Too Many to Fail - How Bonus Taxation Prevents Gambling for Bailouts
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Too Many to Fail - How Bonus Taxation prevents Gambling for Bailouts

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Abstract

Using a simple symmetric principal-agent model with two banks, we study the effects of both bailouts and bonus taxes on risk taking and managerial compensation. We assume financial institutions to be systemic only on a collective basis, implying support with bailouts only if they both fail collectively. This too-many-to-fail assumption generates incentives for herding and collective moral hazard. If banks can anticipate bailouts, they can coordinate on an equilibrium in which they collectively incentivize higher risk-taking. A bonus tax can prevent this excessive risk-taking, even if it is implemented unilaterally: proper bonus taxation reduces risk-taking of the taxed bank(s) and, consequentially, rules out the equilibrium with excessive risk-taking of both banks and 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, governments and central banks were faced with troubled banks and a challenging tradeoff: Either to allow bank insolvencies, leading to contagion and welfare losses, or to rescue banks, leading to public payments for the private sector. On top of this tradeoff, there was a public debate on the fairness of high compensation payments going on, especially in banking industries. Policymakers reacted to this discussion by reforming the tax treatment of managerial compensation, e.g. by imposing bonus taxes.

This paper combines three aspects of the financial crisis: (i) the systemic risk of financial institutions that are not systemic individually, but only on a collective basis, (ii) high compensation payments to bankers, and (iii) bonus taxation. Analyzing these aspects in a principal-agent model with two banks, this paper presents the 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, an anticipated bailout increases risk-taking. Moreover, we show how bonus taxation can reduce overall risk taking. The results suggest that even unilateral bonus taxation eliminates an equilibrium with high risk taking and in addition generates positive external effects on the other country. This contradicts the view of politicians, who emphasized the necessity of a coordinated approach with all major economies implementing the bonus tax jointly.¹

There are two main reasons 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”: For policymakers, it is not only a bank’s size but also its connection to other banks that 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 true 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 high pressure on the regulator for a bailout. In this situation, the regulator would like to reduce banks’ incentives

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.”
to coordinate, but cannot credibly commit to a no bailout-clause.\textsuperscript{2} These incentives for banks to coordinate are a core aspect of this paper and offer new insights vis-à-vis the existing literature on the too-big-to-fail problem.

Another core aspect are managers’ compensation payments and their taxation. From an economic point of view, asymmetric information calls for bonus payments in order to incentivize the agent, manager, to act in the principal’s, bank’s, interest. Nevertheless, it has been considered unfair that bankers receive high bonus payments whilst taxpayers have to bear the costs of the bankers’ decisions. As a response, 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 higher than 25,000 GBP for bankers (UK Finance Act 2010, Schedule 1). Other countries raised bonus taxes for banks that were supported by the government: In 2011, Ireland introduced a 90\% tax, and the US House of Representatives approved such a 90\% tax in 2009.\textsuperscript{3}

The analysis in this paper leads to the following result: If banks anticipate bailouts, market discipline weakens, i.e., 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 will request 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 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. A (unilateral) bonus tax reestablishes market discipline as it prevents market failure that arises due to banks’ collective moral hazard.

\textsuperscript{2}See Acharya and Yorulmazer (2007) for an analysis of time-inconsistency in bank closure policies and a general explanation of the differences between too-big-to-fail and too-many-to-fail.

\textsuperscript{3}See “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).
2 Related Literature

This paper is related to several strands of literature. In terms of methodology, we draw on papers dealing with executive compensation and especially with delegated expertise. Most of these papers focus on optimal contracting by using agency theory. 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 agency models (Jensen and Meckling 1976, Holmstrom 1979, and Grossman and Hart 1983, among others), agents are typically assumed to exert effort in order to increase (the probability of high) profits. As (costly) effort is not directly observable by the principal, an agency problem arises.

In the literature on delegated expertise, a delegated expert can generally 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. This creates a conflict of interest. In contrast to this literature, the paper at hand abstracts from costs to acquire superior information, but assumes the agent to already have this expertise. Thus, the paper is most closely related to Lambert (1986), as the agent does not subsequently receive a noisy signal on the success probability of projects, but observes the actual success probabilities. Given this knowledge, the agent decides whether or not to invest in a risky project. 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 aligns interests between principal and agent best, when the agent’s task is to select a portfolio of risky financial assets. Likewise our model, 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.

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\(^4\) Another 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 agents that are able to influence their own pay. For an analysis of taxation of rent-seeking activities see Glazer and Konrad (1999) or Rothschild and Scheuer (2011). Frydman and Jenter (2010) and Murphy (2013) discuss the contributions in both strands of literature.

\(^5\) Existing papers differ in their assumptions on costs of information. Some assume fixed costs (Lambert 1986, Gromb and Martimort 2007, Core and Qian 2002), while in others agents can exert continuous effort that improves information quality (Malcomson 2009, Feess and Walzl 2004, Barron and Waddell 2003).

\(^6\) Existing models differ in the agent’s choice set. While in Core and Qian (2002), Barron and Waddell (2003), Feess and Walzl (2004) and Gromb and Martimort (2007) the agent 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.
A second strand of literature this paper belongs to is the literature on systemic risk due to a too-many-to-fail problem. Brown and Dinc (2009) provide empirical evidence for the too-many-to-fail problem. Acharya and Yorulmazer (2007) and Acharya (2009) develop theoretical models to show banks’ incentives for herding and for correlating assets and returns, especially when they are small in size. In correlating assets, 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, and Acharya (2009) suggests implementing regulation at a collective level so that banks are required to hold greater capital against general risk than against specific risk. Farhi and Tirole (2012) find that anticipated bailouts lead to high levels of short-term debt, high leverage and wide-scale maturity mismatch and thus to collective moral hazard. They demand policy intervention by means of a reduction in interest rates and the use of direct transfers only when a large fraction of banks is affected by a crisis.

The effects of bonus taxation have been studied empirically and theoretically.7 Von Ehrlich and Radulescu (2012) analyze the effects of the UK bank payroll tax on compensation. Their empirical findings suggest that the bonus tax caused a reduction in bonus payments of 40%, which, however, was accompanied by a one-to-one increase in other pay components not subject to the tax.

Theoretically, the 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. The effects in their model depend on the agent’s degree of risk aversion and the variance in firm value. By extending the agent’s choice set by risk taking, Grossmann et al. (2012) observe an effect opposite to ours. Because of risk aversion and marginal costs of risk that decrease more than marginal revenue from risk-taking, they find that a bonus tax induces the agent to increase risk-taking.8 A comparison of different ways to implement bonus taxation is provided in 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 a similar way. However,

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7A review on the literature on systemic externalities of bank failures is provided by Wagner (2010). For a broader analysis of proposed and discussed taxes on the financial sector, e.g. a financial transactions tax, see Shackleford et al. (2010), Keen (2011a) and Devereux (2011). Brunnermeier et al. (2009) state principles of financial regulation.

8See Buchholz and Konrad (2014) for a recent survey on the possible effects of taxation on risk-taking activities and the determinants that drive the results.
welfare can even be increased by paying a subsidy for bonus payments. Radulescu (2012) studies the effects of a bonus tax in a two-country framework where reservation wages are endogenous or exogenous. In her model, a unilateral bonus tax leads to a decline in effort, while incidence mainly falls on the firm’s shareholders. Results are largely similar with endogenous reservation wages, but depend on the strength of the negative reaction of the reservation wage to the bonus tax. Thanassoulis (2012) emphasizes the externality of competition. He finds that remuneration is increasing when banks compete for the best teams of bankers. In turn, higher remuneration drives up the expected costs of bankruptcy of competing banks.

Besley and Ghatak (2013) model bonus taxation in the 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 by analyzing the effects of anticipated bailouts on bonus payments and risk taking and the effects of a bonus tax. While the literature has concentrated on systemic risks due to banks that are too-big-to-fail10, we are the first to study the effects of bonus taxation due to a too-many-to-fail problem. This provides several new insights: First, the too-big-to-fail argument only applies to large banks that will individually adjust their activity to maximize profit. In contrast, the too-many-to-fail analysis is a meaningful extension as it also includes smaller banks and moral hazard on a collective basis. As the payment of a bailout crucially depends on the decision of another bank, banks cannot be sure to receive a bailout in all circumstances. This, in turn, leads to several possible equilibria, with collective moral hazard being one solution. Second, apart from multiple equilibria, the too-many-to-fail framework with two banks allows deeper insights when it comes to taxation. This is especially true when fiscal jurisdiction only covers a subset of

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9Keen (2011b) does not model bonus taxes, but also addresses the problem of taxing or regulating banks in the 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.

10Hakenes and Schnabel (2014) show how bonuses change when bailouts can be anticipated. Similar to the present model, an anticipated bailout increases bonuses and risk-taking in their analysis. In contrast to this model, Hakenes and Schnabel (2014), alike Besley and Ghatak (2013), study the too-big-to-fail problem. In addition, they do not analyze the effects of bonus taxation.
banks such that regulation can not capture all banks collectively. For this analysis, we also examine the effects of bonus taxation that only addresses one bank, showing that this can prevent possible negative welfare effects that can arise in case of common bonus taxation.

In the following section, we introduce the general model, derive benchmark results and analyze the implications of an anticipated too-many-to-fail bailout policy when the managers of both banks simultaneously decide on project implementation. Section 4 illustrates how a bonus tax leads to reduced risk taking, both when imposed on one manager or on both managers. Section 5 concludes.

3 Impact of a Too-Many-to-Fail Bailout Policy on Project Choice

3.1 Model Overview and Available Projects

Consider a situation with two symmetric banks $k \in \{1, 2\}$ that both face an identical principal-agent structure and the same structures: a risk-neutral shareholder $k$ (principal) delegates the task of implementing a project to a hired risk-neutral manager $k$ (agent). The principal offers 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 $u = 0$ and zero initial wealth.\footnote{It suffices to assure that $u \geq 0$. We will later explain the implications of our simplifying assumptions.} If manager $k$ accepts the contract, he chooses between a risky project $R_k$ and a safe asset $S$ in which he invests all the bank’s money. Finally, returns are realized and payments are made.

We assume that risks in projects $R_1$ and $R_2$ are perfectly correlated.\footnote{One could think of these projects as an investment in subprime mortgages.} Thus, if both managers invest into the risky projects $R_k$, the projects generate the same payoffs for both banks. All moves as the contract offer and project implementation take place simultaneously and are therefore not observable by the other bank. However, strategic choices available for each bank and the distribution of project returns are common knowledge.

**Available Projects** With respect to project implementation, investment into $R_k$ causes a non-monetary fixed cost $C > 0$ to the manager, while there is no such cost for $S$.\footnote{Assuming costs for investment into $S$ to be zero is a normalization. Results do not change qualitatively if we allow for costs of the safe asset $C_S > 0$, as long as $C > C_S$.} After implementation,
asset $S$ generates a payoff $s$ in any state of the world, which, without loss of generality, we normalize to $s = 0$. For the risky project $R_k$, possible returns depend on the state of the world. There are three states of the world with payoffs $r_H > s = 0 > -r_L$ and according probabilities $Pr(r_H | R_k) = p_i$, $Pr(s | R_k) = q$ and $Pr(-r_L | R_k) = (1 - p_i - q)$. We assume that $p_i \in (0, 1)$ and $q \in (0, 1 - p_i)$, so that each return is realized with positive probability. In addition, we assume that $R_k$ is profitable for some distribution of probabilities $(p_i, q)$, while it is not profitable for other distribution of probabilities $(p_i, q)$. For simplicity, we hold $q$ fixed and assume that there exist two different probabilities $p_i$ (with $i \in \{l, h\}$) that the project yields the high return $r_H$: $p_l < p_h$, with $Pr(p_h) = \gamma$, $Pr(p_l) = (1 - \gamma)$ and $\gamma \in (0, 1)$. While the distribution of $p_i$, possible returns $\{r_H, 0, -r_L\}$, costs $C$, and probability $\gamma$ are common knowledge, the realization of $p_i$ is private information of the manager when it comes to signing the contract.\footnote{Following Lambert (1986), an agent can also acquire superior information by investing in knowledge after contract signing. As the focus here is on compensation payments and taxation rather than the agent’s information acquisition, the assumption of the agent’s exogenous ex ante superior information simplifies the analysis, but is not crucial.}

**Agency Problem** Ex post only realizations $\{r_H, 0, -r_L\}$ are observable, but not the agent’s actual investment. As payoff $s = 0$ can occur for both asset $S$ and project $R_k$, the principal cannot perfectly infer whether the agent has implemented the risky project or not. This implies a first informational advantage of the manager vis-à-vis the principal. Next to this, there is a second source of information asymmetry, which regards the profitability of the risky project $R_k$. While the manager (as an expert) knows the actual success probability $p_i$ when signing the contract, the principal only knows the distribution of possible success probabilities $p_i$. Thus, the principal cannot observe the information the manager based his project implementation decision on. This information asymmetry is especially severe as $R_k$ is profitable only for some probabilities $(p_i, q)$. In order to make this information asymmetry sufficiently severe, we assume that $R_k$ is not profitable for probability $p_l$ and maintain this assumption throughout the rest of the paper.

**Assumption 1.** The probability $p_l$ is such that $p_l < \frac{C}{r_H}$.

**Compensation Payments** There are three states of nature that can possibly occur, with corresponding payoffs $\{-r_L, 0, r_H\}$. Thus, as compensation for the task of operating the company
and implementing the investment project, the bank can offer a state-contingent wage with payments \((A_k \mid -r_L), (Y_k \mid 0)\) and \((A_k + b_k r_H \mid r_H)\). Thereby, the manager receives fixed wages \(A_k\) and \(Y_k\) if the outcomes are \((-r_L)\) and \(0\), respectively, and a bonus \(b_k \geq 0\) as a fraction of payoff \(r_H\) additionally to the fixed wage \(A_k\) if the outcome is \(r_H\).

Note that the bank has no wealth and can therefore not credibly commit to positive wage payments for outcomes \([-r_L, 0]\). At the same time, as the agent has zero wealth and is protected by limited liability, compensation payments \(\{A_k, Y_k, A_k + b_k r_H\}\) are restricted to be non-negative. This implies \(A_k = 0\) and \(Y_k = 0\).\(^{15}\) 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. In expectation, the manager’s compensation when implementing the risky project amounts to \(p_i b_k r_H\) while he faces costs \(C\) for this task.\(^{16}\)

### 3.2 First-Best

In order to analyze the agency problem and the impacts of a too-many-to-fail bailout policy and bonus taxation, we first identify the first-best solution in absence of any externality (like the bailout later introduced). As maximization problems of banks \(k = 1\) and \(k = 2\) are independent in absence of externalities, we omit the subscript \(k\) for notational convenience for the time being.

In first best, efficiency is maximal as the bank can observe project implementation, as it knows the realization \(p_i\) and as it maximizes its payoff by directly choosing the optimal investment policy. 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.\(^{17}\) For these compensation costs and in absence of an agency problem, the principal wants to implement the project as long as his expected net payoff equals or exceeds the compensation costs, i.e. \(p_i r_H + (1 - p_i - q) (-r_L) \geq C\).

**Lemma 1.** An investment decision is efficient if and only if \(p_i \geq \frac{C + (1-q)r_L}{r_H + r_L} \equiv p_i^{opt}\).

\(^{15}\)Y_k = 0 is a restriction caused by the assumption \(s = 0\) while \(A_k = 0\) is caused by \(u\). When analyzing the equilibrium compensation payments, we will discuss the implications of \(u = 0\) and \(s = 0\). Moreover, the restriction of \(A_k = 0\) is well established in literature (e.g. Besley and Ghatak, 2013) for similar cases.

\(^{16}\)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). This paper abstracts from effort choices as the focus shall be on the effects of bonus taxation on the implementation of risky projects (in contrast to distortions of managerial effort). For the effects of a bonus tax on managerial effort, see Radulescu (2012), Dietl et al. (2013) or Hilmer (2013).

\(^{17}\)Due to the bank’s restriction on \(A\) and \(Y\), a feasible and equivalent payment is \(b = \frac{C}{r_H}\) whenever \(r_H\) is realized.
3.3 Second-Best Risk Choices without Bailouts

In presence of the agency problem, both managers will again accept any contract for which their expected compensation equals or exceeds costs $C$. As the agents’ expected net-compensation $p_i br_h$ is linear in $p_i$, there exists a threshold $\hat{p}$ which determines whether or not to accept the contract. This threshold $\hat{p}$ is characterized by a binding Participation Constraint given the bonus payment $b$:

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

**Optimization Problem Principal** Taking the manager’s optimality condition (1) into account, the principal in the first stage chooses a bonus parameter $b$ which maximizes his expected payoff $E(\pi)$. As the principal only knows the distribution of $\{p_l, p_h\}$ and their likelihood to occur ($\gamma$ and $(1 - \gamma)$), his maximization problem is:

$$\max_b \quad (1 - \gamma) [p_l (1 - b) r_H + (1 - p_l - q) (-r_L)] + \gamma [p_h (1 - b) r_H + (1 - p_h - q) (-r_L)]$$

$$\text{s.t.} \quad p_i br_H \geq C \quad (3)$$

Equation (3) is the agent’s Participation Constraint (PC), which the principal has to consider as the agent will only accept the principal’s contract offer if his expected compensation at least remunerates him for the exogenous costs $C \in \mathbb{R}^+$ of implementing the risky project.$^{18}$

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 $b^* \in \left\{ \frac{C}{p_l r_H}, \frac{C}{p_h r_H} \right\}$. For the first bonus payment, the agent accepts the contract only for a probability $p_h$, while he accepts the contract for $p_h$ and $p_l$ if he receives the latter (steeper) bonus. Suppose a principal wants the manager to implement the risky project $R$ if the probability for $r_H$ is $p_i = p_h$, thus $\hat{p} = p_h$. 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 $p_h$. If, on the other hand, the principal offers a bonus $b > \frac{C}{p_l r_H}$, he pays a higher bonus than needed to incentivize the

$^{18}$Note: an Incentive Compatibility Constraint (ICC) is not necessary for this maximization problem. As $u = 0$, $Y = 0$ and $C > 0$, the ICC for implementing $R$ rather than $S$ (given by $p_i br_H + qY - C \geq Y$) is fulfilled whenever the PC ($pbr_H + qY - C \geq u$) is fulfilled.
manager to accept the contract for \( p_h \). This unnecessarily high bonus leaves a rent to the manager and lowers the principal's payoff. Therefore it cannot be optimal for him and optimal compensation for \( \hat{p} = p_h \) is given by \( b^h = \frac{C}{p_h r_H} \). The same argument as above applies if the principal wants to implement \( R \) for both \( p_l \) and \( p_h \). For \( \hat{p} = p_l \), optimal compensation is given by \( b^l = \frac{C}{p_l r_H} \).

**Equilibrium** In order to determine the optimal investment strategy, the principal compares the two expected payoffs \( E(\pi^l) \) and \( E(\pi^h) \) when incentivizing \( \hat{p} = p_l \) or \( \hat{p} = p_h \). Substituting the respective optimal compensation schemes \( b_h \) and \( b_l \) into the expected payoff (2), we get:

\[
E(\pi^l) = (1 - \gamma)[p_l r_H - C - (1 - p_l - q) r_L] + \gamma \left[ p_h r_H - \frac{p_h}{p_l} C - (1 - p_h - q) r_L \right] \quad (4)
\]
\[
E(\pi^h) = 0 + \gamma [p_h r_H - C - (1 - p_h - q) r_L] \quad (5)
\]

Equation (4) denotes the principal's expected payoff \( E(\pi^l) \) if he incentivizes the manager to accept the contract for all \( p_l \geq \hat{p} = p_l \). In order to do so, and, as for \( p_l \) the probability of receiving the bonus 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 \( C \). As \( b \) stays constant but the success probability is higher for \( p_h \), the manager in expectation gets compensated for \( C \) if the actual probability is \( p_l \), but earns a rent \( \left( \frac{p_h}{p_l} - 1 \right) C \) if it is \( p_h \). 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 \( r_L \)).

However, if the principal only incentivizes acceptance of the high probability \( p_h \) (equation (5)), he pays a bonus \( b^h \) which in expectation perfectly compensates the agent for the implementation costs \( C \) if the actual success probability is \( p_h \). Hence, the agent will not accept the contract if \( p_i = p_l \) and the principal earns 0 with probability \( (1 - \gamma) \).

**Lemma 2.** Suppose that Assumption 1 holds. Then, there exists a unique equilibrium \( (b^*, \hat{p}^*) \) in which both principals choose to offer a bonus rate \( b^* = b^h = \frac{C}{p_h r_H} \) if and only if

\[
p_h \geq \frac{C + (1 - q) r_L}{r_H + r_L} \equiv \hat{p}^*. \quad (6)
\]
Both agents accept the contract and implement 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). Due to Assumption 1, $E(\pi_l) < E(\pi_h)$. $E(\pi_h) \geq 0$ if and only if $p_h \geq \frac{C+(1-q)r_L}{r_H+r_L}$.

Due to Assumption 1, $p_l$ is too small to generate a positive expected payoff. Consequently, as the principal maximizes expected payoff, he offers a bonus $b^h$ to the agent, who will only accept the contract if $p_l = p_h$. 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 only then the principal earns an expected payoff $E(\pi_h) \geq 0$.

For this result and the following analysis, the simplification $s = u = 0$ has no qualitative implications. Instead, it has a level effect on the principal’s expected payoff for both the safe and the risky investment (as the principal does not have to compensate the manager for his reservation wage $u$) and a constant effect on the tradeoff between implementing the risky project $R$ rather than the safe asset $S$ (depending on the difference $(s-u)$). Suppose $u > s > 0$. Then, the principal could pay a maximum fixed wage $Y = s$, but would still need a bonus to incentivize the agent correctly. Due to $u > s$, $S$ is never profitable for the principal while $R$ is only if $p_h$ is large enough. If, on the other hand, $s > u > 0$, $S$ is always profitable. Still, $R$ is more profitable for some $p_i$. Thus, the principal again needs a bonus payment to incentivize the agent correctly. In addition, it will not be optimal for the principal to pay $Y > u$.\textsuperscript{20} This either results in suboptimal rent payments to the agent or in the agent always choosing $S$ rather than $R$.\textsuperscript{21}

\textsuperscript{19}In the absence of Assumption 1, the results of Lemma 2 hold if $\gamma\left(\frac{p_h}{p_l} - 1\right)C > (1 - \gamma)(p_l r_H - C - (1 - p_l - q) r_L)$: 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. $\gamma\left(\frac{p_h}{p_l} - 1\right)C$.

\textsuperscript{20}If $Y > u$, the agent shirks and never implements $R$ unless the principal increases $b$ above $b^*$, causing rent payments to the manager. If $b = b^*$, both principal and manager are indifferent in absence of bonus taxation for all remaining $0 \leq Y \leq \min\{s, u\}$. With bonus taxation, $Y$ optimally satisfies $Y = \min\{s, u\}$.

\textsuperscript{21}The following holds for the fixed wage $A$ if the principal could pay $A > 0$: due to Assumption 1, a bonus is still necessary in order for the agent to implement $R_h$ only for $p_h$. Otherwise, the manager would also implement the project for $p_l$, and thereby harm the principal. Neglecting Assumption 1, the principal may want to incentivize also the probability $p_i$. He could pay a fixed wage $A = \frac{C}{q}$ and $b = 0$, the agent would accept the contract for all $p_i$, without having an agency problem in the project choice. With bonus taxation, this is the only case where the restriction on $A \geq 0$ makes a qualitative difference.
3.4 Second-Best Risk Choices with a Too-Many-to-Fail Bailout Policy

Up to this point, there was no difference with respect to bank’s strategies or payoffs vis-à-vis a one-bank case. This changes when introducing a “too many to fail” problem: banks’ losses are possibly carried over by a bailout. This implies a modification regarding project implementation choices of banks: next to individual choices, collective risk choices now matter for 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. For this decision, it has to weigh gains of a bailout (corresponding to welfare costs associated with bank insolvencies) against the cost associated with the bailout. In order to analyze the implications of a too-many-to-fail bailout policy, we make the following assumption that imposes too-many-to-fail:

**Assumption 2.** Banks receive a bailout covering their losses $r_L$ only if both banks fail simultaneously. If only one bank fails, no bailout takes place.

Banks are not systemic on an individual basis but only on a collective basis. This yields the too-many-to-fail problem if more than one bank fails. As a result, society is able to stand one failing bank and therefore will not pay a bailout if the bank invested in a risky project and failed. If however both banks invest into their risky projects at the same time, then both fail together. As financial markets cannot be sustained if both banks fail at the same time, both banks will receive a bailout.

**Equilibrium with Anticipated Bailouts** Banks may expect a bailout, as defined above, either because of explicit communication about a bailout or because they anticipate the welfare losses a breakup of the financial system would cause. If banks expect a bailout, they may change their bonus payments and risk taking in equilibrium. If they take different actions, i.e. if one bank incentivizes risk taking and the other bank does not, banks still earn expected payoffs $E(\pi_L^1)$ and $E(\pi_L^h)$ as denoted in equations (4) and (5). Therefore, the equilibrium strategy of project implementation for $p_h \geq \hat{p}^*$ as denoted in Lemma 2 still applies, individually as well as collectively.

---

22Next to a direct cash-payment to failed banks, a bailout can also 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) by the US government.
If, however, both banks take the same decision, they either both fail, or none. Taking into account that they receive a bailout in the bad state, so that \( r_L = 0 \), banks’ expected payoffs are given by:\(^{23}\)

\[
E(\pi_l^{\text{hB}}) = (1 - \gamma) [p_l r_H - C] + \gamma \left[ p_h r_H - \frac{p_h}{p_l} C \right]
\]

(7)

\[
E(\pi_h^{\text{hB}}) = \gamma [p_h r_H - C]
\]

(8)

Comparing (7) and (8), the principal has to prove which cutoff probability \( p_l^B \in [p_l^B, p_h^B] \) yields higher expected payoff, and whether in expectation he can reckon with positive payoffs at all for the respective cutoff probability \( \hat{p}^B = p_l \) or \( \hat{p}^B = p_h \). Due to Assumption 1, \( E(\pi_k^{\text{hB}}) > E(\pi_k^{\text{lB}}) \) \( \forall \gamma \), and therefore the principal will, if at all, incentivize the agent to implement the project for the success probability \( p_h \). As an incentive payment for \( p_h \), he still has to pay a bonus \( b_k^h = \frac{C}{p_n H} \). However, when both banks invest into \( R_k \), a bailout erases the principals’ downside of the risky project and increases their expected payoffs \( E(\pi_k^{\text{hB}}) \). Ceteris paribus, project \( R_k \) now yields a non-negative payoff \( E(\pi_k^{\text{hB}}) \) already if \( p_h \geq \frac{C}{r_H} := \hat{p}^B \), given both banks invested.

Let us focus on success probabilities \( p_h \in [\hat{p}^B, \hat{p}^*] \), for which project implementation is profitable only collectively. By Assumption 2, whether or not there is a bailout depends upon the other bank’s decision and so do equilibrium strategies. Suppose bank 2 does not implement the project. Then, the project yields a negative expected payoff for bank 1 as \( E(\pi_1^h) < 0 \) for \( p_h < \hat{p}^* \). 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 \( b_k^h \) that optimally incentivizes the manager to implement the project for \( p_h \), or the bank does not offer an appropriate bonus. Then, the manager will reject the contract and thus the project is not going to be implemented. This gives us four combinations of banks’ implementation decisions for success probabilities \( p_h \in [\hat{p}^B, \hat{p}^*] \).

Computing the corresponding payoffs shows that there exist two pure strategy Nash Equilibria for success probabilities \( p_h \in [\hat{p}^B, \hat{p}^*] \):

**Lemma 3.** Suppose Assumptions 1 and 2 hold. Then, for success probabilities \( p_h \in [\hat{p}^B, \hat{p}^*] \), there exist two pure strategy equilibria where either

\(^{23}\)Where superscript \( ^{\text{B}} \) denotes the case of a bailout.
1. both principals refrain from project implementation and do not offer a contract to the manager,
2. or both principals implement the project by offering a bonus rate \( b^h_k = \frac{C}{p_h r_H} \).

The symmetric Nash Equilibrium with project implementation is payoff dominant compared to refraining.

Proof. Banks’ mutual best responses are “do not offer contract if other bank does not offer contract” and “offer bonus \( b^h_1 \) if the other bank offers \( b^h_2 \)”. Deviations from these strategies yield at least weakly lower expected payoffs. As \( E(\pi^h_{kB}) > 0 \) for \( p_h \in [\hat{p}^B, \hat{p}^*] \), the latter equilibrium is payoff dominant compared to a payoff zero of “do not offer”.

In the first case, suppose bank 1 refrains from offering a contract. By Assumption 2, 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. Hence, bank 2 has to bear possible losses itself and earns an expected payoff according to equation (5). However, as stated in Lemma 2, project implementation without bailout is only profitable if \( p_h \geq \hat{p}^* \). Thus, if \( p_h \in [\hat{p}^B, \hat{p}^*] \), the best response by bank 2 is to refrain from the project as well.

In the second case, assume bank 1 wants to implement the project and offers a bonus \( b^h_1 = \frac{C}{p_h r_H} \). Bank 2 then can be sure to receive a bailout if it implements the project as well and fails. As a bailout makes investments profitable also for probabilities \( p_h \in [\hat{p}^B, \hat{p}^*] \), the best response by bank 2 to higher risk taking by bank 1 is to also increase risk taking. In contrast to the one-bank case, the bank now neglects the expected costs of failing as those are going to be socialized. With an anticipated bailout, the government provides an externality to the bank such that the banks’ private marginal benefits from risk-taking increase. Consequently, the bank takes more risk than it would do on an individual basis.

3.5 Welfare Implications of Collective Moral Hazard

Whether an increase in risk taking is socially desirable or not depends on its welfare implications and thus on assumptions on the welfare function and the success probabilities \( p_i \). Lemma 1 shows the banks’ efficient investment decision in absence of any externalities. We take this as a benchmark.
While a bailout itself is welfare improving compared to the case where both banks go bankrupt, it leads to the undesired risk taking effects. 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 shows the following:

**Proposition 1.** Suppose Assumptions 1 and 2 hold. Then, there exists a payoff dominant equilibrium where both banks implement $R_k$ for $p_h \geq \hat{p}^B$, while the socially desirable level they decide upon on an individual level is $p_h \geq \hat{p}^{opt}$, with $\hat{p}^{opt} > \hat{p}^B$.

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

Proposition 1 demonstrates how banks change their project implementation decision, and consequently also their risk taking when they can anticipate bailouts. While information asymmetry between principal and agent does not affect welfare (as $\hat{p}^* = \hat{p}^{opt}$), the presence of a too-many-to-fail bailout policy does. Both principals can increase their expected payoff by incentivizing more risk taking. While principals have to bear real risks and losses in the absence of a bailout, they do not suffer losses in the presence of a bailout. This increases the bank’s marginal benefits from risk-taking and provides the incentives to accept risky projects also for lower success probabilities which principals would not incentivize their manager for in the absence of a bailout. Project implementation becomes profitable for success probabilities below the socially desired level, $\hat{p}^B < \hat{p}^{opt}$. 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 for banks compared to the equilibrium where both banks refrain from implementing the project for $p_h \in [\hat{p}^B, \hat{p}^*)$. Thus, when banks anticipate bailouts due to a too-many-to-fail systemic risk, they can coordinate on a socially undesirable equilibrium where both increase their risk taking by implementing risky projects also for low success probabilities.
4 Impact of a Bonus Tax

To analyze the welfare effects of a bonus tax in the presence of too-many-to-fail bailout policies, we introduce an additional stage into the model: before the take-it-or-leave-it contract is offered to the manager, the government can implement a bonus tax. When it is implemented, bonus payments become subject to a bonus tax $t_b \in [0; 1)$ that has to be paid by the managers. Therefore, with a gross compensation $p_i b_k r_H$, managers only receive expected net-compensation payments of $p_i (1 - t_b) b_k r_H < p_i b_k r_H$ if they accept the contract.

4.1 Effects of a Tax on Managers’ Bonuses

Due to the manager’s additional tax burden, his optimal threshold level $\hat{p}$ changes from (1) to:

$$\hat{p}^t = \frac{C}{(1 - t_b) b_k r_H}.$$  \hspace{1cm} (9)

As seen above, an expected bailout influences possible additional profits by eliminating the risk of losing $r_L$. The newly introduced bonus tax, in turn, acts as a Pigouvian tax and affects the costs of incentive payments. For a given bonus $b$, a bonus tax leads, compared to $\hat{p}^B$, to an increased threshold level $\hat{p}^t$ for the minimum success probability for which the manager accepts the contract in the presence of a bonus tax. Otherwise, if the principal wants to incentivize a given threshold level $\hat{p}$, the bonus payment $b^t$ to the manager has to increase in a way such that the manager is fully compensated for the bonus tax. While net incentive payments to the agent stay constant, the principal’s costs thereof increase the higher the bonus tax is. Hence, a bonus tax is associated with higher costs for the principal in expectation, either in terms of lost expected profits due to a higher threshold probability, or in terms of higher compensation payments.

Compared to equations (7) and (8), the principal now additionally takes into account the costs associated with the bonus tax when deciding upon the optimal threshold probability $\hat{p}^t$. Expected payoffs change to $E(\pi_k^{lt})$ and $E(\pi_k^{ht})$.\footnote{Where superscript $^{\text{tst}}$ denotes the case of a bailout together with a (possible) tax on bonuses.}
\[
E \left( \pi_k^h \right) = (1 - \gamma) \left[ p_h r_H - \frac{C}{(1 - t_b)} \right] + \gamma \left[ p_h r_H - \frac{p_h}{p_h} \frac{C}{(1 - t_b)} \right] \tag{10}
\]
\[
E \left( \pi_k^{ht} \right) = \gamma \left[ p_h r_H - \frac{C}{(1 - t_b)} \right] \tag{11}
\]

Whether or not a bonus tax can reverse the principal’s distorted risk taking of \( p_h \geq \hat{p}^B \) in the presence of bailouts back to the benchmark threshold \( p_h \geq \hat{p}^{opt} \) depends upon the extent to which bonuses are taxed. In order to be profitable for the principal to incentivize the manager to implement the project solely for \( p_h \geq \hat{p}^* \), the cutoff probability under taxation \( \hat{p}^t \) must equal the optimal cutoff probability \( \hat{p}^* \) defined in Lemma 2. Then, a proper bonus tax can be effective in reversing the threshold for the success probability, in spite of bailouts, back to the benchmark level.

The necessary tax rate is given by \( t^*_b = \frac{r_L((1-q)r_H-C)}{r_H((1-q)r_L+C)} \). With this bonus tax \( t^*_b \), incentives change for both principals compared to a situation without bonus taxation as for any bonus payment principals now bear costs of \( \frac{b}{1-t_b} \) rather than only \( b \). This increases costs and makes projects (intendedly) unattractive that are profitable without a bonus tax.

**Lemma 4.** Suppose Assumptions 1 and 2 hold. If the government introduces a bonus tax

\[
t^*_b = \frac{r_L((1-q)r_H-C)}{r_H((1-q)r_L+C)}, \text{ then,}
\]

1. for \( p_h < \hat{p}^t = \hat{p}^* \), banks will not implement the risky project.

2. for \( p_h \in [\hat{p}^t, \hat{p}^*_2] \), there exist two symmetric pure strategy equilibria, in which both principals either refrain from project implementation or implement the project by offering a bonus rate \( b_k^{ht} = \frac{C}{(1-t^*_b)p_h r_H} \). The Nash Equilibrium with project implementation is payoff dominant.

3. for \( p_h \geq \hat{p}^*_2 \), there exists a unique equilibrium in which both principals implement the project by offering a bonus rate \( b_k^{ht} \).

**Proof.** If \( t_b = t^*_b \), \( E \left( \pi_k^{ht} \right) \geq 0 \) if and only if \( p_h \geq \hat{p}^t \). Individually, i.e. without bailout, expected payoff \( \gamma \left[ p_h r_H - \frac{C}{(1-t^*_b)} - (p_h - q) r_L \right] \geq 0 \) if and only if \( p_h \geq \hat{p}^*_2 = \frac{[1-q]r_L}{r_H(r_H+s)} + \frac{r_H(1-q)r_L+C}{(r_H+s)^2} \).

As Lemma 4 describes, with bonus taxation there exist two threshold levels \( \hat{p}^t \) and \( \hat{p}^*_2 \) for the success probability \( p_h \). This gives us three possible ranges for \( p_h \) to lie in. First, suppose \( p_h < \hat{p}^t \).
For this range, the incentive payments necessary to align the manager’s interest with the principal’s are too high to make it profitable to invest in the risky project. Banks independently of each other will not implement the risky project anymore. That is, the tax $t_b^*$ is effective in reversing the threshold probability from $\hat{p}_B = \frac{C}{r_H}$ with bailout-externality back to the second-best threshold $\hat{p}^t = \hat{p}^* = \frac{C+(1-q)r_L}{r_H+r_L}$. Thereby, the bonus tax exactly balances the externality a bailout entails and reduces the banks’ incentives for risk taking to the socially desired level.\textsuperscript{25} If, however, $p_h \geq \hat{p}^t$, there exists another threshold level $\hat{p}_2^t$ that constitutes whether project implementation is profitable both individually and collectively, or only collectively. Whenever $p_h \geq \hat{p}_2^t$, implementing $R_k$ is profitable for both banks individually (and consequently collectively). Also without receiving a bailout, success probabilities $p_h \geq \hat{p}_2^t$ are high enough to guarantee a positive expected payoff. Thus, both principals incentivize their agents to implement $R_k$. Agents receive a bonus $b_{ht}^k = \frac{C}{(1-t^*b)p_hr_H}$ which perfectly compensates them for the bonus tax $t_b^*$. Therefore, $b_{ht}^k$ is larger than the bonus $b_{ht}^k$ in absence of taxation. However, in the medium range $p_h \in [\hat{p}^t, \hat{p}_2^t)$, two symmetric equilibria exist. For probabilities $p_h \in [\hat{p}^t, \hat{p}_2^t)$ it is only profitable to implement $R_k$ if the other bank also implements $R_{-k}$. Taking the risk on an individual basis is too expensive and in expectation leads to losses. Thus, either both banks offer a contract with a bonus $b_{ht}^k$, or none of them does. As in Lemma 3, the Nash Equilibrium with project implementation payoff dominates the equilibrium with abstaining from project implementation.

4.2 Welfare Implications of a Bonus Tax

From Proposition 1 we know the welfare effects caused by a too-many-to-fail bailout policy. Collective moral hazard leads to increased risk taking, such that banks implement projects with success probabilities lower than the socially desired level $\hat{p}_B < \hat{p}_{opt}$. Comparing the results of Lemma 3 to the findings denoted in Lemma 4, we can state the following with respect to bonus taxation:

**Proposition 2.** Suppose Assumptions 1 and 2 hold. Then,

1. for the payoff dominant equilibrium with collective moral hazard, a bonus tax $t_b^*$ is welfare improving if $p_h < \hat{p}^t$ and welfare neutral if $p_h \geq \hat{p}^t$.

\textsuperscript{25}If $t_b < t_b^*$, socially undesirable investment is still profitable if undertaken collectively, i.e. $\hat{p}^t < \hat{p}_{opt}$. If $t_b > t_b^*$, the bonus tax prevents socially optimal risk taking. In this case, banks incentivize too little risk taking, i.e. $\hat{p}^t < \hat{p}^t$.\hfill
2. For the payoff dominated equilibrium, a bonus tax \( t_b^* \) is welfare neutral if \( p_h < \hat{p}^* \) or \( p_h \geq \hat{p}^*_2 \), and welfare decreasing if \( p_h \in [\hat{p}^*, \hat{p}^*_2) \).

**Proof.** Follows directly from Proposition 1 and Lemma 3 and 4. As \( \hat{p}^* = \hat{p}^{opt} \) for \( t_b = t_b^* \), a bonus tax \( t_b^* \) induces \( \hat{p}^{opt} \) in the payoff dominant equilibrium. For the payoff dominated equilibrium without collective moral hazard, \( t_b^* \) shifts the threshold from \( \hat{p}^{opt} \) to \( \hat{p}^*_2 \).

Welfare effects of a bonus tax depend on two threshold levels \( \hat{p}^* \) and \( \hat{p}^*_2 \) for the success probability \( p_h \). Further, welfare effects crucially depend on whether the equilibrium with project implementation or the equilibrium with abstention is realized. Remember that \( \hat{p}^* = \hat{p}^{opt} \) for \( t_b = t_b^* \) and let us first focus on the welfare effects for the payoff dominant equilibrium with project implementation and collective moral hazard. For \( p_h < \hat{p}^* \), banks implement \( R_k \) in the absence of bonus taxation although it is not socially desirable (\( \hat{p}^B < \hat{p}^{opt} \)). For this range of \( p_h \), a bonus tax \( t_b^* \) non-ambiguously prevents project implementation (Lemma 4) and thus increases welfare. For all remaining possible probabilities \( p_h \geq \hat{p}^* \), a bonus tax \( t_b^* \) does not cause welfare effects as, according to Lemma 1, banks should invest for \( p_h \geq \hat{p}^{opt} \). In this equilibrium, both banks do invest irrespective of a bonus tax.

In contrast to the welfare improving effect of a bonus tax in the presence of collective moral hazard, a bonus tax can be welfare decreasing in the payoff dominated equilibrium where banks abstain from implementing the risky project. In this equilibrium, a bonus tax tries to balance the externality of a bailout that does not lead to distortions in the first place. While the presence of a bailout does not distort risk taking from the socially desirable threshold \( \hat{p}^* = \hat{p}^{opt} \), a bonus tax does. Any bonus tax \( t_b > 0 \) ceteris paribus lowers banks’ payoffs and thereby distorts their optimization problem. As a result, banks will only implement the risky project if \( p_h \geq \frac{C_1 + (1-q)r_L}{r_H + r_L} \).

As \( \frac{C_1 + (1-q)r_L}{r_H + r_L} \geq \hat{p}^{opt} \) if \( t_b > 0 \), any bonus tax leads to inefficiently low risk taking.

As a side effect of bonus taxation, banks not only reduce risk taking, but also bear higher incentive payments for the manager due to the bonus tax. As a result, banks earn less when a bonus tax is introduced. The difference between both payoffs exactly equals the bonus tax revenue the government collects.
4.3 Extension: Supranational Bailout, but National Bonus Taxation

One of the main characteristics of the banking sector is its degree of integration, also across countries.\textsuperscript{26} When studying the effects of a bonus tax in a stylized international framework, it is valuable to analyze a situation of discriminatory bonus taxation. This allows us 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.\textsuperscript{27} In the international context, bailouts linked to systemic risk due to a too-many-to-fail problem are often 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.”\textsuperscript{28} As a result, bank regulation at the moment still is mainly a national responsibility, whereas resolution is undertaken already on a supranational level.

This institutional setup is captured by an extension of the model: Suppose only manager 1 is subject to a bonus tax. Hence, for manager 1 the optimality condition under the 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 therefore earns an expected payoff (10) or (11), while bank 2’s expected payoffs are given by (7) and (8). Thus, mutual best responses by bank 1 and 2 are not symmetric anymore and lead to the following results:

\textbf{Lemma 5.} Suppose Assumptions 1 and 2 hold. If only manager 1 is subject to a bonus tax \( t_b = t_b^* \), there exists a unique equilibrium where both principals choose to incentivize project implementation if and only if

\[
p_h \geq p^* = p_{\text{opt}}^*.
\]

Banks offer a bonus rate \( b_{1h} \) and \( b_2 \) and earn payoffs \( E(\pi_{1h}) \) and \( E(\pi_{2B}) \). Government 1 raises

\textsuperscript{26}As financial markets have integrated more and more in the last decades, also cross-border banking has increased (Allen et. al, 2011). Degryse et. al (2010) show that this increase in cross-border banking also caused an increase of financial contagion by banks.

\textsuperscript{27}For supranational regulation, cross-national coordination is necessary but often difficult to implement. Hence, discriminatory taxation is equivalent to a situation where banks are located in different countries with different fiscal jurisdiction but within a single economic area.

\textsuperscript{28}See ECB (2010, 2011) on the ECB’s response to the financial crisis and its impacts. Among standard measures such 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).
expected tax revenue \( T = \gamma \frac{t_b}{1-t_b^*} C \).

Proof. If \( t_b = t_b^* \), \( E (\pi_{11}^{ht}) \geq 0 \) if and only if \( p_h \geq \hat{p}^l \). If bank 1 implements \( R_1 \) only for \( p_h \geq \hat{p}^l \), bank 2’s best response is to follow this strategy.

Proper taxation can reduce risk taking of both banks to a level that 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 bank 1, but also on bank 2. This follows from the increase in necessary incentive payments to the manager such that bank 1 is not willing to finance those costs anymore. As a result, the equilibrium with project implementation, which is payoff dominant for \( p_h \in [\hat{p}^B, \hat{p}^*] \) without bonus taxation, becomes payoff dominated for the taxed bank. Although it stays a payoff dominant response for bank 2 to implement the project for \( p_h \in [\hat{p}^B, \hat{p}^*] \) when bank 1 implements the project as well, it is no longer a mutual best response in presence of taxation: As the untaxed bank 2 always incentivizes project implementation for \( p_h \geq \hat{p}^* \), it is profitable for bank 1 to do so as well. On the other hand, as bank 1 abstains from implementation for \( p_h \in [\hat{p}^B, \hat{p}^*] \), it is also not profitable for bank 2 to invest for \( p_h \in [\hat{p}^B, \hat{p}^*] \). Due to this fact, there is a unique equilibrium where both banks incentivize their agents to implement the project for the high success probability \( p_h \geq \hat{p}^* \), but prevent project implementation by means of compensation for \( p_h < \hat{p}^* \).

Proposition 3. Suppose Assumptions 1 and 2 hold. Then, a bonus tax \( t_b^* \) that covers only one bank is welfare improving if \( p_h < \hat{p}^l \) and welfare neutral if \( p_h \geq \hat{p}^l \).

Proof. Directly follows from Proposition 1 and Lemma 3 and 5.

With respect to welfare, 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 cannot cause negative welfare effects unlike when both banks are taxed and they do not coordinate on the payoff dominant equilibrium. In this sense, taxing the bonus of only one bank manager is welfare equivalent to a taxation of both banks when banks choose the equilibrium with collective moral hazard. Whenever there is a chance that banks abstain from collective moral hazard and implement projects only when they are profitable individually, unilateral or discriminatory taxation is welfare superior.
5 Conclusion

In this paper, we modeled a symmetric principal-agent structure with two banks where the agents’ task was the implementation of a project of a certain risk profile. 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 the 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. Thereby 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 under the stated assumptions 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 a unilateral bonus tax without global coordination is effective in reducing risk taking in the taxing country and additionally has a positive externality on other countries. It not only reduces the gamble for bailouts for the taxed bank, but also increases market discipline of other banks with 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.
References


