Incentives for risk-taking: bonuses and dismissals

Preliminary and incomplete

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Abstract

It is widely believed that job security is essential for risk-taking. Yet, we show that a firm that faces a population of managers with heterogeneous risk aversion may use dismissals for sorting purposes: performance-based but random dismissals without compensation are used to screen out managers with high risk aversion. The structure of performance-based bonuses is then set to provide effort and risk-taking incentives, for a given level of managerial risk aversion. Thus, bonuses and dismissals serve two complementary purposes in a corporate governance system. The model notably suggests a theory of employment and compensation in the investment banking industry which can explain a number of apparent anomalies.

Keywords: corporate governance; executive compensation; risk aversion; risk-taking; turnover.

JEL classification codes: D81; D82; G30; G34.

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The provision of risk-taking incentives is a central issue in the finance literature. It is notably a crucial aspect of corporate governance.[1] The common wisdom is that risk-taking incentives are provided by rewarding the manager for success and protecting him against the consequences of failure (e.g., Feltham and Wu (2001), Coles, Daniel and Naveen (2006), Dittmann and Yu (2010), Manso (2011)), notably with job security (Manso (2011)). Yet, dismissals are widely used in the investment banking industry, where risk-taking is an integral part of the job.[2] According to Cohan (2012) in a survey of Wall Street dismissals: "Wall Street bankers and traders (...) [are] summarily fired, often with surprisingly little in the way of severance or explanation (...) often for no reason other than business has turned sour.", which is contrary to economic theory.[3] Even CEOs do not really benefit from job security (Kaplan and Minton (2011)). More generally, in a seminal book, Deal and Kennedy (1982) describe four types of corporate cultures, including the "Tough guy, macho" culture where both risk-taking *and* turnover are high.

The model developed in this paper can explain these stylized facts. As emphasized in Ross (2004), it is essential to know the properties of individual preferences in the face of risk to design a contract which provides risk-taking incentives. In this regard, a major obstacle in the calibration of incentive schemes is that degrees of risk aversion differ across the population, as documented in Barsky, Juster, Kimball and Shapiro (1997), even after controlling for observable variables

[1] To quote Tirole (2006): "The premise behind modern corporate finance (...) is that corporate insiders need not act in the best interests of the providers of the funds." Corporate governance involves mechanisms whose purpose is to align the interests of the former with the interests of the latter. The "corporate insiders" in question whose jobs involve risk-taking include project managers, top executives, asset managers in the financial industry, bankers, and traders.

[2] This is true even at positions below the senior executive level. For example, in a recent high-profile case, a JP Morgan trader known as the "London Whale" reportedly accumulated positions worth $100bn in credit default swaps markets and single-handedly lost $6bn in 2012, even though there was no suggestion that his activities were in any way irregular. Source: http://www.reuters.com/article/2012/05/11/us-jpmorgan-iksil-idUSBRE84A12620120511 and http://www.reuters.com/article/2012/08/31/us-jpmorgan-loss-transatlantic-idUSBRE87U06420120831.

[3] More precisely, the ex-post utility of dismissed and non-dismissed employees should coincide (see, e.g., section III in Rosen (1985)), which is clearly not the case in the financial industry. According to Cohan (2012): "Reducing pay across the board would be an obvious solution to grappling with a lower-revenue environment. But that's not the Wall Street way. (...) The strategy now is to pay as little severance as possible. (...) [Dismissed] bankers and traders can never hope to make again what they were once making." Arguably, firms will only be risk neutral with respect to idiosyncratic risk, but not with respect to systematic risk. As a consequence, there may be risk sharing of the systematic risk between the firm and its employees (Thanassoulis (2011)). This however does not affect the result that the ex-post utility of dismissed and non-dismissed employees should coincide. By contrast, it is notable that other firms which are also highly exposed to the business cycle nevertheless tend to largely shield their employees from these macroeconomic shocks, as predicted by economic theory.

(Guiso and Paiella (2010)). We propose a model that takes into account this heterogeneity, and we demonstrate that exposing managers to the risk of dismissal will elicit self-selection at the hiring stage: only managers with low risk aversion will accept the contract. Bonus payments can then be designed to provide (second-best) efficient effort and risk-taking incentives to this type of managers. Thus, we propose a new rationale for dismissals in a corporate governance system,[4] and we argue that dismissals can actually be an important part of a contract that fosters risk-taking.

Formally, we study the problem of providing effort and risk-taking incentives to a manager in a stylized principal-agent model similar to John and John (1993). In short, the manager has some private information on the investment opportunity set of the firm, and decides whether to invest in a safe or a risky project. The first major difference is that we assume that managers are risk averse, and that the firm faces a population of managers whose (unobservable) risk aversion is either high or low. The second difference is that we allow the firm to not only pay a performance-based bonus payment, but also to "dismiss" a manager with a certain probability after performance is observed, in which case the manager does not earn his compensation. We also let the probability of success of the risky project depend on the manager's effort.

To start with, for a given commonly known level of managerial risk aversion, we describe the second-best optimal compensation contract. This contract involves a performance-based bonus paid at the end of the period. The bonus in case of an intermediate performance (which follows from an investment in the safe project) is equal to the bonus in case of a low performance (a failure of the risky project), but the manager receives a higher bonus in case of a high performance (a success of the risky project). Thus, the bonus-performance relation is convex.[5] We find that any type of dismissal without compensation, whether random or performance-based, is suboptimal. Intuitively, with a risk averse manager, it is optimal to minimize the dispersion of payments in equilibrium, which explains why managerial compensation is not

[4]Obviously, we do not argue that screening of risk preferences is the sole purpose of dismissals. Dismissals can also serve an incentive purpose (Shapiro and Stiglitz (1984)), whereby managers with low performance are dismissed (although this is inefficient in our model), or they can serve a sorting purpose (ex-post) when managers are heterogeneous in terms of ability (Kugler and Saint-Paul (2004)).

[5]If the measure of performance were the stock price, the optimal state-contingent compensation of the manager could be implemented with stock-options. We will emphasize the bonus interpretation instead.

sensitive to performance on the downside and why dismissals are not used. To provide adequate incentives *and* adequate compensation for effort, the bonus in case of success adjusts upwards. Furthermore, the relationship between pay and performance is all the more convex that the manager is more risk averse, ceteris paribus. Intuitively, the convexity of the pay-performance relation must offset the concavity of the manager's utility function. This notably implies that it is important to know the level of risk aversion of the manager to design his incentive scheme. We also show that the investment policy of the firm at the second-best involves less risk-taking than at the first-best if the manager is risk averse, and that this investment distortion is more pronounced for more risk averse managers.

In this context, a screening mechanism at the hiring stage which discourages applications from managers with high risk aversion has two advantages. First, it reduces the aforementioned investment distortion. Second, it enables the firm to calibrate the compensation contract to a known managerial type – i.e., a manager with a known level of risk aversion. However, in an economy where employment opportunities provide a stochastic wage, we show that managers with low risk aversion have a higher reservation wage than managers with high risk aversion. This makes it more difficult to screen out the latter. Accordingly, we identify three equilibria.

First, there is a pooling equilibrium in which the firm hires both types of managers. In this case, risk-taking varies across managers. In addition, there are no dismissals (since screening is not required), the level of pay is relatively high (to ensure the participation of managers with low risk aversion), and a high performance is highly rewarded (to offset the risk aversion of the more risk averse managers).

Second, there is another separating equilibrium in which the firm only hires managers with high risk aversion. In this case, risk-taking is moderate, there are no dismissals, and bonuses are relatively low. Compensation costs are lower in this equilibrium, but the investment distortion is greater.

Third, there is an equilibrium in which the firm only hires managers with low risk aversion. To screen out managers with high risk aversion, who are more adversely affected by the risk of dismissal, the probability of dismissal without compensation is strictly positive in case of an investment in the safe project, and, following an investment in the risky project, it is strictly higher in case of low performance than in case of high performance. Thus, dismissals are random but their probability is performance-based. However, this is not because it is optimal to use dismissals to provide incentives: indeed, given an investment policy and a dismissal policy, bonus payments adjust so that performance-based dismissals do not affect either effort or risk-taking incentives. Instead, dismissals are performance-based because the difference between the utility of managers with low risk aversion and the utility of highly risk averse managers is increasing in wealth. That is, managers with low risk aversion value high payments relatively more. Consequently, to discourage applications from managers with high risk aversion while maintaining managers with low risk aversion at their reservation level of utility, it is more efficient to randomly deprive managers of their compensation (via dismissals) in cases when it is relatively low.[6] Roughly speaking, the firm sets the dismissal probabilities to optimally achieve screening, then it calibrates the incentive scheme to address moral hazard. Note that this separation between the roles of bonuses and dismissals is not assumed, but is a result of the model. This separating equilibrium in which the firm only hires managers with low risk aversion is characterized by strong risk-taking, frequent dismissals, and high bonuses for the "survivors". The model predicts that it is all the more likely that the expected return on the risky project is higher than the return on the safe project.

The characteristics of this second separating equilibrium are consistent with the finding of Oyer (2008) that MBAs who opt for an investment banking career earn "on average substantially more money", with the evidence in Sapienza, Maestripieri, and Zingales (2009) that individuals with low risk aversion are more likely to choose "risky careers in finance", and with the especially high level of involuntary turnover in investment banking. For example, in 2011 alone, 200,000 Wall Street employees lost their jobs, including 40,000 bankers or traders at the managing

[6]Incidentally, to the extent that dismissals are used to screen employees based on their risk aversion, the explanatory power of a statistical model of employee-level turnover will be relatively low. This is because, even after conditioning for the action and performance of the employee, dismissals are random in the second separating equilibrium. In the existing literature, it is typically optimal to dismiss an employee – whether for incentives or sorting purposes, see footnote 2 – if and only if his performance falls below a threshold, so that dismissals are a deterministic function of performance.

director or vice-president level.[7] In this separating equilibrium, high pay is a compensation for the high risk of dismissal, which is necessary to filter out highly risk averse managers, who have a lower reservation wage precisely because of their high risk aversion.[8] More generally, the model generates different types of "business models", which may co-exist in industries where risk-taking matters. Each is described by its set of internally consistent and complementary practices (note that a business model can be implemented at the level of a business unit or profit center, and not necessarily at the firm level): the degree of risk-taking is *positively* associated with the level of bonuses and with the turnover frequency. On the contrary, job security is essential to encourage risk-taking in Manso (2011). This apparently paradoxical result of our model is due to the adjustment of bonuses, which neutralizes the incentives effects of dismissal (so that managers are protected from failure in equilibrium,[9] as in Manso (2011)), and to the sorting effect of dismissals described above.

To screen out highly risk averse managers, the firm could alternatively use bonus payments which are stochastic even conditional on performance. That is, it could use pay-for-luck instead of dismissals. We show however that if the heterogeneity in risk preferences mainly concerns the aversion to downside risk, then it is more efficient to use dismissals than stochastic bonuses with "moderate" payments in some states of the world. The intuition is that screening is then efficiently achieved by increasing the downside risk faced by the manager. This is achieved with dismissals, i.e., a payment of zero.

The paper contributes to the theoretical literature on risk and uncertainty. Indeed, we emphasize that exposing an agent to some risk if he takes some action can induce him to reveal his level of risk aversion. Thus, even though pure randomness in labor income is suboptimal ex-

[7]Source: Bloomberg data, cited in Cohan (2012). This is not an isolated episode. For example, from 2001 to 2003, some large investment banks such as Goldman Sachs and Merrill Lynch dismissed from 20% to 30% of their workforce.

[8]This said, a few decades ago, the banking sector arguably fitted into the first separating equilibrium described above. According to Philip Coggan, "Banking was once thought of as a dull sector. (...) You didn't want [a banker] to be imaginative because you wanted to make sure he gets his money back. (...) The banking model was described as 3-6-3: borrow money at 3%, lend it at 6% and be on the golf course by 3pm. (...) People who worked in the US financial sector actually earned less than those with similar qualifications in different professions in the late 1970s." Sources: Coggan (2011), and public lecture at the LSE, January 19 2012.

[9]In all separating equilibria, the expected utility of hired managers conditional on a low performance is equal to their expected utility conditional on an intermediate performance.

post for a risk-averse agent, it can serve a screening purpose ex-ante. This result complements the result from the moral hazard literature that state-contingent compensation is typically suboptimal ex-post for a risk averse agent, but can provide incentives ex-ante.

The paper is also related to the literature on background risk. We know that exposing an agent to a background risk to his wealth *raises* his aversion to other (independent) risks if his utility function satisfies some natural conditions (Gollier and Pratt (1996)). In this paper, the risk of dismissal either leaves the income of the manager unchanged, or brings it down to zero. Crucially, for any concave utility function, a non-performance-based risk of dismissal does not have any effect on risk-taking. In addition, the probability of dismissal is performance-based in the model, but bonus payments adjust so that it does not affect incentives. However, by increasing the variability of future income, it ensures that managers who accept the contract offer have a low level of risk aversion. This sorting effect explains our result that exposing managers to this risk tends to *lower* the level of risk aversion of hired managers.

There is a large literature on heterogeneous risk preferences, especially in asset pricing (e.g. Benninga and Mayshar (2000) and Chan and Kogan (2002)), but also in insurance (e.g. Landsberger and Meilijson (1994), de Donder and Hindriks (2009)). In a closely related paper, Jullien, Salanié, and Salanié (2007) show how the incentive schedule should be adjusted in a standard model of moral hazard when the agent's risk aversion is his private information. There are three important differences with our paper. First, in their paper the agent can exert effort to improve the probability of success of a project, but there is no investment decision and risk-taking is not an issue. Second, they derive the optimal compensation contract, but they do not consider dismissals. Third, they assume that the participation constraint of both types of agents (with high and low risk aversion) should be satisfied (see also Oyer (2004)), whereas we study a mechanism which precisely ensures that the participation constraint of the manager with high aversion is *not* satisfied.

1 The model

We use a stylized principal-agent model of investment choice in the spirit of John and John (1993) to study the provision of effort and risk-taking incentives when managers have heterogeneous risk aversion. In doing so we abstract from other important determinants of bonus payments such as the retention motive based on updated beliefs about managerial ability, or the sharing of the systematic risk between shareholders and managers (Thanassoulis (2011)).

There are two types of managers: those with high risk aversion, with utility function $\bar{u}$, and those with low risk aversion, with utility function $\underline{u}$. There is a proportion $\eta \in (0,1)$ of managers with high risk aversion. We assume that $\underline{u}$ is strictly increasing, strictly concave, and continuously differentiable, that $\bar{u}(x) \equiv h(\underline{u}(x))$ for a strictly increasing, strictly concave, and continuously differentiable h and any $x \geq 0$. Thus, for technical reasons and for plausibility, we rule out the existence of risk neutral managers.[10] Crucially, we assume that the type of each manager is unobservable, and cannot be revealed. All managers are expected-utility maximizers.

We assume that all managers have access to the same outside employment opportunity which pays a stochastic wage $\tilde{\omega}$, and determines their reservation wages. We denote the reservation wages of a manager of type $\underline{u}$ and $\bar{u}$ by $\bar{W}_{\underline{u}}$ and $\bar{W}_{\bar{u}}$, respectively. Then we have the following preliminary result:

Lemma 1: $\bar{W}_{\underline{u}} > \bar{W}_{\bar{u}}$.

We let $\bar{W}_{\underline{u}} = \bar{W}_{\bar{u}} + \pi$, with $\pi > 0$. In the limit case where $\tilde{\omega}$ is deterministic, then $\pi = 0$. As

[10]First, with risk neutral managers, the optimal contract would not be unique in our model, as it would be costless to increase the pay-performance sensitivity. Second, it is implausible that managers are risk neutral. Indeed, if some managers were risk neutral or risk loving, these economic agents would in principle bear all the macroeconomic risk, thereby fully insuring the rest of the (risk averse) population. Even though this allocation of risk may not be feasible due to incomplete markets, risk neutral or risk loving managers would nevertheless not purchase any non-mandatory insurance, they would borrow as much as they could, and they would only own the assets with the highest betas (to the extent that the risk premium is increasing in beta). In practice, they would only own out-of-the-money options. The fact that lots of managers either own low-beta assets such as prime real-estate or do not reach their borrowing limit is inconsistent with the hypothesis of risk neutrality. This said, all our results still hold even for an arbitrarily small level of risk aversion – as measured by the coefficient of absolute risk aversion for example.

will be clear in the next section, it is important to acknowledge that managers with different risk preferences value differently the same outside option, and therefore have different reservation wages.[11] We also assume that the distribution of $\tilde{\omega}$ is such that $\bar{W}_{\bar{u}}$ is strictly positive.

A manager who is hired by the firm chooses between two projects at $t = 0$, based on the expected utility criterion. The "safe" project produces a contractible payoff of I at $t = 1$. The "risky" project produces at $t = 1$ a contractible payoff of H with probability $P(e)$, and of L with probability $1 - P(e)$, where $H > I > L \geq 0$, and $P(e)$ depends on the manager's effort e. The values I, H, and L are common knowledge, but the firm does not observe the investment decision. We assume that the manager can either exert effort ($e = 1$) or not ($e = 0$) at $t = 0$. If the manager does not exert effort, the probability of a payoff of H with the risky project is 0 ($P(0) = 0$) – this normalization is for simplicity but it is without loss of generality. If the manager exerts effort, the probability of a payoff of H with the risky project is equal to p ($P(1) = p$), where $p \in (0, 1)$ is common knowledge and captures "market conditions".[12] The necessity for the principal to adjust the contract to market conditions is arguably a realistic and important feature of the job market, especially in the banking industry. The private cost of effort for the manager is C ($C > 0$), and it is additively separable in the utility of wealth.[13] This setup parsimoniously captures the potential divergence of interests between the manager and the principal along two dimensions: risk-taking (the investment decision) and effort provision.[14]

[11] Note that we do not consider managerial ability. In practice, there are reasons to believe that ability is more easily measurable and estimable than risk aversion: the employer knows the academic degrees of the applicants, their GPAs, their performances at standardized tests, their previous employment histories, not to mention the additional tests run during the review process.

[12] The model could alternatively be solved, and yield qualitatively similar results, with a noncontractible p observed only by the CEO once he is hired. This would notably implies that the participation constraint should be solved for a CEO who does not know the value p yet. However, this would markedly complicate the analysis. In the current model, the participation and incentive constraints should hold state-by-state, which greatly enhances tractability, as in Edmans and Gabaix (2011) for example. These assumptions are further discussed in sections 4.2 and 4.3.

[13] If effort were not costly ($C = 0$), an approximately flat incentive scheme would be optimal, since it could be designed to provide efficient risk-taking incentives at an arbitrarily small agency cost.

[14] In particular, by assuming only two possible levels of effort, including one which is clearly inefficient, we only focus on the issues of providing risk-taking incentives and effort incentives, but we do not consider the selection of the optimal level of effort. As discussed for example in Edmans and Gabaix (2011), this is quite standard in the literature. If we were to allow effort e to take other values, the results related to the structure of the incentive scheme and the use of dismissals would essentially be unchanged. The only difference would be related to the optimal level of effort, and therefore to the power of the incentive scheme, which would notably depend on the postulated forms of the *functions* $P(e)$ and $C(e)$. In our setup, we will show that the power of

The risk neutral principal, which we also refer to as "the firm", designs the manager's contract to maximize the expected payoff of the project net of the compensation cost. This contract specifies the probability with which a manager will be dismissed depending on his performance, and the compensation of a manager who is not dismissed depending on his performance. Compensation can be payoff-contingent and is paid at the end of the period. We call it the "bonus".[15] We assume that managers are protected by limited liability, so that their bonus must be non-negative in any case (although these constraints will be nonbinding in equilibrium). At $t = -1$, the firm offers a compensation contract to a potential manager of (unknown) type u, who can either accept or reject it, in which case he earns $\bar{W}_u$. If he accepts the contract, at $t = 0$ the manager makes the investment decision, and chooses whether to exert effort if he invests in the risky project.

At $t = 1$, the payoff of the project is then realized as described above. Depending on his contract and his performance, the manager is dismissed with a certain probability. The payment of a dismissed manager is normalized at zero, and we set $\underline{u}(0) = h(\underline{u}(0)) = 0$, and $\underline{u}(\bar{W}_{\bar{u}}) = \bar{u}(\bar{W}_{\bar{u}}) = \bar{W}_{\bar{u}}$. These two equalities are without loss of generality, since individual preferences are invariant to a linear increasing transform of the utility function. If not dismissed, the manager earns his performance-based bonus, as specified in the contract. This seems to be in line with observed practices: bankers who get fired at some point in the year do not receive their year-end bonus, while CEOs and top executives who get fired typically lose their unvested stocks and options. For simplicity, there is no time discounting.

2 Bonuses and dismissals

We first establish the first-best, where the manager's effort, type, and investment decision are observable. This problem is quite standard. The optimal contract is described in the following Proposition:

the incentive scheme simply depends on C, p, and the probability of dismissal ρ.

[15] For senior bankers and traders, anecdotal evidence suggests that bonuses account for about 80% of compensation.

Proposition 1 (first-best): If $p > p^{FB}$, then the manager is paid a bonus $w^{FB,R} = u^{-1}(u(\bar{W}) + C)$ if he invests in the risky project and exerts effort, and is dismissed otherwise; if $p \leq p^{FB}$, then the manager is paid a bonus $w^{FB,S} = \bar{W}$ if he invests in the safe project, and is dismissed otherwise. In addition,

$$p^{FB} \equiv \frac{I - L + w^{FB,R} - w^{FB,S}}{H - L} \tag{1}$$

The firm proposes a contract such that the manager always invests in the project with the highest net present value. The manager is never dismissed in equilibrium, and he is at his reservation level of utility. Note that neither the first-best investment strategy nor the first-best contract depend on the manager's type.

At the second-best, the effort of the manager is unobservable. We let p_u^{SB} denote the value of p above which an investment in the risky project is second-best optimal with a manager of type u, and below which an investment in the safe project is second-best optimal. When the firm knows the manager's type, the second-best equilibrium is as follows:

Proposition 2 (bonuses and investment policy): At the second-best, for a given managerial type u, a given dismissal policy $\{\rho_I, \rho_L, \rho_H\}$, and a given p_u^{SB}, the manager's state-contingent bonuses are

$$W_I = u^{-1}\Big(\frac{u(\bar{W}_u)}{1 - \rho_I}\Big) \tag{2}$$

$$W_L = u^{-1}\Big(\frac{u(\bar{W}_u)}{1 - \rho_L}\Big) \tag{3}$$

$$W_H(p) = u^{-1}\Big(\frac{u(\bar{W}_u)}{1 - \rho_H} + \frac{C}{p(1 - \rho_H)}\Big) \qquad \text{for } p > p_u^{SB} \tag{4}$$

$$W_H(p) = 0 \qquad \text{otherwise} \tag{5}$$

In addition, for any u, the dismissal probabilities are $\rho_I = \rho_L = \rho_H = 0$.

PROPOSITION 3 (INVESTMENT DISTORTION):

$$p_{\bar{u}}^{SB} > p_{\underline{u}}^{SB} > p^{FB} \tag{6}$$

At the second-best, the compensation of the manager is contingent on performance, and it is an increasing and convex function of performance, since $W_L = W_I < W_H$. The wage W_I is set at the level required to provide the agent with the same expected utility that he would get with a fixed wage of $\bar{W}_u$ (his reservation wage) and no probability of dismissal. In addition, since dispersion in pay is costly for risk averse agents, W_L is set at the same level, while W_H is higher to provide effort incentives and compensate (in expectation) the agent for the cost of effort. For a given p, the convexity of the compensation profile is reinforced by the risk aversion of the manager ($u'' < 0$). Indeed, if u is (more) concave, then u^{-1} is (more) convex. The intuition is that an incentive schedule must offset the effect of risk aversion on investment decisions, so that it must be more convex if the manager is more risk averse, i.e., if his utility function is more concave.

The power of the incentive scheme may be measured by the difference between W_H and W_L, i.e., the difference in pay in case of success and failure. It is increasing in the cost of effort C and in the probability of dismissal ρ_H, and it is decreasing in the probability of success p. The intuition is that an agent who rarely achieves a performance of H in equilibrium (low p) or who rarely reaps the fruits of this success (high ρ_H) must be all the more rewarded when he does. The parameter p can also be viewed as a measure of the attractiveness of risky strategies (e.g., investing in junk bonds, in subprime mortgages, proprietary trading, etc.) relative to safe strategies (e.g., investing in Treasury bonds, in "traditional" mortgages, market making, etc.).

There are no dismissals at the second-best when the Principal knows the manager's type. In particular, there are no performance-based dismissals: it is inefficient to use dismissals to provide incentives, whether effort incentives or risk-taking incentives. With risk averse managers, using performance-based bonuses is more efficient for this purpose.[16] We can actually derive a

[16] At the second-best, the manager invests in the risky project for less values of p than would be socially optimal. Given this, one could presume that dismissing with a positive probability a manager who invests in

more general result:

Lemma 2: For a given managerial type u, and given the bonus structure in Proposition 2 for this type of manager, the expected cost of compensation is increasing in ρ_I, ρ_L, and ρ_H.

An investment in the risky project is optimal for a smaller set of parameter values at the second-best than at the first-best. Since p is contractible ex-post, the second-best inefficiency is due to the cost of effort and to managerial risk aversion. Indeed, the cost of effort C requires that pay be sensitive to performance for investments in the risky project, which is costly to the principal because of the manager's risk aversion: a risk averse manager needs to be compensated for increases in the power of the compensation profile, i.e., for increases in the dispersion in equilibrium payments. As discussed above, the power of the incentive scheme is decreasing in the probability of success p. Therefore, increasing the cutoff probability p_u^{SB} enables to lower the power of the incentive scheme (remember that a manager invests in the risky project for any $p > p_u^{SB}$), which diminishes the cost of managerial compensation – all the more that the manager is more risk averse. However, increasing p_u^{SB} also distorts the investment policy toward less risk-taking than would be first-best optimal. Importantly, this distortion is stronger with more risk averse managers not only if the contract is designed separately for each manager's type (Proposition 3), but also if all managers are given the same contract:

Lemma 3: Given that both types of managers accept the contract in Proposition 2 calibrated for any u and associated $\bar{W}_u$, then a manager of type $\bar{u}$ invests in the risky project for a smaller set of values of p than a manager of type $\underline{u}$.

This result and Proposition 3 emphasize that investment inefficiencies are exacerbated at the second-best if managers of type $\bar{u}$ are not screened out.

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the safe project would allow to optimally adjust risk-taking incentives. However, with $W_L = W_I$, the effort constraint is binding in equilibrium. Therefore, dismissing with a positive probability a manager who invests in the safe project without adjusting W_H upwards would only result in the manager investing in the risky project but not exerting effort for some values of p, a clearly inefficient outcome.

So far, we have studied the second-best outcome when the firm knows the type of the manager. We now derive the form of the second-best optimal compensation schedule when the firm faces both types of managers and types are unobservable.

Even though managers with different levels of risk aversion will clearly value differently a given stochastic compensation profile, it is noteworthy that the compensation profile in Proposition 2 (with zero dismissal probabilities) calibrated for managers of type $\underline{u}$ does not achieve any screening. Indeed, a manager of any type will earn at least his reservation wage if he invests in the safe project. This is problematic, since Proposition 3 shows that the investment distortion will be worse with more risk averse managers. To the extent that risk preferences are heterogeneous, a screening mechanism may then help to minimize this investment distortion. We now show that imposing a positive and exogenous probability of dismissal fulfills this purpose.

PROPOSITION 4: For a firm which faces managers of types $\underline{u}$ and $\bar{u}$, there are three possible equilibria:[17]

- A pooling equilibrium in which the firm employs both types of managers. The bonuses are $W_I = W_L = \bar{W}_{\underline{u}}$, and $W_H(p) = \bar{u}^{-1}\Big(\bar{u}(\bar{W}_{\underline{u}}) + \frac{C}{p}\Big)$, and the probabilities of dismissal are $\rho_I = \rho_L = \rho_H = 0$.

- A separating equilibrium in which the firm only employs managers with high risk aversion. The bonuses are as in Proposition 2 and calibrated for $u = \bar{u}$, and the probabilities of dismissal are $\rho_I = \rho_L = \rho_H = 0$.

- A separating equilibrium in which the firm only employs managers with low risk aversion. The bonuses are as in Proposition 2 and calibrated for $u = \underline{u}$, and the probabilities of dismissal are $\rho_I > 0$, and either $\rho_L \in (0, 1)$ and $\rho_H = 0$, or $\rho_L = 1$ and $\rho_H > 0$.

In the pooling equilibrium, the firm employs both types of managers. As in Proposition 2, the dismissal probabilities are zero. This is again because dismissal probabilities do not

[17] For brevity, we only consider the constellation of parameter values such that it is optimal to provide effort incentives.

inefficiently provide either effort or risk-taking incentives, and because no screening is required. The level of pay in this equilibrium depends on the reservation wage of the manager with low risk aversion, whereas the sensitivity of pay to performance depends on the preferences of the manager with high risk aversion. On the one hand, the level of bonuses must be high enough to ensure the participation of both types of managers. Since the manager with low risk aversion has a higher reservation wage, the "minimum bonus" matches this reservation wage of $\bar{W}_{\underline{u}}$. On the other hand, the sensitivity of pay to performance must be high enough to ensure that both types of managers have adequate effort incentives. Since the manager with high risk aversion is less sensitive to higher pay, the dispersion of payments depends on the utility function of the more risk averse manager.

In the first separating equilibrium, the firm only employs managers with high risk aversion. The contract offered is the same one that would be offered if all managers had a high level of risk aversion. This is because, with this contract, managers with low risk aversion are below their reservation level of utility and therefore do not apply. Since there is no screening problem, the dismissal probabilities are zero, as in Proposition 2. Consequently, the bonuses are relatively low (this is because equilibrium bonuses are increasing in the probabilities of dismissal, see Proposition 2). We also know from Proposition 3 that risk-taking will be moderate in this equilibrium, in the sense that a manager will invest in the risky project for a relatively small subset of values of p.

In the second separating equilibrium, the firm only employs managers with low risk aversion. The contract offered cannot be the one that would be offered if all managers had a low level of risk aversion. Indeed, with such a contract, managers with high risk aversion would be above their reservation level of utility and therefore would apply, so that the equilibrium would not be separating. To screen out managers with high risk aversion, the dismissal probability in case of "average" performance is strictly positive (I), while the dismissal probability in case of low performance (L) is always strictly higher than the dismissal probability in case of high performance (H). Intuitively, since $\bar{u}$ is a concave transformation of $\underline{u}$, and given the normalization of the utility functions described in section 1, the difference between the utility of a given payment with $\underline{u}$ and $\bar{u}$ is increasing in the payment for the range of equilibrium bonuses.[18] Therefore, the loss of utility from dismissal in case of high (respectively low) performance will be relatively higher for managers with low (respectively high) risk aversion. Consequently, dismissing the manager for low rather than high performance helps to ensure that managers with low risk aversion reach their reservation level of utility while managers with high risk aversion do not. In particular, it is only optimal to use dismissals in case of high performance if dismissals in case of low performance are not sufficient to screen out managers with high risk aversion. We illustrate two possible cases on Figures 1 and 2. However, in general we do not know how ρ_L and ρ_H compare with ρ_I in this equilibrium. This is because there are two opposing forces at play, which notably depend on the concavity of h, i.e., on the difference in risk aversion between managers of type $\bar{u}$ and managers of type $\underline{u}$, so that any result on this dimension would presumably not be robust to modeling assumptions.[19]

With positive dismissal probabilities, the bonuses are relatively high – once again, this is because equilibrium bonuses are increasing in the probabilities of dismissal, as in Proposition 2. With bonuses as in (2)-(4), the expected utility of a manager (with low risk aversion) conditional on performance is not affected by the dismissal probabilities. That is, performance-based bonus payments adjust so that dismissal probabilities do not have any effect on effort or risk-taking incentives. We also know from Proposition 3 that risk-taking will be relatively strong in the second separating equilibrium of Proposition 4, in the sense that a manager will invest in the risky project for a relatively large subset of values of p.

By construction, for any given set of dismissal probabilities, the bonus structure described in (2), (3), and (4) in Proposition 2 calibrated for $u = \underline{u}$ ensures the participation of a manager of type $u = \underline{u}$. We now show that a more risk averse manager is more adversely affected by an

[18] More generally, a more risk averse manager will suffer more from a "loss" and will discount a "gain" more. However, in our model, precisely because managers are risk averse and effort is costly, the optimal contract is such that bonuses are not lower in case of bad performances.

[19] In the limit case where the degree of concavity of h approaches zero, the fact that $\rho_H = 0$ leads to $\rho_L > \rho_I$. EXPLAIN WHY On the contrary, for a given ρ_I which is such that a manager of type $\bar{u}$ is below his reservation level of utility with the safe project, if $\bar{u}(x) = \bar{u}(W_I)$ for any $x \geq W_I$ (i.e., $\bar{u}$ is so risk averse that his utility is capped), then $\rho_I > \rho_L$. EXPLAIN WHY This said, if we use the Innes (1990) argument that a manager can "burn profits" in case his expected utility conditional on performance (but prior to the dismissal shock) is decreasing in performance, then we must have $\rho_L \geq \rho_I$.

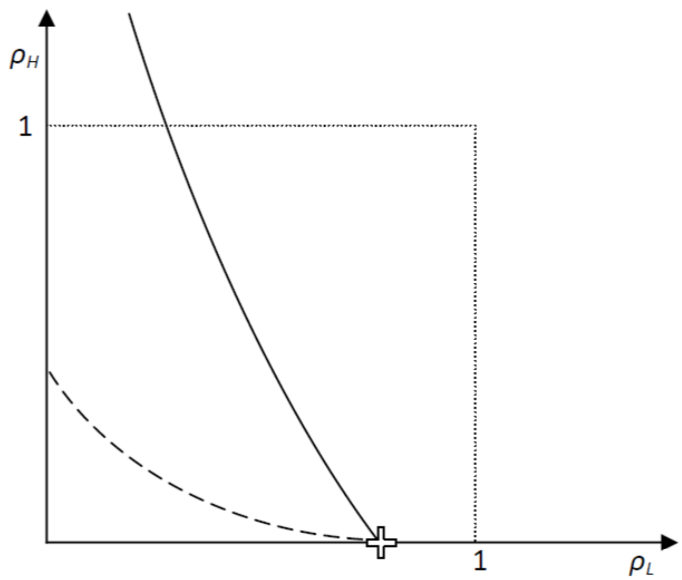

Figure 1: Optimal dismissal probabilities in the separating equilibrium where the firm only employs managers with low risk aversion. The solid line is the set of dismissal probabilities that satisfy the participation constraint of a manager with high risk aversion as an equality. The dotted line is the isoprofit line. The optimum is identified by the cross.

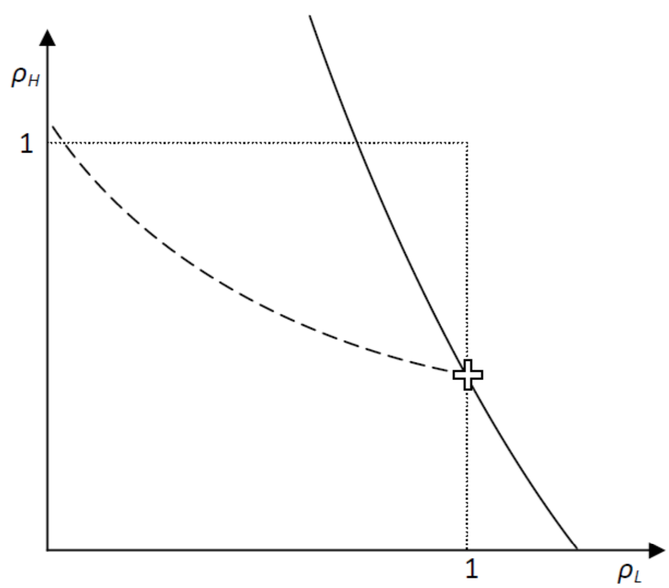

Figure 2: Optimal dismissal probabilities in the separating equilibrium where the firm only employs managers with low risk aversion. The solid line is the set of dismissal probabilities that satisfy the participation constraint of a manager with high risk aversion as an equality. The dotted line is the isoprofit line. The optimum is identified by the cross.

increase in dismissal probabilities:

Lemma 4: Given the bonus structure described in (2), (3), and (4) calibrated for $u = \underline{u}$, the expected utility of a manager with high risk aversion is decreasing in ρ_I, ρ_L, and ρ_H.

To screen out managers with high risk aversion, Lemmas 2 and 4 imply that the firm will set the dismissal probabilities at the minimum level such that these managers are below their reservation level of utility, whether they invest in the safe or the risky project. That is, given the bonuses in Proposition 2 calibrated for $\underline{u}$, and given p if the manager invested in the risky project:

$$(1-\rho_I)\bar{u}\Big(\underline{u}^{-1}\Big(\frac{\underline{u}(\bar{W}_{\underline{u}})}{1-\rho_I}\Big)\Big) = \bar{u}(\bar{W}_{\bar{u}}) \tag{7}$$

$$p(1-\rho_H)\bar{u}\Big(\underline{u}^{-1}\Big(\frac{\underline{u}(\bar{W}_{\underline{u}})}{(1-\rho_H)} + \frac{C}{p(1-\rho_H)}\Big)\Big) + (1-p)(1-\rho_L)\bar{u}\Big(\underline{u}^{-1}\Big(\frac{\underline{u}(\bar{W}_{\underline{u}})}{1-\rho_L}\Big)\Big) - C = \bar{u}(\bar{W}_{\bar{u}}) \tag{8}$$

where $\rho_H > 0$ only if $\rho_L = 1$ (see Proposition 4). Note that Lemma 4 does not state that dismissal probabilities that screen out managers with high risk aversion necessarily exist.

Note that dismissals are not used in equilibrium at the first-best (Proposition 1) or when the firm knows the manager's type (Proposition 2). By contrast, in the second separating equilibrium of Proposition 4, the firm uses random ex-post dismissals for screening purposes. Dismissals are then random in two senses. First, in the case of the risky project, performance is not a deterministic function of effort. Second, the probability of dismissal is not a deterministic function of performance (except when $\rho_H = 0$ and the payoff is H or when $\rho_L = 1$ and the payoff is L).

To summarize, given some dismissal probabilities, the compensation contract in Proposition 2 gives second-best efficient risk-taking and effort incentives for a manager with a given level of risk aversion. In addition, we know from Proposition 4 that the screening of highly risk averse managers (of type $\bar{u}$) will be achieved through strictly positive dismissal probabilities. For a given investment policy p^{SB}, it is notable that dismissal probabilities do not affect risk-taking incentives or effort provision at the project selection stage. That is, we find that it is optimal to resort to random ex-post dismissals to address screening at the hiring stage on the one hand, and to use performance-based compensation to provide incentives on the other hand. Note that this neat separation between the two different roles (screening and incentives) played by these two instruments (dismissal and compensation) is not assumed, but is a result of the model.

We conclude this section with some comparative statics regarding equilibrium selection. A change in the parameters I, L, and H does not have any effect on the state-contingent bonuses or on the dismissal probabilities. A higher L or H, or a lower I, simply increases the expected return of the risky project relative to the safe project. This increases the cost of any given investment distortion toward the safe project. Since the investment distortion toward the safe project is lowest in the separating equilibrium in which the firm only hires managers with low risk aversion, the following result immediately obtains:

Proposition 5 (choice of business model): The second separating equilibrium of Proposition 4, where the firm only hires managers with low risk aversion, is more likely when H is higher, L is higher, or I is lower.

This result means that screening out highly risk averse managers is especially valuable when the risky investment opportunities available are especially attractive.

Incidentally, neither a uniform change in risk aversion (a less concave $\underline{u}$, say) nor a change in the heterogeneity of risk preferences across the population (a less concave h, say) have an unequivocal effect on equilibrium selection. Indeed, a less concave $\underline{u}$ has several countervailing effects. First, it increases the reservation wage of managers with low risk aversion, $\bar{W}_{\underline{u}}$, which results in higher compensation costs in the separating equilibrium in which managers with low risk aversion are hired, and in the pooling equilibrium. Second, it results in a smaller wedge between W_H and W_L in the former equilibrium. Third, it increases the dismissal probabilities required for screening, which increases the compensation cost in this equilibrium (as long as $\underline{u}$ is strictly concave). Likewise, a less concave h has several countervailing effects. First, it increases the reservation wage of managers with high risk aversion, $\bar{W}_{\bar{u}}$, which results in higher compensation costs in the separating equilibrium in which managers with high risk aversion are hired. Second, it results in a smaller wedge between W_H and W_L in this equilibrium and in the pooling equilibrium. Third, it results in a lower investment distortion in these two equilibria. Fourth, it increases the dismissal probabilities associated with the equilibrium in which managers with low risk aversion are hired, which increases the compensation cost in this equilibrium. Overall, it is not clear which effect dominates in general.

This said, screening is (approximately) costless under some conditions on risk preferences. In two special cases, it is approximately costless to have some managers with a high level of risk aversion in the population, in the sense that these managers can be screened out at an arbitrarily small cost.

Proposition 6 (costless screening):

- In the limit case where $\underline{u}$ is linear, screening is costless.
- If $\pi \to 0$, then letting $\rho_I \to 0$, $\rho_L \to 0$, and $\rho_H = 0$ screens out managers with high risk aversion at an arbitrarily small cost.

In the first case, only managers of type $\underline{u}$ are hired. But as they are risk neutral, it is costless to expose them to any type of risk, including the risk of dismissal. In the second case, the reservation wages of both types of managers almost coincide. Even though managers with low risk aversion are still risk averse, an arbitrarily small probability of dismissal is almost costless in terms of risk premium, but it is sufficient for screening purposes. Specifically, $\pi \to 0$ either if h is approximately linear, so that there is barely any heterogeneity in terms of risk preferences, or in the limit case where outside employment opportunities provide a nonstochastic wage.

3 Aversion to downside risk and dismissals

The preceding section derived the optimal contract with two mechanisms, namely dismissals and state-contingent bonus payments. However, it might be the case that managers with high risk aversion are more efficiently screened out with another mechanism, such as a bonus payment which is stochastic even conditional on performance (a "stochastic bonus"). This section presents some results on stochastic bonuses and on the optimal mechanism.

In principle, a mechanism with stochastic payments can achieve screening. Indeed, suppose that a given fixed payment of W ($W = W_I$, say) is replaced by a stochastic payment of $\tilde{w}$ such that

$$E[\underline{u}(\tilde{w})] = \underline{u}(W) \tag{9}$$

Then

$$h(E[\underline{u}(\tilde{w})]) = h\underline{u}(W) \tag{10}$$

Applying Jensen's inequality and using the concavity of h:

$$E[h\underline{u}(\tilde{w})] < h\underline{u}(W) \tag{11}$$

Therefore

$$E[\underline{u}(\tilde{w})] - E[\bar{u}(\tilde{w})] > \underline{u}(W) - \bar{u}(W) \tag{12}$$

That is, adding a compound lottery (i.e., paying $\tilde{w}$ instead of W) increases the difference in expected utility between a manager of type $\underline{u}$ and a manager of type $\bar{u}$. Thus, a more general lesson of the model is that adding (or not removing) an element of randomness in executive compensation can potentially screen out the executives who are too risk averse.

Even though stochastic bonuses and dismissals are both potentially effective screening mechanisms, in general we do not know whether it is more efficient to use one or the other. Such a comparative exercise is all the more difficult that stochastic bonuses can take an infinity of forms, and that we did not restrict attention to a particular class of utility function.[20]

The effectiveness and potential efficiency of bonuses which are stochastic even conditional on performance has a number of implications. First, it can explain why bonus payments are often

[20] In the limit case where $\underline{u}(x)$ is linear for $x \in [0, \hat{W}]$, with $\hat{W} \geq W_H$ as defined in (**??**), then a mechanism with dismissals as described in Proposition 4 achieves the first-best, since $\underline{u}$ is linear on the whole domain of possible payments. It is then optimal to use dismissals for screening purposes.

discretionary, as opposed to formula-based or explicit. Discretion has been criticized because of its arbitrary or random nature, but this randomness is actually required for screening. Second, it can explain the existence of "pay-for-luck". Bertrand and Mullainathan (2001) document that the compensation of U.S. CEOs is contingent upon exogenous and contractible shocks that are not under their control, and which should a priori be filtered out of the performance measure used for evaluation and compensation purposes (Holmstrom (1979)).

Finally, we establish a result that holds for any mechanism, whether with dismissals, stochastic payments, or a combination of the two. If the divergence in risk preferences is especially pronounced on the downside – that is, if managers of type $\bar{u}$ are especially averse to downside risk – then it is inefficient to have payments in the interval $(0, \bar{W}_{\bar{u}})$ to obtain a separating equilibrium with managers of type $\underline{u}$:

Proposition 7 (inefficiency of moderate payments): To screen out managers of type $\bar{u}$, if h is sufficiently concave on $(0, \bar{W}_{\bar{u}})$, or if the concavity of h is sufficiently small on $(\bar{W}_{\bar{u}}, \infty)$, then any mechanism with payments in $(0, \bar{W}_{\bar{u}})$ is dominated by another mechanism with payments in $\{0\} \bigcup [\bar{W}_{\bar{u}}, \infty]$.

Intuitively, if managers of type $\bar{u}$ are especially averse to downside risk, then screening is optimally achieved by *not* protecting managers against the downside. In this case, stochastic payments will never take the form of "moderate" payments. On the contrary, it is more efficient to increase risk on the downside, which is achieved by exposing managers to the risk of dismissal (a payment of zero). Thus, to the extent that managers of type $\bar{u}$ are especially averse to downside risk, and that firms use stochastic bonus payments and/or dismissals to screen them out, the model can explain why managers whose occupations involve risk-taking rarely receive moderate payments, i.e., the "all-or-nothing" banking culture for example.

4 Discussion

4.1 Two levels of risk aversion

We have assumed that managers can be of only two types, i.e., there are only two possible levels of risk aversion. This being said, our main results can be extended to more levels of risk aversion. Indeed, suppose that there are N possible levels of risk aversion, with associated utility functions denoted by $\{u_1, u_2, \ldots, u_N\}$, where u_i is a concave transformation of u_{i-1}, for any $i \in \{2, \ldots, N\}$. Then a demonstration along the same lines of the proof of Proposition 4 shows that if a manager of type u_i accepts a given contract, then all types $j \leq i$ also accept the contract, and that if a manager of type u_{i+1} rejects the contract, then all types $j \geq i+1$ also reject the contract.

4.2 State-by-state participation constraint

In section 1, we argued that the firm must offer a contract such that the manager, who observes p at $t = 0$, is at his reservation level of utility state-by-state, i.e., for any value of p. While this assumption seems relevant in the financial industry, where human capital is easily transferable from one firm to the next, we now argue that is it not crucial for our results.

Now suppose that the firm offers a contract to the manager at $t = 0$. If he accepts, the manager learns the value of p. However, if he decides to leave the firm at this stage, he can only get a wage of zero. In this case, the firm must satisfy (or not) the participation constraint of a manager of a given type ex-ante, before p is realized. First, notice that if the participation constraint holds state-by-state, then it holds in expectation. Second, the bonus structure in Proposition 2 minimizes the deviation in expected payments state-by-state (for different values of p). Since managers are risk averse, it would therefore remain optimal with a participation constraint that must hold in expectation. Likewise, it remains suboptimal to set a strictly positive ρ_H in the second separating equilibrium of Proposition 4 for the same reasons as before, while setting strictly positive ρ_I and ρ_L can still screen out managers with high risk aversion, for the same reasons as before.

4.3 Bonuses cannot be based on p

In section 1, we argued that even though p is not observable by the firm ex-ante at $t = 0$ (at the time of making investment decisions), it is observable ex-post, at $t = 1$ (at the time of dismissing managers and paying bonuses). We invoked the possibility for the firm to observe the performance of sufficiently many managers and to be able to infer ex-post the value of p from the law of large numbers.

Now suppose that p is also unobservable at $t = 1$, and that the firm only employs managers of type u. In this case, W_I W_L are unchanged, but, for a given p_u^{SB}, W_H becomes

$$W_H(p) = u^{-1}\Big(\frac{u(\bar{W}_u)}{1-\rho_H} + \frac{C}{p_u^{SB}(1-\rho_H)}\Big) \tag{13}$$

Thus, the manager gets a rent for all $p > p_u^{SB}$. This in turn increases the second-best optimal level of p_u^{SB} if the participation constraint must hold state-by-state, i.e., for any value of p. That is, there is less risk-taking in this case.

4.4 Dismissals and the business cycle

The financial sector tends to mostly dismiss its employees during recessions or financial crises. We argue that a straightforward extension of the model can explain this stylized fact.

Suppose that business conditions can be either "good" or "bad", and that the payoff from either project is equal to zero with bad business conditions. Suppose that the firm hires before it learns about business conditions. Suppose also that the reservation wage of a manager at the time when business conditions are realized is as before with good business conditions, and is equal to zero with bad business conditions. The timeline is modified as follows. First the firm hires a manager, then it learns about business conditions, then it can dismiss the manager without compensation. If the manager is not dismissed, investment takes place as before. A manager who is dismissed can earn his reservation wage, which is contingent upon business conditions. These assumptions parsimoniously capture the stochastic evolution of business conditions, the ability of firms to adjust their workforce dynamically, and the fact that reservation wages depend on business conditions.

As in the baseline model, a positive probability of dismissal can in principle screen out managers with high risk aversion. The first difference is that, in this model, dismissal cannot be contingent on performance since the dismissal decision is taken before performances are realized. The second is that dismissal can now be contingent on business conditions. If business conditions are good, then the manager is indifferent with respect to dismissal, since he can still earn his reservation wage after being dismissed. However, if business conditions are bad, then dismissal has the same effect as in the baseline model. Furthermore, dismissal is ex-post optimal with bad business conditions, but it is ex-post suboptimal with good business conditions. It follows that firms will only dismiss under bad business conditions (note that because it is optimal for a risk neutral principal to insure a risk averse agent, firms will not necessarily dismiss with probability one with bad business conditions). This is consistent with the countercyclical dismissal patterns in the financial industry.

In this extension of the model, dismissals are related to macroeconomic conditions not only because a firm is negatively affected by an economic downturn, but also because dismissals need to be random and "painful" for the managers concerned to be effective as a screening mechanism.

5 Conclusion

This paper studies the role of dismissals as part of a corporate governance system designed to provide incentives for efficient investment decisions. We have shown how to use performance-based pay to provide efficient effort and risk-taking incentives when managers have a given level of risk aversion, which is quite standard. More importantly, we have shown that subjecting all managers to the risk of losing their compensation via random yet performance-based dismissals can induce them to reveal their level of risk aversion at the hiring stage, with only managers with a low level of risk aversion accepting the contract offer. In this case, dismissals do not serve either an incentive or an ex-post sorting purpose, and they are nevertheless accompanied by a drop in ex-post utility – in violation of Borch's rule for optimal risk sharing. More generally, we have shown that compensation which is stochastic even conditional on performance can in principle play the same screening role as dismissals. This said, dismissals are more efficient than moderate stochastic payments if the heterogeneity in risk preferences mainly concerns the aversion to downside risk. Thus, we propose another role for dismissals in a corporate governance system, a role which is complementary to that of state-contingent pay.

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