation or implement the project by offering a bonus rate $b_h^t = \frac{C}{(1-t_b)p_h r_H}$. The latter Nash Equilibrium is payoff dominant.*
3. *for $p_h \geq \hat{p}_2^t$, there exists a unique equilibrium where both principals implement the project by offering a bonus rate b_h^t .*

Proof. If $t_b = t_b^*$, $EP_h^t \geq 0$ if and only if $p_h \geq \hat{p}^{opt}$. Individually, i.e. without bailout, expected payoff $\gamma \left[p_h r_H - \frac{C}{1-t_b} - (1-p_h-q)r_L \right] \geq 0$ if and only if $p_h \geq \hat{p}_2^t$. \square

For $p_h < \hat{p}^t$ banks independently of each other will not implement the risky project anymore as in expectation implementation would yield a negative payoff. If on the other hand $p_h \in [\hat{p}^t, \hat{p}_2^t)$, a bank's best response depends on the other bank's action as seen in Lemma 3. Again, there exist two symmetric pure strategy equilibria (I, I) and (N, N) where both banks either offer a contract or not. Suppose first one bank wants to implement the project for $p_h \in [\hat{p}^t, \hat{p}_2^t)$. Then the other bank should as well offer an according contract to the agent as it can expect a bailout to take place if it implements the project as well and fails. In order to incentivize the manager correctly, an according contract is specified by a bonus payment $b_h^t = \frac{C}{(1-t_b)p_h r_H}$ which is higher than the bonus $b_h = \frac{C}{p_h r_H}$ in absence of a bonus tax. If on the other hand one bank does not implement the project for $p_h \in [\hat{p}^t, \hat{p}_2^t)$, then the other bank's best response is too abstain from according incentive payments, too. Taking the risk on an individual basis would be too expensive and leads to losses in expectation. Comparing the two equilibria with each other, the equilibrium (I, I) with project implementation for $p_h \in [\hat{p}^t, \hat{p}_2^t)$ is again payoff dominant compared to the other. Thus, banks can credibly coordinate to implement the project for $p_h \in [\hat{p}^t, \hat{p}_2^t)$. Finally, for $p_h \geq \hat{p}_2^t$, there exists a unique equilibrium where both banks (independently of each other) implement the project by offering a bonus rate b_h^t . Also without receiving a bailout, success probabilities $p_h \geq \hat{p}_2^t$ are high enough to guarantee a positive expected payoff.

Welfare implications of a Bonus Tax

Comparing the cutoff level with proper bonus taxation \hat{p}^t from Lemma 4 to the findings denoted in Proposition 1, the following can be shown:

Proposition 2. *Suppose banks are aware of the systemic risk they collectively cause and coordinate on the payoff dominant equilibrium. Then, a bonus tax t_b^* for both banks is welfare improving. It reverses the distorted cutoff probability under a bailout policy \hat{p}^B back to the socially optimal cutoff probability $\hat{p}^t = \hat{p}^{opt}$.*

Proof. Directly follows from Proposition 1 and Lemma 4 and 5. As $\hat{p}^t = \hat{p}^{opt}$ for t_b^* , a bonus tax t_b^* induces the socially optimal cutoff in presence of collective Moral Hazard. \square

From Proposition 1, we know the welfare effects caused by a too-many-to-fail bailout policy. When banks can anticipate that they will be rescued if they failed, both principals can coordinate on a payoff dominant equilibrium where they increase their expected payoff by increasing risk taking and implementing projects with success probabilities lower than the socially desired level $\hat{p}^B < \hat{p}^{opt}$. However, as Lemma 5 shows, with proper bonus taxation the threshold level for the riskiness of the project can be shifted back to the socially desired level ($\hat{p}^t = \hat{p}^{opt}$). Banks reduce risk taking again and so in expectation earn lower expected payoffs than without bonus tax. As a side effect, banks not only reduce risk taking, but also have to bear higher incentive payments for the manager due to the bonus tax. As a result, banks earn less than without a bonus tax. The difference between both payoffs exactly equals the bonus tax revenue the government collects.

Nonwithstanding the above discussed welfare improving effects of a proper bonus tax, there still exists another pure strategy equilibrium where a bonus tax causes welfare losses. Suppose banks do not coordinate on the equilibrium with collective Moral Hazard analyzed above but on the payoff dominated equilibrium where banks refrain from project implementation for success probabilities $p_h \in \underline{P}_h$. In this case, a bailout does not distort risk taking from the socially desirable threshold $\hat{p}^* = \hat{p}^{opt}$ to the coordinated excessive-risk taking threshold \hat{p}^B . Rather, a bonus tax causes distortions for this equilibrium. Any bonus tax $t_b > 0$ ceteris paribus lowers banks' payoffs and thereby distorts their optimization problem. Internalizing the bonus tax through the requirement of higher compensation payments for the manager, both banks will only implement the risky project if $p_h \geq \frac{\frac{C}{1-t_b} + (1-q)r_L}{r_H + r_L}$; otherwise they will not make a contract offer to the manager. As $\frac{\frac{C}{1-t_b} + (1-q)r_L}{r_H + r_L} > \hat{p}^{opt}$ if $t_b > 0$, any bonus tax will lead to inefficient low risk taking by banks. For this equilibrium, a bonus tax tries to balance the externality of a bailout, that actually did not lead to distortions in first place.

Discriminatory or unilateral bonus taxation

One of the main characteristics of the banking sector is its degree of integration, also across countries. To study the effects of a bonus tax in a stylized international framework, it is valuable to analyze a situation of discriminatory bonus taxation between the two banks. This assumption makes it possible to examine the effects of bonus taxation that only addresses one bank and thus the effects of unilateral bonus taxation, when cross-national coordination is not possible.²² In the international context, bailouts linked to systemic risk due to a too-many-to-fail problem often are executed by supranational organizations like central banks in order to prevent contagion. For financially distressed banks in the Eurozone for example, the ECB introduced non-standard monetary policy measures in order to “keep contagion in financial markets contained.”²³ As a result, bank regulation at the moment still is mainly a national responsibility, whereas resolution is undertaken already on a supranational level.

Suppose only manager 1 is subject to a bonus tax. By that, for manager 1 the optimality condition under presence of a bonus tax (9) applies, whereas for manager 2 the optimality condition without taxation (1) is relevant. Consequently, bank 1 incurs higher costs to incentivize the manager and may therefore earn expected payoffs (10) and (11). Bank 2’s expected payoffs on the other hand stay constant compared to section 4. Hence, mutual best responses by bank 1 and 2 are not symmetric anymore, but change compared to sections 4 and 5.

As in the case without bonus tax, for bank 2 it is optimal to offer the following contracts to the agent: if bank 1 wants to implement the project for $p_h \in \underline{P}_h$, bank 2 should as well offer an according contract to the agent. If on the other hand bank 1 does not implement the project for $p_h \in \underline{P}_h$, bank 2’s best response is to abstain from according incentive payments, too. For bank 1 on the other hand, best responses to the actions of bank 2 change due to a proper bonus tax t_b^* . Assume bank 2 does not want the project to be implemented for $p_h \in \underline{P}_h$. Then,

²²Ex ante, for supranational regulation cross-national coordination is necessary, but is often difficult to implement. In this sense, the possibility of discriminatory taxation is equivalent to a situation where banks are located in different countries with different fiscal jurisdiction but a single economic area.

²³See ECB (2010, 2011) on the ECB’s response to the financial crisis and its impacts. Among standard measures as lowering key interest rates to historically low levels, measures included long lasting Long-Term Refinancing Operations (LTROs), extension of assets accepted as eligible collateral and purchase of euro-denominated covered bonds (€60 billion program).

for the same arguments as above, also the best response by bank 1 is to abstain from project implementation as it would be the only failing bank. In expectation, project implementation for $p_h \in \underline{P}_h$ yields a loss. But in contrast to bank 2 and due to bonus taxation, project implementation for $p_h \in \underline{P}_h$ even yields a loss in expectation for bank 1 even if both banks invested and therefore can expect a bailout if $-r_L$ occurs. Assume bank 2 chooses to incentivize implementation for $p_h \in \underline{P}_h$. Without a bonus tax but anticipating the too-many-to-fail problem, the best response of bank 1 would be incentivizing project implementation for p_h as well. With the bonus tax however, incentive compensation for the agent's higher risk taking becomes too expensive for the principal to outweigh the profits of the project. Therefore he abstains from higher risk taking, and chooses to refrain from project implementation for $p_h \in \underline{P}_h$.

Lemma 6 summarizes these results:

Lemma 6. *Suppose that $p_l < \frac{C}{r_H}$ and banks receive a bailout according to Definition 1. If only manager 1 is subject to a bonus tax $t_b = t_b^*$, there exists a unique equilibrium (b^*, b^{t*}, \hat{p}^t) where both principals choose to incentivize project implementation if and only if*

$$p_h \geq \hat{p}^t = \hat{p}^{opt}. \quad (12)$$

Bank 1 (2) offers a bonus rate $b_h^t = \frac{C}{(1-t_b^)p_h r_H}$ ($b_h = \frac{C}{p_h r_H}$) and earns payoffs EP_h^t (EP_h^B). The government raises expected tax revenue $T = \gamma \frac{t_b^*}{(1-t_b^*)} C$.*

Proof. If $t_b = t_b^*$, $EP_h^t \geq 0$ if and only if $p_h \geq \hat{p}^t$. If bank 1 implements R only for $p_h \geq \hat{p}^t$, bank 2's best response is to follow this strategy. \square

A Comparison between Lemma 3 and 5 shows, how bonus taxation in presence of a distortive too-many-to-fail problem changes risk taking in equilibrium. Proper taxation can reduce risk taking of both banks to a level which would have been implemented also in absence of bailouts. In doing this, a taxation of bonuses of manager 1 imposes an externality not only on that manager's bank, but also to bank 2. This is done by increasing necessary incentive payments to the manager in a way, that bank 1 is not willing anymore to finance those costs. As a result, the equilibrium (I, I) , which is payoff dominant for $p_h \in \underline{P}_h$ without bonus taxation, becomes payoff dominated for the taxed bank. Although it will stay a payoff

dominant response for bank 2 to implement the project for a success probability $p_h \in \underline{P}_h$ when bank 1 implements the project as well, it will no longer be a mutual best response in presence of taxation: As the untaxed bank 2 will always incentivize project implementation for $p_h \in \overline{P}_h$, it is profitable for bank 1 to do so as well. On the other hand, as bank 1 will abstain from implementation for $p_h \in \underline{P}_h$, it is also not profitable for bank 2 to invest for $p_h \in \underline{P}_h$. Due to this fact, there is an unique equilibrium where both banks incentivize their agents to implement the project for the high success probability (for $p_h \in \overline{P}_h$), but refrain from project implementation and do not offer a contract to the agent for $p_h \in \underline{P}_h$.

Proposition 3. *Suppose banks are aware of the potential systemic risk they collectively cause and thus can expect a bailout if they jointly fail. Then, a bonus tax t_b^* is welfare improving even if only one bank is taxed. The bonus tax breaks collective Moral Hazard and eliminates the equilibrium with excessive risk taking.*

Proof. Directly follows from Proposition 1 and Lemma 4 and 6. □

Thus, bonus taxation of only one bank eliminates the equilibrium with higher risk taking and leads to a reduction of risk taking of both banks, the taxed one and the untaxed one. At the same time, bonus taxation of a single bank unambiguously can not cause negative welfare effects as it can be the case if both banks are taxed and do not coordinate on the payoff dominant equilibrium.

6 Conclusion

In this paper, a symmetric principal-agent structure with two banks was modelled where the agents' task was implementation of a project up to a certain risk. This was used to study the effects of too-many-to-fail bailout policies and bonus taxation on risk taking, compensation and welfare.

With respect to the effects of bailout policies, the following has been shown: If banks can anticipate bailouts due to a too-many-to-fail bailout policy it is profitable for them to incentivize agents to implement the project also for lower success probabilities. Thus, if banks foresee that they are systemic in a herd, they invest riskier than they would do in absence of a possible bailout.

Introducing a bonus tax can reduce the risk taking externality a bailout causes. If the bank manager is taxed by a bonus tax, he requests a higher gross bonus payment to be compensated for the additional tax burden. Therby incentive payments for risk taking become more expensive for the bank. Given that the bonus tax rate is properly chosen, the increase in expenses leads to lower risk taking by the manager. Due to the specialty of too-many-to-fail bailout policies and their dependency on collective bankruptcy, reduced risk taking in one bank also leads to lower risk taking in the other bank. Thus, it is sufficient that only the manager of one bank is taxed by a bonus tax. Translating this into a multi-country framework leads to the result that unilateral bonus taxation can prevent risk taking in the other country and thereby improve welfare in both countries.

The implications of the model for real world policy are the following: Proper bonus taxation reduces banks' risk taking. Beyond that, there is no need for a coordinated (global) approach in order to implement actions to reduce risk taking in banking and gambling for bailouts on a cross-national level. Even an unilateral introduction of a proper bonus tax has a positive externality on other countries, leading to lower risk taking also in countries without bonus taxes. Thus, a single country can circumvent gambling for bailouts on its own, fixing risk incentives at the same level as without bailouts. A limitation of this model is the omission of negative externalities on the taxing country, as in this model taxation only has distributional consequences but does not harm overall welfare in the taxing country.

As a conclusion, proper bonus taxation in this model reduces a gamble for bailouts not only for the taxed bank, but also increases market discipline of other banks. Thus, the tax is also effective in reducing risk taking if only introduced on an unilateral level without global coordination.

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