Is Making Deferred (Bonus) Pay Mandatory a Good Idea for Banking?

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Abstract

This paper assesses the case for forcing financial institutions to defer bonus pay so as to make incentives more commensurate with the longer-term risk of transactions. We derive conditions for when such mandatory deferred compensation curbs risk-taking and improves the quality of assets. But we also show when such regulatory interference has the *opposite* effect of leading to deferred but more high-powered incentives and thus, ultimately, to a lower quality of assets. Our modeling framework allows us to study, more generally, the interaction of financial institutions' own *internal agency* problem with *external agency* problems that arise from securitization.

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1 Introduction

In the wake of the current (as of mid 2009) global financial crisis, the financial industry's bonus-driven compensation scheme is being blamed for everything from the housing market bubble to the implosion of the markets for CDOs or, more sweepingly, the demise of the Anglo-American financial system. Consequently, both practitioners and academics have been demanding regulatory intervention.[1]

As the crisis unfolds, financial institutions, at least in hindsight, arguably have taken on too much risk. Furthermore, highly "front-loaded" compensation for investment bankers or mortgage brokers may have played a key role in this. Agents who are paid commissions, fees, or a bonus based mainly on yearly or even shorter-term revenues take little account of the longer-term risk – e.g., the long-term performance of a loan. Such high-powered and short-term incentives may, though, be optimal for financial institutions that themselves have a high appetite for risk. Reining in their risk-taking could, however, be achieved by standard means, such as stricter capital adequacy requirements and, thus, would not require policy makers to micromanage firms' internal compensation strategies.[2] It is equally unconvincing that financial institutions should be unable to choose optimal compensation schemes, because they are in a rat race to attract the best staff.[3] Labor-market competition should not prevent individual banks from striking the at least privately optimal trade-off between costs of compensation and (risk-taking) incentives.[4]

One contribution of this paper is to provide a consistent rationale for regulating compensation in the financial industry. However, our results also provide a stern warning, as such a policy may have unintended consequences.

We consider the compensation of an agent who could be an investment banker, but

[1] See, e.g., Rajan, Raghuram, "Bankers' pay is deeply flawed." *Financial Times*, Jan 9 2008; or, more generally, Institute of International Finance (2008).

[2] That being said, financial supervisors may wish to incorporate the structure of financial institutions' compensation schemes into their risk measures. They could then end up imposing additional capital charges for banks with high-powered and short-term incentive structures. A related point is made by Bebchuk and Spamann (2009). They focus on the fact that tying a bank's agents' incentives to those of its common shareholders – e.g., through executive stock options, creates a risk-shifting problem.

[3] See, e.g., Wolf, Martin, "Regulators should intervene in bankers' pay." *Financial Times*, Jan 16 2008.

[4] In fact, as more intense labor-market competition increases agents' reservation values, standard agency theory would predict a *positive* relationship between contractual efficiency and competition. Acharya and Volpin (2009) or Dicks (2009) provide a more sophisticated argument. They assess the scope for regulating corporate governance when a firm's choice of governance – which serves as a substitute for incentive pay – affects the outside option of its competitors' executives.

also a loan officer or mortgage broker. The agent has two tasks to perform: to identify a possible deal-making opportunity and, subsequently, to assist in deciding whether or not to undertake this transaction. For a mortgage broker, the second task could be simply to ensure that the appropriate information about a prospective borrower is correctly fed into the system (instead of, say, colluding with the customer and providing wrong or misleading information). A loan officer, instead, may be asked to provide additional soft information that is relevant for credit-risk analysis.[5] Moreover, the decision whether to undertake a deal may also be delegated to the respective agent.[6] This is more likely if the deal is complex.

The agent does not directly bear risk associated with the transaction, which creates an *internal* agency problem. However, the originating institution also may not remain fully exposed, as it could securitize some or all of the generated assets or cash flows. In this case, there is an additional *external* agency problem. Our model studies how these two agency problems interact.

In the model, the agent's compensation can be short-term or long-term, as well as more or less high-powered. When compensation is deferred, it can be made contingent on more information about the quality of the transaction – e.g., whether a borrower ultimately defaults. However, in line with much of the literature (cf. Section 2), we presume that deferring compensation is costly, as the agent has a higher time (or liquidity) preference than the firm.[7]

The incentives that the bank gives the agent determine both how effort is exerted to locate potentially profitable transactions and which transactions will ultimately be made. If deals are undertaken irrespective of their quality, then this reduces the agent's incentive problem to a single task: generating deals. Consequently, the optimal compensation will be very high-powered and only short-term. This observation suggests that by forcing the bank to defer compensation, the bank could be induced to use the additional available

[5] As noted by Berger and Udell (2002), such information may be "hard to quantify, verify and communicate through the normal transmission channels of a banking organization." See, also, Inderst (2008) for a model of soft-information lending in a multi-task framework.

[6] In this case, the (additional) judgment of a risk officer would then be reduced to a mere rubber stamping of the deal-maker's "suggestion."

[7] As is standard, this presumes that the agent can not borrow against his future (expected) income. In fact, in our model, a party that is aware of the agent's incentive problem would not be willing to provide the agent with funds for early consumption, as it knows that the agent would then shirk and, thereby, forfeit future compensation.

information and incentivize the agent to undertake only high-quality deals. We provide conditions for when this is, indeed, the case, but we also show that the *opposite* result may arise: When deferred compensation is too costly for what it delivers in terms of additional information, forcing the bank to defer compensation may have the unintended consequence of leading to *more* high-powered, though deferred, incentive pay and, thus, to lower average deal quality.

One possible protection against such unintended consequences is to impose mandatory deferred compensation only if this is in the bank's self-interest. The bank may, thereby, solve a commitment problem vis-à-vis third parties who buy securities backed by cash flows or assets from these transactions. However, we also identify circumstances in which mandatory deferred pay improves the average quality of deals, even though it reduces banks' profits. Though not a necessary condition, this is more likely when some investors are naive, as in Bolton et al. (2008). While there a fraction of investors does not rationally anticipate the potential misalignment of rating agencies' incentives, in our setting, the lack of rational anticipation is with respect to the incentives that the bank gives its own agents. Furthermore, policy makers' and banks' interests may diverge because banks do not internalize their contribution to systemic risk and the resulting negative externalities on the real economy. Even without securitization and, thus, without the external agency problem, we find that our main insights survive in the presence of such externalities: Mandatory deferred compensation leads to less risk-taking only in some circumstances.

Our model brings together banks' internal compensation structure with their choice of securitization and deal quality. This allows us to further employ our model to study banks' incentives for securitization. In an extension, we consider a problem of optimal security design. The tranche that is optimally kept commits the bank to give its agents only low-powered incentives, while also freeing up as much capital as possible. We also derive predictions on the prevailing level of securitization. Apart from the bank's capability to commit to retain a given fraction ("transparency"), the level of securitization depends also on the bank's internal agency problem vis-à-vis its employees (agents) and on whether the compensation structure is regulated.

Related Literature. Our model combines an internal agency problem between the bank and its employees with an external agency problem between the bank and the buyers of the securities that it issues. With respect to the external agency problem, ours is not the first paper to show that a reduction of the bank's own exposure can undermine incentives. Such incentives may relate to the subsequent monitoring of borrowers, as in Parlour and Plantin (2008), who consider an application to the market for CDOs.[8] Gorton and Pennacchi (1995) argue that the selling institution may overcome the incentive problem either by issuing an implicit guarantee against default or by restricting the fraction of the total loan portfolio (or of any individual loan) that is sold. Morrison (2005) shows that a liquid market for credit-risk derivatives can destroy the signaling role of bank debt and lead to a reduction in welfare.[9]

In our model, the misalignment of the bank's incentives is (in part) owed to the fact that outsiders cannot observe its internal compensation scheme. Also the implications of untransparent executive compensation have been subject to prior analysis. Bebchuk and Fried (2004), for instance, argue that compensation schemes are often designed to "camouflage" excessive compensation. Kuehnen and Zwiebel (2008) find empirical support for the view that managers are "partially entrenched" and use hidden forms of compensation to maximize their own pay, subject to the threat of being replaced by shareholders.

Technically, our model borrows from the literature on multi-task principal-agent problems, following the seminal analysis of Holmström and Milgrom (1991). More specifically, the interaction of an *ex-ante* moral hazard problem with a problem of *interim* private information borrows from Dewatripont and Tirole (1999) and, in particular, from Levitt and Snyder (1997). These papers share with ours the insight that incentives that a principal provides on one task can distort the agent's incentives on another task.

Organization of the Paper. Section 2 introduces the baseline model. To set the stage, Section 3 briefly solves for the benchmark case where there is no internal agency problem (and, thus, also no role for compensation). With the internal problem, we solve for the optimal compensation contract in Section 4. Sections 5 and 6 characterize the equilibrium outcomes with and without mandatory deferred compensation, while Section

[8] See, also, Arping (2005). Chiesa (2006) emphasizes the positive effect of credit-risk transfer on banks' lending capacity, instead.

[9] There is also literature that considers the implications of credit-risk transfer and securitization from the perspective of overall (systemic) risk in the financial system (e.g., Allen and Carletti 2006). More generally, Duffie (2008) provides an overview of the various ways to transfer credit-risk and the resulting policy issues.

7 shows how the equilibrium outcome changes due to such regulation. Section 8 extends the analysis by introducing naive investors and externalities. Sections 9 and 10 endogenize the bank's securitization strategy and discuss the role of commitment to a maximum level of securitization. We offer some concluding remarks in Section 11.

2 Baseline Model

Consider an agent who has to generate new deals for a bank (the principal) while also judging the deals' quality. Deals can be of two different types, $\theta \in \{H, L\}$, where *a priori* a deal is of type H with probability $0 < \mu < 1$. In the basic model, we stipulate that a deal requires the up-front capital $\kappa > 0$. A deal of type $\theta = L$ results in zero cash flows for sure, while a deal of type $\theta = H$ results with probability one in strictly positive cash flows $x > \kappa$. While this specification helps to simplify the analysis, all that is needed is that for type L, the risk of failure does not warrant the expenditure of κ. We normalize costs of capital to zero. For the firm (and its investors), we abstract from discounting. As all parties are risk-neutral, we have that only "high-quality" ($\theta = H$) deals have positive NPV.

A potential deal arrives with probability $\pi > 0$ only when the agent exerts non-observable effort at private disutility $c > 0$. A sufficient condition for the bank to make positive profits is that $\pi(\mu x - \kappa) > c$, which is what we assume.

After a deal is closed, the bank will securitize it with probability ψ, thereby transforming the underlying risky payoff into a cash payment p. (In the present setting, we may equally suppose that, for each deal, the bank sells the fraction ψ of the resulting proceeds $\{0, x\}$.) The endogenization of the payment (price) p is part of the equilibrium characterization.

For now, ψ is taken to be exogenously given. For instance, a maximum bound on ψ could depend on the type of transaction, which may or may not lend itself to full or partial securitization, given the degree of standardization or the possibility of ring-fencing assets and cash flows. Below, we also consider the case where ψ is endogenous and could, in principle, be set equal to one. Moreover, by introducing two positive payoffs, instead of zero and x, we will later be able to discuss implications for optimal security design under endogenous securitization.

Finally, we show below that our key insights on the impact of compensation regulation survive even without securitization, when the riskiness of the bank's assets has externalities, e.g., on the stability of the financial system.

Timing. The precise timing is as follows. At time $t = 0$, the agent is offered a compensation contract, which we describe below. Subsequently, at the beginning of time $t = 1$, the agent can exert effort and, provided that this generates a potential deal, observe the type of the deal. A decision must then be made on whether to close the deal, in which case it is securitized with probability ψ. We stipulate that the agent makes this decision. This can be shown to be without loss of generality, given that θ is privately observed by the agent.[10] The proceeds $\{0, x\}$ from the deal are realized only later, in the final time $t = 3$.

The agent can be compensated at two points in time: at the end of time $t = 1$, where the principal observes a verifiable but noisy signal $s_1 \in \{h, l\}$ on the quality of a closed deal, and at time $t = 2$, where the principal observes yet another, more informative signal $s_2 \in \{h, l\}$.[11] We argue below why compensation in $t = 3$ is too costly.

Information and Compensation. To capture the fact that the later signal, s_2, is always more informative, we stipulate that in $t = 1$, a correct signal is obtained with probability $q_1 := \mathbf{P}(s_1 = h|H) = \mathbf{P}(s_1 = l|L)$, and in $t = 2$, with probability $q_2 := \mathbf{P}(s_2 = h|H) = \mathbf{P}(s_2 = l|L)$, where $0.5 < q_1 < q_2 < 1$, while s_2 is a "sufficient statistic" as $\mathbf{P}(\theta|s_1, s_2) = \mathbf{P}(\theta|s_2)$.[12] While the signal in $t = 2$ is more informative, deferring compensation is costly, as the agent is more impatient than the firm: He discounts payoffs in $t = 2$ with the factor $0 < \delta < 1$. This assumption is common in the labor literature, the literature on executive compensation, or the contracting literature.[13]

[10] More precisely, we can set up a general mechanism design problem where the agent, after observing θ, sends a message $\widehat{\theta}$ to the principal, which then maps into the principal's decision and the agent's compensation. The optimal deterministic mechanism can be implemented simply by designing an optimal compensation scheme and then delegating the decision to the agent.

[11] The principal's signal may come from an internal review process. Note, also, that the specification that the agent perfectly observes θ is not necessary, though it simplifies the derivation of results.

[12] One way to generate this information structure is to assume that θ is first mapped into s_2, such that $\mathbf{P}(s_2 = h|H) = \mathbf{P}(s_2 = l|L) = q_2 > 0.5$. Then, s_2 is itself mapped into s_1. For instance, when applying the same level of precision there, we have $\mathbf{P}(s_1 = h|s_2 = h) = \mathbf{P}(s_1 = l|s_2 = l) = q_2$. Signal s_1 is then correct with probability $q_1 = q_2^2 + (1 - q_2)^2$.

[13] Cf. Rogerson (1997), Ray (2002), or Grenadier and Wang (2005). In the literature, this common assumption is justified on various grounds. For instance, employees may have higher liquidity preferences than the firm, as they are (more) credit-constrained. In addition, deferred compensation, unless it is

Given that the principal can not verify whether the agent shirked or whether he generated a potential deal, compensation can only be made contingent on, first, whether a deal has been closed or not and, second, on the subsequently received signals. Let $\overline{w} \geq 0$ be the agent's base wage when no new deal is closed, where we invoke for the agent a limited liability constraint. As noted below, $\overline{w}$ will optimally not be deferred. If a deal is closed, the agent receives, instead, compensation $w_1(s_1)$ and $w_2(s_1, s_2)$ in the respective periods. Given that s_2 provides a sufficient statistic, without loss of generality, we can restrict attention to a second-period compensation that depends only on s_2: $w_2(s_1, s_2) = w_2(s_2)$. Furthermore, without loss of generality, we can suppose that all payments that are made in $t = 1$, but that the firm can credibly claw-back later (i.e., that are not "vested" and consumed), are postponed until $t = 2$. Together with limited liability, this implies that $w_1(s_1) \geq 0$ and $w_2(s_2) \geq 0$.

As will be immediate, the principal will want the agent to either close all deals indiscriminately or to only close deals when $\theta = H$. This allows us to further restrict attention to bonus payments made only when the respective signal is positive, while $w_1(l) = w_2(l) = 0$.[14] For simplicity, we abbreviate $w_1(h) = w_1$ and $w_2(h) = w_2$, where w_1 captures the agent's *early bonus pay* and w_2 his *deferred bonus pay.*

As a final note, observe that the agent's payoff does not condition on the ultimate proceeds realized at the final period $t = 3$. This can be justified by too-high incremental costs of compensation, given the agent's time preferences, when the final realization of payoffs is far in the future. All our results continue to hold, however, if this was feasible – e.g., when payoffs are already realized in $t = 2$, provided that the mapping between the outcome and the type of the deal is stochastic.

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securely "ring-fenced," carries for the agent the additional risk that the employer may, also through opportunistic behavior, fail to honor his commitment in the future. Furthermore, Raith (2009) shows that paying some of the agent's bonus based on an early signal can be optimal also absent such frictions. The intuition for this is that, while providing no additional information regarding output or the agent's action, the early signal is informative about his total wage and, thus, helps the agent to smooth consumption over time.

[14] If the agent is incentivized to make deals indiscriminately, this is not uniquely optimal. However, if we made the transaction's type θ continuous, implying that the agent's decision was represented by some interior "cutoff type," then this would always be uniquely optimal.

3 Benchmark without Internal Agency Problem

We first abstract from the bank's internal agency problem. Denote by λ the probability with which an *entrepreneurial* banker rejects a low-quality deal. The case with $\lambda = 1$ corresponds to the pure strategy of closing only high-quality deals, while the case with $\lambda = 0$ corresponds to the pure strategy of undertaking both high- and low-quality deals.

The banker's choice of λ is not observed by third parties. Denote the respective expectations by $\widehat{\lambda}$. In a rational-expectations equilibrium, it must hold that $\widehat{\lambda} = \lambda$. Once the initial capital outlay κ has been sunk, the expected fair value of a closed deal, which the bank realizes from a sale, is given by[15]

$$p = x \left(\frac{\mu}{\widehat{\lambda}\mu + (1 - \widehat{\lambda})} \right). \tag{1}$$

The entrepreneurial bank's expected payoff, net of own effort costs, when only high-quality deals are made equals

$$V_H = \mu\pi \left[\psi p - \kappa + (1 - \psi)x \right] - c,$$

while its expected payoff from closing all deals equals

$$V_{HL} = \pi(\psi p - \kappa) + \mu\pi(1 - \psi)x - c.$$

Both expressions take into account that a deal is subsequently sold, at price p, with probability ψ (or, likewise, that a fraction ψ of the proceeds is sold and generates ψp).

An equilibrium is, thus, characterized by a pair (λ, p) such that p satisfies (1), expectations are fulfilled with $\widehat{\lambda} = \lambda$, and the bank's strategy is optimal: $\lambda = \lambda^*$, where

$$\lambda^* = \begin{cases} 1 & \text{if } V_H > V_{HL} \\ 0 & \text{if } V_H < V_{HL} \\ \in [0,1] & \text{if } V_H = V_{HL} \end{cases}. \tag{2}$$

Proposition 1 *Take the benchmark case of an entrepreneurial banker. Then there exists a unique equilibrium with the following characterization: For* $\psi \leq \kappa/x$ *only high-quality*

[15] This presumes, as is standard, that investors compete themselves down to zero profits. Note, also, that the contract with outside investors can not condition on the signals s_t that the bank could observe internally and that will later be used as part of the (explicitly or implicitly enforced) compensation contract with its own agents.

deals are made ($\lambda = 1$)*, for* $\psi \geq \kappa/(\mu x)$ *both high- and low-quality deals are made indiscriminately, while for* $\kappa/x < \psi < \kappa/(\mu x)$ *the banker rejects low-quality deals only with probability* $0 < \lambda < 1$*, where*

$$\lambda = \frac{\kappa - \psi x \mu}{(1-\mu)\kappa}. \tag{3}$$

The proof of Proposition 1 is immediate and, thus, omitted. Note that when $\psi \geq \kappa/(\mu x)$, the entrepreneurial banker would strictly prefer to commit to close only high-quality deals. As we show in what follows, when deals are closed by an agent of the bank, mandatory deferred compensation may provide such a commitment, though not always.

4 Internal Agency Problem

Recall that the agent has two tasks to perform: First, he must exert effort in order to generate new deals; and second, he must close only those deals that generate profits for the bank. Recall, also, that after a deal is closed, the bank obtains two signals s_1 and s_2, as described in Section 2. As a correct signal in $t = 1$ ($t = 2$) is obtained with probability q_1 (q_2), closing a deal of high-quality gives the agent the expected payoff from compensation

$$U_H = q_1 w_1 + \delta q_2 w_2,$$

while closing a low quality deal yields

$$U_L = (1 - q_1)\, w_1 + \delta\, (1 - q_2)\, w_2.$$

These expressions will be instrumental to pinning down the agent's incentive constraints and the principal's contract-design problem. We proceed by supposing, first, that the agent is induced to close only high-quality deals. Subsequently, we consider the case where the agent no longer discriminates between deals of low or high quality. In Section 5, we then analyze when either of the two cases arises in equilibrium.

4.1 Only High-Quality Deals

The agent will refrain from closing low-quality deals only if

$$U_L \leq \overline{w}. \tag{4}$$

In addition, the agent's compensation must ensure that new deals are generated in the first place. Provided that condition (4) is satisfied, the agent will exert effort if the expected utility from searching for a new deal, $\mu\pi U_H + (1-\mu\pi)\overline{w} - c$, does not fall short of the agent's utility when doing nothing, which is $\overline{w}$. From this, we have the requirement that[16]

$$\mu\pi\left(U_H - \overline{w}\right) \geq c. \tag{5}$$

An optimal compensation scheme minimizes expected wage costs

$$K = \mu\pi\left(q_1 w_1 + q_2 w_2\right) + \left(1-\mu\pi\right)\overline{w} \tag{6}$$

subject to, first, the incentive constraints (4) and (5), which ensure that only high-quality deals are made and that the agent does not shirk, and second, the limited liability constraints $w_t \geq 0$.

Proposition 2 *Suppose that the agent shall close only high-quality deals. Then there exists a cutoff* $0 < \delta_W < 1$ *satisfying*

$$\frac{\delta_W}{1-\delta_W} = \mu\pi\left(\frac{2q_1-1}{q_2-q_1}\right) q_2, \tag{7}$$

such that the agent's optimal compensation is characterized as follows:
i) If $\delta < \delta_W$*, the agent receives a base wage of*

$$\overline{w} = \frac{c}{\mu\pi}\frac{1-q_1}{2q_1-1}, \tag{8}$$

an early incentive component of

$$w_1 = \frac{c}{\mu\pi}\frac{1}{2q_1-1}, \tag{9}$$

and no deferred compensation: $w_2 = 0$*.*
ii) If $\delta > \delta_W$*, the agent receives a base wage of*

$$\overline{w} = \frac{c}{\mu\pi}\frac{1-q_2}{2q_2-1}, \tag{10}$$

a deferred incentive component of

$$w_2 = \frac{c}{\mu\pi}\frac{1}{2q_2-1}\frac{1}{\delta}, \tag{11}$$

and no early compensation: $w_1 = 0$*.*
iii) If $\delta = \delta_W$*, either compensation scheme, as characterized in i) and ii), is optimal.*

[16] Note that this implies that the agent strictly prefers to close high-quality deals.

Proof. Once we substitute the binding incentive constraints (4) and (5), expected wage costs K can be written as

$$K = c + \frac{c}{\mu\pi}\frac{1-q_1}{2q_1-1} + w_2\left[\mu\pi q_2 - \delta\left(\mu\pi q_2 + \frac{q_2-q_1}{2q_1-1}\right)\right],$$

such that $w_2 \geq 0$ is optimal when $\delta \geq \delta_W$ and $w_1 \geq 0$ when $\delta \leq \delta_W$. The respective values for w_1, w_2, and $\overline{w}$ then follow immediately from the binding incentive constraints (4) and (5), together with $w_2 = 0$ in case i) and $w_1 = 0$ in case ii). **Q.E.D.**

Non-Deferred Compensation. Take first case i), where there is no deferred compensation. Given $\overline{w} > 0$ from (8), an agent who closes a deal has the chance of obtaining a higher compensation, namely when $s_1 = h$, but he risks receiving less than $\overline{w}$, namely when $s_1 = l$. In practice, these three outcomes $(0 < \overline{w} < w_1)$ may reflect the share of a year-end bonus pool that a banker obtains, based on his performance. Note, also, that in our setting, $\overline{w} > 0$ represents a rent for the agent, given that this is the compensation that he could realize even without trying to originate a deal. The agent's expected compensation, which is equal to the principal's wage costs, is thus given by $c + \overline{w}$: the sum of his private disutility from searching for a prospective deal, for which he has to be compensated, and his rent. We refer to this as

$$K_1 = c + \frac{c}{\mu\pi}\left(\frac{1-q_1}{2q_1-1}\right). \tag{12}$$

The agent's rent, $\overline{w}$ in (8), is strictly increasing in $c/(\mu\pi)$. As this term increases, it becomes harder to generate a prospective deal, which implies that the agent must be paid a higher expected bonus when a new deal is made. Otherwise, he will prefer to shirk (cf. incentive constraint (5)). When w_1 increases, however, it is necessary to also increase $\overline{w}$. Otherwise, the agent will start closing deals indiscriminately (cf. incentive constraint (4)). Finally, note that the agent's rent, $\overline{w}$, decreases as the signal s_1 becomes more informative – i.e., as q_1 increases. In fact, as the signal becomes perfectly informative with $q_1 \to 1$, the agent's rent decreases to zero: $\overline{w} \to 0$.

Deferred Compensation. Next take case ii), where compensation is optimally deferred. Intuitively, the rent that is left to the agent, $\overline{w}$, is now strictly lower, given that the principal can condition the bonus on a more informative signal, s_2. On the other hand, deferred compensation creates a "deadweight loss" due to the inefficient allocation of compensation over time. Taking this into account, once we substitute the expressions for case ii), the expected costs of compensating the agent are given by

$$K_2 = c + \frac{c}{\mu\pi}\left(\frac{1-q_2}{2q_2-1}\right) + c\left(\frac{q_2}{2q_2-1}\right)\frac{1-\delta}{\delta}. \tag{13}$$

The last term in (13) captures the "deadweight loss." This is strictly decreasing in δ and disappears altogether for a perfectly patient agent, $\delta \to 1$.

For $\delta = \delta_W$, the bank is indifferent between early and deferred compensation. There, the information gain ($q_2 > q_1$) and the "deadweight loss" ($\delta < 1$) under deferred compensation exactly offset each other. Formally, the respective expressions (12) and (13) are just equal: $K_1 = K_2$. Note, also, that the critical value δ_W increases in q_1 and decreases in q_2. The more information that can be gained by waiting for s_2, the more attractive deferred compensation becomes, compared to early compensation. On the other hand, as $q_2 \to q_1$, the information gain vanishes and $\delta_W \to 1$.

For future reference, it is convenient to use a short-hand expression for the expected costs of compensation – i.e., the minimum of $K = K_1$ in (12) and $K = K_2$ in (13). As we presently consider the case where only high-quality deals are made, we refer to this as K_H.

Corollary 1 *If the agent shall only close high-quality deals, the firm's expected costs of compensation are given by*

$$K_H := c + \frac{c}{\mu\pi}\frac{1-q_1}{2q_1-1} + \min\left\{c\left(\frac{1-\delta}{\delta}\frac{q_2}{2q_2-1} - \frac{1}{\mu\pi}\frac{q_2-q_1}{(2q_1-1)(2q_2-1)}\right), 0\right\}. \tag{14}$$

4.2 High- and Low-Quality Deals

In this case, the agent needs to be incentivized only to exert effort. In analogy to (5), the respective constraint becomes

$$\pi\left[\mu U_H + (1-\mu)U_L\right] \geq c. \tag{15}$$

The optimal compensation scheme again minimizes the expected wage costs subject to (15) and $w_t \geq 0$.

Recall now that deferring compensation is costly whenever $\delta < 1$. Thus, if the principal wants the agent to close deals indiscriminately, the agent will be compensated only in $t = 1$:

There are no benefits, only costs, from deferred compensation. Moreover, there is no longer a need to leave the agent with a positive rent, such that the base payment is equal to zero: $\overline{w} = 0$. Without "deadweight loss" from deferred compensation and without a rent for the agent, the firm's cost of compensation is equal to the agent's cost of effort, c.

Proposition 3 *If the agent shall close all deals indiscriminately, he receives an early incentive pay of*

$$w_1 = \frac{c}{\pi}\left(\frac{1}{\mu q_1 + (1-\mu)(1-q_1)}\right),$$

while there is no deferred compensation, $w_2 = 0$, and a zero base wage, $\overline{w} = 0$. The firm's expected costs of compensation are given by $K_{HL} = c$.

5 The (Unregulated) Market Outcome

The bank's compensation scheme is not observed by outsiders (and can not be credibly revealed to them). The bank may set either a compensation scheme that leads to only high-quality deals or one under which deals are made indiscriminately. Or it may randomize. As in the benchmark analysis of Section 3, denote by λ the probability with which the bank sets a compensation scheme that subsequently induces the agent to close only high-quality deals. Likewise, we still denote the respective expectations by $\widehat{\lambda}$, such that in a rational-expectations equilibrium, it must hold that $\widehat{\lambda} = \lambda$. Given expectations, the fair value of a closed deal equals p, as given by (1).

The bank's payoff from the different strategies must now be adjusted for the agent's compensation. For given price p, the bank's payoff when only high-quality deals are made now equals

$$V_H = \mu\pi\left[\psi p - \kappa + (1-\psi)x\right] - K_H, \tag{16}$$

while the payoff when deals of both types are made equals

$$V_{HL} = \pi(\psi p - \kappa) + \mu\pi(1-\psi)x - K_{HL}. \tag{17}$$

With these modifications to the benchmark analysis with an entrepreneurial bank, an equilibrium is still characterized by a pair (λ, p) that satisfies condition (1) for p, $\widehat{\lambda} = \lambda$, and $\lambda = \lambda^*$, which uses (2). The respective optimal compensation schemes are obtained from Propositions 2 and 3.

5.1 Equilibrium Characterization

Only High-Quality Deals. We ask, first, when an equilibrium with $\lambda = 1$ and, thus, only high-quality deals exists. In this case, the fair value is $p = x$. Substituting this into the expressions for V_H in (16) and V_{HL} in (17), respectively, it follows that the bank does not want to deviate only if

$$\psi x \leq \kappa - \frac{K_H - K_{HL}}{\pi (1-\mu)}. \tag{18}$$

From this, we obtain, after substitution for K_H and K_{HL} , the following result.

Lemma 1 *An equilibrium where the bank incentivizes the agent to close only high-quality deals can be supported whenever $\psi \leq \underline{\psi}$. The characterization of $\underline{\psi}$ is given as follows:*
i) For $\delta < \delta_W$:

$$\underline{\psi} = \frac{\kappa}{x} - \frac{c}{x}\left(\frac{1}{(1-\mu)\,\mu\pi^2}\right)\left(\frac{1-q_1}{2q_1-1}\right). \tag{19}$$

ii) For $\delta > \delta_W$:

$$\underline{\psi} = \frac{\kappa}{x} - \frac{c}{x}\left(\frac{1}{(1-\mu)\,\mu\pi^2}\right)\left(\frac{\delta\left[1-q_2\left(1+\mu\pi\right)\right]+q_2\mu\pi}{\delta\left(2q_2-1\right)}\right). \tag{20}$$

iii) For $\delta = \delta_W$: The characterizations in (19) and (20) are identical.

In case i), the agent is compensated only in $t = 1$, and, thus, the cutoff $\underline{\psi}$ does not depend on δ. Note that the expression for $\underline{\psi}$ in (19) can be negative when the additional costs of providing incentives to close only high-quality deals – i.e., the respective agency rent $\overline{w}$ – become too high. In this case, there is no high-quality equilibrium for $\delta < \delta_W$, even if the bank retains 100 percent of all deals. In case ii), the optimal contract entails deferred compensation, implying that $\underline{\psi}$ also becomes a function of δ. As the additional costs from deferred compensation decrease with δ, we have that $\underline{\psi}$ is an increasing function of δ.

High- and Low Quality Deals. Consider, next, the candidate equilibrium with $\lambda = 0$, where both types of deals are closed indiscriminately. Then, the value of a deal is $p = \mu x$, once κ has been sunk. Hence, we have that $V_{HL} > V_H$ holds only if

$$\psi\mu x \geq \kappa - \frac{K_H - K_{HL}}{\pi (1-\mu)}. \tag{21}$$

From this condition, together with the definitions of K_H and K_{HL}, we obtain the following result.

Lemma 2 *An equilibrium where the bank incentivizes the agent to close deals of both types indiscriminately can be supported whenever* $\psi \geq \overline{\psi}$. *The characterization of* $\overline{\psi}$ *is given as follows:*

i) For $\delta < \delta_W$*:*

$$\overline{\psi} = \frac{\kappa}{\mu x} - \frac{c}{\mu x}\left(\frac{1}{(1-\mu)\,\mu\pi^2}\right)\left(\frac{1-q_1}{2q_1-1}\right). \tag{22}$$

ii) For $\delta > \delta_W$*:*

$$\overline{\psi} = \frac{\kappa}{\mu x} - \frac{c}{\mu x}\left(\frac{1}{(1-\mu)\,\mu\pi^2}\right)\left(\frac{\delta\left[1-q_2\left(1+\mu\pi\right)\right]+q_2\mu\pi}{\delta x\left(2q_2-1\right)}\right). \tag{23}$$

iii) For $\delta = \delta_W$*: The characterizations in (22) and (23) are identical.*

Comparing Lemmas 1 and 2, note that $\overline{\psi} > \underline{\psi}$. Also, $\overline{\psi}$ is always smaller than one. Thus, if all deals are fully securitized, there is no equilibrium with only high-quality deals, but there is an equilibrium where all deals are closed indiscriminately. We postpone a comparative analysis of the thresholds until after presenting a full characterization of the equilibrium outcome in Proposition 4.

Mixing. When $\psi \in \left(\underline{\psi}, \overline{\psi}\right)$ holds, there is a mixed-strategy equilibrium: As $V_H = V_{HL}$, the bank is indifferent between inducing the agent to close all deals or only high-quality deals. The respective price is given by (1), where we have to substitute the respective value of λ.

Lemma 3 *If* $\underline{\psi} < \psi < \overline{\psi}$ *holds, there exists an equilibrium where the bank mixes between incentivizing the agent to close only high-quality deals and incentivizing him to close all deals indiscriminately.*

i) For $\delta < \delta_W$*:*

$$\lambda = \frac{1}{1-\mu} - \psi x\left(\frac{(2q_1-1)\left(\mu\pi\right)^2}{\kappa\left(2q_1-1\right)\left(1-\mu\right)\mu\pi^2 - c\left(1-q_1\right)}\right), \tag{24}$$

while

$$p = \frac{\kappa}{\psi} - \frac{c}{\psi}\left(\frac{1}{(1-\mu)\,\mu\pi^2}\right)\left(\frac{1-q_1}{2q_1-1}\right).$$

ii) For $\delta > \delta_W$*:*

$$\lambda = \frac{1}{1-\mu} - \delta\psi x\left(\frac{(2q_2-1)\left(\mu\pi\right)^2}{\delta\kappa\left(2q_2-1\right)\left(1-\mu\right)\mu\pi^2 - c\left[\left(1-q_2\right)\delta + q_2\left(1-\delta\right)\mu\pi\right]}\right), \tag{25}$$

while

$$p = \frac{\kappa}{\psi} - \frac{c}{\psi}\left(\frac{1}{(1-\mu)\,\mu\pi^2}\right)\left(\frac{\delta\left[1-q_2\left(1+\mu\pi\right)\right]+q_2\mu\pi}{\delta(2q_2-1)}\right).$$

iii) For $\delta = \delta_W$: The characterizations in cases i) and ii) are identical.

Proof. Given the equilibrium value for λ, it must hold that $V_H = V_{HL}$, and, thus,

$$p = \frac{1}{\psi}\left(\kappa - \frac{K_H - K_{HL}}{\pi\,(1-\mu)}\right). \tag{26}$$

The result is then obtained by substituting the respective expressions for K_H and K_{HL} and using (1). **Q.E.D.**

Equilibrium. Taken together, from Lemmas 1 to 3 we obtain the following full characterization of the equilibrium in an unregulated market.

Proposition 4 *There exists a unique equilibrium with the following properties:*
i) If $\psi \in [0, \underline{\psi}]$, only high-quality deals are closed.
ii) If $\psi \in (\underline{\psi}, \overline{\psi})$, the bank induces the agent with probability $0 < \lambda < 1$ to close only high-quality deals and with probability $1-\lambda$ to close all deals indiscriminately, where λ is given by either (24) or (25), depending on δ.
iii) If $\psi \in [\overline{\psi}, 1]$, deals of high and low quality are closed indiscriminately.

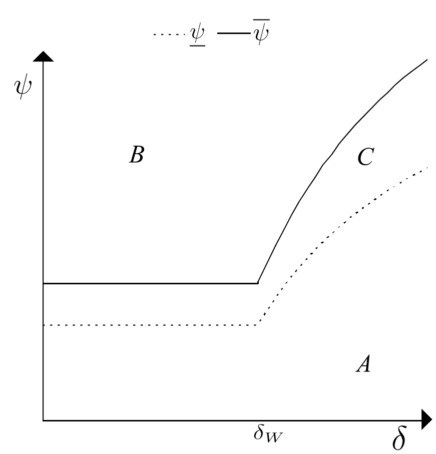

Figure 1: (Parameters $\mu = 0.7$, $\kappa = 0.8$, $x = 5$, $\pi = 0.8$, $c = 0.1$, $q_1 = 0.7$, $q_2 = 0.85$)

In Figure 1, we illustrate the characterization of Proposition 4. Note that region A corresponds to case i), where only high-quality deals are closed; region B corresponds to case ii), where all deals are closed; while in region C, the bank mixes (case iii). Recall, also, that for $\delta \geq \delta_W$, the respective boundaries $\underline{\psi}$ and $\overline{\psi}$ are both strictly increasing in δ.

5.2 Comparative Analysis

To conduct a comparative analysis, it is convenient to first summarize some of our previous observations.

Corollary 2 *When, following a change in the primitives, it becomes more likely that the bank induces the agent to close deals indiscriminately (lower λ), then this has the following implications:*
i) The average quality of deals deteriorates, leading to a lower price p.
ii) The agent's compensation is more likely to be very high-powered – i.e., to consist only of a bonus (as $\overline{w} = 0$).
iii) When, in addition, $\delta \geq \delta_W$ holds, then the agent is less likely to receive deferred compensation.

Corollary 2 links a characterization of the bank's internal compensation scheme to the quality of deals. We ask next how λ itself depends on the primitives, where we draw on the derivation of the boundaries $\underline{\psi}$ and $\overline{\psi}$, as well as on the characterization of $0 < \lambda < 1$ for $\underline{\psi} < \psi < \overline{\psi}$ in Lemmas 1 to 3.

Corollary 3 *The high-quality outcome becomes less likely (lower λ) if*
i) a deal is more likely to be sold (higher ψ);
ii) the internal agency problem becomes more severe as the bank's own information becomes less precise (lower q_t);
iii) deal-making costs play a relatively larger role (higher c/π);
iv) or deals are of smaller size, holding constant the return of a high-quality deal ($(x-\kappa)/\kappa$).

Proof. For $\psi \in (\underline{\psi}, \overline{\psi})$, λ is given by

$$\lambda = \frac{1}{1-\mu} - \frac{\psi x \mu \pi}{\kappa \pi (1-\mu) - (K_H - K_{HL})},$$

which is strictly decreasing in ψ. Using the auxiliary notation $\eta = \left\{q_t, \frac{c}{\pi}\right\}$, assertions ii) and iii) follow from

$$\frac{d\lambda}{d\eta} = \frac{d}{d\eta}\left[\frac{1}{\pi}(K_H - K_{HL})\right]\left(\frac{\psi x \mu}{\left[\kappa(1-\mu) - \frac{1}{\pi}(K_H - K_{HL})\right]^2}\right) < 0,$$

which follows immediately from the comparative statics results of K_H and K_{HL} discussed in Section 4. When holding constant the return of a high-quality deal, assertion iv) follows as

$$\left.\frac{d\lambda}{d\kappa}\right|_{(x-\kappa)/\kappa \text{ constant}} = \frac{\psi\mu\pi}{\left[\kappa\pi(1-\mu) - (K_H - K_{HL})\right]^2}\left(\frac{x}{\kappa}\right)(K_H - K_{HL}) > 0.$$

Finally, the comparative analysis in the two boundaries $\underline{\psi}$ and $\overline{\psi}$ is analogous and, therefore, omitted. **Q.E.D.**

Assertion i) is intuitive. Assertion ii) on the informativeness of the bank's signals, s_t, also follows from our previous observations: A less informative signal translates into higher compensation costs, K_H, when the agent shall only close high-quality deals, while it leaves K_{HL} unaffected. The difference $K_H - K_{HL}$ is also strictly increasing in c/π, which measures how hard it is to locate a potential deal (assertion iii). While a rise in c/π increases both K_H and K_{HL}, the effect on K_H is larger: When the agent's bonus must be increased, the bank also has to increase $\overline{w}$, given that, otherwise, the agent would close deals indiscriminately.

Finally, note that for assertion iv), we change the scale both of the required capital outlay κ and of the respective proceeds, zero and x. This leaves the return $(x - \kappa)/\kappa$ of a high-quality deal constant. (The return of a low-quality deal is invariably at -100 percent.) The intuition for assertion iv) is the following : When the deal is of smaller size, the difference in compensation costs $K_H - K_{HL} > 0$ plays a relatively larger role. We next offer a broader interpretation of these comparative results.

Interpretation. Assertion i) of Corollary 3 speaks to the pitfall of securitization, which undermines the bank's incentives to keep the quality of deals high. This problem becomes worse when the bank's internal agency problem becomes more severe. In practical terms, the parameters q_t may depend on the types of transactions. While there may be good indicators of whether standardized transactions created value, this may not be the case with novel and complex transactions. Likewise, when considering only loans, it may be harder to gauge in the short-term the ultimate quality of a long-term loan.

Although this must remain outside the model, one interpretation of the comparative analysis in assertion iii) may be in terms of competition. In a more competitive environment, it may become harder for any individual agent to close a deal of a given quality. In our model, this would be captured by a rise in c/π and would reduce the average quality of deals. As for assertion iv), holding the expected return constant, when the bank expands into deals of smaller size, then our model would predict a deterioration of the average quality of deals, given that these are less likely to warrant the *incremental* compensation costs $K_H - K_{HL} > 0$.

Comparing the outcome of the benchmark model with an entrepreneurial bank to one where there is an internal agency problem, we can make the following additional observations. Recall that when the pool of possible deals deteriorates, as captured by a reduction of μ, this causes a price decrease. It is straightforward that an *entrepreneurial* bank's incentives then shift unambiguously towards making only high-quality deals. The introduction of the internal agency problem, however, creates a countervailing force, that can generate a *positive* relationship between the quality of the pool of deals and the bank's preference to close only high-quality deals. This follows, as an increase in μ reduces the additional agency costs from implementing the high-quality outcome: As a given deal is more likely to be higher-quality, this reduces the need to pay a high bonus, which, in turn allows the bank to reduce the agent's rent, while still ensuring that he rejects low-quality deals.

6 Equilibrium with Regulation

Suppose that the bank is forced to defer any bonus that it wants to pay. That is, while the bank will (optimally) still pay the fixed wage in $t = 1$, a bonus must be paid in $t = 2$, such that $w_1 = 0$. In particular, this forces the bank to defer compensation when it wants to induce the agent to close deals indiscriminately. In this case, as the agent's expected compensation must still be equal to the cost of effort, c, this imposes compensation costs c/δ on the bank and, thus, creates incremental costs of $(1 - \delta)c/\delta$. Suppose next that only high-quality deals are made. Recall that the respective costs of compensation are then given by expression K_2 in (13).

From these observations, we have the following immediate results.

Proposition 5 *If deferred bonus compensation is mandatory, such that $w_1 = 0$, the costs of incentivizing the agent to make only high-quality deals are given by $K_H^R = K_2$ as in (13), while compensation costs when all deals are closed indiscriminately equal $K_{HL}^R = c/\delta$.*

Given Proposition 5, we can obtain the regulated market outcome by following the same steps as in the analysis of the case without regulation. In fact, to obtain the respective thresholds $\underline{\psi}$ and $\overline{\psi}$, we simply have to replace the compensation costs K_H and K_{HL} in expressions (18) and (21) with the respective costs K_H^R and K_{HL}^R. Thus, a high-quality equilibrium can be supported for $\psi \leq \underline{\psi}^R$, where

$$\underline{\psi}^R = \frac{\kappa}{x} - \frac{c}{x}\left(\frac{1-q_2}{2q_2-1}\right)\left(\frac{(1-\mu\pi)\,\delta + \mu\pi}{\delta\,(1-\mu)\,\mu\pi^2}\right), \tag{27}$$

and an equilibrium with high- and low-quality deals exists whenever $\psi \geq \overline{\psi}^R$, where

$$\overline{\psi}^R = \frac{\kappa}{\mu x} - \frac{c}{\mu x}\left(\frac{1-q_2}{2q_2-1}\right)\left(\frac{(1-\mu\pi)\,\delta + \mu\pi}{\delta\,(1-\mu)\,\mu\pi^2}\right). \tag{28}$$

Furthermore, for $\underline{\psi}^R < \psi < \overline{\psi}^R$, there exists a unique mixed-strategy equilibrium, where indifference now leads to the probability

$$\lambda^R = \frac{1}{1-\mu} - \delta\psi x\left(\frac{(2q_2-1)\,(\mu\pi)^2}{\delta\kappa\,(2q_2-1)\,(1-\mu)\,\mu\pi^2 - c\,(1-q_2)\,[\delta + (1-\delta)\,\mu\pi]}\right) \tag{29}$$

with which the bank induces the agent to close only high-quality deals.

Proposition 6 *If deferred bonus compensation is mandatory, such that $w_1 = 0$, then there exists a unique equilibrium with the same characterization as in the unregulated case of Proposition 4, provided that the respective thresholds are replaced by $\underline{\psi}^R$ and $\overline{\psi}^R$, while for $\psi \in (\underline{\psi}^R, \overline{\psi}^R)$, the bank's probability λ^R of inducing the agent to close only high-quality deals is now given by (29).*

Figure 2 illustrates the outcome with regulation, as characterized in Proposition 6. As in Figure 1, region A again corresponds to the case where only high-quality deals are closed; region B corresponds to the case where all deals are closed; and in region C, the bank mixes. Note now that, in contrast to Figure 1, the boundaries $\underline{\psi}^R$ and $\overline{\psi}^R$ depend on δ for the whole range of values, given that bonus compensation *must* be deferred.[17]

[17] The above results are derived under the assumption that the bank's profits are positive, which would

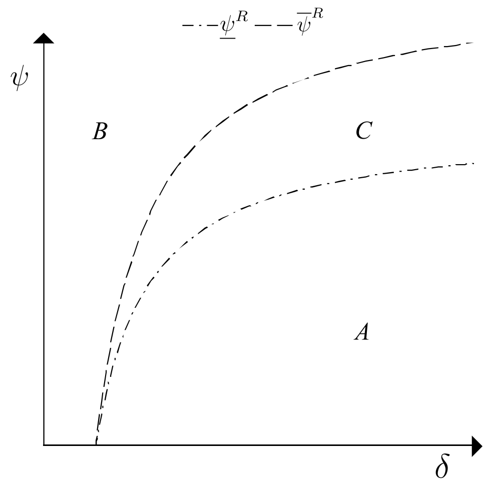

Figure 2: (Parameters $\mu = 0.7$, $\kappa = 0.8$, $x = 5$, $\pi = 0.8$, $c = 0.1$, $q_1 = 0.7$, $q_2 = 0.85$)

7 Impact of Regulation

We now analyze how mandatory deferred compensation *changes* the equilibrium outcome. Recall from the Introduction that a key argument for such regulation could be to induce banks to use the additional peformance-related information, so as to deter agents from closing deals that, in our model, result in a sure loss. As we will see, however, the opposite also can happen.

7.1 Impact of Regulation on Cost of Compensation

Regulation can lead to a shift towards only high-quality deals only if this becomes *relatively* cheaper for the bank to implement. This is the case if

$$K_{HL}^R - K_{HL} \geq K_H^R - K_H. \tag{30}$$

We already noted that making deferred bonus payment mandatory strictly increases the compensation costs when all deals are made indiscriminately: $K_{HL}^R - K_{HL} > 0$. Since for $\delta \geq \delta_W$, the optimal compensation that induces only high-quality deals also entails deferred compensation without regulation, we have that $K_H^R - K_H = 0$. Hence, for $\delta \geq \delta_W$,

be ensured by the following condition: $\pi(\mu x - \kappa) > c(1-\delta)/\delta$. Note, however, that there is no longer a sufficient condition for the bank's profits to be positive that is *independent* of δ (cf. the respective condition in Section 2).

condition (30) holds strictly. Instead, for $\delta < \delta_W$, we have to undertake a further case distinction.

Lemma 4 *Mandatory deferred compensation imposes relatively higher incremental costs of compensation when deals are made indiscriminately, compared to the case where only high-quality deals are made, if* $\delta > \widehat{\delta}$ *holds, where* $0 < \widehat{\delta} < \delta_W$ *is given by*

$$\frac{\widehat{\delta}}{1-\widehat{\delta}} = \mu\pi \left(\frac{2q_1 - 1}{q_2 - q_1} \right) (1 - q_2) . \tag{31}$$

Instead, for $\delta < \widehat{\delta}$*, the incremental costs imposed by such regulation are strictly higher when only high-quality deals are made. For* $\delta = \widehat{\delta}$*, incremental costs are the same (such that* $K^R_{HL} - K_{HL} = K^R_H - K_H$*).*

Proof. Given the argument in the main text, we can restrict consideration to the case where $\delta < \delta_W$. The incremental costs $K^R_H - K_H$ are then strictly positive and equal to

$$c\left(\frac{1-\delta}{\delta}\right)\left(\frac{q_2}{2q_2 - 1}\right) - \frac{c}{\mu\pi}\left(\frac{q_2 - q_1}{(2q_1 - 1)(2q_2 - 1)}\right). \tag{32}$$

Comparing this to

$$K^R_{HL} - K_{HL} = c\frac{\delta}{1-\delta},$$

we have that (30) holds only if $\delta > \widehat{\delta}$, where $\widehat{\delta}$ is given by (31). The comparison with δ_W is immediate from comparing the respective definitions in (31) and (7), while noting that $q_t > 0.5$. **Q.E.D.**

Intuitively, the critical cutoff $\widehat{\delta}$ decreases when the precision of the second signal improves relative to the first signal (q_2 increases or q_1 decreases). The critical cutoff increases, however, when it is harder to generate a high-quality deal, given that π or μ decreases. It then becomes more likely that mandatory deferred compensation imposes relatively higher incremental compensation costs when only high-quality deals are made. The intuition for this is as follows. As noted previously, in order to incentivize the agent to make only high-quality deals, the bank must pay a fixed wage ("rent") $\overline{w}$. To ensure that the agent still has incentives to acquire a deal in the first place, together with $\overline{w} > 0$, the bank must also step up the bonus, compared to the case where deals are made indiscriminately. Moreover, the lower the likelihood that efforts result in a high-quality deal, $\pi\mu$, the larger the incremental bonus will be. Hence, when $\pi\mu$ is lower, such that the bonus must be more valuable to the agent, deferring the bonus becomes more costly in terms of the generated deadweight loss.

7.2 Impact of Regulation on the Equilibrium Outcome

We first consider the case where regulation leads to a switch from one pure-strategy equilibrium to another. When $\delta > \widehat{\delta}$ holds, such a switch to a high-quality equilibrium can occur, though this condition is only necessary, not sufficient. In addition, it must hold that the resulting compensation costs K_H^R are not too large, such that there is a non-empty set of values (δ, ψ) satisfying $\overline{\psi} < \psi < \underline{\psi}^R$. In Figure 3, which illustrates the comparison between the regulated and the non-regulated outcomes, this corresponds to area a. For $\delta < \widehat{\delta}$, however, where the converse to the inequality in (30) holds strictly, the opposite shift can occur – i.e., from a high-quality equilibrium without regulation to an equilibrium under regulation where deals are made indiscriminately. This corresponds to area b in Figure 3. While mandatory deferred pay makes it less profitable to close all deals, the compensation costs of implementing a high-quality strategy increase by even more for $\delta < \widehat{\delta}$.

It is worthwhile to briefly elaborate on why the second case may arise. Recall that to ensure that not all deals are closed indiscriminately, the agent must be paid a positive fixed wage ("rent"), $\overline{w}$. But the higher $\overline{w} > 0$ is, the larger the expected bonus must be, so as to still incentivize the agent to exert effort in the first place. Given that the expected bonus payment is larger when only high-quality deals are made, also the "deadweight loss" from deferred compensation is higher. Moreover, this difference is higher when δ is smaller. Consequently, when parameters (δ, ψ) fall into area b of Figure 3, the policy to regulate deferred bonus pay has the unintended consequence of *destroying* the high-quality equilibrium.

While, so far, we have considered only parameter regions where before and after regulation there is a pure-strategy equilibrium, the results survive in mixed-strategy equilibria. Again, $\widehat{\delta}$, as given by (31), determines whether the likelihood that a low-quality deal is rejected increases (higher λ for $\delta > \widehat{\delta}$) or decreases (lower λ for $\delta < \widehat{\delta}$).

Note, finally, that there are clearly parameter regions for which regulation has no impact at all. As Figure 3 shows, this is the case for high ψ, where all deals will be made under either regime, as well as for low ψ and high δ, where only high-quality deals will be made under either regime.

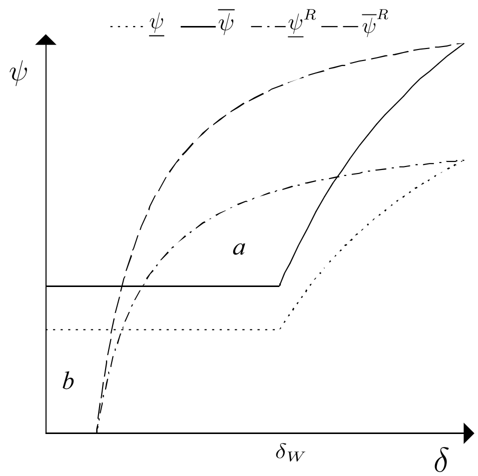

Figure 3: (Parameters $\mu = 0.7$, $\kappa = 0.8$, $x = 5$, $\pi = 0.8$, $c = 0.1$, $q_1 = 0.7$, $q_2 = 0.85$)

Proposition 7 *Suppose that deferred bonus compensation is mandatory. Then, this (weakly) increases the likelihood that only high-quality deals are made ($\lambda^R > \lambda$) if $\delta > \widehat{\delta}$. In contrast, for $\delta < \widehat{\delta}$, the likelihood that low-quality deals also will be undertaken (weakly) increases ($\lambda^R < \lambda$).*

Proof. Note that for $\delta \geq \delta_W$, we always have $\lambda^R > \lambda$. Thus, take the case with $\delta < \delta_W$. Comparing the expressions λ and λ^R, as given by (24) and (29), we obtain that $\lambda^R > \lambda$ holds if and only if $\delta > \widehat{\delta}$.

We can next conduct an analogous comparison for the boundaries of the pure-strategy equilibria, namely $\underline{\psi}$ from (19), $\overline{\psi}$ from (22), $\underline{\psi}^R$ from (27), and $\overline{\psi}^R$ from (28). Precisely, we can use that $\underline{\psi}$ as well as $\overline{\psi}$ are strictly decreasing in the compensation cost difference $K_H - K_{HL}$, and that the same holds for $\underline{\psi}^R$ and $\overline{\psi}^R$ with respect to the difference $K_H^R - K_{HL}^R$. The assertion follows from Lemma 4. **Q.E.D.**

Taken together with Lemma 4, we have the following comparative results.

Corollary 4 *Making deferred compensation mandatory is more likely to have the unintended consequence of leading to more low-quality deals if*
i) the additional information gained over $t = 1$ to $t = 2$ is small (low $q_2 - q_1$, or generally

low q_2 and high q_1);

ii) the fraction of possible low-quality deals is low (high μ);

iii) or making a deal is altogether more difficult as π is low.

Assertion i) is immediately intuitive, while the intuition for assertions ii) and iii) follows from the argument after Lemma 4.

Intuitively, a way to safeguard against the discussed unintended consequences is to regulate only if the respective bank also prefers it. The imposition of deferred bonus compensation is never in the bank's interest if it leads to a reduction in λ. Instead, the bank benefits from imposed mandatory pay only when it helps to overcome a commitment problem vis-à-vis the buyers of its securities. In this case, without regulation, it would not be credible for the bank to defer pay and, at the same time, provide agents with less-high-powered and, thus, less-deal-oriented incentives.

The bank's and the social planner's (regulator's) preferences are, however, not perfectly aligned. Presently, the difference arises only from the fact that the agent receives a rent under the high-quality equilibrium, which represents a pure transfer for the social planner. Hence, while the social planner takes into account only the implied change in deal quality and the "deadweight loss" from deferred compensation, the bank's profits also depend on the agent's rent.

8 Discussion of the Impact of Regulation

8.1 Naive Investors

We first relax the presumption that all investors form expectations in a fully rational way. Instead, we assume that naive investors do not adequately take into account the bank's incentives to create more deals at the expense of quality. Closely following Bolton et al. (2008), we stipulate that naive investors believe that deals are always of high quality. That is, while in Bolton et al. (2008), naive investors do not correctly anticipate the self-interest of rating agencies, in our model, they do not correctly anticipate the bank's self-interest. As suggested in Bolton et al. (2008), this could be the case, as these investors are managing third-party investment and have insufficient incentives to perform due diligence.

Thus, let α be the probability that a given investor is naive, while being sophisticated with probability $1 - \alpha$. As sophisticated investors correctly assess the probability with which deals are of high-quality, their willingness to pay p is given by (1). The expected market price is, thus, equal to[18]

$$\widehat{p} = \alpha x + (1 - \alpha)p. \tag{33}$$

The introduction of naive investors does not qualitatively change the characterization of the equilibrium outcome, which is again fully described by two thresholds $\underline{\psi}_\alpha < \overline{\psi}_\alpha$, as well as the (mixing) probability λ_α when $\psi \in (\underline{\psi}_\alpha, \overline{\psi}_\alpha)$. By conducting a comparative analysis of these parameters in α, we obtain the following result. (The proof of Proposition 8 also provides the explicit expressions.)

Proposition 8 *When it is more likely that a given investor in the bank's securities is naive (higher α), then it is more likely that low-quality deals also are made in equilibrium (lower λ_α).*

Proof. See Appendix.

While sophisticated investors also do not observe the incentives that the bank gives to its agent, they have wary expectations and adjust their valuation for the securities that are backed by the deals. When the bank, instead, finds a naive investor, which happens with probability α, it can always charge a price equal to x. The higher is α, the higher is the expected price $\widehat{p}$ (provided that $\lambda_\alpha < 1$), which makes it more attractive for the bank to incentivize aggressive deal-making by the agent: The equilibrium value of λ_α is then lower.

Even though the presence of naive investors makes it more likely that low-quality deals are also made, the impact of mandatory deferred compensation on deal quality remains unchanged. To see this, recall that mandatory deferred compensation makes it more likely that only high-quality deals are made if and only if the resulting *incremental* compensation costs are lower compared to the incremental costs when deals are made indiscriminately (cf. condition (30)). This condition is independent of the presence of naive investors.

Proposition 9 *Irrespective of α, imposing mandatory deferred bonus compensation improves average deal quality (higher λ) if and only if $\delta > \widehat{\delta}$, where $\widehat{\delta}$ is given by (31).*

[18]Hence, we suppose here, more precisely, that the bank meets a naive buyer of its securities with probability α.

Still, a key difference in the case with naive investors is that the bank now no longer fully internalizes an increase in average deal quality, as this is not fully reflected in a change of $\widehat{p}$. Therefore, the bank has less to gain if mandatory deferred compensation allows it to commit to less-indiscriminate deal-making. This, in turn, implies that it is more likely that the interests of a social planner and of the bank will diverge.

8.2 Systemic Risk and Externalities

For the purpose of this Section only, suppose that the bank does not securitize the respective deals: $\psi = 0$. Furthermore, we now suppose, more generally, that a deal of type θ is successful (through generating $x > 0$) with probability ϕ_θ, where $\phi_H > \phi_L$ (cf. also Section 9.3). The novelty in this Section is, however, that when the deal results in a failure (zero cash flow), there is a negative externality of size $z > 0$. Without adding more structure at this point, we may suppose that this relates to systemic risk in the financial sector. While it enters the objective function of a regulator or supervisor, it does not enter into the bank's profit function.

We suppose that

$$\phi_H x - (1 - \phi_H) z - \kappa > 0 > \phi_L x - (1 - \phi_L) z - \kappa, \tag{34}$$

such that from the perspective of social welfare it still holds that only high-quality deals should be undertaken. It is easily established from our previous results (notably, expressions (16) and (17)), that without regulation, the bank finds it optimal to incentivize its agents to undertake only high-quality deals if

$$K_H - K_{HL} \leq \pi(1 - \mu) (\kappa - \phi_L x) . \tag{35}$$

Clearly, when low-quality deals also generate a positive NPV for the bank, though they are, from (34), socially inefficient, the bank strictly prefers to undertake deals indiscriminately. However, from $K_H - K_{HL} > 0$, the bank may still prefer to undertake all deals when low-quality deals are of negative NPV and, thus, both privately and socially inefficient.[19] When the converse of (35) holds strictly, private and social objectives coincide: Only high-quality deals will be made in equilibrium.

[19] For brevity's sake, we abstract from the fact that the deadweight loss from deferred compensation also enters the social welfare function. This does, however, not affect the result that the bank has too-high incentives to also undertake low-quality deals.

It is now immediate that our previous insights on the implications of mandatory deferred compensation carry over to this extension, given that they hinge only on how regulation affects the difference in compensation costs $K_H - K_{HL}$. Thus, we have the following result.

Proposition 10 *Take the modified model where there is no securitization, but where failure of a deal results in negative externalities ("systemic risk"), such that (34) holds. Then, imposing deferred bonus compensation (weakly) reduces the risk of failure by inducing the bank to undertake only high-quality deals, when $\delta > \widehat{\delta}$. In contrast, for $\delta < \widehat{\delta}$, such regulation (weakly) increases the risk of failure by making it relatively more profitable for the bank to undertake deals indiscriminately.*

9 Endogenous Securitization

So far, we have taken ψ, the fraction of any deal that is sold, as exogenously given, depending on the characteristics of the underlying deal. In what follows, we first endogenize ψ, before then considering, more generally, the optimal design of the bank-issued security.

Suppose, therefore, that for any dollar that the bank receives (early) from securitization it can generate subsequent cash flows of $1 + \tau$, where $\tau \geq 0$. Hence, when $\tau > 0$ holds strictly, there are (efficiency) gains realized from securitization.[20] Note that we assume that the bank is, at least to some extent, financially constrained, as otherwise it could fund these profitable activities in different ways.[21] Alternatively, gains from securitization may arise from risk diversification, either because the bank's owners are not fully diversified or because of expected costs arising from the threat of bankruptcy or regulatory constraints.[22] In this section, we will restrict our attention to the case where the bank can commit to a maximum level of securitization. We discuss the case where no such commitment is possible in Section 10.

[20] Note that this assumes that the bank can extract all benefits from any newly funded activities such as corporate loans. (Otherwise, the efficiency gains from securitization would be higher.)

[21] To reconcile the bank's preferences with $\delta < 1$ for the agent, we may suppose that the time span between the two signals, $t = 1$ and $t = 2$, is relatively small, compared to the lifetime of the considered deals – e.g., a mortgage or a long-term corporate loan. Furthermore, as the agent's compensation occurs "early" in the lifetime of a deal, the "true" costs of compensation are still given by K_H and K_{HL}, respectively.

[22] For a further formal analysis of the benefits of credit-risk transfer, see Froot et al. (1993) or Froot and Stein (1998).

9.1 Ex-ante Commitment

Suppose that the bank can commit ex-ante – i.e., before it implements a compensation scheme – to the value $\psi = \psi_c$. It is immediate that the bank will then consider only the following two strategies. It will sell off with probability one all of a deal, such that $\psi_c = 1$. We know that this implies that deals will be made indiscriminately. Alternatively, the bank will keep ψ_c sufficiently low so as to (just) credibly commit to incentivize the agent to close only high-quality deals.[23]

In the first case, where $\psi_c = 1$, the bank's payoff is, in analogy to (17), equal to[24]

$$V_{HL} = \pi((1+\tau)\mu x - \kappa) - K_{HL}. \tag{36}$$

In the second case, where only high-quality deals are made, the bank optimally chooses the highest possible level of ψ_c that is still incentive-compatible. Adjusting (18) for the additional benefits τ, the respective boundary $\underline{\psi}_c$ is given from the binding constraint that the bank does not deviate, which, after some transformations, yields

$$\underline{\psi}_c = \frac{1}{x(1+\tau)}\left(\kappa - \frac{K_H - K_{HL}}{\pi\,(1-\mu)}\right). \tag{37}$$

This can then be substituted into the respective profits, which, in analogy to (16), are given by

$$V_H = \mu\pi\left[\underline{\psi}_c x\tau + x - \kappa\right] - K_H. \tag{38}$$

Note that the threshold $\underline{\psi}_c$ in (37) depends both on the characteristics of deals and, through the respective compensation cost differential $K_H - K_{HL}$, on the bank's internal agency problem.

Proposition 11 *Suppose that the bank wants to commit vis-à-vis investors that it will incentivize the agent to conduct only high-quality deals, and can commit to a sufficiently low level of securitization* $\underline{\psi}_c > 0$. *Then,* $\underline{\psi}_c$ *is lower if*
i) the internal agency problem becomes more severe, as the bank's own information becomes less precise (lower q_t*);*
ii) or deal-making costs play a relatively larger role, as either c/π *is higher or deals are of smaller size (*κ*), holding constant the return of a high-quality deal (*$(x-\kappa)/\kappa$*).*

[23] Note that, in particular, it will not be optimal to choose ψ_c such that this subsequently gives rise to a mixed-strategy equilibrium.

[24] Here, κ still accounts for the bank's "true" opportunity cost of providing the required up-front capital.

Proof. Let $\eta = \left\{ q_t, \frac{c}{\pi} \right\}$. The first two assertions follow from

$$\frac{d\underline{\psi}_c}{d\eta}\underline{\psi}_c = -\frac{1}{x(1+\tau)}\frac{d}{d\eta}\left[\frac{1}{\pi}\left(K_H - K_{HL}\right)\right] < 0,$$

which is due to our earlier comparative statics results of compensation costs. Furthermore, when holding constant the return of a high-quality deal, we get

$$\left.\frac{d\underline{\psi}_c}{d\kappa}\right|_{(x-\kappa)/\kappa \text{ constant}} = \left(\frac{K_H - K_{HL}}{(1-\mu)\,(1+\tau)\,\pi}\right)\frac{1}{x\kappa} > 0.$$

Q.E.D.

Note that the bank can commit to only *high-quality* deals whenever $\underline{\psi}_c$, as given by (37), is greater than zero. Nonetheless, the bank might prefer to make all deals indiscriminately if this leads to greater profits. From comparing (38) and (36), it follows that the bank strictly prefers to commit to make only high-quality deals only if

$$\underline{\psi}_c > \frac{\tau\mu}{1-\mu+\tau}. \tag{39}$$

Taken together, this leads to the following equilibrium characterization.

Proposition 12 *Suppose that the bank can commit ex-ante to some maximum level of securitization ψ_c. Then, when (39) holds, the bank commits to $\underline{\psi}_c$, as given by (37), and makes only high-quality deals subsequently. If the converse of (39) holds strictly, then the bank fully securitizes all deals ($\psi_c = 1$), and all deals are made indiscriminately. Finally, if (39) holds weakly, the bank is indifferent between both strategies.*

Proof. See Appendix.

Discussion. Propositions 11 and 12, together, provide implications for the optimal level of securitization. Similarly, Duffie (2008) illustrates how fractional retention of a CLO issue helps the issuer to commit to exert costly effort and, thereby, to lower the borrower's default risk.[25] Clearly, the securitization decision, in practice, clearly depends on the characteristics of a transaction. The prominence of consumer loans as collateral in CDO issues suggests that these loans lend themselves particularly well to securitization. One

[25] He shows that if effort becomes more costly, the retained fraction increases in order to "convince" investors that the issuer has "enough at stake." For too-high costs, however, the issuer eventually stops providing effort and sells the entire loan.

reason might be that consumer loans are typically smaller, making the collateralizing portfolio less vulnerable to single name concentration. Our analysis, however, suggests that with smaller deals, quality is more likely to suffer given the bank's internal agency conflict (cf. Corollary 3). Another reason might be that household loans tend to be more standardized, which, in our model, would be reflected in more precise signals s_t and, thus, a less severe internal agency conflict.[26]

Impact of Regulation on the Equilibrium Outcome. As $\underline{\psi}_c$ depends on the compensation cost differential $K_H - K_{HL}$, we know from our previous observations that under mandatory deferred compensation, commitment will be easier – i.e., it can be achieved at a strictly higher value $\psi_c = \underline{\psi}_c$, if and only if $\delta > \widehat{\delta}$. If the converse holds, as $\delta < \widehat{\delta}$, mandatory deferred compensation will make commitment harder and, thereby, reduce $\underline{\psi}_c$. Based on these observations, we can still show that with endogenous securitization, our previous results on the impact of regulation hold.

Proposition 13 *Suppose that the bank can commit to a level of securitization, $\underline{\psi}_c$. Then, mandatory deferred compensation has the following implications:*
i) If $\delta > \widehat{\delta}$, then $\underline{\psi}_c$ increases and it becomes more likely that the bank prefers to commit to $\underline{\psi}_c$, such that only high-type deals are made.
ii) If $\delta < \widehat{\delta}$, then $\underline{\psi}_c$ decreases and it becomes more likely that the bank will close all deals indiscriminately.

Proof. With $\underline{\psi}_c$ given by (37), note that the bank will commit to $\psi_c = \underline{\psi}_c$ whenever

$$\kappa\pi(1-\mu) - \tau\pi\mu x\left(\frac{(1-\mu)(1+\tau)}{(1-\mu)(1+\tau)+\tau\mu}\right) > K_H - K_{HL}.$$

The assertions, then, follow immediately from our previous observations on how mandatory deferred compensation affects the compensation cost differential $K_H - K_{HL}$. **Q.E.D.**

9.2 Ex-post Commitment

We will now consider the alternative specification where the bank can, though still credibly, choose a level of securitization $\psi = \psi_s$ only *after* a particular transaction has been made. (The subscript in ψ_s indicates that this now gives rise to a game of signaling.)

[26] Consistent with this view, Sufi (2007) shows empirically that a higher fraction of syndicated loans is retained if the respective transaction is more "opaque."

It is well known that by specifying sufficiently "pessimistic" beliefs for any "out-of-equilibrium" choice of ψ_s, a wide range of equilibria can be supported in such games. In particular, we can still support the same outcome as with *ex-ante* commitment; that is, either all deals are closed and then sold off ($\psi_s = 1$), or only high-quality deals are made, and the fraction $\underline{\psi}_s = \underline{\psi}_c$ is subsequently securitized.

In contrast to a standard signaling game, however, the "type" of the bank is endogenous in our model. Instead of applying standard equilibrium refinements for signaling games (such as the "Intuitive Criterion") to the respective continuation game, it is thus more adequate to take into account the dynamic nature of the game and to use the concept of "Forward Induction" (cf. Govindan and Wilson, 2009) to narrow down the set of possible equilibria.[27]

Proposition 14 *Suppose that the level of securitization, ψ_s, is chosen only after a deal has been made. Then, we can still support as a (now perfect Bayesian) equilibrium in both the unregulated and regulated cases the outcome of the game where ex-ante commitment is possible. Moreover, this is the unique outcome consistent with Forward Induction.*

Proof. See Appendix.

9.3 Optimal Security Design

So far, we have abstracted from the potential role of security design when the bank wants to sell a fraction of a newly originated transaction. Formally, this was possible since the outcome from a transaction was restricted to be either zero or x.[28] Suppose now, instead, that a deal generates the outcomes $0 \leq x_l < x_h$, where the respective probability of realizing the high outcome is given by $\phi_H > \phi_L$. Denote the expected outcomes by $\overline{x}_H := x_h\phi_H + x_l(1-\phi_H)$ and $\overline{x}_L := x_h\phi_L + x_l(1-\phi_L)$, respectively. If deals are closed indiscriminately, then the average outcome is $\overline{x}_{HL} = \mu\overline{x}_H + (1-\mu)\overline{x}_L$. A security that

[27] Forward Induction captures the idea that players should, even if they observe something unexpected, assume that other players chose rationally in the past and that they will choose rationally in the future. Consequently, the support of investors' updated beliefs is restricted to strategies that are an optimal continuation in some perfect Bayesian equilibrium. Applied to our setting, investors' beliefs should, thus, put positive probability mass on "HL" after observing an out-of-equilibrium value ψ_s only if there exists an equilibrium such that the combination of "HL" and ψ_s is a profit-maximizing strategy.

[28] Note that we also do not consider the possibility that, based on some other assets or income, the bank provides collateral or other guarantees.

the bank sells at a price p can now stipulate the contingent payoffs $0 \leq R_l \leq x_l$ and $0 \leq R_h \leq x_h$. As is standard, we assume that the payout is monotonic with $R_h \geq R_l$.

In order to commit not to incentivize its agent too aggressively, the bank must keep some exposure to any newly-made deal, which is now captured by the residual cash flows $(x_l - R_l)$ and $(x_h - R_h)$. If such commitment is feasible, the bank's profits are given by

$$V_H = \mu\pi\left[\tau\left(R_h\phi_H + R_l(1-\phi_H)\right) + \overline{x}_H - \kappa\right] - K_H, \tag{40}$$

where we substituted the (fair) price $p = R_h\phi_H + R_l(1-\phi_H)$. Incentive compatibility requires that

$$\kappa - \frac{K_H - K_{HL}}{\pi(1-\mu)} \geq \tau\left(R_h\phi_H + R_l(1-\phi_H)\right) + \overline{x}_L + (R_h - R_l)(\phi_H - \phi_L), \tag{41}$$

where the term $(R_h - R_l)(\phi_H - \phi_L)$ represents the "overpayment" by investors if the bank deviates and issues a security that is, contrary to the investors' expectations, backed by only a low-quality deal. If the bank wants to commit, the optimal security (R_l, R_h) maximizes V_H, subject to the bank's incentive-compatibility constraint (41).

Proposition 15 *Suppose that the bank wants to commit vis-à-vis investors that it incentivizes the agent to conduct only high-quality deals and can, for this purpose, design a security (R_l, R_h). Under the uniquely optimal security design, the bank keeps the most risky tranche, as either $R_h = R_l \leq x_l$ or $R_h > R_l = x_l$.*

Proof. See Appendix.

Thus, if the bank wants to commit to make only high-quality deals, this is optimally achieved by retaining the most risky tranche, as this is most affected when a deal is of low quality.[29] Even for the extended model of security design, we can still show that our main insight on regulation holds. That is, mandatory deferred compensation improves average quality only when $\delta > \widehat{\delta}$. For brevity's sake, we omit a formal statement.

[29] Incidentally, when the bank wants to commit to incentivize its agents to generate only high-quality deals, then it may not be feasible to secure all of the riskless cash flows, x_l, such that $R_l = R_h < x_l$. This is the case, as greater securitization of even the riskless part of the deal increases the bank's payoff from *any* deal, which increases its incentives to deviate through incentivizing the agent to make deals indiscriminately. (This is also different from security design with *ex-ante* or *interim* private information, as in DeMarzo and Duffie (1999), Nachman and Noe (1994), or Myers and Majluf (1984).) However, in our model, in this case it would be more profitable for the bank to securitize the entire deal and make deals indiscriminately.

10 Unobservable Securitization

We will now consider the case where the bank can no longer commit to retain a minimum fraction of its deals. Assume, thus, that the fraction ψ_{nc} is offered to an investor before the internal compensation scheme is set. Furthermore, an additional fraction, up to $1-\psi_{nc}$, can be sold to the "market" at a price that corresponds to expected cash flows when all deals are made indiscriminately. It is, then, immediate that whenever the bank sells anything to the "market," it will sell off the entire residual fraction $1-\psi_{nc}$.[30]

Equilibrium Characterization. Intuitively, there is again a highest value for ψ_{nc} ("non commitment"), denoted by $\underline{\psi}_{nc}$, such that making only high-quality deals is incentive-compatible, and the bank will subsequently not sell the residual share to the market.[31] Furthermore, as in the case with commitment (cf. Section 9), we need to consider only two levels of securitization, namely $\psi_{nc}=\underline{\psi}_{nc}$ and $\psi_{nc}=1$. From the binding incentive-compatibility constraint (cf. the proof of Proposition 16 for formal details), we obtain

$$\underline{\psi}_{nc}=\frac{\kappa\pi(1-\mu)-(K_H-K_{HL})-\tau\pi\mu x}{x\pi\left[(1+\tau)(1-\mu)-\tau\mu\right]}, \tag{42}$$

implying that, when only high-quality deals are made, the bank's profits are given by

$$V_H=\mu\pi\left[\underline{\psi}_{nc}\tau x+x-\kappa\right]-K_H,$$

and when all deals are made indiscriminately ($\psi_{nc}=1$), the bank's profits are equal to

$$V_{HL}=\pi\left[(1+\tau)\mu x-\kappa\right]-K_{HL}.$$

Interestingly, $V_H>V_{HL}$ holds if $\underline{\psi}_{nc}>0$. Thus, whenever the high-quality outcome *can* be achieved, then the bank also prefers this. Not surprisingly, in the current setting, only a lower level of securitization can be sustained in the high-quality equilibrium, compared to the case where commitment to ψ_c is possible (cf. expression (37)). These observations give rise to the full equilibrium characterization.

[30] This specification is chosen to abbreviate the analysis. We can show that the same outcome obtains in a setting where there are N identical investors that the bank can secretly contact, with $N\to\infty$.

[31] Notice that for $\mu(1+\tau)>1$, the bank would prefer to sell off the residual fraction under either quality regime. In this case, however, there is no high-quality equilibrium, as $\underline{\psi}_{nc}<0$ (cf. Proof of Proposition 16).

Proposition 16 *If the bank offers ψ_{nc} to an investor and can secretly sell off additional securities to the "market," then the unique equilibrium has the following properties:*
i) If $\underline{\psi}_{nc} > 0$, as given in (42), the bank sells the fraction $\underline{\psi}_{nc}$ to the investor. Only high-quality deals are subsequently made, the bank keeps the remaining stake $1 - \underline{\psi}_{nc}$;
ii) If $\underline{\psi}_{nc} < 0$, all deals are made indiscriminately and then fully securitized ($\psi_{nc} = 1$); or
iii) If $\underline{\psi}_{nc} = 0$, the bank is indifferent between the strategies in parts i) and ii).

Proof. See Appendix.

Impact of Regulation on the Equilibrium Outcome. As $\underline{\psi}_{nc}$ depends on the compensation cost differential in the by-now standard way, our prior results on mandatory deferred compensation also extend to the case with unobservable securitization.

Proposition 17 *If the bank offers ψ_{nc} to an investor and can secretly sell off additional securities to the "market," then making deferred bonus compensation mandatory has the following implications:*
i) If $\delta > \widehat{\delta}$, then the maximum level of securitization, $\underline{\psi}_{nc}$, increases and it becomes more likely that only high-quality deals are made.
ii) If $\delta < \widehat{\delta}$, then $\underline{\psi}_{nc}$ decreases and it becomes more likely that the bank will close all deals indiscriminately.

Proof. The assertions follow immediately from inspection of $\underline{\psi}_{nc}$, as given by (42); and our previous observations on how mandatory deferred compensation affects the compensation cost differential $K_H - K_{HL}$, together with the fact that $\underline{\psi}_{nc} > 0$ is both necessary and sufficient for the high-quality outcome to occur. **Q.E.D.**

Finally, note that our analysis of regulatory interference focuses exclusively on mandatory deferred compensation. For the case where market participants can not observe the level of securitization (or, alternatively, default protection), one may also consider an imposed minimum retention requirement, as proposed, for instance, by the Commission of the European Communities, Internal Market and Services (2008). We leave an analysis of such a policy instrument, as a substitute or a complement to mandatory deferred compensation, for future research.

11 Concluding Remarks

This paper began with a critique of some common arguments for why bankers' pay should be regulated. Against this background, we offered a rationale for why mandatory deferred bonus pay may help banks to overcome a commitment problem vis-à-vis the buyers of their securities. At the heart of our argument is the combination of a bank's internal agency problem and its external agency problem from securitization. This gives rise to a commitment problem, which can potentially be resolved through regulating compensation. As we also showed, however, such intervention has the potential of aggravating the problem, instead leading to more risky, low-quality deals. In this case, while policy intervention would force banks to defer bonus pay, compensation would end up being more high-powered and deal-oriented.

We also showed that these insights also apply in the absence of an external agency problem – i.e., when banks do not securitize, provided that banks' risk taking then generates negative externalities ("systemic risk"). Again, while without regulation, banks may incentivize their agents to conclude deals too indiscriminately, mandatory deferred compensation may have the unintended consequence of decreasing average deal quality.

Our model also generates implications for (optimal) securitization strategies. Retention of the highest-risk tranche allows banks to securitize a large fraction of deals while remaining committed to relatively low-powered internal incentives. Banks' ability to commit and, thus, securitize more depends, amongst other things, on variables that affect their internal agency problem, such as the quality of (early) performance measures, the difficulty of generating deals, or the average size of deals.

In future work, our model may be applied to other questions of regulation in the financial industry. For instance, as noted in the Introduction, supervisors may want to link capital adequacy requirements to banks' chosen compensation schemes.[32] Also, as noted above, the joint regulation of securitization ("minimum retention") and compensation may warrant further study.

[32] In fact, monitoring firms' compensation to their financial sales people, such as mortgage and insurance brokers or staff in call centers, is often part of the compliance check that is performed by the respective supervisor.

12 Appendix

Proof of Proposition 8. Since the proof proceeds as in the case where $\alpha = 0$ ("all sophisticated"), we can be relatively short. Without regulation, for $\delta < \delta_W$, an equilibrium where deals are made indiscriminately exists when $\psi \geq \overline{\psi}_\alpha$, where $\overline{\psi}_\alpha$ is given by

$$\overline{\psi}_\alpha = \frac{1}{x}\left(\frac{1}{\alpha + (1-\alpha)\mu}\right)\left[\kappa - c\left(\frac{1}{(1-\mu)\mu\pi^2}\right)\left(\frac{1-q_1}{2q_1-1}\right)\right].$$

The lower boundary $\underline{\psi}_\alpha$ is independent of α, $\underline{\psi}_\alpha = \underline{\psi}$. Finally, with $\delta < \delta_W$ and $\psi \in [\underline{\psi}, \overline{\psi}_\alpha]$, the agent is incentivized with probability λ_α to reject low-quality deals, where

$$\lambda_\alpha = \frac{1}{1-\mu} - \psi x\left(\frac{(1-\alpha)(2q_1-1)(\mu\pi)^2}{(\kappa - \alpha\psi x)(2q_1-1)(1-\mu)\mu\pi^2 - c(1-q_1)}\right).$$

Next, for $\delta \geq \delta_W$, we have that $\overline{\psi}_\alpha$ is given by

$$\overline{\psi}_\alpha = \frac{1}{x}\left(\frac{1}{\alpha + (1-\alpha)\mu}\right)\left[\kappa - c\left(\frac{1}{(1-\mu)\mu\pi^2}\right)\left(\frac{\delta[1-q_2(1+\mu\pi)] + q_2\mu\pi}{\delta(2q_2-1)}\right)\right],$$

while λ_α is given by

$$\lambda_\alpha = \frac{1}{1-\mu} - \delta\psi x\left(\frac{(1-\alpha)(2q_2-1)(\mu\pi)^2}{\delta(\kappa - \alpha\psi x)(2q_2-1)(1-\mu)\mu\pi^2 - c[(1-q_2)\delta + q_2(1-\delta)\mu\pi]}\right).$$

Again, $\underline{\psi}_\alpha = \underline{\psi}$ does not depend on α. The assertion, then, follows from a comparative analysis of λ_α and $\overline{\psi}_\alpha$ in both cases; that is,

$$\frac{\partial\overline{\psi}_\alpha}{\partial\alpha} = -\frac{1}{x}\left(\frac{1-\mu}{[\alpha + (1-\alpha)\mu]^2}\right)\left[\kappa - c\left(\frac{1}{(1-\mu)\mu\pi^2}\right)\left(\frac{1-q_1}{2q_1-1}\right)\right] < 0,$$

for $\delta < \delta_W$, and

$$\frac{\partial\overline{\psi}_\alpha}{\partial\alpha} = -\frac{1}{x}\left(\frac{1-\mu}{[\alpha + (1-\alpha)\mu]^2}\right)\left[\kappa - c\left(\frac{1}{(1-\mu)\mu\pi^2}\right)\left(\frac{\delta[1-q_2(1+\mu\pi)] + q_2\mu\pi}{\delta(2q_2-1)}\right)\right] < 0$$

for $\delta \geq \delta_W$. Whereas for $\delta < \delta_W$,

$$\frac{\partial\lambda_\alpha}{\partial\alpha} = \psi x\pi\mu\frac{(\kappa - \psi x)(1-\mu)\pi - \left(\frac{c}{\mu\pi}\right)\left(\frac{1-q_1}{2q_1-1}\right)}{\left[(\kappa - \alpha\psi x)(1-\mu)\pi - \left(\frac{c}{\mu\pi}\right)\left(\frac{1-q_1}{2q_1-1}\right)\right]^2} < 0,$$

and for $\delta \geq \delta_W$,

$$\frac{\partial\lambda_\alpha}{\partial\alpha} = \psi x\pi\mu\frac{(\kappa - \psi x)(1-\mu)\pi - \left(\frac{c}{\mu\pi}\right)\left(\frac{\delta[1-q_2(1+\mu\pi)]+q_2\mu\pi}{\delta(2q_2-1)}\right)}{\left[(\kappa - \alpha\psi x)(1-\mu)\pi - \left(\frac{c}{\mu\pi}\right)\left(\frac{\delta[1-q_2(1+\mu\pi)]+q_2\mu\pi}{\delta(2q_2-1)}\right)\right]^2} < 0,$$

which holds whenever $\psi > \underline{\psi}_{\alpha} = \frac{1}{x}\left(\kappa - \frac{K_H - K_{HL}}{(1-\mu)\pi}\right)$. **Q.E.D.**

Proof of Proposition 12. Given the argument in the main text, it remains to be shown that the restriction to $\psi_c \in \{\underline{\psi}_c, 1\}$ is without loss of generality and, in particular, that there will be no mixing between compensation strategies in equilibrium. Thus, assume that, to the contrary, ψ_c is such that $\lambda \in (0,1)$. Given that the equilibrium price satisfies (1), the bank's (ex-ante) profits are given by

$$\pi\mu x\left(1+\tau\psi_c\right) + \lambda\left[\left(1-\mu\right)\pi\kappa - \left(K_H - K_{HL}\right)\right] - \kappa\pi - K_{HL}. \tag{43}$$

It then follows, again from indifference, that

$$\lambda = \frac{1}{1-\mu} - \frac{\left(1+\tau\right)\pi\mu x\psi_c}{\left(1-\mu\right)\pi\kappa - \left(K_H - K_{HL}\right)},$$

which, after substituting into (43), implies that the bank's profits are equal to

$$\left(1-\psi_c\right)\pi\mu x - \frac{K_H - \mu K_{HL}}{1-\mu},$$

which is strictly decreasing in ψ_c (on the interval of ψ_c that induces mixing) and, thus, attains its maximum at $\underline{\psi}_c$.

Finally, to complete the proof, we explicitly characterize the boundary $\underline{\psi}_c$ for the different cases. Suppose, first, that $\delta < \delta_W$. Then, if

$$\mu x\tau \leq \left(\frac{1+\tau-\mu}{1+\tau}\right)\left[\kappa - c\left(\frac{1}{\left(1-\mu\right)\mu\pi^2}\right)\left(\frac{1-q_1}{2q_1-1}\right)\right] \tag{44}$$

holds, the bank uniquely prefers to set $\psi = \underline{\psi}_c$, which in this case is given by

$$\underline{\psi}_c = \frac{1}{x\left(1+\tau\right)}\left[\kappa - c\left(\frac{1}{\left(1-\mu\right)\mu\pi^2}\right)\left(\frac{1-q_1}{2q_1-1}\right)\right].$$

If the converse of (44) holds, the bank sets $\psi_c = 1$. (When (44) holds with equality, then both $\psi = \underline{\psi}_c$ and $\psi_c = 1$ are equally profitable for the bank.) Next, when $\delta > \delta_W$ holds and when

$$\mu x\tau \leq \left(\frac{1+\tau-\mu}{1+\tau}\right)\left[\kappa - c\left(\frac{1}{\left(1-\mu\right)\mu\pi^2}\right)\left(\frac{\delta\left[1-q_2\left(1+\mu\pi\right)\right]+q_2\mu\pi}{\delta\left(2q_2-1\right)}\right)\right], \tag{45}$$

the bank sets $\psi_c = \underline{\psi}_c$, which is now given by

$$\underline{\psi}_c = \frac{1}{x\left(1+\tau\right)}\left[\kappa - c\left(\frac{1}{\left(1-\mu\right)\mu\pi^2}\right)\left(\frac{\delta\left[1-q_2\left(1+\mu\pi\right)\right]+q_2\mu\pi}{\delta\left(2q_2-1\right)}\right)\right].$$

If the converse of (45) holds, the bank sets $\psi_c = 1$. (When (45) holds with equality, both $\psi = \underline{\psi}_c$ and $\psi_c = 1$ are equally profitable for the bank.) Finally, note that for $\delta = \delta_W$, the two characterized values of $\underline{\psi}_c$ coincide. **Q.E.D.**

Proof of Proposition 14. The game with ex-post securitization choice can be formalized as follows. At stage 1, the bank decides on the "quality" $Q \in \{H, HL\}$, where λ is the probability that $Q = H$ is implemented. At stage 2, the bank offers the fraction ψ_s to investors. A strategy $\sigma(\psi_s|Q)$ specifies the probability that offer ψ_s is made, given the actually chosen compensation strategy and the achieved quality of deals Q.[33] At stage 3, investors then buy at the fair price, given their updated beliefs. Investors' beliefs are given by a probability distribution $\mu(\cdot|\psi_s)$ over $\{H, HL\}$, which is formed according to Bayes' rule when possible – i.e., given the observed ψ_s and the equilibrium strategies λ^* and $\sigma^*(\cdot)$, it holds that

$$\mu^*(H|\psi_s) = \frac{\mu\lambda^*\sigma^*(\psi_s|H)}{\mu\lambda^*\sigma^*(\psi_s|H) + (1-\lambda^*)\sigma^*(\psi_s|HL)}.$$

We first support a perfect Bayesian equilibrium that generates the same outcome as Proposition 11. If for $\delta < \delta_W$, condition (44) holds (condition (45) for $\delta \geq \delta_W$), we specify $\lambda^* = 1$ and $\sigma^*(\underline{\psi}_s|H) = 1$, where $\underline{\psi}_s = \underline{\psi}_c$. If the converse of (44) holds ((45) respectively), we set $\lambda^* = 0$ and $\sigma^*(1|HL) = 1$. If (44) holds ((45) respectively) with equality, we specify $\lambda^* \in (0, 1)$ and $\sigma^*(\underline{\psi}_s|H) = \sigma^*(1|HL) = 1$. For investors we specify the beliefs

$$\mu^*(H|\psi_s) = \begin{cases} 1 \text{ if } \psi_s \leq \underline{\psi}_s \\ 0 \text{ if } \psi_s > \underline{\psi}_s \end{cases},$$

implying the price function

$$p^*(\psi_s) = \begin{cases} x \text{ if } \psi_s \leq \underline{\psi}_s \\ \mu x \text{ if } \psi_s > \underline{\psi}_s \end{cases}.$$

We show next that this is also the unique outcome that is consistent with Forward Induction. Take any candidate equilibrium where the bank would, after implementing $Q = H$, choose some $\psi_s = \widetilde{\psi}_s < \underline{\psi}_s$. To support this, after observing $\widehat{\psi}_s \in (\widetilde{\psi}_s, \underline{\psi}_s)$ investors must put positive probability on $Q = HL$. However, for $\widehat{\psi}_s < \underline{\psi}_s$, the bank would be strictly better off if it had chosen $Q = H$, such that this strategy profile is ruled

[33] More precisely, this generally specifies a probability distribution.

out by forward induction. An analogous argument holds for any "pooling strategy," where $\lambda^* \in (0,1)$ and, subsequently, $\sigma^*(\psi_s'|H) = \sigma^*(\psi_s'|HL) = 1$. **Q.E.D.**

Proof of Proposition 15. Observe, first, that the (by optimality binding) incentive constraint (41) becomes

$$[(1+\tau)\phi_H - \phi_L] R_h + [\tau(1-\phi_H) - (\phi_H - \phi_L)] R_l = \kappa - \overline{x}_L - \frac{K_H - K_{HL}}{\pi(1-\mu)}. \quad (46)$$

Now, suppose that $R_l < x_l$ while $R_h > R_l$. We show that this can not be optimal. To see this, note that increasing R_l marginally requires, in order to maintain incentive compatibility, to decrease R_h by

$$\frac{\tau(1-\phi_H) - (\phi_H - \phi_L)}{(1+\tau)\phi_H - \phi_L},$$

which implies a marginal change in profits equal to

$$-\phi_H\left(\frac{\tau(1-\phi_H) - (\phi_H - \phi_L)}{(1+\tau)\phi_H - \phi_L}\right) + (1-\phi_H) > 0.$$

We next have to distinguish between two cases. When

$$\tau x_l \leq \kappa - \overline{x}_L - \frac{K_H - K_{HL}}{\pi(1-\mu)} \quad (47)$$

holds, incentive-compatibility can be achieved with a security that satisfies $R_h > R_l = x_l$. The remaining variable R_h is, from (46), given by

$$R_h = \frac{1}{(1+\tau)\phi_H - \phi_L}\left[\kappa - (1+\tau)(1-\phi_H)x_l - \phi_L x_h - c\left(\frac{1}{(1-\mu)\mu\pi^2}\right)\left(\frac{1-q_1}{2q_1-1}\right)\right]$$

for $\delta < \delta_W$, and by

$$R_h = \frac{1}{(1+\tau)\phi_H - \phi_L}\left[\begin{array}{c}\kappa - (1+\tau)(1-\phi_H)x_l - \phi_L x_h \\ -c\left(\frac{1}{(1-\mu)\mu\pi^2}\right)\left(\frac{\delta[1-q_2(1+\mu\pi)]+q_2\mu\pi}{\delta(2q_2-1)}\right)\end{array}\right]$$

for $\delta \geq \delta_W$. When the converse of (47) holds, we have

$$R_h = R_l = \frac{1}{\tau}\left[\kappa - \phi_L x_h - (1-\phi_L)x_l - c\left(\frac{1}{(1-\mu)\mu\pi^2}\right)\left(\frac{1-q_1}{2q_1-1}\right)\right],$$

for $\delta < \delta_W$ and

$$R_h = R_l = \frac{1}{\tau}\left[\begin{array}{c}\kappa - \phi_L x_h - (1-\phi_L)x_l \\ -c\left(\frac{1}{(1-\mu)\mu\pi^2}\right)\left(\frac{\delta[1-q_2(1+\mu\pi)]+q_2\mu\pi}{\delta(2q_2-1)}\right)\end{array}\right]$$

for $\delta \geq \delta_W$. **Q.E.D.**

Proof of Proposition 16. Incentive compatibility requires $\underline{\psi}_{nc}$ to be smaller than

$$\left[\frac{1}{x}\left(\kappa - \frac{K_H - K_{HL}}{\pi(1-\mu)}\right) - \mu(1+\tau)\right]\left(\frac{1}{(1+\tau)(1-\mu)}\right).$$

As the first term in rectangular brackets is equal to $\underline{\psi} < 1$, note that when $\mu(1+\tau) \geq 1$, there is no incentive-compatible value $\underline{\psi}_{nc} \geq 0$. Assume, thus, that $\mu(1+\tau) < 1$.

By rewriting the binding incentive-compatibility constraint, we obtain

$$V_H = V_{HL} + \pi(1+\tau)(1-\mu)\, x\underline{\psi}_{nc},$$

implying that $V_H > V_{HL}$ holds if and only if $\underline{\psi}_{nc} > 0$. The respective expressions for $\underline{\psi}_{nc}$ are finally obtained by

$$\underline{\psi}_{nc} = \frac{\pi\left[\kappa(1-\mu) - \tau\mu x\right] - c\left(\frac{1}{(1-\mu)\mu\pi^2}\right)\left(\frac{1-q_1}{2q_1-1}\right)}{x\pi\left[(1+\tau)(1-\mu) - \tau\mu\right]}$$

for $\delta < \delta_W$, and by

$$\underline{\psi}_{nc} = \frac{\pi\left[\kappa(1-\mu) - \tau\mu x\right] - c\left(\frac{1}{(1-\mu)\mu\pi^2}\right)\left(\frac{\delta[1-q_2(1+\mu\pi)]+q_2\mu\pi}{\delta(2q_2-1)}\right)}{x\pi\left[(1+\tau)(1-\mu) - \tau\mu\right]}$$

for $\delta \geq \delta_W$.

As a final step, we rule out optimality of setting ψ_{nc} such that subsequently $\lambda \in (0,1)$ would prevail ("mixing"). From indifference, it follows that

$$\lambda = \frac{1}{1-\mu} - \frac{\psi_{nc}(1+\tau)\pi\mu x}{\kappa\pi(1-\mu) - K_H + K_{HL} - (1-\psi_{nc})\tau\pi\mu x}. \tag{48}$$

The bank's profits, once we substitute (48) for λ, equal

$$(1-\psi_{nc})\mu\pi x\left[\frac{1-\mu(1+\tau)}{1-\mu}\right] - \frac{K_H - \mu K_{HL}}{1-\mu},$$

which is strictly decreasing in ψ_{nc}, and, thus, attains its maximum in $\underline{\psi}_{nc}$. **Q.E.D.**

13 References

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