Taxing Managers' Bonuses: Essays on the Implications of Bonus Taxation

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To Martina.

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Introduction and Summary

Over the past years, financial markets were hit by two crises: the global financial crisis of 2007 - 2009 and the subsequent and currently ongoing sovereign debt crisis in the Eurozone. Initiated by the bursting of the housing bubble in the United States, the global financial crisis led to a strong economic downturn worldwide. During the crisis, US GDP fell by nearly 5 percent from December 2007 to June 2009. Likewise, US employment declined by 8.8 million between January 2008 and February 2010. Taking into account projections for cumulative US output losses associated with the financial crisis, estimated costs amount from several trillion USD to more than USD 13 trillion.[1] Without an intervention by governments and central banks, this crisis might have had catastrophic consequences for the world economy.

However, we will never know these "what ifs" as central banks promptly responded to the financial crisis in order to reestablish interbank lending. In addition to cutting interest rates, central banks used and still use unconventional policy measures such as Quantitative Easing (QE), Longer-Term Refinancing Operations (LTROs), or extending the list of assets eligible for collateral (European Parliament, 2012).[2] Furthermore, governments tried to strengthen the financial sector by providing aid to financial institutions. With its Troubled Asset Relief Program (TARP), the US government invested a total of USD 245 billion in assets and equity of financial institutions (US Department of the Treasury, 2013). In the European Union, between 2008 and 2011 EUR 1616 billion were used to support financial institutions, either by recapitalizing banks to increase their solvency or by granting guarantees to enhance liquidity (European Commission, 2012). These government expenditures made in support of the financial sector were one of many reasons

[1] See US Government Accountability Office (2013) for an examination of financial crisis losses to the US economy, including data on GDP decline and projections for cumulative US output losses. For US employment data, see Bureau of Labor Statistics (2011).

[2] While QE is an asset purchasing program, LTROs provided liquidity to banks for periods of up to three years. In addition, in 2012 the ECB announced its Outright Monetary Transactions (OMT) program with its potential engagement in the secondary markets for government bonds.

for the subsequent and persistent sovereign debt crisis in Europe.[3]

In an attempt to identify the sources for the financial crisis, the US Senate entrusted its Permanent Subcommittee on Investigations with the matter. This US Senate Permanent Subcommittee on Investigations (2011, p. 1) concluded that the financial crisis was "the result of high risk, complex financial products; undisclosed conflicts of interest; and the failure of regulators, the credit rating agencies, and the market itself to rein in the excesses of Wall Street." The committee found that in recent years financial markets changed in several dimensions. For example, banks became larger and more complex. This alters a lot. As a bank's probability to be bailed out by the government is found to increase in bank size, large firms are likely perceived as too-big-to-fail.[4] This boils down to an implicit government guarantee for large banks, results in moral hazard and provides incentives for excessive risk-taking.[5] In addition to the change in bank size, the committee also attested that banks set up financial instruments that were difficult to analyze, and, above all, they faced lax government regulation. In combination, these factors resulted in a highly dangerous mixture that can be seen as one of the main drivers of the financial crisis.[6] In 2008, this mixture forced governments to quickly support banks as stated above.

Furthermore, in response to the financial crisis, governments have taken manifold initiatives, temporary or permanent, to reform the financial sector. Their motivation was threefold: governments wanted (i) banks to take a share in the realized rescuing costs, (ii) reestablish stability of the financial industry, (iii) prevent future crises. To reach these goals, governments started initiatives that included and still include regulatory standards for financial institutions and means of taxation.[7]

Regarding regulation, major reforms such as the agreement on Basel III rules and, on the European scale, the introduction of the European banking union, aim at strengthening resilience and stability of the financial industry (Bundesministerium der Finanzen, 2014b). While Basel III is meant to strengthen bank capital requirements and will be fully put into effect by 2019, the European banking union is a framework for a single

[3]For a discussion of other explanations for excessive public debt and reform possibilities, see Konrad and Zschäpitz (2010).
[4]By analyzing financially distressed firms across industries and countries, Smith (2014) finds that bigger firms and financial sector firms were more likely to receive a bailout.
[5]DeYoung et al. (2013) provide empirical evidence for this risk-taking channel.
[6]See US Senate Permanent Subcommittee on Investigations (2011).
[7]See Keen (2011a) and Bundesministerium der Finanzen (2014b, pages 39-48) for an overview and for the facts stated below.

supervision and resolution mechanism in the European Union, which is to be fully operational in 2016. In addition to European legislation, Germany passed a law for the implementation of a separate banking system by 2016 and set rules for high-frequency trading that include mandatory supervision by the BaFin, the German Federal Financial Supervisory Authority.

As a further package of measures, governments also discussed the implementation of taxes. Long-lasting negotiations have concluded in the introduction of a financial transactions tax - a Tobin tax - in Germany and ten other member states of the EU that is due in 2016.[8] This tax shall ensure that banks make a substantial contribution to the costs of rebuilding and strengthening the financial sector. Further, the transactions tax aims at creating disincentives for short-term speculation and enhancing sustainable investment strategies (European Commission, 2013). When banks have to pay the financial transaction tax, they are expected to rethink the benefit of large numbers of short-term transactions. All these initiatives, reforms and taxes, show that governments initiated a broad range of provisions in order to rethink and redesign financial markets in the medium- and long-term.

In contrast to the reforms mentioned above that are expected to directly influence certain bank processes, early initiatives focused especially on those deciding upon investments - the bankers. The reason for first intervening at this issue was mainly a political one: to calm down the public debate about compensation practices. When the financial crisis began, compensation practices in financial markets focused on short-term profits rather than long-term success (UK Financial Services Authority, 2008). In addition, due to the fact that bonus payments are paid with a time lag, bankers received huge bonus payments at times their banks had to be rescued by public money. In 2008, the year the financial crises peaked, nine banks, including Goldman Sachs, Morgan Stanley and Citigroup, paid out bonuses of USD 32.6 billion. At the same time, the very same banks reported combined losses of nearly USD 100 billion and had received USD 175 billion from the TARP by the US government.[9] The corresponding press reports promoted a public debate about the magnitude of bonus payments to bankers, about the incentives the bankers' compensation packages entail and about the excesses of Wall Street. Initiatives to regulate compensation practices and to tax bonus payments followed quickly.

On the regulatory side, the initiatives included the introduction of "principles for sound

[8]See Bundesministerium der Finanzen (2014a, page 38).
[9]See "Bank Bonus Tab: $33 Billion" (The Wall Street Journal 2009, July 31).

compensation practices" (Financial Stability Forum, 2009) which was intended to establish incentive systems that prevent excessive risk taking in the future. On the tax side, reforms of the fiscal treatment of managerial compensation first and foremost aimed at decreasing the net-value of bonus payments. In doing so, governments hoped to achieve several goals at the same time. On the one hand, they wanted to raise additional tax revenue with the bonus tax while simultaneously decreasing "shameful" bonus payments.[10] On the other hand, they hoped that bonus taxes might act as a corrective tax - a Pigouvian tax - that can be used in order to internalize possible externalities (Keen, 2011a). Thus, several countries discussed surtaxes on managerial bonuses, and some countries like the United Kingdom, France or Italy introduced such taxes for the financial sector on a temporary or permanent basis (IMF, 2010). These real world examples show how policy-relevant bonus taxes have been in the aftermath of the financial crisis. However, governments pursued the introduction of bonus taxes while only having little knowledge about their effects and benefits.

By analyzing the various effects of bonus taxation in three different environments, the chapters of this dissertation make a contribution to the literature that aims to fill this gap in our knowledge. As a look at bonus payments in different industries reveals, bonus payments in the financial sector are much higher than bonus payments in the non-financial sector (Von Ehrlich and Radulescu, 2012). With this in mind, two inevitable questions arise: (i) Why does the financial sector pay higher bonuses than the non-financial sector and (ii) can a bonus tax improve welfare? In general, a company has the right and the possibility to pay its executives any level of compensation and to compose the payments anyway it wants. However, the level of overall compensation will crucially depend on the degree of competition in the market for executives, while the reason for paying bonuses lies in the presence of information asymmetry. In the presence of imperfect information, the firm has to pay some kind of incentive wage in order to deter the executive from moral hazard.[11]

In order to focus on the relationship between the bank and its manager, Chapter 1 shows the effects of bonus taxation on compensation and welfare in a framework without any additional externality. The finding is that bonus taxation distorts bonus payments and thereby incentives for the executive in a way such that no one benefits: neither a welfare

[10] See, for example "Darling Targets Bonuses, Says Rich will Pay More Tax" (bloomberg.com, 2009, Sep 28) or "Obama attacks Wall Street's executive bonuses as 'shameful"' (Financial Times, 2009, Jan 30).

[11] There exists a broad literature on efficient contracting, starting with the seminal paper by Jensen and Meckling (1976). An overview can be found in Laffont and Martimort (2001).

maximizing government, nor the firm nor the executive. This is not only true for a bonus tax like the UK bank payroll tax, but also for different kinds of bonus taxation, e.g. a limited deductibility provision. However, while this result holds for the situation analyzed in Chapter 1, it does not hold in general. The analyses in Chapter 2 and Chapter 3 show the possible positive implications of bonus taxation on welfare. The main difference compared to Chapter 1 is the presence of externalities that banks face, like the too-many-to-fail or too-big-to-fail problem. Both externalities produce bonus ratios that are higher than in the absence of these externalities, providing a theoretical rationale for the observation of higher bonuses in the financial industry. In addition, both Chapter 2 and Chapter 3 make a case for the Pigouvian element of a bonus tax and show that a bonus tax can be used in order for a bank to (partly) internalize the externality of a bailout. By that, a bonus tax can prevent excessive risk-taking and short-termism on the one hand and increase welfare on the other hand.

In the following, the main results from each chapter of this thesis are presented. The results in all three chapters were derived by using theoretical models within the basic structure of the principal-agent theory. The number of players or the time structure in each model has been extended and adjusted to analyze the respective research question. As each chapter is based on a stand-alone paper, each chapter can be read separately.

The thesis starts with a comparison of different fiscal instruments that can affect managerial compensation and were discussed or even implemented by some governments. We use a unified principal-agent model to analyze and compare the consequences of three different instruments: (i) bonus taxes managers (agents) need to pay, (ii) limited deductibility of bonuses from company profits and (iii) a corporate income tax (CIT) payable by the bank (principal). In the model, a manager with limited liability exerts unobservable effort that positively affects expected profit. As a compensation, the manager can be paid a fixed wage and an outcome-contingent bonus as incentive device. Based on this framework, we explore how the three tax instruments mentioned above affect managerial incentives and how they change the design of incentive contracts used in equilibrium. For a given compensation structure, we find that a bonus tax decreases net bonuses and reduces effort. In contrast, limited deductibility neither has an effect on the manager's bonus payment nor on effort. However, for incentive contracts used in equilibrium, both a bonus tax and limited deductibility of bonus payments from company profits reduce the manager's effort. On the one hand, this reduced equilibrium effort allows the bank to lower the manager's net bonus - both for a bonus tax and limited deductibility. On the other hand, as the bonus tax is payable by the manager, his gross bonus payments may even increase when a bonus tax is introduced in order to compensate him for his additional costs. Nevertheless, limited deductibility and bonus taxes are close substitutes in terms of welfare. Both lead to a welfare loss compared to a CIT raising the same tax revenue. This is due to the fact that the CIT has no effect on the incentive contract. Beyond that, the CIT can even be used to reduce the welfare loss associated with the information asymmetry between manager and bank. To achieve this loss reduction, the government has to increase the CIT and use this increase to finance a subsidy for bonus payments. This chapter builds on Hilmer (2013).

The second chapter analyzes for the effects of a bonus tax in the presence of an externality. It simplifies the analysis of Chapter 1 by focusing on a bonus tax, but extends the previous model by covering the systemic nature of highly interconnected financial institutions. In contrast to the too-big-to-fail literature, we assume financial institutions to be systemic only on a collective basis, generating the too-many-to-fail externality. This assumption has several features which distinguish the analysis from the too-big-to-fail approach. Most importantly, it implies that banks receive a bailout only if several banks fail jointly. Thereby, the model in Chapter 2 does not only cover large banks, but also incorporates small banks. Moreover, as a bailout crucially depends on the decision of another bank, this too-many-to-fail assumption generates incentives for herding and collective moral hazard, which are absent within the too-big-to-fail literature. We use a simple symmetric principal-agent model with two banks in order to analyze the incentives in the presence of this too-many-to-fail externality in a straightforward framework. In case a wealth-constrained manager is the only one knowing about the distribution of returns to an available project, the bank has to use incentive payments such as a bonus in order to align interests. In combination with the bailout externality, this agency problem allows us to analyze the effects of both bailouts and bonus taxes on risk-taking, collective moral hazard and managerial compensation. We find that if banks can anticipate bailouts, they can coordinate on an equilibrium in which they collectively incentivize excessive, inefficient risk-taking. A bonus tax can prevent this excessive risk-taking. It reduces the risk-taking of the taxed bank and, consequently, rules out the equilibrium with excessive risk-taking by both banks and reestablishes market discipline. This is also true if the bonus tax is implemented unilaterally for one bank only. Chapter 2 is based on Hilmer (2014b).

In Chapter 3 of this thesis, we provide another principal-agent model, which extends the number of periods analyzed. In doing so, we can examine in which respect i) the externality of a bailout and ii) the introduction of a bonus tax on short-term payments influence the timing of investment strategies and how they affect the relationship between long-term and short-term compensation. For this purpose, we model investments that last for two periods. The manager can (costly) choose the degree of short-termism. While short-termism increases expected short-term profits, it comes at the expense of expected long-term profits. As short-termism is assumed to be harmful not only for society, but also for the bank itself, it should be in the bank's best interest to prevent any short-termist action by the manager. However, this does not happen in the presence of a bailout. As it allows the bank to neglect the costs of failure, an anticipated bailout induces the bank to tolerate short-termist behavior more often and to a higher degree. The reason for this can be found in the manager's compensation structure. While it is indeed in the bank's interest to prevent short-termism by using an appropriate compensation structure in the absence of a bailout, it is not anymore in the presence of a bailout. In the presence of a bailout, it is more profitable for the bank to change its compensation structure towards higher short-term payments while tolerating the negative consequence of increased short-termism. However, an appropriate tax on short-term bonuses can induce the bank to internalize the costs of a bailout. With such a tax, the determinants of incentive provision can be changed and the compensation structure of managers can be shifted towards long-term bonuses. Finally, inefficient short-termism can be prevented. Chapter 3 is based on Hilmer (2014a).

To sum up, the models in Chapter 2 and Chapter 3 offer a rationale for a bonus tax when banks anticipate bailouts and adjust their compensation payments accordingly. Whenever there exists some probability that the government covers a part of the losses, banks want to adjust their investment strategies in order to exploit this (partial) risk coverage by the government. As banks depend on their managers taking action in their interest, they adjust their managers' compensation structure and their incentives. In such an environment, a bonus tax is beneficial as it can increase the costs of incentive provision and internalize (part of) the externality. However, this positive effect of a bonus tax only occurs in the presence of an externality. And the effects of a bonus tax differ in the type of externality. While a bonus tax (up to a certain point) is always beneficial in the presence of the too-big-to-fail externality, it must not be for the case of collective moral hazard in the presence of the too-many-to-fail externality. Without an externality as shown in Chapter 1, a bonus tax intensifies the principal-agent problem and reduces welfare.

Hence, whenever a government considers the implementation of a bonus tax, it has to take the specific purpose of the tax into account. Bonus taxation can be helpful in internalizing externalities. However, as bonus taxation may distort incentive provision, it is not the optimal instrument to use when a government wants to raise tax revenue. In such a case it could happen that bonus taxation hurts banks, bank managers, and society as a whole.

Chapter 1.

Fiscal Treatment of Managerial Compensation - a Welfare Analysis

1.1. Introduction

In the context of the recent financial and fiscal crisis, a public debate about high payments for bankers and other managers, their compensation packages and possible regulating mechanisms came up. Several politicians called out “greed and recklessness” in the financial system[12] and considered bankers’ pay to be disproportionately high.[13] In response, some countries reformed and many others discussed the tax treatment of managerial compensation. Nevertheless, there is not much known about the various effects thereof.

This chapter compares three taxation instruments in a unified principal-agent framework and fills this gap. We use a tax system with tax instruments that were discussed - and partly even implemented. These are bonus taxes, limited deductibility of bonus payments and a corporate income tax (CIT). Comparing them, we analyze their effects on managerial incentives, the design of incentive contracts used in equilibrium and their welfare implications. This will be done using a principal-agent model in which the agent with limited liability can receive a fixed wage and a bonus and in which both the principal’s profit and the agent’s income are potentially subject to the following taxes. First, we

[12]“Darling Targets Bonuses, Says Rich will Pay More Tax” (bloomberg.com, 2009, Sep 28).

[13]See “E.U. Could Trim Bank Bonuses” (advisorone.com, 2012, Apr 25): “[...] According to Michel Barnier, the financial services commissioner of the E.U., some banker pay is beyond ‘all reason, common sense and morality.‘ [...]“ or “Obama attacks Wall Street’s executive bonuses as ’shameful‘” (Financial Times, 2009, Jan 30).

consider a CIT payable by the principal and based on net profit. Second, we introduce a bonus tax which is a surtax on managerial bonuses payable by the agent. This tax is comparable to the 50% bank payroll tax introduced in the UK in 2009 and levied on bankers' bonus payments exceeding GBP 25.000 for the fiscal year 2009-2010 (UK Finance Act 2010, Schedule 1).[14] Other examples are Ireland, that introduced a 90% bankers' bonus tax in January 2011 for banks supported by the government, and the US, where the House of Representatives approved such a 90% tax already in March 2009.[15] The third tax instrument modeled is a set of rules concerning the deductibility of bonus payments as operating expenses against the corporate income tax.[16] Limited deductibility of bonuses from the corporate tax base broadens the corporate tax base and leads to a higher corporate tax burden, ceteris paribus. In the US, annual salaries exceeding USD 1 Mio are not deductible.[17] In other countries like Germany and Switzerland, limited deductibility was part of the public debate. In Germany, the parties "Die Linke" and "Bündnis 90, Die Grünen" started such a request, while in Switzerland, the Swiss Federal Council and the Council of States tried to incorporate a limited deductibility of salaries exceeding CHF 3 Mio in a referendum but were blocked by the National Council.[18]

Our results suggest the following: For a given compensation structure, a bonus tax directly lowers the agent's net bonus and leads to a reduced effort choice once it is introduced. In contrast, neither limited deductibility nor a CIT affect existing managerial incentives. In equilibrium, where the principal anticipates the agent's optimal effort choice, any taxation of bonuses will lead to reduced effort and net bonus. In the case of limited deductibility, the principal accounts for his own higher tax burden and thus incentivizes a lower effort level by reducing the agent's bonus. A bonus tax, however, can also lead to an increased gross bonus payment by the principal. Nevertheless, both mentioned ways of bonus taxation are close substitutes and lower welfare. Compared to a situation where only a CIT is used to raise tax revenue, both reduce the principal's and the agent's rent. With full deductibility of bonuses thereof, a CIT is superior as

[14] In UK, the bank payroll tax had to be paid by the banks. Even though, as our interest in the tax incidence and the effects on compensation structure does not depend on the taxpayer, we model the bonus tax in line with literature (e.g. Dietl et al., 2013) that it be payable by the manager.

[15] 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).

[16] A change in deductibility is a prevalent policy instrument also for other areas of governmental intervention. See, for instance, Koethenbuerger and Stimmelmayr (2014) for deductibility of investments.

[17] According to § 162 (m)(1) IRC, for the CEO and the next four highest-paid officers of a firm, no deduction for remuneration that exceeds USD 1 Mio for the tax year is allowed. There exists a complex exception for compensation paid under a "performance-based plan".

[18] See "Switzerland: Proposals affecting executive compensation" (pwc.ch, 2012, Oct).

it affects neither managerial incentives nor the design of the incentive contracts used in equilibrium.[19] Without regard to its political implications, we find that governmental intervention can increase welfare towards the first-best solution. This can be achieved by using a corrective tax system: subsidizing bonus payments while financing those expenses by way of an increased CIT.

1.2. Related Literature

Methodically, we rely on the literature of efficient contracting and the agency theory that studies the relationship between a firm owner and a manager who is incentivized to operate the company.[20] Competitive market forces foster optimal contracting and allow an analysis of the problem of imperfect information and moral hazard.[21] Specifically we build our analysis on the assumption of limited liability as first introduced by Sappington (1983), but rather analyze a situation in which the agent makes an ex-ante effort choice (Innes 1990, Park 1995 and Kim 1997, among others). In addition, we follow Laffont and Martimort (2001, p. 194) and assume two possible outcomes with a continuum of effort levels. In order to compare tax instruments, we expand their specification in this respect and adjust the structure of compensation payments to our purposes.

Apart from the literature on agency theory, this chapter is related to studies on the taxation of the financial sector and on the taxation of risky returns.[22] Regarding bonus taxation, this literature can be split in two basic lines of theoretical research: with and without externalities.[23] With the externality of bailouts, a bonus tax affects the trade-

[19] Among others, Buchholz and Konrad (2000) support this neutrality result for a non-redistributive tax on profits in the presence of moral hazard.

[20] Another view on executive compensation is given by Bebchuk et al. (2002), Bebchuk and Fried (2003) and Bebchuk and Fried (2004) who believe in compensation agreements as an outcome of powerful, rent-seeking managers. For the taxation of rent-seeking activities, see Glazer and Konrad (1999) and Rothschild and Scheuer (2011), among others. Frydman and Jenter (2010) and Murphy (2013) provide an overview on the contributions in both lines of literature and analyze strengths and weaknesses of both.

[21] Early contributions in this area were made by Ross (1973), Jensen and Meckling (1976), Harris and Raviv (1979), Holmstrom (1979), Shavell (1979), and Grossman and Hart (1983) among others.

[22] See, for instance, Shackelford et al. (2010), Keen (2011a) and Devereux (2011) for a broader analysis of other discussed new tax measures on the financial sector (e.g. the Financial Transactions Tax or the Financial Activities Tax), and Konrad (1991) and Buchholz and Konrad (2014) for the effects of taxation on risk-taking activities.

[23] For the empirical impacts of various tax rates (personal, corporate and capital gains tax rates) on executive compensation, Hall and Liebman (2000) find little evidence for tax policy influencing remuneration. However, for personal income taxes, Katuscák (2009) estimates that higher tax rates

off between efficiency and rent extraction, but is optimal when there is moral hazard with respect to both effort and risk taking (Besley and Ghatak, 2013). According to Keen (2011b), corrective taxation in the presence of bailouts requires a charge on the bank's borrowing which can be supported by minimum capital requirements. Thanassoulis (2012) emphasizes the negative externality of competition. He finds that competing for the best teams of bankers drives up market wages and so rival banks' expected costs of bankruptcy. Nevertheless, he does not observe any effect of bonus taxation other than redistributing money to the government.

For bonus taxation in the absence of systemic externalities, Radulescu (2012) examines the effects of a bonus tax in a two-country framework with endogenous or exogenous reservation wages. She finds that the introduction of a bonus tax in one country results in a decline in the agent's effort and that the incidence mainly falls on the firm's shareholders. In the case of endogenous reservation wage, results are largely similar and depend on the strength of the negative reaction of the reservation wage to the bonus tax. However, alike Dietl et al. (2013) and Grossmann et al. (2012), Radulescu (2012) focuses in her analysis solely on the effects of a bonus tax. Therefore, we extend existing research in analyzing different tax instruments in a unified framework. The work by Dietl et al. (2013) is closest to the present model. They analyze the effects of a bonus tax on the composition of executives' compensation and their incentives to exert effort in a principal-agent model with a risk-averse agent. As in this chapter, they identify that a bonus tax increases the costs of incentive payments which in turn results in decreased managerial effort. However, for the composition of managerial compensation, their effects depend on the uncertainty of the economic environment and the agent's risk aversion. Although abstaining from uncertainty and risk aversion, our model still identifies circumstances in which bonus payments are increasing and other situations in which they are decreasing. Grossmann et al. (2012) extend the model by Dietl et al. (2013) to an agent who can influence expected outcome next to effort also via his risk-taking behavior. In this constellation, they observe a substitution effect between effort and risk-taking where the agent increases risk-taking and simultaneously decreases effort as a response to a bonus tax.[24]

decrease the pay-to-performance sensitivity for option grants, while no such effect can be found with respect to restricted stock grants. For bonus taxes, Von Ehrlich and Radulescu (2012) show that bonus payments decreased by 40% in the course of the UK bank payroll tax. However, their findings also suggest an one-to-one increase in other pay components not subject to the tax.

[24] As compensation structure shifts towards a fixed salary, the bonus tax in Grossmann et al. (2012) decreases the agent's marginal revenue of risk taking. However, as the risk averse agent faces less income uncertainty, his marginal costs of risk decrease even more. This results in risk taking that increases in the bonus tax.

This chapter contributes to the literature as it - next to an analysis of the effects of a bonus tax - additionally examines the effects of different tax instruments such as a CIT and limited deductibility of bonus payments from the CIT in a simple model. Therefore, we provide a unified framework that makes the mentioned tax instruments and their effects on effort choice and welfare comparable.

The chapter is structured as follows. In Section 1.3, we introduce the model and derive the optimal compensation structure chosen by the principal. An analysis of the different tax instruments and their effects on the effort level and the bonus payments follows. Section 1.4 discusses the welfare effects of the different tax instruments. Section 1.5 concludes.

1.3. Incentive Contracts in a Principal-Agent-Setup

1.3.1. Model and Equilibrium

Principal-Agent Setup The model specification is as follows: There is one risk-neutral shareholder (principal) who delegates the task of operating the company to a risk-neutral manager (agent), who has limited liability and zero initial wealth.[25] This is done by offering a take-it-or-leave-it contract to the manager, who has an exogenous outside option $\underline{u} = 0$.[26] If the manager accepts the contract, he starts operating the firm by choosing an unobservable effort level from a continuum $e \in [0, 1]$. For the manager, the effort he exerts comes at an effort cost $C(e)$. In line with the literature, we make two assumptions on the effort cost function: First, it is considered as strictly convex ($C'(e) > 0$, $C''(e) > 0$, $C'''(e) > 0$) with $C(0) = 0$.[27] Second, to ensure interior solutions, the Inada conditions $C'(0) = 0$ and $\lim_{e \to 1} C'(e) = \infty$ are imposed on the cost function. Firm's profit is random and depends on the state of the world $s \in \{1, 2\}$. It can take two values: high

[25] We decided on a risk-neutral principal and a risk-neutral agent as we are interested in the effects of different tax instruments rather than in risk sharing issues.

[26] For simplicity, we assume the manager's outside option $\underline{u}$ being exogenous and equal to zero. While taxation may cause feedback effects on the outside option, those effects should be treated equal for different kinds of bonus taxation. For this reason feedback effects would cancel out in a comparison of taxation instruments. Our results are also generally applicable to $\underline{u} > 0$. However, to analyze the case with information asymmetry between principal and agent and to implement moral hazard we would have to assume $eC'(e) - C(e) \geq \underline{u}$, which is always satisfied if $\underline{u} = 0$. We discuss the implications of this assumption following up on Proposition 1.1. For the effects of endogenous outside option, it may be referred to Radulescu (2012).

[27] Note that $C'''(e) > 0$ ensures strict concavity of the principal's maximization problem. Though, in order to satisfy the second-order condition for a maximum, $C'''\left(e^{SB}\right) > -\frac{2C''\left(e^{SB}\right)}{e^{SB}}$ is sufficient.

(and equal to π_1) or low (and equal to π_2) with $\pi_1 > \pi_2 \geq 0$. Effort e determines the probability by which profit is high. By appropriate normalization, this probability is equal to e. Once the profit π_s is determined, the agent is paid. As compensation for the task of operating the company, the manager is offered a linear payment scheme consisting of two components. First, the agent is paid a fixed wage $A \in \mathbb{R}_0^+$ independently of the state of the world. Secondly, the principal can remit an additional bonus when the task was successful, i.e. if $\pi_s = \pi_1$.[28] This bonus is specified such that a bonus rate $b \geq 0$ is applied on the difference between the profit levels in the good and the bad state of the world. This gives, in total, a bonus $b(\pi_1 - \pi_2)$ to be added to the fixed wage A.

Government Before the take-it-or-leave-it contract is offered to the agent, the government can implement up to three different tax instruments. First, the principal's operating profits net of compensation payments can be taxed by a corporate income tax (CIT), $t \in [0, 1)$. Second, deductibility of bonus payments from the CIT base can be restricted, thereby broadening the CIT base and increasing taxes. Tax deductibility of bonus payments is captured by parameter $\alpha \in [0, 1]$, where $\alpha = 1$ covers full deductibility of the bonus payment from the CIT base. For $\alpha \neq 1$, fixed compensation A and bonus payments $b(\pi_1 - \pi_2)$ are treated differently when it comes to corporate income taxation. While the fixed wage always is fully deductible from the CIT base, bonus payments are not, e.g. if $\alpha = 0$, bonuses are not tax deductible at all from the CIT base. Thus, with bonus payments, the firm's tax base, and, accordingly, its tax burden, is higher the lower α is.[29] Third, bonuses can be subject to a bonus tax, $t_b \in [0, 1)$, which has to be paid by the agent.

Maximization The principal keeps the residual of the profit after compensation payments to the agent and CIT t with bonus deductibility α. Accordingly, the expected payoff $E(U_P)$ for the principal is

$$E(U_P) = e(1-t)(\pi_1 - A) - e(1-\alpha t)b(\pi_1 - \pi_2) + [1-e](1-t)(\pi_2 - A). \quad (1.1)$$

[28]Because the principal can observe profit but not the agent's effort, an enforceable contract can only be specified on realized profit π_S.

[29]Because of these two tax instruments, the principal's expected payoff $E(U_P)$ is defined as the difference between operating profit π_s and compensation payments, taking into account the applied tax rates and deductibility.

The agent's total net-compensation after bonus taxes t_b, x_1 in the good state of the world and x_2 in the bad state of the world, are denoted by:

$$\begin{aligned} x_1 = A + (1 - t_b)b(\pi_1 - \pi_2), \\ x_2 = A. \end{aligned} \tag{1.2}$$

When the principal offers a contract to the agent, the agent maximizes his expected net income $E(x) - C(e)$ by choosing effort e. Depending on the proposed fixed wage, bonus payments, his effort costs and taxes, the agent's maximization problem is given by

$$\max_{e \in [0,1]} \left\{ A + e(1 - t_b)b(\pi_1 - \pi_2) - C\left(e\right) \right\},$$

from which we get the following first order condition (FOC):

$$\left(1 - t_b\right) b \left(\pi_1 - \pi_2\right) = C'\left(e\right) \tag{1.3}$$

The agent's effort choice will be such that the marginal (net of tax) benefit of an increase in effort equals the marginal effort costs. Moreover, (1.3) shows the effects of bonus taxation on existing managerial incentives. While the introduction of a bonus tax ceteris paribus decreases the agent's net bonus and leads to reduced effort by the agent, limited deductiblity has no effects on existing managerial incentives as it has to be borne by the principal via the CIT.

Taking (1.3) as given, the principal in the first stage chooses compensation consisting of fixed wage A and bonus parameter b which maximizes his expected payoff $E\left(U_P\right)$:

$$\max_{(A,b) \geq 0} \quad \left\{ e\left(1 - t\right)\left(\pi_1 - A\right) - e\left(1 - \alpha t\right) b(\pi_1 - \pi_2) + [1 - e](1 - t)(\pi_2 - A) \right\} \tag{1.4}$$

$$s.t. \qquad A + e^{SB}(1 - t_b)b^{SB}(\pi_1 - \pi_2) - C\left(e^{SB}\right) \geq \underline{u} \tag{1.5}$$

$$\left(1 - t_b\right) b^{SB} \left(\pi_1 - \pi_2\right) = C'\left(e^{SB}\right) \tag{1.6}$$

$$x_1,\, x_2 \geq 0 \tag{1.7}$$

Equation (1.5) shows the agent's participation constraint (PC), which the principal has to consider. It states that the agent will only accept the principal's take-it-or-leave-it offer if his expected net-compensation (after income-/ bonus tax) at least remunerates him for the effort level e^{SB} that the principal chooses to induce and his exogenous outside option $\underline{u}$ which he forgoes. Moreover, with (1.6) the principal accounts for the agent's first order condition (1.3) that ensures that the agent has a higher expected income when choosing the principal's desired effort level than he would have with any other effort level. In addition, we impose the limited liability constraint (1.7) on the agent's net compensation, by which the compensation in any state of the world cannot be negative due to the wealth restrictions the agent is faced with.[30] As the bonus payment is positive by definition, the fixed wage has to be non-negative.[31] This makes (1.7) binding for x_2, while it remains slack for x_1.

Proposition 1.1. *There exists a unique equilibrium (A^{SB}, b^{SB}, e^{SB}) where the principal offers a fixed compensation $A^{SB} = 0$ and a bonus rate b^{SB} that satisfies*

$$b^{SB} = \frac{1-t}{1-\alpha t} - \frac{e^{SB} C''\left(e^{SB}\right)}{\left(1-t_b\right)\left(\pi_1 - \pi_2\right)}. \tag{1.8}$$

The agent's effort choice e^{SB} is implicitly given by his first order condition (1.3).

Proof. A binding limited wealth constraint (1.7) with respect to x_2 directly implies $A^{SB} = 0$. As $eC'(e) - C(e) \geq 0$, the incentive constraint must be binding such that agent's effort is implicitly defined by (1.3). Using this fact, (1.8) states the solution to the principal's maximization with respect to the optimal bonus b^{SB}. By substituting (1.3) in (1.8) and taking the derivative with respect to e^{SB}, one can show that the second-order condition for a maximum is satisfied whenever $C'''\left(e^{SB}\right) > -\frac{2C''\left(e^{SB}\right)}{e^{SB}}$. By assumptions $C''(e) > 0$ and $C'''(e) > 0$, this is always the case.

□

The fact that the fixed wage $A^{SB} = 0$ comes from the assumption on the agent's exogenous outside option.[32] In order to incentivize the agent to exert the desired effort level e^{SB}, the principal has to pay a bonus b^{SB}. By assuming $\underline{u} = 0$, this bonus is in expectation

[30] Constraint (1.7) ensures that the principal can not apply the general solution of making the agent the residual claimant of the firm to overcome the moral hazard problem when both the agent and the principal are risk neutral (Harris and Raviv 1979, Shavell 1979).

[31] This prevents the principal from extracting rents from the agent by paying a negative fixed wage.

[32] The outcome of $A^{SB} = 0$ relies on the agent's limited liability and the assumptions on the exogenous outside option $\underline{u} = 0$. While limited liability ensures $A \geq 0$, the latter constraint makes the Limited Liability Constraint (1.7) for the bad state of the world binding, i.e. $x_2 = A^{SB} = 0$. As shown by Pitchford (1998), lump sum transfers like A have no incentive effects as opposed to an increase in the gap between state-contingent payments.

already higher than would be necessary in order to satisfy the participation constraint (1.5). Thus, the principal would like to pay a negative fixed wage, as this would lead to a binding PC and a higher rent for him. However, the limited liability constraint (1.7) prevents the principal from paying negative compensation. Combined with the agent's informational advantage, this results in an expected rent $E(U_A)$ for the agent:

$$E(U_A) = [E(x) - C(e)] = eC'(e) - C(e) > 0 \tag{1.9}$$

By substitution, the principal's optimal bonus payment (1.8) and the agent's first order condition with respect to effort (1.3) yield

$$(1-t)(\pi_1 - \pi_2) = \frac{1-\alpha t}{(1-t_b)} \left[C'\left(e^{SB}\right) + e^{SB} C''\left(e^{SB}\right) \right], \tag{1.10}$$

which defines the second-best effort level e^{SB} that is induced by the principal.[33] This second-best effort level under moral hazard is lower than in the first-best case, where effort e^{FB} is observable and contractible. In the first-best scenario, characterized by $(1-t)(\pi_1 - \pi_2) = \frac{1-\alpha t}{(1-t_b)} C'\left(e^{FB}\right)$, the marginal expected profit gain (on the left hand side of the equation) from increasing the effort level by a small amount equals the marginal expected employment costs. In the second-best scenario, there is an additional term $\frac{1-\alpha t}{(1-t_b)} e^{SB} C''\left(e^{SB}\right)$.[34] This additional expression states the tax adjusted marginal costs of the agent's limited liability rent under moral hazard and induces the principal to reduce the implemented effort level to one below the first-best level. This in turn reduces his expected employment costs.[35]

[33] Equation (1.10) allows us to prove existence and uniqueness of the equilibrium denoted in Proposition 1.1. By the imposed Inada condition on the cost function, the right hand side is zero for $e = 0$, whereas the left hand side is positive by assumption. As the right hand side is monotonically increasing in e (by $C'''\left(e^{SB}\right) > -\frac{2C''\left(e^{SB}\right)}{e^{SB}}$) and with the Inada condition $\lim_{e\to 1} C'(e) = \infty$, there is exactly one intersection for the unique equilibrium $e = e^{SB}$.

[34] For comparison, the equation for first-best effort shows a situation where only a bonus is paid to the agent. However, as the principal in the first-best case can observe agent's effort, a fixed wage $A^{FB} = C(e^{FB}) + \underline{u}$ and a bonus $b^{FB} = 0$ or a combination making the participation constraint binding is also possible. This payment will be made whenever the agent exerts the desired effort e^{FB} - no matter whether the task was successful or not.

[35] As we are interested in the differential taxation of compensation components, we abstract from a taxation of the fixed wage. Including a personal income tax, $t_i \in [0, 1)$, based on all of the agent's income components would mean that bonuses would be burdened twice with taxes if both $t_i > 0$ and $t_b > 0$. Note that for the equilibrium fixed wage $A^{SB} = 0$, a personal income tax and a bonus tax would have the same tax base and therefore would be substitutes.

1.3.2. Comparative Statics

Proposition 1.1 shows that the equilibrium bonus rate paid to the agent (and so equilibrium effort) depends on the different taxation instruments included in the model. In the following, we analyze their effects on equilibrium effort and the respective bonus payment required.

Starting with a bonus tax, we can see from the optimality conditions (1.8) and (1.3) that both the optimal bonus and the optimal effort depend on t_b, whereas the fixed wage is not affected by a bonus tax. Moreover, it can be shown that the agent's effort choice negatively reacts to a bonus tax and that the bonus rate b does not necessarily decrease in the bonus tax t_b.

Corollary 1.1. *(i) Equilibrium effort e^{SB} is strictly decreasing in the bonus tax t_b.*

(ii) The equilibrium bonus rate b^{SB} is strictly increasing in the bonus tax t_b if and only if

$$\frac{b^{SB}}{1-t_b} > \frac{(1-t)}{(1-\alpha t)(1-t_b)} \frac{C''\left(e^{SB}\right)}{[2C''(e^{SB}) + e^{SB}C'''(e^{SB})]}. \tag{1.11}$$

Proof. Part (i): The implicit function theorem on (1.10) yields $\frac{\partial e^{SB}}{\partial t_b} = -\frac{\frac{1-t}{1-\alpha t}(\pi_1-\pi_2)}{[2C''(e^{SB})+e^{SB}C'''(e^{SB})]} < 0$.

Part (ii): Taking $\frac{\partial b^{SB}\left(e^{SB}\right)}{\partial t_b}$ from (1.3), using part (i) of this proof and substituting (1.3) into the derivative yields $\frac{\partial b^{SB}\left(e^{SB}\right)}{\partial t_b} = \frac{b^{SB}}{1-t_b} - \frac{(1-t)}{(1-\alpha t)(1-t_b)} \frac{C''\left(e^{SB}\right)}{[2C''(e^{SB})+e^{SB}C'''(e^{SB})]}$.

□

Ad (i): According to the agent's FOC (1.3), a (higher) bonus tax reduces the agent's marginal net of tax benefit while leaving marginal costs unchanged. This leads to reduced equilibrium effort as long as the agent does not get perfectly compensated by an increased bonus rate for the additional tax burden. This again is not profitable for the principal. While the principal's marginal expected profit gain from effort remains unchanged, the marginal expected employment costs of effort increase with the bonus tax. Therefore, equilibrium effort strictly decreases in the bonus tax.

Part (ii) of Corollary 1.1 shows that the total effect of a bonus tax on the bonus rate is ambiguous with two effects driving the bonus rate: an indirect effort effect and a direct tax effect. As equilibrium effort decreases in the bonus tax, the agent also accepts a lower net-of-tax bonus as his marginal cost of exerting effort decreases. However, as the agent is only interested in his net-wage, the principal has to compensate him for the additional tax burden. This effect, ceteris paribus, increases the (gross) bonus rate which the principal has to pay to the agent. For any effort level e^{SB} for which condition (1.11) is satisfied, the latter positive tax effect exceeds the negative effort effect.

For the CIT and limited tax deductibility of bonus payments, the described tax-effect of a bonus tax does not exist. Limited deductibility of bonuses from the CIT-base broadens the tax base for the CIT and indirectly increases the principal's tax burden. The agent, in contrast, is not subject to this tax. As the agent's net and gross bonus rates do not differ for these instruments, effects on effort and bonus will always go in the same direction in equilibrium. Still, there is an effect on effort and the bonus payment via the principal's optimization.

Corollary 1.2. *(i) If bonuses are fully deductible ($\alpha = 1$), e^{SB} and b^{SB} are not affected by the CIT t.*

(ii) If there is limited deductibility of bonuses from the CIT ($\alpha < 1$), then e^{SB} and b^{SB} are strictly decreasing in t. The less deductible bonus payments are, the stronger is the marginal effect of the CIT t on e^{SB} and b^{SB}.

(iii) If there is a CIT ($t < 1$), then e^{SB} and b^{SB} are strictly increasing in the deductibility α. The higher the CIT is, the larger is the marginal effect of deductibility α on e^{SB} and b^{SB}.

Proof. Applying the implicit function theorem on (1.10) and substituting (1.10) into the resulting derivative yield $\frac{\partial e^{SB}}{\partial t} = -\frac{(1-\alpha)\delta}{(1-\alpha t)(1-t)}$ and $\frac{\partial e^{SB}}{\partial \alpha} = \frac{t\delta}{(1-t)}$, with $\delta = \frac{\left[C'(e^{SB})+e^{SB}C''(e^{SB})\right]}{[2C''(e^{SB})+e^{SB}C'''(e^{SB})]} > 0$. $\frac{\partial e^{SB}}{\partial t}|_{\alpha=1} = 0$, $\frac{\partial e^{SB}}{\partial t}|_{\alpha<1} < 0$ and $\frac{\partial e^{SB}}{\partial a}|_{t<1} > 0$ follow immediately. Taking $\frac{\partial b^{SB}\left(e^{SB}\right)}{\partial t}$ and $\frac{\partial b^{SB}\left(e^{SB}\right)}{\partial \alpha}$ from (1.3) yield $\frac{\partial b^{SB}\left(e^{SB}\right)}{\partial t} = \frac{C''\left(e^{SB}\right)}{(1-t_b)(\pi_1-\pi_2)}\frac{\partial e^{SB}}{\partial t}$ and $\frac{\partial b^{SB}\left(e^{SB}\right)}{\partial \alpha} = \frac{C''\left(e^{SB}\right)}{(1-t_b)(\pi_1-\pi_2)}\frac{\partial e^{SB}}{\partial \alpha}$. Thus, $sign\left(\frac{\partial b^{SB}\left(e^{SB}\right)}{\partial t}\right) = sign\left(\frac{\partial e^{SB}}{\partial t}\right)$ and $sign\left(\frac{\partial b^{SB}\left(e^{SB}\right)}{\partial \alpha}\right) = sign\left(\frac{\partial e^{SB}}{\partial \alpha}\right)$. For the strength of marginal effects, $\frac{\partial\left|\frac{\partial e^{SB}}{\partial t}\right|}{\partial \alpha} = -\frac{\delta}{(1-\alpha t)^2} < 0$ and $\frac{\partial \frac{\partial e^{SB}}{\partial \alpha}}{\partial t} = \frac{\delta}{(1-t)^2} > 0$.

□

Part (i) of the Corollary follows from (1.10). With full deductibility of bonus payments from the CIT, a (higher) CIT changes the marginal expected profit gain of effort to the same extent as do the marginal expected employment costs. Therefore there is no change of the bonus rate and, as a result, no adjustment in the desired effort level.[36] Parts (ii) and (iii) of Corollary 1.2 show the distortion due to the limited deductibility of bonus payments from the CIT-base. According to (1.10), there is still no change in the principal's marginal expected profit gain due to the combination of CIT and limited deductibility compared to a situation with full deductibility of bonuses. However, limited deductibility increases the marginal expected employment costs via broadening the CIT-base in case the agent was successful. Therefore, equilibrium effort decreases and a lower bonus is paid in equilibrium. This effect is more pronounced either for the CIT the less deductible bonus payments are, or for limited deductibility the higher the CIT already is.

1.4. Welfare Comparison of the Tax Instruments

Having seen how the different taxation instruments distort equilibrium effort and bonuses, we now want to assess whether or not one instrument is superior to the others with regard to welfare implications. For this purpose, we define welfare as the sum of agent's expected payoff $E(U_A)$, principal's expected payoff $E(U_P)$ and expected tax revenue $E(T)$, resulting in expected welfare $E(W) = e\pi_1 + (1-e)\pi_2 - C(e)$. By assumption, the government sets its tax rates before the contract between principal and agent is specified and therefore takes the equilibrium results from Proposition 1.1 as given. Furthermore, we suppose that the government has to raise an exogenous tax revenue to fulfill its public duties. We denote this revenue requirement by B.[37]

The total expected tax revenue consists of two parts: The expected bonus tax paid by the agent, $E(T_b) = eb(\pi_1 - \pi_2)t_b$, and the expected corporate income tax paid by the principal, $E(T_{cit}) = et(\pi_1 - A - \alpha b(\pi_1 - \pi_2)) + (1-e)t(\pi_2 - A)$. Inserting the results from Proposition 1.1, we get the following expression for total expected tax revenue $E(T)$:

[36] For the sake of completeness, we would like to add that without CIT ($t = 0$), limited deductibility does not have any effects as a broadening of the (non-existing) tax base cannot have an impact.

[37] Note that there exists a bound on the maximal achievable revenue requirement B^{max} that satisfies $E(U_A) \geq 0$ and $E(U_P) \geq 0$. Otherwise, no principal-agent contract would be signed. While the condition $E(U_A) \geq 0$ holds by (1.9) for any tax rate, we need $B \leq B^{max} \equiv \pi_2 + e^{SB}\left[\pi_1 - \pi_2 - C'\left(e^{SB}\right)\right]$ in order that the principal weakly prefers offering a contract compared to not offering a contract. In the presence of tax rates that lead to distortions (as in Subsections 1.4.2 and 1.4.3), the maximal achievable tax revenue B is lower than B^{max}. To guarantee the presence of the principal-agent problem, we assume B to be as small that the principal can finance the tax duties.

$$E(T) = t[\pi_2 + e(\pi_1 - \pi_2)] + e\frac{C'(e)(t_b - \alpha t)}{(1 - t_b)}. \tag{1.12}$$

As all parties involved in our model (principal, agent and government) are risk neutral, all payments (wage, tax) have only distributional impacts and do not affect welfare. Altogether, our welfare optimization problem can be written as

$$\max_{t,t_b,\alpha} \left\{ e^{SB}\pi_1 + \left(1 - e^{SB}\right)\pi_2 - C\left(e^{SB}\right) \right\} \tag{1.13}$$

$$s.t. \qquad E(T(t, t_b, \alpha)) \geq B \tag{1.14}$$

where the agent's effort choice e^{SB} is implicitly given by (1.10). Government chooses its tax instruments in such a way that overall efficiency is highest while still being able to raise in expectation the desired tax revenue B from (1.12).

Note that without the tax revenue constraint (1.14) and being able to directly choose the effort level, the welfare maximizing government would opt for the following result:

$$\pi_1 - \pi_2 = C'(e^*). \tag{1.15}$$

Confronted with (1.14) and knowing that the second-best case, due to the agent's limited liability rent, is already characterized by an inefficiently low effort $e^{SB} < e^*$, the government will choose a tax structure which least distorts the agent's effort choice beyond that.

1.4.1. Optimal Mixture of Tax Instruments

Let us first consider a situation in which the government can choose between the tax instruments in a "normal" range - meaning $t, t_b \in [0, 1)$ and $\alpha \in [0, 1]$.[38] In this setting, the government will always choose to raise its necessary tax revenue solely with the neutral CIT whereas the bonus tax and limited deductibility would reduce effort and, consequently, welfare. According to Corollary 1.2, the CIT does not distort equilibrium

[38]This assumption on the ranges of α and t_b will be abolished in Subsection 1.4.3.

effort beyond the limited liability rent when there is full deductibility. Equation (1.10) reduces to $(\pi_1 - \pi_2) = \left[C'\left(e_{t^*}^{SB}\right) + e_{t^*}^{SB} C''\left(e_{t^*}^{SB}\right)\right]$ and implies the highest possible effort level in this case, where $e_{t^*}^{SB}$ denotes the incentivized effort given the optimal tax structure with t^*. This structure is given by $t^* = \left[\frac{B}{\pi_2 + e_{t^*}^{SB}\left[\pi_1 - \pi_2 - C'\left(e_{t^*}^{SB}\right)\right]}, 1\right)$, $\alpha^* = 1$ and $t_b^* = 0$.[39] Moreover, it implies that bonus taxation should not be used for revenue purpose because both a bonus tax and limited deductibility of bonuses from the CIT are inferior to a CIT.[40]

1.4.2. Comparison of Bonus Tax and Limited Deductibility of Bonuses

In order to compare the different bonus taxation regimes, suppose there are restrictions, e.g. an exposure to tax competition, which limit the CIT to $\bar{t} < t^*$ and therewith prohibit the government from raising it to the optimal level analyzed above. In this case, there is some tax revenue which has to be raised from one of the remaining instruments. We maximize welfare with an exogenously given bound for the CIT $\bar{t} < t^*$ by choosing t_b and α.

From corollaries 1.1 and 1.2, we know that both a bonus tax and limited deductibility strictly decrease equilibrium effort e^{SB} and welfare. Due to this distortion, a welfare maximizing government will not raise tax revenue beyond its requirement B. This allows us to use (1.14) in order to express each α and t_b as a function of the other. Inserting either $\alpha(t_b, t)$ or $t_b(\alpha, t)$ in (1.10) to derive equilibrium effort shows that any combination of the two instruments which satisfies the tax revenue requirement (1.14) is welfare equivalent. Moreover, welfare is maximized by applying the maximum possible CIT $\bar{t}$, yielding effort $e_{\bar{t}}^{SB}$. It does not matter whether the government limits deductibility to $\alpha^{SB} = \frac{\bar{t}\pi_2 + e_{\bar{t}}^{SB}\bar{t}(\pi_1 - \pi_2) - B}{e_{\bar{t}}^{SB}\bar{t}C'\left(e_{\bar{t}}^{SB}\right)} < \alpha^*$ while abstaining from a bonus tax, or whether it chooses a bonus rate $t_b^{SB} = \frac{\bar{t}+\mu}{1+\mu} > t_b^*$ with $\mu = \frac{B - \bar{t}\pi_2 - e_{\bar{t}}^{SB}\bar{t}(\pi_1 - \pi_2)}{e_{\bar{t}}^{SB}C'\left(e_{\bar{t}}^{SB}\right)}$ while making bonus payments fully deductible from the CIT. Any $\alpha(t_b) = \frac{t_b}{\bar{t}} - \frac{1-t_b}{e_{\bar{t}}^{SB}C'\left(e_{\bar{t}}^{SB}\right)\bar{t}}B + \frac{1-t_b}{e_{\bar{t}}^{SB}C'\left(e_{\bar{t}}^{SB}\right)}\left[\pi_2 + e\left(\pi_1 - \pi_2\right)\right]$ is welfare equivalent and induces the principal to incentivize effort $e_{\bar{t}}^{SB} < e_{t^*}^{SB}$. Compared

[39] It follows that $t^* < 1$ whenever $B < B^{max}$ with B^{max} as defined in footnote 37.

[40] As we prescind from distributional aspects in our welfare analysis, there is a range of equilibrium taxes t^*. Any CIT that is large enough to finance the revenue requirement B but is still less than 1 is welfare equivalent to another CIT that fulfills the same requirements. It is only important that the agent works for the principal and that he exerts optimal second-best effort. The profit of the principal is irrelevant.

to the optimal structure of tax instruments (t^*, α^*, t_b^*), taxation of bonuses reduces welfare as equilibrium effort will be inefficiently low. Moreover, they are substitutes as they distort effort and welfare to the same extent.

1.4.3. Increasing Welfare by Subsidizing Bonus Payments

Note that welfare maximizing effort is indirectly defined by (1.15), which in our model cannot be reached as information asymmetry and limited liability lead to moral hazard. The principal is faced with a trade-off between efficiency and distribution of rents. Because of the additional marginal costs of the agent's limited liability rent $\frac{1-\alpha t}{(1-t_b)} e^{SB} C'' \left(e^{SB}\right)$, the principal can reduce his expected employment costs by inducing lower effort. This distortion in inducing effort increases the principal's expected rent $E\left(U_P\right)$ at the expense of the agent's rent $E\left(U_A\right)$. Because of reduced efficiency, this goes along with a welfare loss. Unlike the principal, the government does not pay attention to the distribution of rents but is only interested in welfare maximization.

With moral hazard and limited liability, a welfare increase can be achieved if the government is allowed to choose corrective tax instruments, i.e. a negative bonus tax or a very high deductibility of bonus payments ($\alpha > 1$), while financing these subsidies by a higher CIT.[41] By subsidizing costs related to incentivizing the agent, the government can reduce the principal's expected employment costs. This in turn leads the principal to induce a higher effort level where the effort level with subsidy e_{sub}^{SB} is shifted towards the welfare maximizing effort e^*. According to (1.10) for second-best effort, this is the case for small deviations from the equilibrium as long as the tax component $\frac{1-\alpha t}{(1-t)(1-t_b)}$, on the right hand side, is smaller than 1. Deviating from any tax system with $\alpha \leq 1$ and $t_b \geq 0$, the government can increase welfare by choosing $t^{sub} > t^*$ and financing with the higher expected revenues either $\alpha^{sub} > \alpha^* = 1$ or $t_b^{sub} < t_b^* = 0$. This leads to higher net bonus payments for the agent.

Proposition 1.2 summarizes the results gained above:

Proposition 1.2. *Given a tax revenue requirement B, the following tax structures maximize welfare:*

[41] This result has been shown in a setting of optimal tax interventions with incomplete insurance markets by Banerjee and Besley (1990). There, a risk neutral government can use a profit tax to subsidize and thus reduce the capital market interest rate for the risk-averse agent. By this intervention in the credit market, welfare can be increased.

(i) For $t, t_b \in [0,1)$ *and* $\alpha \in [0,1]$*, the optimal tax structure is given by* $t^* = \frac{B}{\pi_2 + e^{SB}[\pi_1 - \pi_2 - C'(e^{SB})]}$*, full deductibility* ($\alpha^* = 1$) *and no bonus tax* ($t_b^* = 0$).

(ii) If $\bar{t} < t^*$*, any combination of a bonus tax* $t_b \geq 0$ *and deductibility of degree* $\alpha\left(t_b, \bar{t}\right) = \frac{t_b}{\bar{t}} - \frac{1-t_b}{e_{\bar{t}}^{SB} C'\left(e_{\bar{t}}^{SB}\right)\bar{t}} B + \frac{1-t_b}{e_{\bar{t}}^{SB} C'\left(e_{\bar{t}}^{SB}\right)} \left[\pi_2 + e_{\bar{t}}^{SB}\left(\pi_1 - \pi_2\right)\right] \leq 1$ *is welfare maximizing.*

(iii) Allowing for $t_b < 0$ *and/or* $\alpha > 1$ *is welfare increasing compared to* $t_b \geq 0$ *and* $\alpha \leq 1$.

Proof. See Appendix A.

□

The different tax combinations analyzed in the subsections above also influence the distribution of rents between principal and agent differently. According to (1.9), the agent gains an expected rent $E\left(U_A\right) = e^{SB} C'\left(e^{SB}\right) - C\left(e^{SB}\right)$. As the marginal expected rent $e^{SB} C''\left(e^{SB}\right)$ is always positive by assumption, the agent's rent increases when a higher effort level is incentivized and decreases with a less incentivized effort level. As $e_{\bar{t}}^{SB} < e_{t^*}^{SB} < e_{sub}^{SB}$ in the cases analyzed above, the agent's rent is highest when a bonus subsidy is paid and lowest when the CIT cannot be chosen, but is exogenously given.

The principal's rent can be expressed by simplifying his maximization problem (1.4) to

$$E\left(U_P\right) = e^{SB}\pi_1 + \left(1 - e^{SB}\right)\pi_2 - e^{SB} C'\left(e^{SB}\right) - E\left(T\right) \tag{1.16}$$

which, by assumption, is strictly concave in e^{SB} and has a global maximum (in the presence of moral hazard) at the effort satisfying $\left(\pi_1 - \pi_2\right) = \left[C'\left(e^{SB}\right) + e^{SB} C''\left(e^{SB}\right)\right]$. According to the findings above, the principal's expected rent is maximized for effort $e_{t^*}^{SB}$ and a tax system $t^* = \frac{B}{\pi_2 + e_{t^*}^{SB}\left[\pi_1 - \pi_2 - C'\left(e_{t^*}^{SB}\right)\right]}$, α^* and t_b^*. Whenever either the bonus tax or the limited deductibility deviate from their optimal level t_b^* and α^*, the principal's expected net profit $E\left(U_P\right)$ decreases. This is the case for both an exogenous CIT $\bar{t}$ and a bonus subsidy ($t_b < 0$ or $\alpha > 1$).

1.5. Conclusion

In this chapter, we used a principal-agent model to study the effects of different tax treatments of managerial compensation. More precisely a corporate income tax, a special tax on bonuses and limited deductibility of bonuses from the corporate income tax were subject to our analysis. We identified how these tax instruments affect existing managerial incentives, how they change the design of incentive contracts used in equilibrium and, keeping total tax revenue constant, what their welfare effects are.

Introducing an additional bonus tax decreases the agent's net bonus and brings him to reduce effort. The firm anticipates this reaction in equilibrium and incentivizes a lower effort level by adjusting the gross bonus paid to the agent. Weighing up the principal's (reduced) desired effort and (higher) bonus tax costs, this gross bonus payment can be higher or lower than it would be without a bonus tax. If the net bonus necessary to induce the desired effort is sufficiently high, a bonus tax further increases bonus payments to the agent.

Limited deductibility of bonuses from the corporate income tax base has no direct effect on the gross- and/or net bonus payment and, thus, on the agent's incentives. Because limiting the tax deductibility of bonuses makes bonus payments more costly to the principal, in equilibrium he offers a lower bonus rate. This leads to lower effort exerted by the agent in equilibrium.

This negative effect on effort cannot be found under a corporate income tax with full deductibility of bonuses thereof. In our setup, this tax has neither an effect on managerial incentives nor on the design of the incentive contracts used in equilibrium.

In terms of welfare, this makes the corporate income tax superior compared to the other tax instruments as it does not distort the equilibrium effort induced by the principal beyond the adjustment due to moral hazard. Bonus taxation as well as limited deductibility of bonuses from the corporate income tax are close substitutes in their distortionary effects when it comes to the decision of how much effort to incentivize. In spite of different mechanisms, both reduce effort to an inefficiently low level and therewith lead to lower welfare compared to the situation in which only the CIT is used for tax revenue.

In contrast to reforms of tax treatments of managerial compensation conducted by politicians, the model suggests a corrective tax system which, despite moral hazard, increases welfare towards the first-best solution. By subsidizing bonus payments to the agent either via a negative bonus tax or via a deductibility of bonuses higher than 100 percent and a simultaneous increase in the corporate income tax financing the subsidy, the government can reduce the principal's marginal expected employment costs and thereby increase equilibrium effort and welfare.

Finally, one can state that both a bonus tax and a limitation of deductibility can be used if the government has distributional objectives towards firm owners and managers. Limited deductibility or a bonus tax should only be used if the objective is to reduce both the managers' and firm owners' rents. This is additional to the disadvantage of inefficiently low welfare. If welfare is to be maximized, a subsidy on managerial compensation should be paid to the companies. This results in a higher rent for managers and a lower rent for firm owners.

Chapter 2.

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

2.1. 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 chapter 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 chapter 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.[42]

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 to coordinate, but cannot credibly commit to a no bailout-clause.[43] These incentives for banks to coordinate are a core aspect of this chapter 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 GBP 25.000 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.[44]

The analysis in this chapter 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

[42] See "For Global Finance, Global Regulation" (Gordon Brown and Nicolas Sarkozy, The 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."

[43] 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.

[44] 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).

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.

2.2. Related Literature

This chapter 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.[45] 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 chapter at hand abstracts from costs to acquire superior information, but assumes the agent to already have this expertise.[46] Thus, the chapter is most closely related to Lambert (1986), as the agent does not subsequently receive a noisy signal on

[45] 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.

[46] 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).

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.[47] 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.

A second strand of literature this chapter belongs to is the literature on systemic risk due to a too-many-to-fail problem. Brown and Dinc (2011) 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.[48] 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

[47] 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.

[48] A 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 Shackelford et al. (2010), Keen (2011a) and Devereux (2011). Brunnermeier et al. (2009) state principles of financial regulation.

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 opposed 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.[49] 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, 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.[50]

This chapter 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-fail[51], we are the first

[49] See 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.

[50] Keen (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.

[51] Hakenes 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.

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 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 2.4 illustrates how a bonus tax leads to reduced risk taking, both when imposed on one manager or on both managers. Section 1.5 concludes.

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

2.3.1. 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 $\underline{u} = 0$ and zero initial wealth.[52] 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.

[52]It suffices to assure that $\underline{u} \geq 0$. We will later explain the implications of our simplifying assumptions.

We assume that risks in projects R_1 and R_2 are perfectly correlated.[53] 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.[54] 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 $Pr\left(r_H \mid R_k\right) = p_i$, $Pr\left(s \mid R_k\right) = q$ and $Pr\left(-r_L \mid R_k\right) = (1 - p_i - q)$. 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 $Pr\left(p_h\right) = \gamma$, $Pr\left(p_l\right) = (1 - \gamma)$ and $\gamma \in (0, 1)$. While the distribution of p_i, possible returns $\{r_H, 0, -r_L\}$, costs C, and probability γ are common knowledge, the realization of p_i is private information of the manager when it comes to signing the contract.[55]

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

[53] One could think of these projects as an investment in subprime mortgages.

[54] 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 $C > C_S$.

[55] 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.

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 chapter.

Assumption 2.1. *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 $Y_k = 0$.[56] 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.[57]

2.3.2. 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

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

[57] 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 chapter 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).

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.[58] 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 2.1. *An investment decision is efficient if and only if* $p_i \geq \frac{C+(1-q)r_L}{r_H+r_L} \equiv \hat{p}^{opt}$.

2.3.3. 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 $p_i b r_h$ 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:

$$\hat{p} = \frac{C}{b r_H}. \tag{2.1}$$

Optimization Problem Principal Taking the manager's optimality condition (2.1) 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 (γ and $(1-\gamma)$), his maximization problem is:

[58] 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.

$$\max_{b} \quad (1-\gamma)\left[p_l\left(1-b\right)r_H + \left(1-p_l-q\right)\left(-r_L\right)\right] + \\ +\gamma\left[p_h\left(1-b\right)r_H + \left(1-p_h-q\right)\left(-r_L\right)\right] \tag{2.2}$$

$$s.t. \qquad p_i b r_H \geq C \tag{2.3}$$

Equation (2.3) 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.[59]

For the Principal, it is clearly optimal to choose a bonus payment which makes the agent's optimality condition (2.1) 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 $b^* \in \left\{\frac{C}{p_h r_H},\, \frac{C}{p_l r_H}\right\}$. 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 $b > \frac{C}{p_h r_H}$, he pays a higher bonus than needed to incentivize the 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 $E\left(\pi^l\right)$ and $E\left(\pi^h\right)$ 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 (2.2), we get:

[59] Note: 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.

$$E\left(\pi^{l}\right) = (1-\gamma)\left[p_l r_H - C - (1-p_l-q)\, r_L\right] + \\ +\gamma\left[p_h r_H - \frac{p_h}{p_l} C - (1-p_h-q)\, r_L\right] \quad (2.4)$$

$$E\left(\pi^{h}\right) = 0 + \gamma\left[p_h r_H - C - (1-p_h-q)\, r_L\right] \quad (2.5)$$

Equation (2.4) denotes the principal's expected payoff $E\left(\pi^{l}\right)$ if he incentivizes the manager to accept the contract for all $p_i \geq \hat{p} = p_l$. 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 (denoted by (2.5)), 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 2.2. *Suppose that Assumption 2.1 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*

$$p_h \geq \frac{C + (1-q)\, r_L}{r_H + r_L} \equiv \hat{p}^*. \quad (2.6)$$

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 (2.4) and (2.5). Due to Assumption 2.1, $E\left(\pi^{l}\right) < E\left(\pi^{h}\right)$. $E\left(\pi^{h}\right) \geq 0$ if and only if $p_h \geq \frac{C+(1-q)r_L}{r_H+r_L}$.

□

Due to Assumption 2.1, 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 $p_i = p_h$. 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 only then the principal earns an expected payoff $E\left(\pi^h\right) \geq 0$.[60]

For this result and the following analysis, the simplification $s = \underline{u} = 0$ 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 $\underline{u}$) and a constant effect on the tradeoff between implementing the risky project R rather than the safe asset S (depending on the difference $(s - \underline{u})$). Suppose $\underline{u} > s > 0$. Then, the principal could pay a maximum fixed wage $Y = s$, but would still need a bonus to incentivize the agent correctly. Due to $\underline{u} > s$, S is never profitable for the principal while R is only if p_h is large enough. If, on the other hand, $s > \underline{u} > 0$, 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 $Y > \underline{u}$.[61] This either results in suboptimal rent payments to the agent or in the agent always choosing S rather than R.[62]

2.3.4. 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

[60]In the absence of Assumption 2.1, the results of Lemma 2.2 hold if $\gamma\left(\frac{p_h}{p_l} - 1\right)C > (1-\gamma)\left(p_l r_H - C - (1 - p_l - q)\, r_L\right)$: the principal's increase in expected payoff by implementing p_l and p_h rather than only p_h, i.e. $(1-\gamma)\left(p_l r_H - C - (1 - p_l - q)\, r_L\right)$, is smaller than the additional expected incentive costs of a rent to the agent, i.e. $\gamma\left(\frac{p_h}{p_l} - 1\right)C$.

[61]If $Y > \underline{u}$, 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 $0 \leq Y \leq min\left\{s, \underline{u}\right\}$. With bonus taxation, Y optimally satisfies $Y = min\left\{s, \underline{u}\right\}$.

[62]The following holds for the fixed wage A if the principal could pay $A > 0$: due to Assumption 2.1, a bonus is still necessary in order for the agent to implement R_k only for p_h. Otherwise, the manager would also implement the project for p_l, and thereby harm the principal. Neglecting Assumption 2.1, the principal may want to incentivize also the probability p_l. He could pay a fixed wage $A = \frac{C}{1-q}$ and $b = 0$, 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 $A = 0$ makes a qualitative difference.

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.[63] 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 2.2. *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 $E\left(\pi_k^l\right)$ and $E\left(\pi_k^h\right)$ as denoted in (2.4) and (2.5). Therefore, the equilibrium strategy of project implementation for $p_h \geq \hat{p}^*$ as denoted in Lemma 2.2 still applies, individually as well as collectively.

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:[64]

[63] Next 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.

[64] Where superscript "^{B}" denotes the case of a bailout.

$$E\left(\pi_k^{lB}\right) = (1-\gamma)\left[p_l r_H - C\right] + \gamma\left[p_h r_H - \frac{p_h}{p_l}C\right] \tag{2.7}$$

$$E\left(\pi_k^{hB}\right) = \gamma\left[p_h r_H - C\right] \tag{2.8}$$

Comparing (2.7) and (2.8), the principal has to prove which cutoff probability $p_i^B \in \left[p_l^B, p_h^B\right]$ 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 2.1, $E\left(\pi_k^{hB}\right) > E\left(\pi_k^{lB}\right)$ $\forall\gamma$, 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 $b_k^h = \frac{C}{p_h r_H}$. However, when both banks invest into R_k, a bailout erases the principals' downside of the risky project and increases their expected payoffs $E\left(\pi_k^{iB}\right)$. Ceteris paribus, project R_k now yields a non-negative payoff $E\left(\pi_k^{hB}\right)$ 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 2.2, 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 $E\left(\pi_1^h\right) < 0$ 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 2.3. *Suppose Assumptions 2.1 and 2.2 hold. Then, for success probabilities* $p_h \in [\hat{p}^B, \hat{p}^*)$*, there exist two pure strategy equilibria where either*
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 $b_k^h = \frac{C}{p_h r_H}$.
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_1^h if the other bank offers b_2^h". Deviations from these strategies yield at least weakly lower expected payoffs. As $E\left(\pi_k^{hB}\right) > 0$ 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 2.2, 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 (2.5). However, as stated in Lemma 2.2, 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 $b_1^h = \frac{C}{p_h r_H}$. 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.

2.3.5. 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 2.1 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 2.1. *Suppose Assumptions 2.1 and 2.2 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 2.1 - 2.3. 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 2.1 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 2.3 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.

2.4. 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.

2.4.1. Effects of a Tax on Managers' Bonuses

Due to the manager's additional tax burden, his optimal threshold level $\hat{p}$ changes from (2.1) to:

$$\hat{p}^t = \frac{C}{(1-t_b)\, b_k^t r_H}. \tag{2.9}$$

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 (2.7) and (2.8), 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 $E\left(\pi_k^{lt}\right)$ and $E\left(\pi_k^{ht}\right)$:[65]

$$E\left(\pi_k^{lt}\right) = (1-\gamma)\left[p_l r_H - \frac{C}{(1-t_b)}\right] + \gamma\left[p_h r_H - \frac{p_h}{p_l}\frac{C}{(1-t_b)}\right] \tag{2.10}$$

$$E\left(\pi_k^{ht}\right) = \gamma\left[p_h r_H - \frac{C}{(1-t_b)}\right] \tag{2.11}$$

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 2.2. Then, a

[65] Where superscript "^{t}" denotes the case of a bailout together with a (possible) tax on bonuses.

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 2.4. *Suppose Assumptions 2.1 and 2.2 hold. If the government introduces a bonus tax* $t_b^* = \frac{r_L((1-q)r_H - C)}{r_H((1-q)r_L + C)}$*, then,*
1. for $p_h < \hat{p}^t = \hat{p}^*$*, banks will not implement the risky project.*
2. for $p_h \in [\hat{p}^t, \hat{p}_2^t)$*, 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 $p_h \geq \hat{p}_2^t$*, 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 $p_h \geq \hat{p}^*$. 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 $p_h \geq \hat{p}_2^t \equiv \frac{(1-q)r_L}{r_H + r_L} + \frac{r_H[(1-q)r_L + C]}{(r_H + r_L)^2}$.

□

As Lemma 2.4 describes, with bonus taxation there exist two threshold levels $\hat{p}^t$ and $\hat{p}_2^t$ 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.[66] 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

[66] 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. $\hat{p}^* < \hat{p}^t$.

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 $b_k^{ht} = \frac{C}{(1-t_b^*)p_h r_H}$ which perfectly compensates them for the bonus tax t_b^*. Therefore, b_k^{ht} is larger than the bonus b_k^h 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_k^{ht}, or none of them does. As in Lemma 2.3, the Nash Equilibrium with project implementation payoff dominates the equilibrium with abstaining from project implementation.

2.4.2. Welfare Implications of a Bonus Tax

From Proposition 2.1 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 2.3 to the findings denoted in Lemma 2.4, we can state the following with respect to bonus taxation:

Proposition 2.2. *Suppose Assumptions 2.1 and 2.2 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 $p_h \geq \hat{p}^t$.
2. for the payoff dominated equilibrium, a bonus tax t_b^* is welfare neutral if $p_h < \hat{p}^t$ or $p_h \geq \hat{p}_2^t$, and welfare decreasing if $p_h \in [\hat{p}^t, \hat{p}_2^t)$.

Proof. Follows directly from Proposition 2.1 and Lemma 2.3 and 2.4. As $\hat{p}^t = \hat{p}^{opt}$ for 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 $\hat{p}_2^t$.

□

Welfare effects of a bonus tax depend on two threshold levels $\hat{p}^t$ and $\hat{p}_2^t$ 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 $\hat{p}^t = \hat{p}^* = \hat{p}^{opt}$ 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 $p_h < \hat{p}^t$, 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 2.4) and thus increases welfare. For all remaining possible probabilities $p_h \geq \hat{p}^t$, a bonus tax t_b^* does not cause welfare effects as, according to Lemma 2.1, 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 $p_h \geq \frac{\frac{C}{1-t_b}+(1-q)r_L}{r_H+r_L}$. 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 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.

2.4.3. Extension: Supranational Bailout, but National Bonus Taxation

One of the main characteristics of the banking sector is its degree of integration, also across countries.[67] 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.[68] In the international context, bailouts linked to systemic risk due to a too-many-to-fail

[67] 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.

[68] 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.

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."[69] 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 (2.9) applies, whereas for manager 2 the optimality condition without taxation (2.1) is relevant. Consequently, bank 1 incurs higher costs to incentivize the manager and therefore earns an expected payoff (2.10) or (2.11), while bank 2's expected payoffs are given by (2.7) and (2.8). Thus, mutual best responses by bank 1 and 2 are not symmetric anymore and lead to the following results:

Lemma 2.5. *Suppose Assumptions 2.1 and 2.2 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*

$$p_h \geq \hat{p}^t = \hat{p}^{opt}. \tag{2.12}$$

Banks offer a bonus rate b_1^{ht} and b_2^h and earn payoffs $E\left(\pi_1^{ht}\right)$ and $E\left(\pi_2^{hB}\right)$. Government 1 raises expected tax revenue $T = \gamma \frac{t_b^*}{\left(1-t_b^*\right)} C$.

Proof. If $t_b = t_b^*$, $E\left(\pi_1^{ht}\right) \geq 0$ if and only if $p_h \geq \hat{p}^t$. If bank 1 implements R_1 only for $p_h \geq \hat{p}^t$, 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

[69]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 (EUR 60 billion program).

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 2.3. *Suppose Assumptions 2.1 and 2.2 hold. Then, a bonus tax t_b^* that covers only one bank is welfare improving if $p_h < \hat{p}^t$ and welfare neutral if $p_h \geq \hat{p}^t$.*

Proof. Directly follows from Proposition 2.1 and Lemma 2.3 and 2.5.

□

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.

2.5. Conclusion

In this chapter, 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.

Chapter 3.

Bailouts, Bonuses and Bankers' Short-Termism

3.1. Introduction

When governments in the recent financial crisis had little choice but to avoid contagion and to rescue banks by using public money, politicians and policymakers started looking for the underlying causes of the financial crisis. In compensation payments for bankers, they found one key factor for the excessive risk culture in some banks. Especially high bonuses were thought of inducing bankers to take on too much risk and to focus on short-term rather than on sustainable long-term profits.[70] As a consequence and to address this issue for the future, policymakers around the world responded to the heated public debate by limiting compensation payments of executives or by revising the tax treatment of bonus payments. Notwithstanding its effects on long-term profits, it is fully rational that bankers adjust their investment decision to their offered compensation structure. When banks largely base their bankers' compensation on short-term profits, bankers will prefer projects with higher expected profits in the short-run over projects with higher expected long-term profits. However, the question regarding the determinants of incentive provision in banking remains.

In the following, we offer a two period principal-agent model that deals with this question and that combines three aspects of the financial crisis: (i) the time-horizon of investments, (ii) the systemic risk of financial institutions and (iii) bonus taxation. First, we analyze

[70] In the UK, for example, the Treasury Committee of the House of Commons asserted that the "'bonus culture' in the City of London(...) contributed to excessive risk-taking and short-termism and thereby played a contributory role in the banking crisis" (UK House of Commons, 2009).

the determinants of compensation payments and the time-horizon of investments when the bank is faced with moral hazard both with respect to effort and managerial short-termism. In a second step, we introduce the externality of a bailout. This allows us to focus on whether a bailout policy affects the composition of short-term and long-term compensation and whether banks tolerate or even incentivize (higher) short-termism of their bankers. Finally, we pick up the discussion on reforms of the tax treatment of managerial compensation and analyze the effects of a tax specifically on short-term bonuses.

Much attention has been paid to the role of bonuses within the financial services industry. As Suntheim (2011) finds, mean total compensation for chief executive officers (CEO) in the financial services industry is \$3.6 million, with roughly 60% paid as bonuses. While bonuses have an advantageous effect on the alignment of interests and therefore are a heavily used compensation instrument within this industry, they also come at a cost. For instance, the UK Financial Services Authority (2008) states in a letter to CEOs on remuneration policies that "in many cases the remuneration structures of firms may have been inconsistent with sound risk management". Even banks themselves know about the effects of compensation: In an industry survey on compensation practices among wholesale banking businesses, 98% of respondents affirm the Institute of International Finance (2009) that compensation practices were an underlying factor for the financial crisis. This is especially true for cash bonuses which in the financial sector are well above the cash bonus payments in non-financial firms (Von Ehrlich and Radulescu, 2012). De facto, Livne et al. (2013) empirically identify that cash bonuses to CEOs are positively correlated with the bank's intensity of short-term investments. We cover this aspect in a theoretical framework by modeling moral hazard both with respect to effort and short-termism, and by giving the bank two incentive instruments: short-term bonuses and long-term bonuses. However, the bank faces a tradeoff. While short-term bonuses provide incentives for short-termism, long-term compensation is more costly as the manager discounts the future. This tradeoff changes in case banks can anticipate a bailout if they fail.

In fact, banks are more likely to receive a bailout than non-financial firms. Smith (2014) constructs a dataset of financially distressed firms across industries and countries, and identifies that the likelihood of receiving a bailout strongly increases in firm size and when the firm is active in the financial sector. In addition, DeYoung et al. (2013) measure with respect to risk-taking that banks exploit their too-big-to-fail incentives and therefore set incentives in a way that managers increase risk taking. In our model, we analyze how a bailout affects the composition of managerial compensation and the time-horizon of investments. By bailing out a bank that is too-big-to-fail, the government averts further damage from the economy and the financial system. At the same time, this policy can be anticipated by banks of a certain size. If banks know that their imminent bankruptcy prompts the government to act, they may adjust their incentive structures already beforehand. Our findings demonstrate that banks indeed change their compensation structure towards higher short-term payments in most cases. This action does not only increase the likelihood of harmful short-termist behavior in general. It is also accompanied by a further increase in existing, already excessive short-termism.

However, in a third step, we show how the specific taxation of short-term bonuses can reverse the negative effects a bailout entails for short-termism and compensation. In the midst of the financial crisis, several countries introduced a tax on managerial bonuses to raise tax revenue and to appease the public.[71] While the UK imposed a 50% tax on cash bonuses for all bankers, other countries made their bonus tax contingent on governmental aid.[72] To this effect, Ireland introduced a 90% bonus tax in 2011, and the US House of Representatives in 2009 voted for a 90% bonus tax for banks under the Troubled Asset Relief Program (TARP).[73]

Combining the possibility of short-termism with a bailout, this chapter shows how a bailout guarantee by governments changes equilibrium compensation and short-termist behavior. Harmful short-termism is more likely to occur or even increases in the presence of a bailout. In most cases, a bailout makes it profitable for a bank to change its compensation structure towards higher short-term payments, tolerating the negative consequence of short-termism. Moreover, the chapter explains the observation that the financial sector pays higher short-term bonuses than other sectors.[74] It shows that one reason for this could be the systemic externality of banks. However, for a government that anticipates these negative consequences, the chapter provides an argument for a tax on short-term compensation. This leads the banks to internalize the costs of short-termism and sets incentives to reduce short-term bonuses and short-termism.

[71] See Shackelford et al. (2010), Keen (2011a) and Devereux (2011) for other proposals regarding the regulation of the financial sector.

[72] Under the UK Finance Act 2010 (Schedule 1), the so called UK bank payroll tax for the fiscal year 2009-2010 was levied on bonus payments higher than GBP 25.000.

[73] 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).

[74] See Von Ehrlich and Radulescu (2012).

3.2. Related Literature

In order to model the effects of bailouts and bonus taxation on executive compensation and short-termism, we draw on the literature of optimal contracting or agency theory. In the presence of an information asymmetry, firms need some kind of incentive instrument in order to align the manager's interests with their own interests (Jensen and Meckling 1976, Holmstrom 1979, and Grossman and Hart 1983, among others).[75] Adding multiple periods to the analysis, the literature on short-term and long-term compensation extends the standard agency theory by targeting the issue of the time-horizon of the managers' investment decisions. Starting with works by Narayanan (1985), Stein (1989) and Von Thadden (1995), the literature has shown that managers may inflate current profits to raise their own reputation (Narayanan, 1985), to polish the forecast of future firm value (Stein, 1989), or to reduce the likelihood of project termination (Von Thadden, 1995).[76] Even though harmful for the firm, optimal executive compensation is found to emphasize short-termism when stock markets are speculative (Bolton et al., 2006) or when information about short-term performance is very noisy (Peng and Röell, 2014). In addition to internal reasons to accept short-termism, Thanassoulis (2013) presents an externality that leads to short-termism and an optimal contract tolerating it. Within a competitive labor market for managers, he finds that firms exert a negative externality towards each other in driving up managers' outside options. Under certain conditions, industry may partition such that large firms pay high short-term bonuses and tolerate short-termism, while smaller firms use compensation methods that prevent short-termism.

In terms of methodology, this chapter is particularly related to Thanassoulis (2013) whom we follow with respect to the managers business decisions and the instruments for executive compensation. However, we depart from Thanassoulis (2013) in omitting the competitive labor market and in simplifying the assumption of the manager's effort costs. While Thanassoulis (2013) suggests effort costs for the manager to depend on his income (à la Edmans et al., 2009), we use a linear functional form with fixed exogenous effort costs

[75] While in this literature a manager finds himself within a competitive market for employees that drives down compensation payments, the managerial power approach sees managers to be powerful in the wage-setting process and able to extract rents (Bebchuk et al. 2002, Bebchuk and Fried 2003 and Bebchuk and Fried 2004). Glazer and Konrad (1999) and Rothschild and Scheuer (2011) analyze the taxation of rent-seeking activities, while Frydman and Jenter (2010) and Murphy (2013) provide overviews for contributions both within the managerial power approach and the efficient contracting literature.

[76] In contrast to the view of inefficient short-termism, Laux (2012) suggests a beneficial effect of short-term investments: When managers can be replaced, such investment allows an early assessment of the manager's fit to the firm and thus a more efficient replacement process.

independent of income as commonly used in literature.[77] Keeping the manager's outside option exogenous allows us to focus in a simple model on the effects we want to study: the effects of bailouts and a bonus tax on executive compensation and short-termism. Therefore we allow the manager to have a continuous choice of short-termism rather than only a binary one as in Thanassoulis (2013). In addition, we extend Thanassoulis' work by adding the possibility of a bailout and a bonus tax.

Literature has already dealt with the effects of a bailout on managerial compensation and its effects on risk-taking for a one-period case. Both Besley and Ghatak (2013) and Hakenes and Schnabel (2014) analyze how bonuses change when bailouts can be anticipated by systemic banks and both show that risk-taking increases in the anticipation of a bailout. The same result has been shown by Hilmer (2014b), who, in contrast to Besley and Ghatak (2013) and Hakenes and Schnabel (2014), focused on collective moral hazard when banks receive bailouts only if they fail together. All these papers make clear that banks that can anticipate a bailout are likely to change their incentive payments in such a way that risk-taking is encouraged while social costs are neglected. However, they only present results for a single period and ignore longer lasting compensation components as observed in reality. With this chapter, we fill this gap and offer insights into the effects of a bailout on the intertemporal composition of executive pay like cash bonuses and stock options. Moreover, our two-period principal-agent model allows us to study a so far unconsidered element in the literature: the effects of a bailout on managerial short-termism rather than risk-taking.

Besides the effects of a bailout, this chapter deals with the effects of a tax on short-term bonus payments. In this respect, our work is related to the literature on bonus taxation.[78] Part of this literature analyzes the effects of a bonus tax on compensation payments and effort incentives. Both Dietl et al. (2013) and Hilmer (2013) find that effort decreases in the bonus tax while bonus payments to the manager might increase or decrease.[79] In addition, Hilmer (2013) identifies effects to be similar for a bonus tax and a limited deductibility of bonus payments from the corporate income tax and highlights the positive welfare effects of a subsidy for bonus payments. Grossmann et al. (2012), Besley and Ghatak (2013) and Hilmer (2014b) study the effects of a bonus tax on risk-taking. While

[77] See, e.g. Laffont and Martimort (2002).

[78] In addition, this chapter is related to the literature on taxation of risk-taking activities. See Buchholz and Konrad (2014) for a recent survey on this topic.

[79] Von Ehrlich and Radulescu (2012) estimate the effects of the UK bank payroll tax and find a reduction in bonuses of 40% caused by the tax. However, banks one-to-one increased other pay components not subject to the tax.

the findings by Grossmann et al. (2012) imply risk-taking to be increasing in a bonus tax for a risk-averse manager, Besley and Ghatak (2013) and Hilmer (2014b) find the opposite effect for a risk-neutral manager in the presence of a bailout. Both of them emphasize the positive effects of a bonus tax that leads banks to internalize part of the social costs a bailout entails, also when the bonus tax is introduced unilaterally (Hilmer, 2014b).[80] Even though Besley and Ghatak (2013) and Hilmer (2014b) examine the effects of both a bailout and bonus taxation in their frameworks, this is the first model that addresses the optimal taxation of bonus pay in a setting that includes short-term and long-term incentive payments in its analysis. This allows us to introduce potential short-termism and to generate new insights with respect to the effects of bailouts and bonus taxes on the composition of incentive pay between periods and managerial short-termism.

In the following section, we introduce the model and derive the equilibrium compensation contracts and the resulting levels of short-termism. In Section 3.4, the effects of a governmental bailout on managerial compensation and short-termism are analyzed, while Section 3.5 then illustrates how a bonus tax reverses the negative incentives a bailout entails. Section 1.5 concludes.

3.3. The Model

3.3.1. Banks, Managers and Business Decisions

Consider a situation with a risk-neutral bank-shareholder (principal) who delegates the task of running its operations to a risk-neutral bank-manager (agent). In $t = 0$, the bank 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 $\underline{u} \geq 0$ and zero initial wealth. If the manager accepts the contract, he makes a business decision at the beginning of period $t = 1$ about an investment that contains an effort choice $e \in \{0, 1\}$ and a degree of short-termist behavior $a \geq 0$. Depending on his business decision, the investment generates returns both at the end of period $t = 1$ and at the end of $t = 2$.

[80] Thanassoulis (2012) and Radulescu (2012) emphasize the role of the managers' outside option. When competition for bankers entails a negative externality to other banks, Thanassoulis (2012) finds no effects of bonus taxes on the default risk that excessive bonuses cause. According to Radulescu (2012), also a manager with relocation possibilities reduces effort when faced with a bonus tax, but may earn a higher bonus when his risk aversion is high enough.

	Profit at $t = 1$	Profit at $t = 2$
Manager exerts effort (& short-termism)	$\begin{cases} \pi_H & with\, prob.\ x + a \\ \pi_L & with\, prob.\ 1 - (x + a) \end{cases}$	$\begin{cases} \pi_H & with\, prob.\ x - \delta a \\ \pi_L & with\, prob.\ 1 - (x - \delta a) \end{cases}$
Manager exerts zero effort	π_L	π_L

Table 3.1.: Project returns with and without short-termism

Business Decisions The realization of firm profit is independent across periods and can take one of two values in each period: high profit π_H or low profit π_L (with $\pi_H > \pi_L \geq 0$). If the manager does not exert effort, then the investment will fail for sure and low profit π_L will be realized in both periods (see Table 3.1). By exerting effort $e = 1$, the manager increases the probability of the high profit π_H. In this case, profit π_H will be realized with probability x in each period. In addition to effort, the manager may take a short-termist action a. Following Thanassoulis (2013), we model short-termism as increasing the probability of high short-term profit at the expense of the probability of high long-term profit.[81] By focusing on short-term results, i.e. choosing $a > 0$, profit in period $t = 1$ will be π_H with probability $x+a$ rather than x (and π_L with probability $1-(x+a)$). However, in period $t = 2$, the probability for the high profit π_H will only be $x-\delta a$ instead of x for the case without short-termism. By assuming $\delta > 1$, action $a > 0$ not only shifts probability mass for the high profit π_H from period $t = 2$ to period $t = 1$. Moreover, $\delta > 1$ ensures that the model captures short-termism for the bank, i.e. any short-termist action $a \neq 0$ is harmful for the bank and, in addition, socially undesirable. In that sense, δ denotes the bank's cost of the short-termist action that arises as the manager increases short-term results at the expense of long-term results.[82]

Both effort and short-termism are assumed to be costly for the manager. While high effort comes at a fixed nonmonetary investment cost $I > 0$ (and zero costs if the manager

[81] Our concept of modeling short-termism holds for several real-world interpretations of short-termism. Examples are unfavorable and unobservable borrowing against future earnings (Stein, 1989), excessive exposure to derivatives (as futures or swaps) that provide no additional long-term value (Foster and Young, 2010) or lax lending standards to inflate the balance sheet (Shin, 2009). Nevertheless, our agent is fully rational. In that respect we differ from the behavioral literature on myopic loss aversion (Benartzi and Thaler 1995, Thaler et al. 1997, among others).

[82] By interpreting the short-termist action a as degree of earnings manipulation, this model is also related to the literature of costly state falsification (see Crocker and Slemrod 2007 or Laux 2014, among others). In Laux (2014), the agent can manipulate the financial report (at a cost) on which the principal bases his decision about continuing or terminating a certain project (corresponds to $a > 0$). As a result of manipulation, the principal may then not terminate an unprofitable project and destroy long-term value (corresponds to $\delta > 1$).

chooses $e = 0$), costs of the short-termist action are assumed to be quadratic, i.e. $C(a) = \frac{k}{2}a^2$, with $k > 0$.[83] In order to focus on the incentive effects of a bailout and/or a bonus tax on short-termism, we assume that it is always profitable for the bank to offer a contract to the manager that induces high effort.[84]

We model moral hazard in that the choice of effort ($e = 0$ or $e = 1$) and short-termism ($a \geq 0$) is private information to the manager and not observable by the bank. To guarantee that the manager's effort choice cannot be traced back by the bank, we assume that the probability of any outcome is strictly between zero and one, i.e. $0 < x - a\delta \leq x \leq x + a < 1$. Ex post, realized profits in period $t = 1$ and $t = 2$ are observable and verifiable.

Compensation Payments Managers are assumed to receive profit-contingent compensation with three possible payment instruments used by the bank. At the end of period $t = 1$, the manager may receive a fixed wage $A \geq 0$ and a short-term bonus $b_s \geq 0$. While the fixed wage is paid independent of realized returns in any period, the short-term bonus b_s is paid only if the realized profit in $t = 1$ is π_H. In the long run, at the end of period $t = 2$, the manager may receive vested or deferred pay (i.e. a long-term bonus component) $b_l \geq 0$ if the realized profit in $t = 2$ is π_H.[85] Both the bank and the manager are assumed to discount future. While the bank discounts at rate $r \geq 0$, the manager has a

[83] This convex characterization implies that costs for the short-termist action are small in the beginning but increase in the level of short-termism. As short-termism is not in the bank's interest, the manager might need to camouflage short-termism, or, as in Laux (2014), better manipulation may be more expensive.

[84] This implies an implicit assumption on effort costs I and the outside option $\underline{u}$. In particular, for $e = 1$ being more profitable than $e = 0$ for all possible a, effort costs I have to be sufficiently small such that $(2x + \bar{a} - \delta\bar{a})(\pi_H - \pi_L) - \frac{x+a}{1-t_b}[I + C(\bar{a})] \equiv \Omega > 0$, with $\bar{a} = \frac{1}{k}\left(\sqrt{2kI + k^2x^2} - kx\right)$. In order that the principal obtains non-negative equilibrium profits, $\Omega + 2\pi_L - \underline{u} \geq 0$ must hold in addition. Consequently, an equilibrium in which the bank incentivizes effort $e = 0$ does not exist. In particular, there cannot be an equilibrium with $e = 0$ and $a > 0$. For $e = 0$, the manager has no advantage from $a > 0$ (as for example increasing the probability of a certain outcome), but incurs costs $C(a)$.

[85] For the bonus payment b_l, the principal could also use the information he gained meanwhile. Making b_l next to profit in $t = 2$ also conditional on past profit realization in $t = 1$ alters the manager's marginal analysis. Nevertheless, the qualitative effects with respect to the bailout and bonus taxation do not change. We therefore follow the literature (e.g. Thanassoulis, 2013) and stick to this simpler contract structure with deferred payments being conditional only on current profit realization. While to our knowledge there is no literature on the optimal contract with the specification used here, there exist papers (Lambert 1983, Rogerson 1985, Edmans et al. 2012) showing that optimal contracts exhibit memory of past outcomes when the agent chooses effort in each period. Particularly with regard to short-termism, Edmans et al. (2012) present closed-form solutions in a model with risk-aversion and private saving. Still, also their complex optimal contract of a rebalanced account contains deferred pay.

discount rate $\rho \geq r$.[86] Thus, at the end of $t = 1$, the manager's net present value (NPV) of the long-term bonus b_l is $\frac{b_l}{1+\rho}$.

3.3.2. First-Best and Welfare Maximum

Before we turn to the principal-agent problem with information asymmetry between bank and manager, we first identify the first-best solution and solve for the welfare maximum. As the bank can observe the manager's effort choice and the level of short-termist action, it will maximize payoff by directly contracting upon the manager's choice variables. Total compensation must cover the manager's outside option $\underline{u}$ and his costs for effort, I, and for the short-termist action, $\frac{k}{2}a^2$. Dependent on the manager's discount rate, the bank will prefer compensation payments in period $t = 1$ weakly (with strict preference if $\rho > r$) to paying a long-term bonus that may be less valued by the manager. Taking the necessary compensation $\underline{u} + I + \frac{k}{2}a^2$ into account and given our assumption that inducing effort $e = 1$ is always profitable, the principal maximizes expected payoff $E(U_P) = (x + a)(\pi_H - b_s) + (1 - x - a)\pi_L - A + (x - \delta a)\left(\frac{\pi_H - b_l}{1+r}\right) + (1 - x + \delta a)\frac{\pi_L}{1+r}$ by choosing short-termist action a.

For the welfare analysis, we assume that a benevolent social planner maximizes overall efficiency and define welfare as the sum of manager's expected payoff $E(U_A) = A + (x + a)b_s + (x - \delta a)\frac{b_l}{1+\rho} - I - C(a)$ and the bank's expected payoff $E(U_P)$ in the absence of any externality.[87] As both bank and manager are risk neutral, all wage payments except b_l have only distributional impacts and do not affect welfare.[88] Expected welfare is therefore given by $E(W) = (x + a)\pi_H + (1 - x - a)\pi_L + (x - \delta a)\frac{\pi_H}{1+r} + (1 - x + \delta a)\frac{\pi_L}{1+r} - I - C(a)$.

Lemma 3.1. *In first-best, short-termism is chosen welfare maximizing according to*

$$a^{FB} = \max\left\{0, \frac{\pi_H - \pi_L}{k}\left(1 - \frac{\delta}{1+r}\right)\right\}.$$

[86] As will be discussed later (p. 61), there are good arguments to allow for $\rho > r$. Managers not only resist high long-term payments because of their desire for portfolio diversification or liquidity concerns (Walker, 2010). But also, the uncertainty of long-term payments and the unpredictability of personal events may make short-term compensation more favorable for managers. We will later discuss the implications of $\rho = r$ or $\rho > r$ when analyzing the equilibrium.

[87] As we will later introduce a bailout and a bonus tax, both would affect $E(U_P)$. However, in our optimal welfare function that maximizes efficiency we abstract from those effects as they only have distributional impacts.

[88] Due to our assumption $\rho \geq r$, b_l negatively affects welfare and therefore will not be used by the social planner.

Proof. All proofs are contained in appendix B. □

Lemma 3.1 is intuitive. Suppose the bank does not discount future, i.e. $r = 0$. As short-termism is harmful for the bank, i.e. $\delta > 0$, short-termism is inefficient both from the bank's perspective and from a welfare perspective. Therefore, it should be avoided and both the bank in first-best as well as the social planner always want to have the short-termist action $a = 0$. However, if the bank discounts period $t = 2$ profits more than short-termism harms expected payoffs, i.e. $1 + r > \delta$, then, short-termism is actually beneficial. By paying the manager to focus on short-term results, probability mass is shifted from the highly discounted and therefore less valuable period $t = 2$ profits to undiscounted period $t = 1$ profits.[89] In the following, we will focus on cases where short-termism is inefficient and unprofitable. That is, we assume $1 + r \leq \delta$.

3.3.3. Second-Best without Bailouts

In presence of the agency problem, the manager and the bank will choose actions that maximize their expected income and their expected profit, respectively. We solve the model by backward induction and start with the manager's maximization problem, followed by the bank's optimization.

The manager chooses effort e and the short-termist action a so as to maximize his expected payoff $E(U_A)$. Provided that $e = 1$, this defines the optimal amount of short-termism

$$a^* = arg\max_a A + (x + a)\, b_s + (x - \delta a)\, \frac{b_l}{1+\rho} - I - \frac{k}{2}a^2,$$

which, in combination with the restricted domain $a \geq 0$, denotes the manager's first order condition:[90]

$$a^* = \max\left\{0, \frac{1}{k}\left(b_s - \delta \frac{b_l}{1+\rho}\right)\right\} \tag{3.1}$$

When offering a contract to the manager, the bank considers the manager's optimality condition (3.1) and maximizes expected profit $E(U_P)$ by choosing the conditionally

[89] As $1 + r > \delta$, the benefits of this shift outweigh the inefficiency of short-termism in general.

[90] Note that the second order condition for a maximum w.r.t. a is satisfied.

optimal compensation components A, b_s and b_l:

$$\max_{A,b_s,b_l} \quad \overbrace{(x+a)(\pi_H - b_s) + (1-x-a)\pi_L}^{exp.\ short-term\ profit} +$$
$$+\overbrace{\left(\frac{1}{1+r}\right)[(x-\delta a)(\pi_H - b_l) + (1-x+\delta a)\pi_L]}^{NPV\ of\ exp.\ long-term\ profit} - \overbrace{A}^{fixed\ wage} \tag{3.2}$$

$$s.t. \quad (3.1)$$
$$A + (x+a)\,b_s + (x-\delta a)\,\tfrac{b_l}{1+\rho} - I - \tfrac{k}{2}a^2 \geq \underline{u} \tag{3.3}$$
$$(x+a)\,b_s + (x-\delta a)\,\tfrac{b_l}{1+\rho} - I - \tfrac{k}{2}a^2 \geq 0 \tag{3.4}$$

Equation (3.3) is the manager's participation constraint that has to be fulfilled in order for him to accept the bank's contract offer. Expected income in $t = 1$ units must remunerate the manager at least for his outside option $\underline{u}$ and his costs for effort and identifying projects with a high probability of short-term profits. Moreover, the bank has to incentivize the manager to exert effort $e = 1$. Condition (3.4) makes sure that the manager does not shirk with respect to effort. Finally, as explained above, the manager will choose short-termism according to (3.1). The bank has to take into account the three constraints above together with the non-negativity constraint on compensation payments.

Equilibrium In order to incentivize high effort, the bank must either pay a short-term bonus b_s and/or a long-term bonus b_l to the manager (see (3.4)). For the bank, this creates a tradeoff between two different effects that short-term and long-term bonuses induce.

Lemma 3.2. *For $a > 0$, there are two opposing effects with respect to effort inducing bonus payments. (i) The level of short-termism is declining in the level of long-term bonus pay. (ii) Compensation costs increase in the use of the long-term bonus if $\rho > r$; the cost increase is stronger, the larger ρ is compared to r.*

On the one hand, the bank prefers paying a long-term bonus to the manager to induce high effort as compared to paying a short-term bonus. In contrast to a short-term bonus, a long-term bonus better targets sustainable bank profit in the short and in the long run, and thus better aligns the bank's and the manager's interests. Suppose, for example, the bank concentrates on paying only a long-term bonus to induce high effort. In this case, interests between the bank and the manager are perfectly aligned. While short-termism is always harmful for the bank by assumption $\delta > 1 + r$, paying only long-term bonuses makes short-termism also unprofitable for the manager. Any level of short-termism $a \neq 0$ causes not only costs $C(a) > 0$ for the manager, but also reduces the probability of a high period $t = 2$ profit and thus the probability of receiving the bonus b_l.

On the other hand, a long-term bonus increases the bank's compensation costs weakly more than a short-term bonus. As the manager discounts the long-term bonus necessary to incentivize effort at rate $\rho \geq 0$, long-term bonus payments are only worth $\frac{b_l}{1+\rho}$ for the manager, in contrast to a short-term bonus that is worth b_s. As long as the bank's and the manager's discount rates differ, $\rho > r$, the difference in the manager's valuation of short-term and long-term bonuses also creates a difference in the bank's compensation costs.

This wedge in the bank's compensation costs scales down the closer the two discount rates are to each other. In the special case where the discount rates are just the same, i.e. $\rho = r$, the bank discounts future profits and payments just as much as the manager does. In this case, the second effect stated in Lemma 3.2 disappears, and short-term and long-term bonuses become just equally expensive for the bank. As, by assumption $1 + r \leq \delta$, short-termism is unprofitable for the bank, the bank will indeed pay effort incentives in such a way that it prevents short-termism. According to (3.1), this is the case whenever $b_s \leq \frac{\delta b_l}{1+\rho}$.

Lemma 3.3. *Suppose the discount rates of the bank and the manager coincide, i.e.* $\rho = r$*. Then, it is optimal for the bank to prevent short-termism, i.e.* $a = 0$ *by means of compensation payments. Both bank and manager are indifferent between any compensation structure that pays a fixed wage* $A = \underline{u}$ *and bonuses* $b_s \leq \frac{\delta b_l}{1+\rho}$ *and* $b_l = (1+\rho)\left(\frac{I}{x} - b_s\right)$*.*

In contrast to coinciding discount rates, empirical evidence both from natural and field experiments (Warner and Pleeter 2001, Harrison et al. 2002) suggests individuals' discount rates to be far above the risk-free borrowing rates of firms. As is standard in the literature on dynamic models of the principal-agent relationship, we will assume in the following that the agent's discount rate exceeds the market-interest rate that the principal faces (DeMarzo and Sannikov 2006, De Marzo and Fishman 2007, Biais et al. 2007, Biais et al. 2010). This makes the manager more impatient than the bank and generates incentives for the bank to pay short-term bonuses as well as long-term bonuses.[91] For

[91] Although Lemma 3.3 states that short-term bonuses $b_s > 0$ are an equilibrium, those equilibria would be eliminated whenever costs for short-term bonuses increase (e.g. by charging a tax on short-term bonuses).

the sake of convenience, we follow Thanassoulis (2013) and normalize the bank's discount rate to zero and thus continue with the assumption $\rho > r = 0$.[92]

There are two possible situations for the short-termist action a: either the manager does not search for projects with a high likelihood of short-term profits ($a = 0$), or he does ($a > 0$). Let us first analyze the conditions under which short-termism will be ruled out and continue by identifying the conditions under which short-termism takes place.

Proposition 3.1. *When the manager's discount rate is low, $\rho \leq \underline{\rho} \equiv \frac{(\pi_H - \pi_L)(\delta-1)(1+\delta)}{\frac{\delta I}{x}+xk}$, then the manager is incentivized such that he avoids short-termism ($a = 0$). As compensation, the manager receives a fixed wage $A = \underline{u}$, a short-term bonus $b_s = \frac{\delta I}{(1+\delta)x}$ and a long-term bonus $b_l = \frac{(1+\rho)I}{(1+\delta)x}$.*

According to Lemma 3.2, the use of long-term bonuses will reduce short-termism but at the same time increase compensation costs. For the bank, this tradeoff is not too severe if the manager's discount rate is low. Whenever $\rho \leq \underline{\rho}$, effect (i) of Lemma 3.2 impacts bank profits stronger than effect (ii) of the same lemma: The benefit of the long-term bonus in avoiding short-termism is larger than the additional costs for the long-term bonus that arise because of its discounted value. Overall, the bank is better off if it incentivizes the manager in such a way that he exerts high effort, but totally avoids short-termism. In addition, effort incentives are induced by a combination of long-term and short-term bonus. Consider (3.1) that states the manager's optimal level of short-termism. In order that $a = 0$ can be an equilibrium, $b_s \leq \delta \frac{b_l}{1+\rho}$ must hold. Nevertheless, $b_s < \delta \frac{b_l}{1+\rho}$ cannot be an equilibrium outcome for the bank. By increasing the short-term bonus and simultaneously decreasing the, since discounted, more expensive long-term bonus, the bank could still induce effort and avoid short-termism. Beyond that, this action would reduce total compensation costs and increase bank profit. Therefore, both short-term and long-term bonus will be chosen such that both the manager's incentive constraint with respect to effort (3.4) as well as his first order condition with respect to short-termism (3.1) are binding. Finally, the fixed wage A is independent of the manager's choice of effort and short-termism and perfectly covers his reservation wage to make the participation constraint (3.3) binding at the optimum.

While Proposition 3.1 shows under which circumstances, especially $\rho \leq \underline{\rho}$, short-termism can be ruled out, it can also be in the bank's interest to allow for short-termist behavior.

[92] Note that the assumption $\rho > r$ influences equilibrium formation. Nevertheless, as will be shown later, comparative statics results regarding bailout and bonus tax are not qualitatively driven by the difference in discount rates, given that those equilibria emerge.

Consider again (3.1). According to this condition, $b_s > \delta \frac{b_l}{1+\rho}$ is necessary in order that the manager chooses $a = \frac{1}{k}\left(b_s - \delta \frac{b_l}{1+\rho}\right) > 0$. It is easy to see, that for $b_s > \delta \frac{b_l}{1+\rho}$ the level of short-termism is increasing in the level of short-term bonus b_s and decreasing in the level of long-term compensation b_l. Thus, as short-termism is unprofitable for the bank, the cost effect of the long-term bonus described in part (ii) of Lemma 3.2 must outweigh the short-termism avoiding effect denoted in part (i) of the same Lemma so that the bank is willing to accept $a > 0$. Depending on the degree of the manager's impatience, two equilibria exist:

Proposition 3.2. *When the manager's discount rate is high,* $\rho \geq \bar{\rho} \equiv \frac{(\pi_H - \pi_L)(\delta-1)+\bar{a}k}{(x+\bar{a})k} \frac{x(1+\delta)}{(x-\delta\bar{a})}$, *then the bank tolerates a high level of short-termism with* $a = \bar{a} \equiv \frac{1}{k}\left(\sqrt{2kI + k^2x^2} - kx\right) > 0$. *As compensation, the manager receives a fixed wage* $A = \underline{u}$ *and a short-term bonus* $b_s = \sqrt{2kI + k^2x^2} - kx$. *The bank abstains from paying a long-term bonus, i.e.* $b_l = 0$.

There exists a threshold for the manager's discount rate $\bar{\rho}$ above which the bank will fully focus on a short-term bonus to incentivize effort. For $\rho > \bar{\rho}$, the manager discounts the long-term payment b_l so strongly, that its use to incentivize effort is more costly for the bank than accepting short-termist behavior by the manager. Moreover, it is even cheaper to tolerate a very high degree of short-termism, i.e. $a = \bar{a}$, than reducing short-termism below $\bar{a}$ by substituting at least some short-term bonus with long-term pay b_l.

This latter finding changes when the discount rate ρ decreases. Then, the cost effect of the long-term bonus denoted in part (ii) of Lemma 3.2 weakens while the positive effect of b_l on reducing short-termism stays unchanged. Whenever the discount rate belongs to the medium range $\underline{\rho} < \rho < \bar{\rho}$, reducing the manager's incentives for short-termism becomes profitable:

Proposition 3.3. *When the manager's discount rate is in a medium range,* $\underline{\rho} < \rho < \bar{\rho}$, *then the bank tolerates some degree of short-termism* $a \in (0, \bar{a})$. *Optimal short-termism is implicitly defined by*

$$\underbrace{-(\pi_H - \pi_L)(\delta - 1)}_{(A)} \underbrace{- \frac{akx + \delta I - \delta \frac{k}{2}a^2}{(1+\delta)x}}_{(B)} + \delta \underbrace{\frac{I - akx - \frac{k}{2}a^2}{(1+\delta)x}(1+\rho)}_{(C)} + \underbrace{\frac{(x+a)(x-\delta a)k}{x(1+\delta)}\rho}_{(D)} = 0 \tag{3.5}$$

and increasing in the discount rate ρ. *As compensation, the manager receives a fixed wage* $A = \underline{u}$, *a short-term bonus* $b_s = \frac{akx+\delta I - \delta\frac{k}{2}a^2}{(1+\delta)x}$ *and a long-term bonus* $b_l = \frac{I - akx - \frac{k}{2}a^2}{(1+\delta)x}(1+\rho)$.

Both in Proposition 3.2 and Proposition 3.3, the bank wishes to prevent any short-termist behavior by the manager, but has to cope with the manager's impatience. While for $\rho \geq \bar{\rho}$ long-term bonus payments that could reduce short-termism below $a = \bar{a}$ are not profitable for the bank, it is profitable for the bank to tolerate only some degree of short-termism $a < \bar{a}$ and to avoid higher short-termism by paying a long-term bonus $b_l > 0$ if $\underline{\rho} < \rho < \bar{\rho}$. Thereby, the bank equalizes the marginal costs an increase in short-termism would cause on expected profits (A) and on expected short-term payments (B) with the marginal benefits it would create. On the one hand the likelihood that the bank has to pay the long-term bonus decreases (C), on the other hand the bank can save compensation costs for the marginal unit short-termism when paying a short-term bonus rather than a discounted long-term bonus (D).

The costs of preventing short-termism are increasing in the discount rate ρ, and so is short-termism until $\rho = \bar{\rho}$ and $a = \bar{a}$. Beyond that point, a more short-termist behavior is not profitable anymore for the manager. For $a = \bar{a}$, marginal costs of the short-termist action ka just equal the marginal benefit of receiving the short-term bonus b_s with higher probability. For $a > \bar{a}$, the manager's marginal costs further increase by parameter k, while the incentive payment b_s is independent of the manager's impatience and short-termism. Therefore, short-termism $a > \bar{a}$ does not pay off for the manager, independent of his impatience.

Figure 3.1 shows the different equilibria that emerge depending on the manager's discount rate ρ. Going from the left to the right, the figure displays the following: If the manager discounts future income relatively little, i.e. $\rho \leq \underline{\rho}$, the bank will pay both a bonus in period $t = 1$ and a bonus in period $t = 2$ in case of success. Nevertheless, it will not tolerate any degree of short-termism other than $a = 0$. This changes if the manager is more impatient, i.e. $\underline{\rho} < \rho < \bar{\rho}$. Then, the bank will still pay both short-term and long-term bonuses, but is willing to tolerate some short-termist behavior $a > 0$. The more the manager discounts the future, the more the bank will focus on the short-term bonus rather than long-term payments, leading to a higher degree of short-termism. Finally, if the manager's impatience is very high, i.e. $\rho \geq \bar{\rho}$, then the bank fully stops paying long-term compensation and tolerates a high degree of harmful short-termism $a = \bar{a}$ in its investments.

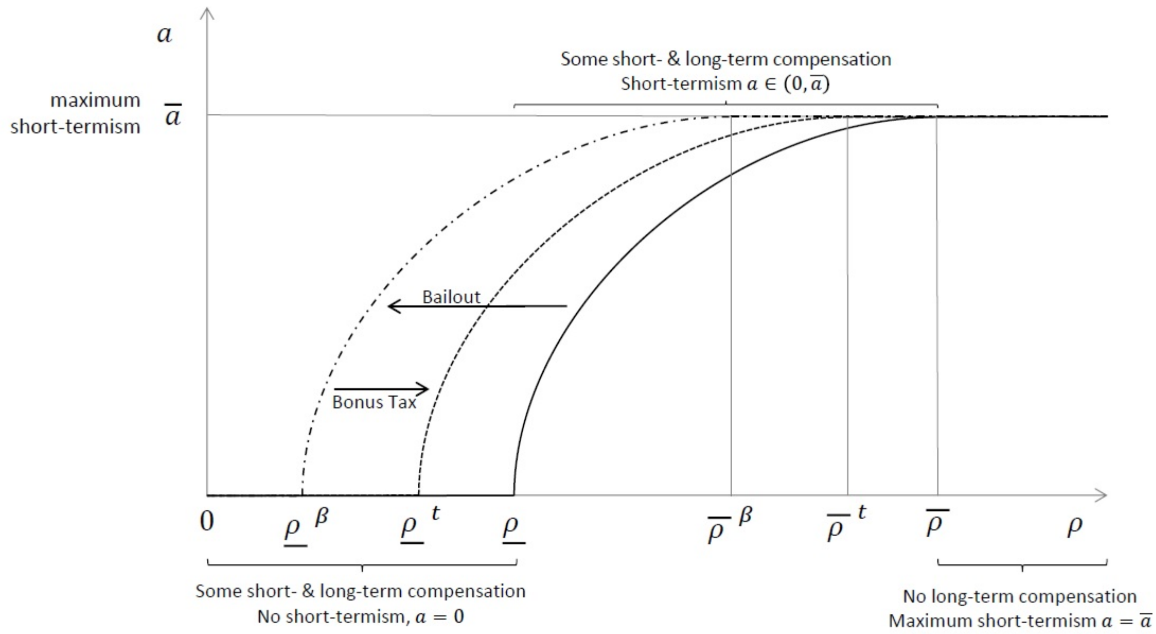

Figure 3.1.: Short-termism a as a function of discount rate ρ with threshold levels in the absence of bailout and bonus tax ($\underline{\rho}$ and $\bar{\rho}$), in the presence of a bailout ($\underline{\rho}^{\beta}$ and $\bar{\rho}^{\beta}$) and in the presence of both bailout and bonus tax ($\underline{\rho}^{t}$ and $\bar{\rho}^{t}$).

3.4. Effects of a Bailout

Having specified the possible equilibria, we can now turn to the implications of a bailout. Following Besley and Ghatak (2013) for the case of a bailout, we will extend possible returns by introducing a bailout payment β, with $\pi_H > \beta > \pi_L$. Whenever profit realization is π_L, the bank would not be able to survive on its own and would harm the economy with its bankruptcy. In order to avoid negative contagion effects caused by a bank that is too-big-to-fail, the government pays a bailout β if the bank was not successful. For simplification, we normalize $\pi_L = 0$, and define β as the difference between the return in case of a public bailout and the return in case of failure.

The anticipation of a bailout ceteris paribus increases the bank's profit in case of failure and therewith total expected payoff. Simultaneously, it also changes the bank's maximization problem from (3.2) to

$$\max_{A,b_s,b_l} (x+a)(\pi_H - b_s) + (1-x-a)\beta + [(x-\delta a)(\pi_H - b_l) + (1-x+\delta a)\beta] - A, \quad (3.6)$$

while the constraints (3.1), (3.3) and (3.4) with respect to the manager's incentives do not alter. As a bailout has the same effects as an increase in π_L, one can immediately see by looking at Propositions 3.1 - 3.3 that a possible bailout does not directly affect compensation payments in any of the given equilibria. Rather, it affects the thresholds $\underline{\rho}$ and $\bar{\rho}$ that determine the actual equilibrium and the bank's profit denoted by (3.2). Receiving a bailout $\beta > \pi_L$ reduces the bank's downside and thus its costs of the short-termist action a. Although any short-termist behavior $a \neq 0$ still is harmful for the bank, the expected loss attributed to this action decreases as β increases. As a consequence, the bank's tradeoff between creating sustainable bank profit by paying long-term bonuses and reducing compensation costs by paying short-term bonuses changes:

Proposition 3.4. *Suppose the government pays a bailout $\beta > \pi_L$. This bailout leads to thresholds $\underline{\rho}^\beta$ and $\bar{\rho}^\beta$ that separate equilibria, with $\underline{\rho}^\beta < \underline{\rho}$ and $\bar{\rho}^\beta < \bar{\rho}$. It*
1. induces an increase in short-term bonuses, a decrease in long-term compensation, and higher levels of short-termism if $\rho \in \left(\underline{\rho}^\beta, \bar{\rho}\right)$,
2. and, has neither an effect on compensation payments nor on short-termism if $\rho \leq \underline{\rho}^\beta$ or $\rho \geq \bar{\rho}$.

If a bank can reckon with a governmental bailout in case of a bad outcome, it changes its contract offers to managers and thereby compensation composition and incentives. By receiving a bailout $\beta > \pi_L$, the bank's costs of the manager's short-termist behavior decrease as the bank in case of failure does not loose $\pi_H - \pi_L$ anymore in comparison to success, but only $\pi_H - \beta$. This leads to changes both with respect to equilibrium selection (extensive margin) as well as with respect to choices for a given equilibrium (intensive margin) as shown in Figure 3.1.

On the extensive margin, the thresholds for the manager's impatience that determine equilibria decline from $\underline{\rho}$ to $\underline{\rho}^\beta$ and $\bar{\rho}$ to $\bar{\rho}^\beta$. This decline in thresholds leads to a situation where the two equilibria with short-termism $a > 0$ (denoted in Propositions 3.2 and 3.3) are more likely to occur, i.e. in addition to $\rho > \underline{\rho}$ also for $\rho \in \left(\underline{\rho}^\beta, \underline{\rho}\right)$. Especially, the equilibrium with very high harmful short-termism $a = \bar{a}$ (Proposition 3.2) is more likely to occur, i.e. the range increases by $\rho \in \left(\bar{\rho}^\beta, \bar{\rho}\right)$. In addition to higher short-termism, this shift in the equilibrium for those ranges of ρ leads to an increase in short-term bonuses, e.g. for $\rho \in \left(\underline{\rho}^\beta, \underline{\rho}\right)$ from $b_s = \frac{\delta I}{(1+\delta)x}$ to $b_s = \frac{akx+\delta I-\delta\frac{k}{2}a^2}{(1+\delta)x}$, and to a reduction in long-term bonuses, e.g. for $\rho \in \left(\bar{\rho}^\beta, \bar{\rho}\right)$ from $b_l = \frac{I-akx-\frac{k}{2}a^2}{(1+\delta)x}(1+\rho)$ to $b_l = 0$. In the absence of a bailout, it is not profitable for the bank to tolerate (high) short-termism for these ranges of ρ. In the presence of a bailout in case of failure, this changes. The bank is willing to tolerate (higher) short-termism in order to save compensation costs that arise due to the manager's impatience. Thereby, it fully neglects the negative external effects it imposes on the government that pays the bailout.

On the intensive margin, similar effects on the composition of incentive pay and tolerated short-termism can be observed for discount rates $\rho \in \left(\underline{\rho}, \bar{\rho}^{\beta}\right)$. For this range, both without and with a bailout the equilibrium denoted in Proposition 3.3 applies. Again, the bank equalizes marginal benefits and marginal costs of an increase of short-termism. However, the only change to (3.5) arises in the marginal costs an increase in short-termism would cause on expected profits (A) for which the absolute value decreases for $\beta > \pi_L$. Consequently, comparative statics on (3.5) show that the bank tolerates higher levels of harmful and inefficient short-termism for $\beta > \pi_L$ and that it changes incentive payments. It reduces compensation costs by lowering the long-term bonus, while it increases the short-term bonus to maintain effort incentives. That this action alters the manager's short-termist behavior is neglected by the bank as the government carries over part of the possible loss via the bailout.

However, if ρ is small or large enough, i.e. $\rho \leq \underline{\rho}^{\beta}$ or $\rho \geq \bar{\rho}$, the according equilibrium denoted either in Proposition 3.1 or 3.2 does not change for this particular discount rate. Short-termism stays either zero (for $\rho \leq \underline{\rho}^{\beta}$) or $a = \bar{a}$ (for $\rho \geq \bar{\rho}$). In both cases neither compensation payments nor short-termism change as the tradeoff for the bank stays the same. For $\rho \leq \underline{\rho}^{\beta}$, the benefit from the bailout is still lower than the remaining costs that short-termism entails. Therefore, it is still more profitable for the bank to give effort incentives via a high long-term bonus while preventing the yet harmful short-termism. In case that $\rho \geq \bar{\rho}$, the manager's discount rate is just too high for it could become profitable to reduce short-termism by paying a long-term bonus. As the cost structure of the short-termist action does not change, short-termism stays unchanged.

Overall, a bailout may or may not affect incentive payments and short-termism. While a bailout does not influence payments and short-termism for very high or very low discount rates, it distorts incentive payments towards short-term bonuses and increases short-termism for a large range of discount rates. Moreover, a bailout makes it more likely in general that the bank focuses on short-term bonuses rather than giving incentives by long-term payments to its manager and that it tolerates inefficiently high short-termism.

3.5. Effects of a Bonus Tax

Anticipating the negative external effects a bailout imposes on short-termism in banking, the government in $t = 0$ may introduce a bonus tax $t_b \in [0, 1)$ on short-term bonuses. At first sight, a bonus tax which is imposed on the manager's short-term bonus and which has to be paid by the manager does not hit the bank as the bank's maximization problem (3.6) does not change. Nevertheless, implicitly it also affects the bank as it impacts the constraints the bank faces. The manager only cares about his net-compensation consisting of the fixed wage A, the short-term bonus net of taxes $(1 - t_b)\, b_s$ and the long-term bonus b_l. This changes the manager's participation constraint from (3.3) to (3.7), his incentives towards exerting effort from (3.4) to (3.8), and the first order condition of undertaking short-termism from (3.1) to (3.9), respectively.

$$A + (x + a)(1 - t_b)\, b_s + (x - \delta a)\, \tfrac{b_l}{1+\rho} - I - \tfrac{k}{2} a^2 \geq \underline{u} \tag{3.7}$$

$$(x + a)(1 - t_b)\, b_s + (x - \delta a)\, \tfrac{b_l}{1+\rho} - I - \tfrac{k}{2} a^2 \geq 0 \tag{3.8}$$

$$a^* = \max\left\{0, \tfrac{1}{k}\left[(1 - t_b)\, b_s - \delta \tfrac{b_l}{1+\rho}\right]\right\} \tag{3.9}$$

For given compensation payments, a bonus tax lowers the manager's net compensation and will make him reject the contract he would accept without bonus tax. Otherwise, if the bank wants to incentivize the manager to exert high effort, it has two options to draw on: either it incentivizes the manager to exert effort by increasing the short-term bonus b_s in a way such that the manager is fully compensated for the bonus tax, or it ensures high effort by changing the composition of compensation payments towards the discounted long-term bonus b_l. Either way, a bonus tax is associated with higher compensation payments and thus higher costs for the bank in expectation: either because of compensating the manager for the bonus tax, or by inducing a suboptimal compensation composition.

Proposition 3.5. *Suppose the government pays a bailout $\beta > 0$, but imposes a bonus tax $t_b \in (0, 1)$ on short-term bonuses b_s. Then, a bonus tax leads to thresholds $\underline{\rho}^t$ and $\bar{\rho}^t$ that separate equilibria, with $\underline{\rho}^t > \underline{\rho}^\beta$ and $\bar{\rho}^t > \bar{\rho}^\beta$, and has effects opposed to those of a bailout. For $\rho \in \left(\underline{\rho}^\beta, \bar{\rho}^t\right)$, it induces a reduction of net short-term bonuses accompanied by an increase of long-term payments. For very high taxes, $t_b \geq \frac{\rho}{1+\rho} \equiv t_b^+$, no short-term bonuses are paid.*

Likewise to the anticipation of a bailout, the bank also changes its contract offers to managers when a bonus tax is introduced. While a bailout decreases the bank's cost of the manager's short-termist behavior, a tax on short-term bonuses increases the costs of paying a short-term bonus to the manager. For the bank, this changes the tradeoff between short-term and long-term compensation.

However, the bank anticipates that the composition of compensation payments directly influences the manager's first order condition with respect to short-termism. Through this channel, a bonus tax also affects equilibrium short-termism tolerated by the bank and has effects on the extensive margin of equilibrium selection as well as on equilibrium choice on the intensive margin as shown in Figure 3.1.

Proposition 3.6. *Suppose the government pays a bailout $\beta > 0$, but imposes a bonus tax $t_b \in (0, 1)$ on short-term bonuses b_s. Then,*
1. the bonus tax reduces harmful short-termism for a broad range of discount rates $\rho \in \left(\underline{\rho}^{\beta}, \bar{\rho}^{t}\right)$ and has no effect for very high (for $\rho \geq \bar{\rho}^{t}$) or very low discount rates (for $\rho \leq \underline{\rho}^{\beta}$).
2. The bonus tax $\underline{t_b}$ necessary to shift back the lower threshold $\underline{\rho}^{t}$ to its second-best level $\underline{\rho}$ differs from the bonus tax $\bar{t}_b$ necessary to shift back the upper threshold, i.e. $\underline{t_b} \mid_{\underline{\rho}^{t}=\underline{\rho}} \neq \bar{t}_b \mid_{\bar{\rho}^{t}=\bar{\rho}^{t}}$.

A comparison between the effects that a bailout imposes (Proposition 3.4) with the effects a tax on short-term bonuses implies (Propositions 3.5 and 3.6) shows the opposing impacts both have on compensation payments and short-termism.[93]

On the extensive margin, the increase of the threshold from $\underline{\rho}^{\beta}$ to $\underline{\rho}^{t}$ makes the situation without short-termism, i.e. $a = 0$ more likely to occur and, at the same time, the shift from $\bar{\rho}^{\beta}$ to $\bar{\rho}^{t}$ reduces the likelihood of a situation with very high short-termism $a = \bar{a}$. In this respect, a bonus tax imposes an opposing effect than the bailout on the bank, and increases not only the costs of short-term bonuses, but also the costs of short-termism per se. By internalizing some of the costs a bailout entails, the government can induce the bank to set its incentives in such a way that short-termism is going to be avoided in the presence of a tax where it is strictly positive in the absence of a tax: with taxation, short-termism will be avoided not only for $\rho \in (0, \underline{\rho}^{\beta}]$, but will be set to $a = 0$ also for $\rho \in (\underline{\rho}^{\beta}, \underline{\rho}^{t}]$ in equilibrium.

[93] For welfare as defined in Subsection 3.3.2, a bailout increases welfare reducing (as inefficient) short-termism while a bonus tax can serve as a converse instrument that increases welfare. Apart from efficiency concerns, a government with redistributive objectives might use the fact that a bailout naturally increases $E(U_P)$ while a bonus tax just has the opposite effect on $E(U_P)$. Regarding the manager, both a bailout and a bonus tax do not affect his expected rents as the participation constraint (3.7) is always binding.

However, a bonus tax may strongly affect the composition of incentive payments. Especially for $\rho \in (\underline{\rho}^{\beta}, \underline{\rho}^{t}]$, where in absence of a bonus tax short-termism is strictly positive in equilibrium, the bonus tax makes short-termism unprofitable. In order to prevent short-termism, the long-term compensation has to increase, which makes it possible for the bank to reduce the short-term bonus net of taxes that the manager receives while it maintains effort incentives. Nevertheless, as the manager has to be compensated for the bonus tax, the gross short-term bonus paid to the manager may even increase due to the tax duty, depending on the bonus tax.

For very high bonus taxes, paying a short-term bonus may even not be an equilibrium anymore. For the range in which short-termism is set at $a = 0$ in equilibrium, i.e. $\rho \leq \underline{\rho}^{t}$, there exists another threshold $t_b^+ \equiv \frac{\rho}{1+\rho}$ which specifies whether $b_s = 0$ or $b_s > 0$. For the first case, consider a very small discount rate, and a small but sufficiently large bonus tax, such that short-term bonuses become more expensive than long-term bonuses. In this case, the bank will not make the manager's incentive constraint with respect to short-termism a binding anymore, but will concentrate only on the long-term bonus. In detail, whenever $t_b \geq t_b^+$, the short-term bonus is more expensive than a long-term bonus, and so the principal will pay only an increased long-term bonus $b_l = \frac{(1+\rho)I}{x}$ and will abstain from paying any short-term bonus at all, i.e. the short-term bonus decreases to $b_s = 0$.[94] For the second case $b_s > 0$, a short-term bonus is in spite of the bonus tax $t_b < t_b^+$ still cheaper than the discounted long-term compensation. Therefore, the bank will pay a short-term bonus $b_s = \frac{\delta I}{(1-t_b)(1+\delta)x}$ and a long-term compensation $b_l = \frac{(1+\rho)I}{(1+\delta)x}$. While the short-term bonus increases gross and stays constant net of the bonus tax, the long-term bonus b_l does not change.

On the intensive margin, i.e. for $\rho \in \left(\bar{\rho}^{t}, \bar{\rho}^{\beta}\right)$, short-termism decreases as a consequence of the bonus tax. Higher costs for the short-term bonus induce the bank to shift compensation towards more long-term bonuses. This in turn gives less incentives to the manager for short-termist behavior who therefore decreases short-termism below the level in the absence of a bonus tax. For compensation payments, the shift towards the long-term bonus enables the bank to lower the net short-term bonus. However, the gross short-term bonus may decrease or increase, depending on the strength of two effects. On the one hand, the tax duty causes a positive direct effect by which the manager will ask for a higher gross short-term bonus in order to be equally well off net of taxes. On the other

[94] Note that in the limit, there must exist some discount rates $\rho > 0$ for which any tax $t_b > 0$ is above the threshold t_b^+. Therefore, there exist discount rates ρ for which any tax $t_b > 0$ yields an equilibrium short-term bonus $b_s = 0$.

hand, as the bonus tax makes short-termism less profitable for the bank, the bank will incentivize less short-termist behavior. This indirect effect causes the negative effects on the net short-term bonus, which itself affects the gross bonus payment.

Despite its reduced likelihood due to $\bar{\rho}^t > \bar{\rho}^\beta$, there still exists the equilibrium with very high short-termism if $\rho \geq \bar{\rho}^t$. Even with a bonus tax, tolerating short-termism $a = \bar{a}$ is still more profitable for the bank than paying a higher long-term bonus b_l. As a result, net compensation will stay constant both for the short-term bonus at $(1 - t_b)\, b_s = \sqrt{2kI + k^2x^2} - kx$ and the long-term bonus $b_l = 0$. However, the gross short-term bonus increases proportionately to the bonus tax in order to compensate the manager for the tax expenses and causes higher costs for the bank.

3.6. Conclusion

In this chapter, we modeled a principal-agent structure with two periods in order to analyze moral hazard both with respect to effort and managerial short-termism. This was used to study the effects of both a bailout and a tax on short-term bonuses on short-termism and managerial compensation.

We find that banks may already tolerate harmful and inefficient short-termism in a second-best equilibrium in the absence of a bailout. This allows a bank to reduce compensation costs for incentivizing the manager to act in its interest. When banks in addition anticipate a future bailout in case of bankruptcy, in most cases it is profitable for them to change compensation structure towards higher short-term payments. So, the bank on the one hand can save on more expensive long-term compensation, while on the other hand it does not have to bear its cost of increased managerial short-termism. As a result, a governmental bailout does not only increase the likelihood of short-termist behavior in general, it also raises existing excessive short-termism even further.

In such a situation, the model suggests the introduction of a tax specifically based on short-term bonuses. Ceteris paribus, the manager will ask for a higher short-term bonus gross of taxes to be compensated for the additional tax burden, leading to higher compensation costs for the short-term bonus. In addition, a bonus tax makes managerial short-termism even less attractive for the bank and thereby induces the bank to tolerate less of it. It turns out that a bonus tax can reverse the negative effects a bailout entails on short-termism and compensation. Furthermore, it can be used in order that banks internalize the social costs their moral hazard causes in the presence of a bailout.

For real world policy, the results of the model suggest that one reason why we observe managerial short-termism in banking may be banks' anticipating governmental bailouts in case of failure. For banks that can anticipate a bailout, especially if they are too-big-to-fail, the model also explains the bonus culture we observe in the financial industry where bankers get paid high cash bonuses based on short-term results. However, a tax on short-term bonuses may help to reverse the negative effects a bailout entails. It is useful in reducing the overall likelihood of harmful short-termism and in reducing excessive short-termism below its level in the absence of a bonus tax. In that sense, a bonus tax is a good instrument for the government to create a situation where necessary bailouts can credibly be carried out, but where the anticipation of bailouts does not lead to increased moral hazard on the banks' side. In addition, a bonus tax also influences compensation payments to bankers and thus can be used to reduce the often discussed short-term payments of bankers.

Appendix A.

Appendix to Chapter 1

Proof of Proposition 1.2

As $e^{SB} < e^*$ and as (1.13) is concave in e^{SB}, an increase in effort from e^{SB} is welfare improving. As effort decreases in t, t_b and $(-\alpha)$ (Corollaries 1.1 and 1.2), (1.14) is binding whenever $t_b > 0$ and $\alpha < 1$. Rearranging (1.10), the right hand side of $(\pi_1 - \pi_2) = \frac{1-\alpha t}{(1-t)(1-t_b)} \left[C'\left(e^{SB}\right) + e^{SB} C''\left(e^{SB}\right)\right]$ is monotonically increasing in e^{SB}. Thus, welfare is maximized by minimizing $\left(\frac{1-\alpha t}{(1-t)(1-t_b)}\right)$.

Part (i): Follows directly from Corollary 1.1, Part (i) and Corollary 1.2, Parts (i) and (ii).

Part (ii): We solve (1.14) for

$$\alpha\left(t_b, t\right) = \frac{t\left(1-t_b\right)\left[\pi_2 + e^{SB}\left(\pi_1 - \pi_2\right)\right] + t_b e^{SB} C'\left(e^{SB}\right) - \left(1-t_b\right) B}{t e^{SB} C'\left(e^{SB}\right)} \tag{A.1}$$

and insert (A.1) in (1.10). This yields

$$\begin{aligned} F &= (1-t)\left(\pi_1 - \pi_2\right) e^{SB} C'\left(e^{SB}\right) && \text{(A.2)} \\ &\quad - \left[C'\left(e^{SB}\right) + e^{SB} C''\left(e^{SB}\right)\right]\left[B + e^{SB} C'\left(e^{SB}\right) - t\left[\pi_2 + e^{SB}\left(\pi_1 - \pi_2\right)\right]\right] = 0. \end{aligned}$$

Directly, (A.2) only depends on t which proves the substituting nature of α and t_b when a shift in t_b has to be compensated by a shift in $\alpha\left(t_b, t\right)$. In addition, applying the implicit function theorem on (A.2), it can be found that effort is monotonically increasing in the CIT, i.e. $\frac{\partial e}{\partial t} > 0$, as long as $t < \Phi$ with

$\Phi \equiv \frac{B+e^{SB}C'\left(e^{SB}\right)-\frac{C'\left(e^{SB}\right)+e^{SB}C''\left(e^{SB}\right)}{C''\left(e^{SB}\right)+e^{SB}C'''\left(e^{SB}\right)}\left[\pi_1-\pi_2-C'\left(e^{SB}\right)-e^{SB}C''\left(e^{SB}\right)\right]}{\pi_2+e^{SB}(\pi_1-\pi_2)}$. Inserting $B^{max} = \pi_2 + e^{SB}\left[\pi_1 - \pi_2 - C'\left(e^{SB}\right)\right]$, it can be shown that $\Phi \geq t^*$ as long as B is not too high to consume more than the principal's profit. Assuming this, t will be set at its maximum $\bar{t}$.

Part (iii): For $t_b \geq 0$ and $\alpha \leq 1$ optimal taxes are (α^*, t_b^*, t^*) as stated in Part (i) above. As $e_{t^*}^{SB} < e^*$, $e_{sub}^{SB} > e_{t^*}^{SB}$ increases welfare. Starting from $\alpha^* = 1$, $t_b^* = 0$, $t^* = \frac{B}{\pi_2+e^{SB}(\pi_1-\pi_2)(1-b^{SB})}$, and $\left(\frac{1-\alpha t}{(1-t)(1-t_b)}\right) = 1$, a welfare increase can be obtained by $t_{sub}^{SB} > t^*$, $t_b^{sub} < t_b^* = 0$ and/or $\alpha^{sub} > \alpha^* = 1$ which yields $\left(\frac{1-\alpha t}{(1-t)(1-t_b)}\right) < 1$.

Appendix B.

Appendix to Chapter 3

Proof of Lemma 3.1

In first-best, the bank maximizes

$$\max_{a} \quad (x+a)(\pi_H - b_s) + (1-x-a)\,\pi_L + (x-\delta a)\left(\tfrac{\pi_H - b_l}{1+r}\right) + \\ + (1-x+\delta a)\,\tfrac{\pi_L}{1+r} - A \tag{B.1}$$

$$s.t. \qquad A + (x+a)\,b_s + (x-\delta a)\,\tfrac{b_l}{1+\rho} \geq \underline{u} + I + \tfrac{k}{2}a^2 \tag{B.2}$$

By paying total expected compensation $\underline{u} + I + \frac{k}{2}a^2$ as fixed wage, short-term bonus or a combination of both, the manager's participation constraint (B.2) is binding. Maximizing (B.1) w.r.t. a and considering the restricted domain $a \geq 0$ yields $a^{FB} = \max\left\{0, \frac{\pi_H - \pi_L}{k}\left(\frac{1+r-\delta}{1+r}\right)\right\}$. Note that the second order condition of (B.1) w.r.t. a for a maximum is satisfied.

For the welfare maximization, b_l will not be used as it is the only compensation method that negatively affects welfare. Maximizing $E(W) = (x+a)\,\pi_H + (1-x-a)\,\pi_L + (x-\delta a)\,\frac{\pi_H}{1+r} + (1-x+\delta a)\,\frac{\pi_L}{1+r} - I - C(a)$ w.r.t. α yields the first-best result α^{FB}.

Proof of Lemma 3.2

Suppose compensation payments are chosen such that the participation constraint (3.3) and the incentive constraint for effort (3.4) are binding (which will be shown to be optimal in the proofs of Propositions 3.1 to 3.3). Equations (3.3) and (3.4) imply $A = \underline{u}$ and

$$b_s = \frac{I + \frac{k}{2}a^2 - \frac{x-\delta a}{1+\rho}b_l}{x+a}. \tag{B.3}$$

For (i): Intuitively, as $x - \delta a > 0$ by assumption, (B.3) directly shows that the short-term bonus b_s necessary to induce high effort declines in the level of the long-term bonus b_l. Substituting (B.3) in the manager's FOC w.r.t. short-termism gives us:

$$I - \frac{k}{2}a^2 - \frac{x(1+\delta)}{1+\rho}b_l - xak = 0.$$

Using the implicit function theorem yields

$$\frac{\partial a}{\partial b_l} = -\frac{x(1+\delta)}{k(x+a)(1+\rho)} < 0.$$

For (ii): Using $A = \underline{u}$ and (B.3), we can compute the bank's costs of compensating the manager for effort as a function of b_l:

$$V(b_l) = \underline{u} + I + \frac{k}{2}a^2 + (x - \delta a)\frac{\rho - r}{(1+r)(1+\rho)}b_l \tag{B.4}$$

Ceteris paribus, especially leaving a unchanged, compensation costs are increasing in the long-term bonus if $\rho > r$, i.e. $\frac{\partial V}{\partial b_l} > 0$ if $\rho > r$. Moreover, the increase is stronger, the larger ρ is compared to r, i.e. $\frac{\partial \frac{\partial V}{\partial b_l}}{\partial \rho} > 0$.

Proof of Lemma 3.3

Using $\rho = r$ in (B.4), compensation costs become independent of b_l. As part (i) of Lemma (3.2) does not change, using a long-term bonus to induce effort has no effect on compensation costs anymore, but still decreases short-termism. As $\delta > 1$ by assumption, $a = 0$ is optimal for the bank. The bank is indifferent between paying $A = \underline{u}$ (from (3.3)) together with only a long-term bonus $b_l = \frac{(1+\rho)I}{x}$, or paying a combination of short-term and long-term bonus that satisfies both $b_s \leq \frac{\delta b_l}{1+\rho}$ (from (3.1)) and $b_l = (1+\rho)\left(\frac{I}{x} - b_s\right)$ (from (3.4)).

Proof of Propositions 3.1 to 3.3

In order to show the derivation of equilibria only once, the following proofs contain the parameters π_L to analyze the implications of a bailout (by replacing π_L with β) and t_b for the analysis of a bonus tax.

The bank maximizes his expected payoff by choosing A, b_s and b_l:

$$\max_{A,b_s,b_l} (x+a)(\pi_H - b_s) + (1-x-a)\pi_L - A + [(x-\delta a)(\pi_H - b_l) + (1-x+\delta a)\pi_L]$$

subject to the short-termism constraint

$$ak = (1-t_b) b_s - \delta \frac{b_l}{1+\rho}, \tag{B.5}$$

the effort incentive constraint

$$(x+a)(1-t_b) b_s + (x-\delta a)\frac{b_l}{1+\rho} - I - \frac{k}{2}a^2 \geq 0, \tag{B.6}$$

the participation constraint

$$A + (x+a)(1-t_b) b_s + (x-\delta a)\frac{b_l}{1+\rho} - I - \frac{k}{2}a^2 \geq \underline{u}, \tag{B.7}$$

and the nonnegativity constraints $A,\ b_s,\ b_l \geq 0$.

The Lagrangian is then as follows

$$\begin{aligned}
\mathcal{L} \;=\; & (x+a)(\pi_H - b_s) + (1-x-a)\pi_L - A + [(x-\delta a)(\pi_H - b_l) + (1-x+\delta a)\pi_L] \\
& +\lambda \left[A + (x+a)(1-t_b) b_s + (x-\delta a)\frac{b_l}{1+\rho} - I - \frac{k}{2}a^2 - \underline{u}\right] \\
& +\gamma \left[(x+a)(1-t_b) b_s + (x-\delta a)\frac{b_l}{1+\rho} - I - \frac{k}{2}a^2\right] \\
& +\sigma \left[(1-t_b) b_s - \delta \frac{b_l}{1+\rho} - ak\right],
\end{aligned} \tag{B.8}$$

where λ, γ, and σ are the Lagrangian multipliers w.r.t. the participation constraint, the effort incentive constraint, and the short-termism constraint, respectively.

In order to fulfill the effort incentive constraint, variable pay is necessary. In addition, as argumented on page 62, $b_s < \delta\frac{b_l}{1+\rho}$ and especially $b_s = 0$ can never be an equilibrium outcome for the bank if $\rho > 0$. By increasing b_s and simultaneously decreasing b_l, the bank could still induce effort and avoid short-termism, but would reduce total compensation costs and increase bank profit.[95]

Thus, there are three possible solutions to the Lagrangian above.

Proposition 3.1 and 3.3:

Suppose that in the optimal solution $A > 0$, $b_s > 0$ and $b_l > 0$ hold. This implies $\frac{\partial\mathcal{L}}{\partial A} = \frac{\partial\mathcal{L}}{\partial b_s} = \frac{\partial\mathcal{L}}{\partial b_l} = 0$, which yields Lagrangian multipliers

$$\lambda = 1 \tag{B.9}$$

$$\gamma = \frac{\rho\,(x-\delta a)}{x\,(1+\delta)} + \frac{t_b}{1-t_b}\frac{(x+a)\,\delta}{x\,(1+\delta)} \tag{B.10}$$

$$\sigma = \frac{(x+a)\,(x-\delta a)}{(1+\delta)\,x}\left(\frac{t_b}{1-t_b} - \rho\right). \tag{B.11}$$

For $\frac{t_b}{1-t_b} \neq \rho$, all constraints must bind.

Proposition 3.1: Suppose $a = 0$. Algebraic manipulation delivers the optimal contract with $A = \underline{u}$, $b_s = \frac{I}{x}\frac{\delta}{(1+\delta)(1-t_b)}$ and $b_l = \frac{I}{x}\frac{1+\rho}{1+\delta}$. Substituting the optimal payments and (B.9) and (B.10) into $\frac{\partial\mathcal{L}}{\partial a} \leq 0$ yields

$$\frac{\partial\mathcal{L}}{\partial a} = (\pi_H - \pi_L)\,(1-\delta) + (\rho - t_b - t_b r)\,\frac{\delta I}{x\,(1+\delta)\,(1-t_b)} - \sigma k \leq 0. \tag{B.12}$$

Substituting (B.11) in (B.12), $\frac{\partial\mathcal{L}}{\partial a} \leq 0$ is satisfied if and only if

$$\rho \leq \frac{(\pi_H - \pi_L)\,(\delta-1)\,(1+\delta)}{\frac{\delta I}{x} + xk} + \frac{t_b}{1-t_b} \equiv \underline{\rho}^t. \tag{B.13}$$

[95] This is true as long as $t_b = 0$. For $t_b > 0$, a more general proof can be found in the proof of Proposition 3.5.

For $t_b = 0$, (B.13) gives the threshold

$$\underline{\rho} \equiv \frac{(\pi_H - \pi_L)(\delta - 1)(1+\delta)}{\frac{\delta I}{x} + xk}, \tag{B.14}$$

for which the specification given in Proposition 3.1 indeed is an equilibrium.

Proposition 3.3: Suppose $a > 0$. Algebraic manipulation delivers the optimal contract with $A = \underline{u}$, $b_s = \frac{akx+\delta I-\delta\frac{k}{2}a^2}{(1-t_b)(1+\delta)x}$ and $b_l = \frac{I-akx-\frac{k}{2}a^2}{(1+\delta)x}(1+\rho)$. Substituting the optimal payments and (B.9), (B.10) and (B.11) into $\frac{\partial\mathcal{L}}{\partial a} = 0$ yields

$$\begin{aligned}(\pi_H - \pi_L)(1-\delta) - \frac{akx+\delta I - \delta\frac{k}{2}a^2}{(1-t_b)(1+\delta)x} + \delta\frac{I - akx - \frac{k}{2}a^2}{(1+\delta)x}(1+\rho)& \\ -\frac{(x+a)(x-\delta a)k}{x(1+\delta)}\left(\frac{t_b}{1-t_b} - \rho\right) &= 0\end{aligned} \tag{B.15}$$

For $t_b = 0$, (B.15) simplifies to (3.5) and yields the optimal a for the equilibrium specified in Proposition 3.3.

Applying the implicit function theorem on (3.5), $\frac{\partial a}{\partial \rho} > 0$ can be shown.

Proposition 3.2:

Suppose that in the optimal solution $A > 0$, $b_s > 0$ and $b_l = 0$ hold. This implies $\frac{\partial\mathcal{L}}{\partial A} = \frac{\partial\mathcal{L}}{\partial b_s} = 0$ and $\frac{\partial\mathcal{L}}{\partial b_l} \leq 0$, which yields Lagrangian multipliers

$$\lambda = 1 \tag{B.16}$$

$$\gamma \leq \frac{\rho(x-\delta a) + \delta\frac{t_b}{1-t_b}(x+a)}{x(1+\delta)} \tag{B.17}$$

$$\sigma = \frac{t_b}{1-t_b}(x+a) - \gamma(x+a). \tag{B.18}$$

For $\frac{t_b}{1-t_b} \neq \gamma$, all constraints must bind. For $b_s > 0$ and $b_l = 0$, $a > 0$ holds due to (B.5). Algebraic manipulation delivers the optimal contract with $A = \underline{u}$, $b_s = \frac{\sqrt{2kI+k^2x^2}-kx}{(1-t_b)}$ and $b_l = 0$. Short-termism is given by $a = \bar{a} \equiv \frac{1}{k}\left(\sqrt{2kI+k^2x^2} - kx\right)$. In order that $a > 0$ is optimal, $\frac{\partial \mathcal{L}}{\partial a} = 0$ must hold. Using the optimal compensation and (B.16) and (B.17), $\frac{\partial \mathcal{L}}{\partial a}$ is given by:

$$\frac{\partial \mathcal{L}}{\partial a} = (\pi_H - \pi_L)(1-\delta) - \frac{ak}{(1-t_b)} - \frac{t_b}{1-t_b}(x+a)k + \gamma(x+a)k = 0. \tag{B.19}$$

Solving (B.19) for γ and substituting in (B.17), $\frac{\partial \mathcal{L}}{\partial a} = 0$ is only satisfied if

$$\rho \geq \frac{x(1+\delta)}{x-\delta a} \frac{\frac{ak}{1-t_b} + (\pi_H - \pi_L)(\delta - 1)}{(x+a)k} + \frac{t_b}{1-t_b} \equiv \bar{\rho}^t. \tag{B.20}$$

For $t_b = 0$, (B.20) gives the threshold

$$\bar{\rho} \equiv \frac{x(1+\delta)}{x-\delta a} \frac{ak + (\pi_H - \pi_L)(\delta - 1)}{(x+a)k}, \tag{B.21}$$

for which the specification given in Proposition 3.2 indeed is an equilibrium.

Proof of Proposition 3.4

A bailout of size β is modeled as comparative statics analysis of an increase in π_L. Applying comparative statics on (B.14) and (B.21) with respect to π_L yields $\frac{\partial \underline{\rho}}{\partial \pi_L} = -\frac{(\delta-1)(1+\delta)}{\frac{\delta I}{x}+xk} < 0$ and $\frac{\partial \bar{\rho}}{\partial \pi_L} = -\frac{x(1+\delta)}{x-\delta\bar{a}}\frac{(\delta-1)}{(x+\bar{a})k}, < 0$, with $\frac{\partial^2 \underline{\rho}}{\partial \pi_L^2} = \frac{\partial^2 \bar{\rho}}{\partial \pi_L^2} = 0$. Note that for $\frac{\partial \bar{\rho}}{\partial \pi_L}$, $\bar{a}$ is independent of π_L. Thus, both threshold are linearly decreasing in the size of the bailout.

A change from $\underline{\rho}$ to $\underline{\rho}^\beta$ and $\bar{\rho}$ to $\bar{\rho}^\beta$ leads to new thresholds that separate the equilibria denoted in Propositions 3.1 - 3.3. For both cases $\rho \leq \underline{\rho}^\beta$ and $\rho \geq \bar{\rho}$, the equilibrium does not change with a bailout. As both compensation and short-termism denoted in Propositions 3.1 and 3.2 are independent of π_L, neither compensation payments nor short-termism changes. This proves part 2.

For part 1, three effects can be distinguished.

1. For $\rho \in \left(\underline{\rho}^\beta, \underline{\rho}\right)$, the equilibrium without a bailout was characterized by Proposition 3.1 with short-termism $a = 0$ and compensation $A = \underline{u}$, $b_s = \frac{I}{x}\frac{\delta}{(1+\delta)}$ and $b_l =$

$\frac{I}{x}\frac{1+\rho}{1+\delta}$. As $\underline{\rho}$ decreases to $\underline{\rho}^{\beta}$ in presence of a bailout, for discount rates $\rho \in \left(\underline{\rho}^{\beta}, \underline{\rho}\right)$ now the equilibrium specified in Proposition (3.3) applies, where short-termism is strictly positive. For $a > 0$, the long-term bonus $b_l = \frac{I-akx-\frac{k}{2}a^2}{(1+\delta)x}(1+\rho)$ defined in Proposition (3.3) is smaller than $b_l = \frac{I}{x}\frac{1+\rho}{1+\delta}$ in absence of a bailout. To make the effort incentive constraint (3.4) binding, b_s has to increase. as defined by equation (3.5).

2. For $\rho \in \left(\bar{\rho}^{\beta}, \bar{\rho}\right)$, the equilibrium without a bailout was characterized by Proposition 3.3 with short-termism $a \in (0, \bar{a})$ and bonuses $b_s = \frac{akx+\delta I-\delta\frac{k}{2}a^2}{(1+\delta)x} > 0$ and $b_l = \frac{I-akx-\frac{k}{2}a^2}{(1+\delta)x}(1+\rho) > 0$. With a bailout, the equilibrium as defined in Proposition 3.2 applies with $a = \bar{a}$, $b_s = \sqrt{2kI + k^2x^2} - kx$ and $b_l = 0$, where b_s is higher due to its sole effort incentive function.

3. For $\rho \in \left(\underline{\rho}, \bar{\rho}^{\beta}\right)$, without and with a bailout, the equilibrium denoted in Proposition 3.3 applies. Here, using the implicit function theorem on (3.5), comparative statics show $\frac{\partial a}{\partial \pi_L} = \frac{(\delta-1)(1+\delta)x}{3ka\delta\rho+(2\delta\rho+1+\delta-\rho)kx} > 0$. For compensation, $\frac{\partial b_s}{\partial \pi_L} = \frac{\partial b_s}{\partial a}\frac{\partial a}{\partial \pi_L} = \left[\frac{k}{x(1+\delta)}(x-\delta a)\right]\frac{\partial a}{\partial \pi_L} > 0$ and $\frac{\partial b_l}{\partial \pi_L} = \frac{\partial b_l}{\partial a}\frac{\partial a}{\partial \pi_L} = \left[-\frac{k(1+\rho)}{x(1+\delta)}(x+a)\right]\frac{\partial a}{\partial \pi_L} < 0$ applies as, by assumption, $x - \delta a > 0$.

Proof of Proposition 3.5

Part 1: Comparative statics on $\underline{\rho}^t$ and $\bar{\rho}^t$ defined in equations (B.13) and (B.20), respectively show that both threshold levels are increasing in a bonus tax, i.e. $\frac{\partial \underline{\rho}^t}{\partial t_b} = \frac{1}{(1-t_b)^2} > 0$ and $\frac{\partial \bar{\rho}^t}{\partial t_b} = \frac{\partial \bar{\rho}^t}{\partial t_b} + \frac{\partial \bar{\rho}^t}{\partial a}\frac{\partial a}{\partial t_b} = \frac{1}{(1-t_b)^2} + \frac{(1+\delta)xa}{(x-\delta a)(x+a)(1-t_b)^2} > 0$. Note that $\frac{\partial^2 \underline{\rho}^t}{\partial t_b^2} > 0$ and $\frac{\partial^2 \bar{\rho}^t}{\partial t_b^2} > 0$.

Part 2:

1. For $\rho \geq \bar{\rho}^t$, the equilibrium is given in the proof of Proposition 3.2 with $a = \bar{a}$. As for $b_s = \frac{\sqrt{2kI+k^2x^2}-kx}{(1-t_b)}$ comparative statics show $\frac{\partial b_s}{\partial t_b} = \frac{b_s}{(1-t_b)} > 0$, the gross short-term bonus proportionally increases with the bonus tax t_b, while the net-bonus $(1-t_b)\, b_s = \sqrt{2kI + k^2x^2} - kx$ stays unchanged.

2. For $\rho \leq \underline{\rho}^t$, the proof of Proposition 3.1 includes the effects of a small tax. For a higher tax, the argument that $b_s = 0$ can never be an equilibrium (as stated on pages 62 and 78) is not true anymore. As long as the costs of the short-term bonus are smaller as those of the long-term bonus, the equilibrium will be given by $A = \underline{u}$,

$b_s = \frac{I}{x}\frac{\delta}{(1+\delta)(1-t_b)}$ and $b_l = \frac{I}{x}\frac{1+\rho}{1+\delta}$ as denoted in the proof of Proposition 3.1 and the short-term bonus will increase gross of taxes but stay constant net of taxes.

For taxes above a threshold t_b^+, the long-term bonus becomes cheaper than the short-term bonus. Formally, to determine t_b^+, we use the Lagrangian from equation (B.8) and search for a threshold where $\frac{\partial \mathcal{L}}{\partial A} = \frac{\partial \mathcal{L}}{\partial b_l} = 0$ and $\frac{\partial \mathcal{L}}{\partial b_s} \leq 0$. Moreover, as for $\rho \leq \underline{\rho}^t$ equilibrium short-termism is given by $a = 0$, we can the choice of short-termism and set $a = \sigma = 0$. $\frac{\partial \mathcal{L}}{\partial A} = 0$ yields $\lambda = 1$, which we can use with $\frac{\partial \mathcal{L}}{\partial b_l} = 0$ to get $\gamma = \rho$. Inserting $\lambda$and γ in $\frac{\partial \mathcal{L}}{\partial b_s} \leq 0$, yields the threshold for which $b_s = 0$ is an equilibrium, i.e. if and only if

$$t_b \geq \frac{\rho}{1+\rho} \equiv t_b^+.$$

Algebraic manipulation delivers the optimal contract with $A = \underline{u}$, $b_s = 0$ and $b_l = \frac{(1+\rho)I}{x}$. The bonus tax leads to a short-term bonus of zero and a higher long-term bonus compared to a no-tax scenario.

3. For $\underline{\rho}^t \leq \rho \leq \bar{\rho}^t$, the equilibrium is given in the proof of Proposition 3.3 with $b_s = \frac{akx+\delta I-\delta\frac{k}{2}a^2}{(1-t_b)(1+\delta)x}$ and $b_l = \frac{I-akx-\frac{k}{2}a^2}{(1+\delta)x}(1+\rho)$. Comparative statics show

$$\frac{\partial b_s(a)}{\partial t_b} = \frac{\partial b_s(a)}{\partial t_b} + \frac{\partial b_s(a)}{\partial a}\frac{\partial a}{\partial t_b} = \frac{b_s}{1-t_b} + \frac{(x-\delta a)k}{(1-t_b)(1+\delta)x}\frac{\partial a}{\partial t_b} \gtreqless 0, \quad \text{(B.22)}$$

$$\frac{\partial b_l(a)}{\partial t_b} = \frac{\partial b_l(a)}{\partial a}\frac{\partial a}{\partial t_b} = -\frac{(1+\rho)k}{(1+\delta)x}(x+a)\frac{\partial a}{\partial t_b} > 0. \quad \text{(B.23)}$$

As $\frac{\partial a}{\partial t_b} < 0$ for $t_b < t_b^+$ (as will be shown in the Proof of Proposition 3.6), the long-term bonus b_l is increasing in the bonus tax. For the gross short-term bonus, two opposing effects influence its reaction on the bonus tax: a positive direct effect (first term) and a negative indirect effect (second term). For the short-term bonus net of taxes, only the indirect effect matters.

Proof of Proposition 3.6

Part 1:

1. For $\rho \geq \bar{\rho}^t$, the equilibrium is given in the proof of Proposition 3.2 with $a = \bar{a}$.

2. For $\rho \leq \underline{\rho}^t$, the equilibrium is given in the proof of Proposition 3.1 with $a = 0$. For the range of parameters $\rho \in (\underline{\rho}^\beta, \underline{\rho}^t]$, a bonus tax changes equilibrium short-termism from $a > 0$ in the absence of a tax to $a = 0$ under taxation.

3. For $\underline{\rho}^t < \rho < \bar{\rho}^t$, the equilibrium is given in the proof of Proposition 3.3. Using the implicit function theorem on (B.15) yields

$$\frac{\partial a}{\partial t_b} = \frac{\frac{1}{(1-t_b)^2}\left[\frac{akx+\delta I-\delta\frac{k}{2}a^2}{(1+\delta)x} + \frac{(x+a)(x-\delta a)k}{(1+\delta)x}\right]}{\frac{k}{(1+\delta)x}\left[-\frac{x-\delta a}{1-t_b} - \delta\left(1+\rho\right)\left(x+a\right) - \left(\frac{t_b}{1-t_b} - \rho\right)\left(x - \delta x - 2\delta a\right)\right]}.$$

As the numerator is clearly positive (note that $\frac{akx+\delta I-\delta\frac{k}{2}a^2}{(1+\delta)x} = (1-t_b)\,b_s \geq 0$), the sign of the denominator determines the sign of $\frac{\partial a}{\partial t_b}$. The denominator is negative, whenever $t_b < \frac{x(1+\delta)+2\delta\rho x-\rho x+3\delta a\rho}{2x\delta-x+3\delta a+2\delta\rho x-\rho x+3\delta a\rho} \equiv \tilde{t_b}$ holds and especially at $t_b = 0$. Note that for the denominator to be positive, $t_b > t_b^+$ is a necessary condition.

Moreover, for the range of parameters $\rho \in [\bar{\rho}^\beta, \bar{\rho}^t)$, a bonus tax changes equilibrium short-termism from $a = \bar{a}$ in the absence of a tax to $a < \bar{a}$ under taxation.

Part 2: Using (B.13) and (B.20) and setting $\pi_L = t_b = 0$, we get the threshold levels $\underline{\rho}$ and $\bar{\rho}$ in the absence of a bailout and a bonus tax.

1. By setting $\underline{\rho}^t$ equal to $\underline{\rho}$, we can derive the bonus tax that is necessary in order that the bank fully internalizes the costs of the bailout, i.e. $\underline{t_b} = \frac{(\delta-1)(1+\delta)\beta}{\frac{I\delta}{x}+xk+(\delta-1)(1+\delta)\beta}$.
2. Similarly, by setting $\bar{\rho}^t$ equal to $\bar{\rho}$, we can derive the bonus tax that is necessary in order that the bank fully internalizes the costs of the bailout, i.e. $\bar{t_b} = \frac{(\delta-1)(1+\delta)\beta}{2\delta I-x\beta-kx^2+2x\sqrt{k^2x^2+2Ik}+x\beta\delta^2}$.
3. Under our assumptions, $\underline{t_b} = \bar{t_b}$ iff $\frac{I\delta}{x} + xk + (\delta-1)(1+\delta)\beta = 2\delta I - x\beta - kx^2 + 2x\sqrt{k^2x^2+2Ik} + x\beta\delta^2$. This is only the case by strongly constraining δ, β, I, x or k on certain parameter values.

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