

# Organizations with Power-Hungry Agents

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## Abstract

We analyze a model of hierarchies in organizations where neither decisions themselves nor the delegation of decisions are contractible, and where power-hungry agents derive a private benefit from making decisions. Agents are probabilistically informed about the optimal action and maximize their private benefits as well as the payoffs of the activities assigned to them. Lower-level managers are more specialized and therefore internalize fewer externalities.

We study delegation decisions and optimal organizational design in this environment. A designer may remove intermediate layers of the hierarchy (eliminate middle managers) or de-integrate an organization by removing top layers (eliminate top managers). We show that stronger preferences for power result in smaller, more de-integrated hierarchies. Our key insight is that hoarding of decision rights is especially severe at the top of the hierarchy. As a result, even a top manager who is a better stand-alone decision-maker than the middle and lower-level managers below him, may add negative value to a hierarchy. In contrast to standard delegation models, the uncertainty surrounding decisions and the magnitude of incentive conflicts of lower-level managers have a non-monotonic impact on the value of top and middle managers.

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# 1 Introduction

Hayek (1945) famously argued that decisions are best made by agents who have relevant, local information.<sup>1</sup> Taking this information to be exogenous, and in the absence of any private benefits or agency conflicts, this immediately delivers a clear theory of the internal structure of organizations—in particular, to whom decision rights should optimally be allocated.

Following from this fundamental observation, a large literature has studied the *optimal design* of organizations both in the presence of agency costs, and without them.<sup>2</sup> This has deepened our understanding of how organizations—especially firms—are structured, how decision rights are allocated, how effectively information is communicated internally, and what decisions are ultimately made.

Relative to this large literature, an innovation of this paper is to consider organizations that are partially designed by managers *themselves*. In particular, we consider managers who are *power hungry* in the sense that they get rents from making decisions themselves, rather than delegating them to a subordinate. We show that this framing can lead to quite different outcomes than the traditional approach. For instance, hoarding of decision-rights has important implications for the size and scope of organizations. While larger “power rents” results in excessive centralization for a given hierarchical organization and firm size, the presence of more power-hungry managers also tends to result in a de-layering of the organization and in smaller, more de-integrated firms. Hence, while an across-the-board increase in decision rents results in smaller and flatter organizations in a number of natural benchmark cases, the impact on the centralization of decision-making tends to be ambiguous.

Our model considers an organization involved in a set of activities, each of which

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<sup>1</sup>As he put it: “If we can agree that the economic problem of society is mainly one of rapid adaptation to changes in the particular circumstances of time and place, it would seem to follow that the ultimate decisions must be left to the people who are familiar with these circumstances, who know directly of the relevant changes and of the resources immediately available to meet them.”

<sup>2</sup>Early important contributions include Chandler (1962) who emphasized the link between a firm’s organization structure and the strategy it pursues; Marschak and Radner (1972) introduced the formal analysis of working in teams, leading an entire literature on “team theory”. The importance of agency costs in organizational design was first noted by Berle and Means (1932), and these have played an important role in much of the organizational economics literature as they have in corporate finance in thinking about the private benefits of control and the optimal structure of voting rights.

requires an action to be undertaken and each of which is assigned to a hierarchy of managers. Managers are probabilistically informed about the optimal decision, and can delegate to lower-level managers. The organization faces two types of agency problems. The first is familiar from the delegation literature.<sup>3</sup> Managers are biased when taking an action and delegation therefore entails a loss of control. Concretely, as in Alonso, Dessein and Matouschek (2008) and Rantakari (2008), managers are assigned a subset of the organization's activities and do not internalize externalities on activities not assigned to them. Importantly, lower-level managers are assigned a smaller set of activities and are therefore more biased. Only the top manager makes unbiased decisions as she is assigned all of the organization's activities. The top manager is also assigned the initial decision right for each activity. One can think of a delegation hierarchy consisting of a CEO, followed by a division manager, a sub-division manager, a department manager, with each subsequent manager being assigned a subset of the activities of his superior.

The second agency problem is novel, and concerns the delegation of the decision itself. Managers are power hungry in that they earn a private benefit if they, themselves, take the decision. As a result, delegation decisions are subject to moral hazard. We think of decisions as complex and multi-dimensional with some aspects of the decision affecting organizational payoffs and other aspects affecting private (even psychological) benefits of managers. As we discuss below, there is also a fast-growing experimental literature which demonstrates how decision rights carry an *intrinsic value*, beyond their instrumental benefits for achieving certain outcomes (e.g. Bartling, Fehr and Herz, 2014). This literature shows how individuals are willing to sacrifice expected earnings to retain control and finds a substantial under-delegation of decision-rights.

The tools of the organization designer are very limited in our model. In the spirit of the incomplete contracting literature<sup>4</sup>, neither decisions nor the delegation of decisions are contractible. Moreover, managers do not respond to monetary incentives. The organization designer, however, can remove *layers of management* to avoid managers from hoarding decision rights. For example, she can remove the CEO or top manager so that the initial decision right is delegated by default to the next layer of management.

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<sup>3</sup>See, for example, Aghion and Tirole (1997), Dessein (2002), Alonso, Dessein and Matouschek (2008) and Rantakari (2008).

<sup>4</sup>The pioneering contributions are Grossman and Hart (1986) and Hart and Moore (1990). See Aghion and Holden (2011) and Dessein (2015) for an overview of the ensuing literature.

Alternatively, she can delay the hierarchy by removing intermediate layers of middle-management. In the limit, only the lowest-level manager remains, who is assumed to be perfectly informed about the optimal decision, but ignores any externalities with other activities. This limit corresponds to a set of de-integrated, stand-alone activities. Equivalently, additional layers of management can be interpreted as increased integration of activities. Similarly, the absence of a top manager can be interpreted as the de-integration of one large hierarchy into a set of smaller, independent hierarchies. Section 3.3 discusses how our model can be re-interpreted in terms of asset ownership, where control (access or ownership) of activity-specific, division-specific or organization-wide assets conveys authority over activities.

Our model sheds light on two important questions. First, what is the optimal number of layers in a hierarchy? When do middle managers – whose role it is to internalize externalities between various activities – destroy value? Second, what is the optimal size or scope of the organization? Concretely: when does integrating two sets of activities by putting them under common control of a top manager add value or destroy value?

In the absence of decision rents, additional layers always improve outcomes and, similarly, integrating disjoint sets of activities always adds value. Naturally, the presence of power-hungry managers may overturn this conclusion. Indeed, uninformed middle or top managers may then hoard decision rights, preventing better-informed lower-level managers from taking informed, albeit somewhat biased, decisions. Our setup thus gives a rather direct answer to Williamson's selective intervention puzzle: why is integration not always value-increasing? By assumption, selective intervention is subject to a moral hazard problem in our model: managers may intervene and centralize decision-making even when delegation is optimal. In this sense, more power-hungry managers decrease the value of managers at all hierarchical levels.

More surprisingly, our model shows that the inefficient hoarding of power tends to be more severe at the top of the organization. While all layers of a hierarchy are valuable when preferences for power are weak, under certain regularity conditions, layers at the top are the first to be removed when preferences for power become stronger. Consider, for example, a three-layered hierarchy with (potentially) a top manager, a middle-level manager and a worker. A sufficient condition for the middle layer to be valuable is that

the middle manager is a better decision-maker than the worker (i.e. in expectation she takes better decisions than the worker). Counter-intuitively, the latter is not true for the top manager. Indeed, the top manager may strictly reduce value even when she is a better decision-maker than both middle manager and worker. To see this, assume that the worker is twice as biased as the middle manager, but also perfectly informed about the best decision to be taken. Note that in this example, the bias of the middle manager from the perspective of top manager is identical to the bias of the worker from the perspective of the middle manager. At the same time, the worker is much more likely to be informed about the optimal decision than the middle manager. It follows that an uninformed middle manager is more likely to delegate to the worker, than an uninformed top manager is willing to delegate to the middle manager. Moreover, the top manager may even be less willing to delegate directly to the worker given the latter's double bias. As a result, for intermediate preferences for power, the top manager rarely delegates, whereas an uninformed middle manager would almost always delegate. Even though the top manager may be a better decision-maker in isolation (without the possibility of delegation), she may be no match for an efficient team of middle manager and worker. The lone top manager is then optimally removed by the organization designer because of an unwillingness to delegate to admittedly inferior lower-level managers.

More generally, in an N-layer hierarchy where (1) all managers are equally good decision-makers in isolation, (2) all managers enjoy the same deterministic decision rent and (3) the bias of managers increases linearly as we move down the hierarchy, we show that the top managers of the hierarchy are removed one by one starting with the highest level manager as the decision rent increases.

Beyond comparative statics with respect of the magnitude of decision rents – which generally result in smaller, more de-layered organizations – we show that the value of both top and middle managers tends to be non-monotonic in the uncertainty surrounding the decision and in the bias and expertise of their subordinates. Intuitively, while say an increase in the bias of subordinates makes a superior more valuable, this also makes it more likely that the latter will inefficiently hoard decision rights. As a result, a manager is least likely to be valuable for intermediate values of bias and expertise of her subordinate. This yields the counter-intuitive result that an increase in externalities between activities may initially result in fewer layers of management and less central-

ization. This finding shows how preferences for power may reverse a standard result in the delegation literature (see, e.g., Alonso, Dessein and Matouschek, 2008)

A final implication of empirical relevance is the extent to which decision-rents result in decision-making becoming more or less centralized. While, by assumption, power-hungry managers are biased towards too much centralization, the optimal size of a hierarchy also tends to be smaller when decision-rents are larger. This is consistent with the observation that firms and hierarchies in developing economies (where decision rents are arguably larger) tend to be both smaller and more centralized (Bloom, Sadun, Van Reenen (2102), Bloom et al. (2013) and Hsieh and Klenow (2014)). Thus, an increase in decision rents may increase the likelihood that agents at the bottom of the hierarchy make decisions.

One open question is whether firm owners (e.g. boards) or managers decide on the size of the hierarchy. In our model, the only conflict between firm owners and the top manager concerns the value of the top manager herself. Indeed, there is complete alignment as to which layers should be ‘active’ or present below the top manager. At the same time, one insight of our paper is that hoarding of decision rights is most extreme at the top of the organization. As a result, if the board is captured by top management, then inefficient organizations are likely to prevail where headquarters decrease total firm value because of their reluctance to delegate.

## 1.1 Related Literature

**Literature on hierarchies** The paper perhaps closest to ours is Hart and Moore (2005), who analyze a model of the design of hierarchies in a setting where agents perform different tasks (coordination versus specialization). Like us, decisions are non contractible, and like us their model speaks to the optimal degree of decentralization. The key assumption they make, however, is that decisions are made hierarchically: the senior person in the hierarchy who “has an idea” about a decision makes it. Agents never actively choose whether or not to delegate. In this setting, they study when, for a given number of agents, generalists (or coordinators) should be senior to specialists. Unlike ours, their model does not speak to the optimal number of hierarchical layers in an organization.

Also closely related to our paper is Aghion and Tirole (1997) who consider a setting

where there are two agents, one of whom has “formal authority” to make a decision.<sup>5</sup> The agents, however, are probabilistically informed about a decision and the likelihood depends on privately costly, non-contractible effort. They show that the agent who has formal authority may not have “real authority”, in the sense that she will not take the actual decision very frequently because she optimally puts in little effort to having an idea. This is likely to occur if, for instance, the two agents have highly congruent preferences about which projects to pursue. Like us, they have an incomplete contracting model of hierarchies. Unlike us, however, they focus on *ex ante* incentives for effort rather than delegation of decision rights in a multi-layer hierarchy.

The two papers above focus on the role of hierarchies in making decisions when information is dispersed and agents have conflicting preferences. Other models in this class of decision hierarchies include Dessein (2002), Alonso, Dessein and Matouschek (2008), Rantakari (2008), Hart and Holmstrom (2010) and Dessein, Garicano and Gertner (2010).<sup>6</sup> Decentralization or ‘removing the top layer’ in a decision hierarchy may be optimal because centralization results in a distortion of information (Dessein, 2002), demotivates information acquisition (Aghion and Tirole, 1997) or because the top-manager is biased (Hart and Holmstrom, 2010). Unlike in our model, however, the principal or top manager is always valuable if she is, on average, a better decision-maker than the agent. Together with Hart and Moore (2005), our paper is also novel in offering a theory of multi-layered hierarchies with more than two layers.

Another strand of literature focuses instead on how hierarchies facilitate the division of labor in information processing or problem solving (Radner 1993, Bolton and Dewatripont, 1994, and Garicano, 2000).<sup>7</sup> While this approach allows the study of large, multi-layered organizations, communication costs (such as delay) rather than incentive conflicts determine the optimal organizational structure.<sup>8</sup>

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<sup>5</sup>Baker, Gibbons and Murphy (1999) analyze a repeated-game version of Aghion and Tirole (1997) and show how the desire to build a reputation can sustain delegation to a subordinate even when it is not an equilibrium in the one-shot game.

<sup>6</sup>Harris and Raviv (2002) and Alonso, Dessein and Matouschek (2015) study decision hierarchies in a team theoretical setting where there are no incentive conflicts, but where communication is limited.

<sup>7</sup>See Garicano and Van Zandt (2013) for a comprehensive review of this literature.

<sup>8</sup>Calvo and Wellisz (1978) emphasize the role of hierarchies in monitoring effort. Their focus is on explaining wage differentials across layers, rather than organizational structure.

**Literature on preferences for power** Social psychologists have long argued that power is a basic human need. Power is one of five *need categories* in Murray (1938)'s system of needs. In his human motivation theory, David McClelland (1961, 1975) proposes that most people are consistently motivated by one of three basic desires: the need for affiliation (or being liked by others), the need for achievement, and the need for authority or power. The intrinsic value of autonomy is also at the center of the self-determination theory of Deci and Ryan (1985). In economics, private benefits of control and preferences for power play a central role in the corporate finance literature (e.g. Aghion and Bolton, 1992, Hart and Moore, 1995, and Dyck and Zingales, 2004) and the organizational economics literature (Aghion and Tirole, 1997).<sup>9</sup>

Perhaps the cleanest evidence that decision rights carry an *intrinsic value*, beyond their instrumental benefits for achieving certain outcomes, is presented in an experimental paper by Bartling, Fehr and Herz (2014). They develop an approach which rules out alternative explanations based on regret and ambiguity aversion, and show that the intrinsic value of decision rights is both significant (on average 17 percent of the monetary payoffs associated with a decision<sup>10</sup>) and correlated across individuals and game parameterizations. Interestingly, higher stakes are associated with proportionally higher intrinsic values. These results confirm similar findings in Owens, Grossman and Fackler (2014), who also find that individuals are willing to sacrifice expected earnings to retain control,<sup>11</sup> and Fehr, Herz and Wilkening (2013), who find a significant under-delegation of decision rights from principals to agents in settings where delegation is clearly optimal.<sup>12</sup> Evidence on the private benefits of autonomy can also be found in the entrepreneurship literature. Non-pecuniary motives such as the desire “to be one’s own boss” are a major self-reported driver of the decision to enter self-employment (Pugsley and Hurst, 2011) and entrepreneurs typically forego substantial earnings when becoming self-employed (Hamilton, 2000, and Moskowitz and Vissing-Jorgensen, 2002).

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<sup>9</sup>In those literatures, control may either convey tangible benefits or be more ‘psychic’ in nature. Both interpretations are consistent with our model.

<sup>10</sup>Bartling et al. compare the certainty equivalents of delegation lotteries and non-delegation lotteries, as all decisions are risky.

<sup>11</sup>They find that the average participant is willing to sacrifice 8 percent to 15 percent of expected earnings in order to control their own payoff.

<sup>12</sup>See also Sloof and von Siemens (2016), who point to overconfidence and an “illusion of control” as a source of preferences for power.



## 1.2 Outline

The paper proceeds as follows. Section 2 illustrates the model for the simplest case when there are just two workers and, potentially, one boss. This section highlights our main assumptions and shows how some central results in the delegation literature may be overturned when there is moral hazard in delegation. Section 3 then considers three-level hierarchies where there are both middle-managers and a top manager. This section allows for an analysis when delayering (removing the middle layer of management) and/or de-integration (removing the top manager) is optimal. Section 4, finally, generalizes our results to hierarchies with an arbitrary number of managerial layers, but restricts the analysis to deterministic decision rents. Section 6 concludes by discussing some empirical implications of our model and future avenues of research. We also discuss the implications our framework has for the possible path dependence of firm boundaries. In the Appendix we provide a micro-foundation of our payoff structure, and also provide proofs of results omitted in the body of the paper.

## 2 Two-level hierarchies

In order to illustrate the basic assumptions which lead to moral-hazard-in-delegation, we first consider a simple example in which the organization consists of at most two levels: A boss and two workers.

### 2.1 A delegation hierarchy with two levels

Consider an organization engaged in two activities  $s \in \{s', s''\}$ . Each activity  $s$  is associated with an action choice  $a_s$  and generates a payoff

$$\pi_s \equiv \pi_s(\theta_s, a_s, a_{-s}) = 2(\theta_s a_s - \sqrt{\mu} a_{-s}) - a_s^2$$

where  $\theta_s$  is an activity-specific i.i.d. shock with variance  $\sigma_\theta^2$ , and where  $\mu$  is an exogenous parameter which reflects externalities between the two activities.

By default, each activity  $s$  is assigned to a worker  $m(s)$  who observes  $\theta_s$ . In addition,

both activities may be assigned to a boss,  $M$ , who observes  $\theta_s$  with probability  $p < 1$ . If  $M$  is part of the organization (see subsection on ‘organization design’ below), then the initial decision-right over  $a_s$  is owned by  $M$ . An uninformed  $M$ , however, may choose to delegate the decision right about  $a_s$  to the relevant worker who always observes  $\theta_s$ .

**Managerial Preferences:** When choosing  $a_s$ , the workers and the boss maximize the payoffs of the activities assigned to them. These preferences are taken as exogenous but can be viewed as stemming from career concerns, the ability of agents (workers, boss) to divert a fraction of the profits of activities assigned to them, or the intrinsic reward agents experience when these activities are successful. In addition, agents are power-hungry in that they derive a private benefit  $r(s) > 0$  from choosing  $a_s$ . This private benefit can be viewed as the intrinsic value of making a decision (as in Bartling, Fehr and Hertz, 2014). Alternatively, one can think of  $a_s$  as a complex, multi-dimensional action with some aspects of  $a_s$  affecting organizational payoffs and other aspects affecting private (even psychological) benefits of workers. Managers are power-hungry in that they derive a private benefit from choosing  $a_s$ . We allow  $r(s)$  to be either deterministic or a random variable with c.d.f  $F(\cdot)$  on support  $[0, R]$  or  $[0, \infty)$ .

**Organization Design.** The organization designer has limited instruments. Neither decisions themselves, nor the delegation of decisions are contractible. Moreover, the workers nor the boss respond to monetary incentives. The organization designer, however, can decentralize decision-making (or de-integrate the organization) by removing the boss.

## 2.2 Expected payoffs and moral hazard in delegation

Since the boss cares about the payoffs of both activities, she will choose the first-best action  $a_s = a_s^* \equiv \theta_s - \sqrt{\mu}$  when informed and  $a_s = E(\theta_s) - \sqrt{\mu}$  when uninformed. The workers are always informed, but only care about the payoffs of the activity assigned to them. When delegated authority, they therefore choose  $a_s = \theta_s$ .

**Informed boss as decision-maker.** Let us denote by  $U_M$  the expected payoffs of the boss and by  $U_{m'}$  and  $U_{m''}$  the expected pay-off of workers  $m(s')$  and  $m(s'')$ . If an *informed boss*

chooses both actions, this yields expected pay-offs

$$\begin{aligned} U_M &= \Pi^* + r(s') + r(s'') \\ U_{m'} &= U_{m''} = \Pi^*/2, \end{aligned}$$

where  $\Pi^*$  are first-best profits:

$$\Pi^* = \sum_{s \in \{s', s''\}} E(\pi_s(\theta_s, a_s^*, a_{-s}^*)),$$

**Workers as decision-makers.** By contrast, if workers  $m(s')$  and  $m(s'')$  are the decision-makers, then payoffs are given by

$$\begin{aligned} U_M &= \Pi^* - 2\mu \\ U_{m'} &= \Pi^*/2 - \mu + r(s') \\ U_{m''} &= \Pi^*/2 - \mu + r(s'') \end{aligned}$$

Note that shifting decision-rights from an informed boss to the workers results both in an efficiency loss,  $\mu$ , as workers do not internalize externalities on each other's activities, and in a shift of the private benefits of control,  $r(s')$  and  $r(s'')$ , from the boss to the workers.

**Uninformed boss as decision-maker.** Finally, if an *uninformed boss* chooses both actions, then

$$\begin{aligned} U_M &= \Pi^* - 2\sigma_\theta^2 + r(s') + r(s'') \\ U_{m'} &= U_{m''} = \Pi^*/2 - \sigma_\theta^2 \end{aligned}$$

Observe that an uninformed boss optimally delegates authority over  $a_s$  to worker  $m(s)$  if and only if

$$\sigma_\theta^2 \geq \mu$$

An uninformed boss, however, only delegates if

$$\sigma_\theta^2 \geq \mu + r(s)$$

Whenever  $r(s) > \sigma_\theta^2 - \mu$ , there is moral hazard in delegation: the boss inefficiently hoards decision rights.

**Proposition 1.** *Assume  $\sigma_\theta^2 - \mu > 0$  so that delegation is optimal whenever the boss is uninformed. Whenever  $r(s) > \sigma_\theta^2 - \mu$ , there is moral hazard in delegation: an uninformed boss inefficiently holds on to decision rights.*

### 2.3 When is a (power-hungry) boss valuable?

With at most two layers, organization design is reduced to a single question: When is it optimal for the organization to have a boss? i.e. when is centralized decision-making optimal?

If the boss has no preferences for power ( $r(s) = 0$ ), she always adds value. With probability  $p$  she is informed, and she chooses the first best action  $a_s^*$ . With probability  $1 - p$ , she is uninformed and she delegates to the worker below her whenever this is optimal, that is whenever  $\sigma_\theta^2 \geq \mu$ .

With preferences for power, this need not be the case. The key trade-off in this setting is as follows. On the plus side, the boss internalizes externalities between activities. On the minus side, the boss may hoard decision rights because of her preference for power, and this creates an inefficiency. Formally, an uninformed boss delegates  $a_s$  if and only if

$$r(s) \leq \bar{r} \equiv \sigma_\theta^2 - \mu.$$

On the one hand, with probability  $(1 - p)(1 - F(\bar{r}))$ , the boss takes an uninformed decision, reducing payoffs by  $\sigma_\theta^2 - \mu$  relative to an organization where authority is directly allocated to the workers. On the other hand, with probability  $p$ , the presence of a boss increases efficiency by  $\mu$ , as she internalizes externalities between activities when informed. Finally, with probability  $(1 - p)F(\bar{r})$ , the presence of a boss does not affect payoffs, as she delegates efficiently. It follows that a boss is valuable if and only if

$$p\mu^2 \geq (1 - p)(1 - F(\bar{r}))(\sigma_\theta^2 - \mu),$$

which can be rewritten as

$$p\sigma_\theta^2 + (1 - p)F(\bar{r})(\bar{r}) > \bar{r}. \quad (1)$$

This immediately leads to the following proposition

**Proposition 2.** *Assume  $\sigma_\theta^2 - \mu > 0$ . Decentralization of authority (no boss) is optimal whenever  $p < \bar{p}$ , with  $\bar{p}$  given by*

$$\bar{p}\sigma_\theta^2 + (1 - \bar{p})F(\bar{r})(\bar{r}) = \bar{r}$$

where  $\bar{r} \equiv \sigma_\theta^2 - \mu$ . The thresholds  $\bar{p}$  is strictly positive whenever  $F(\bar{r}) < 1$ , in which case an increase in preferences for power (downwards shift in  $F(\cdot)$ ) strictly increases  $\bar{p}$ .

The above proposition yields two compelling comparative statics: A boss (or centralization) is only valuable if the boss is sufficiently likely to be informed and when preferences for power are not too strong. Intuitively, hoarding decision-rights is only costly when  $M$  is uninformed. If  $p = 1$ , the boss is always valuable, regardless of her preferences for authority. If  $p = 0$ , the boss is never valuable. For interior values of  $p$ , the value of a boss depends on her preferences for power. In particular, an upward shift in  $F(\cdot)$  makes it more likely that a boss is valuable. The boss then has weaker preferences for power and, hence, is less likely to inefficiently hoard decision-rights when uninformed.

Perhaps surprisingly, comparative statics with respect to the other two parameters  $\mu$  and  $\sigma_\theta^2$  are ambiguous. Inspecting (1), a decrease in  $\bar{r} = \sigma_\theta^2 - \mu$  not only reduces the value of decentralization to the worker (RHS of (1)), but also reduces the probability  $F(\bar{r})$  that the manager delegates to the worker. Intuitively, an increase in the incentive conflict of the workers exacerbates the moral-hazard-in-delegation faced by their boss: the boss is less willing to delegate, even though delegation remains optimal whenever the boss is uninformed. As a result, when workers become more biased (an increase in  $\mu$ ) it may become optimal to remove the boss and decentralize authority to workers.

**Proposition 3.** *An increase in the bias of workers,  $\mu$ , or a decrease in the informational advantage of workers,  $\sigma_\theta^2$ , may result in removal of the boss and decentralization of authority to the workers.*

The above proposition stands in contrast with standard models in the delegation literature (see Dessein (2002), Alonso et al. (2008), Rantakari (2008)), which have the

unambiguous prediction that decisions are less likely to be delegated to the agent when conflicts of interest are larger.

To provide more intuition for the above result, we consider two specific distributions for  $r(s)$  and show that whenever  $p$  is small, an increase in the worker's bias  $\mu$  initially results in a removal of the boss and decentralization of decision-rights to those same workers:

**Proposition 4.** *Assume  $r(s)$  is uniformly distributed on  $[0, R]$  with  $R < \sigma_\theta^2$  or that  $r(s)$  is deterministic, that is  $r(s) \equiv r < \sigma_\theta^2$ . If  $p$  is sufficiently small, then decentralization (no boss) is optimal for intermediate values of worker bias  $\mu$ , whereas centralization (a boss) is optimal for  $\mu$  sufficiently small or sufficiently large.*

We first show this result for uniformly distributed decision rents. We subsequently consider deterministic decision rents:

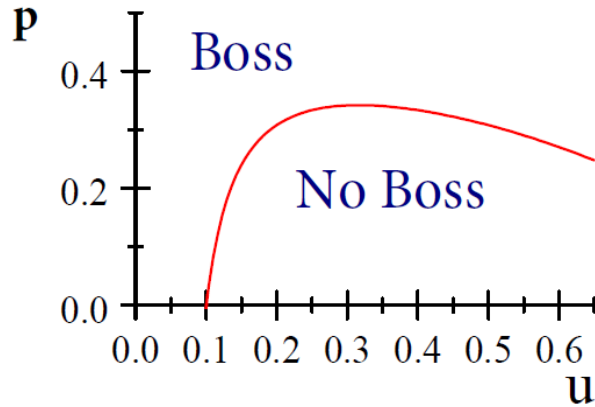
**Case 1 (Uniformly distributed decision rents).** Assume first that  $r(s)$  is uniformly on  $[0, R]$  with  $R < \sigma^2$ . For simplicity, we normalize all parameters so that  $\sigma^2$  equals 1. If  $R < 1 - \mu$ , an uninformed boss always delegates so that she is valuable regardless of  $p$ . In contrast, if  $R > 1 - \mu$ , an uninformed boss delegates with probability  $F(\bar{r}) = (1 - \mu)/R$ . From Proposition 2, decentralization to the workers (no boss) is then optimal

$$\Leftrightarrow p < \bar{p} \equiv (1 - \mu) \frac{R - (1 - \mu)}{R - (1 - \mu)^2} \quad (2)$$

It is now easy to verify that  $\bar{p}$  is hump-shaped in  $\mu$ :  $\bar{p} = 0$  for  $\mu < 1 - R$ ,  $\bar{p}$  is increasing in  $\mu$  for  $\mu \in [1 - R, \sqrt{1 - R}]$  and  $\bar{p}$  is decreasing in  $\mu$  for  $\mu > \sqrt{1 - R}$ . Let  $\hat{p}$  denote the maximized value of  $\bar{p}$  in (2). It follows that for  $p < \hat{p}$ , installing a boss is optimal if the worker's incentive conflict  $\mu$  is small, but an increase in  $\mu$  will eventually result in the boss's removal:

**Result:** *There exists a  $\hat{p} > 0$ , such that*

- *For  $p < \hat{p}$ , decentralization (no boss) is optimal for intermediate values of  $\mu$ . Centralization is optimal for  $\mu$  sufficiently small or large.*
- *For  $p > \hat{p}$ , centralization (boss) is always optimal.*



**Figure 1** – Assume  $r(s) \sim U[0, R]$  and  $\sigma^2 = 1$ . Figure 1 plots the optimal hierarchy (boss, no boss) as a function of the externality parameter  $\mu$  when  $R = 0.9$ . A boss is valuable if  $p > \bar{p}$  (red curve), while she destroys value when  $p < \bar{p}$ .

Figure 1 plots  $\bar{p}$  as a function of  $\mu$  and this for  $R = 0.8$  (green curve) and  $R = 0.9$  (red curve). When boss is not likely to be informed ( $p$  is small), an initial increase in the agency conflict of the workers (an increase in  $\mu$ ) makes it optimal to remove the boss and decentralize authority to those workers. Intuitively, for intermediate values of  $\mu$ , the moral hazard problem in the delegation of the decision then outweighs the agency problem in the decision itself.

**Case 2 (deterministic private benefits).** Assume now that  $r(s) = r$ , so that an uninformed boss delegates if and only if  $\mu < \mu_L \equiv \sigma_\theta^2 - r$ . If  $\mu > \mu_L$ , the boss never delegates and decentralization (no boss) is optimal whenever  $p\sigma_\theta^2 < \sigma_\theta^2 - \mu$ , i.e.  $\mu < \mu_H \equiv (1 - p)\sigma_\theta^2$ .

**Result:** Assume  $p < \hat{p} \equiv r/\sigma_\theta^2$ , then decentralization (no boss) is optimal for  $\mu \in (\mu_L, \mu_H)$  with  $\mu_L < \mu_H$ , whereas centralization (boss) is optimal for  $\mu < \mu_L$  or  $\mu > \mu_H$ .

### 3 Three-level hierarchies

The previous section shows how, when bosses are power-hungry, hierarchical decision-making is only valuable when the boss is sufficiently knowledgeable. Most hierarchical organizations, however, have multiple layers of management. In this section, we study how preferences for power affect the structure of multi-layered hierarchies, and address

the following questions.

- What is the value of middle layers of management?
- How does the value of middle layers of management compare to that of top layers?
- When preferences for power become more pronounced, does this tend to result in smaller organizations or flatter organizations?

To answer these questions, consider the following generalization of the model presented in Section 2:

### 3.1 A delegation hierarchy with three levels

An organization is engaged in a set of activities  $S$  which are partitioned into (non-overlapping) divisions  $\{D_1, \dots, D_n\}$ . Each activity  $s \in S$  is associated with an action choice  $a_s$  and generates a payoff  $\pi_s(\theta_s, a)$  where  $a = (a_s, a_{-s})$  is the organization's action profile and  $\theta_s$  is an activity-specific shock which represents the uncertainty about the optimal action  $a_s$  to take. Section 3.2 discusses the properties of  $\pi_s(\theta_s, a)$  in more detail.

Each activity  $s$  is assigned to a hierarchy of managers

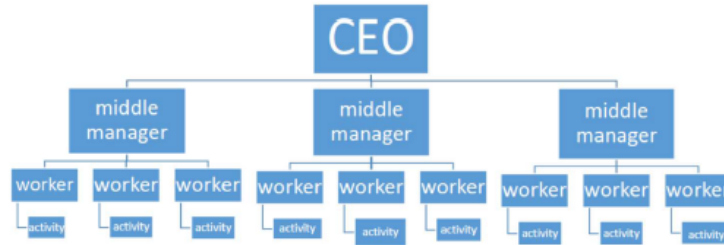
$$h(s) = (h_0(s), h_1(s), h_2(s))$$

where  $h_i(s) \in M \cup \{0\}$  with  $M$  the set of managers. We denote  $h_i(s) = 0$  when no manager is assigned to level  $i$  and  $h_i(s) = m_i(s) \in M$  otherwise. Wlog (see later) we restrict attention to symmetric organizations where  $h_i(s) = 0$  if and only if  $h_i(s') = 0$  for all  $s' \in S$ .

Lower-level managers are more specialized: the 'top manager' (or CEO)  $m_0(s)$  is assigned all activities  $s' \in S$  (or none, if  $h_0 = 0$ ), the 'middle manager'  $m_1(s)$  is assigned all activities  $s' \in D_k$  belonging to the same division as  $s$  (or none, if  $h_1 = 0$ ), and the 'worker'  $m_2(s)$  is only assigned activity  $s$ . Figure illustrates 4 possible organization designs:



### Three-layered hierarchy



### Two-layered integrated hierarchy



### Two-layered non-integrated hierarchy



### Stand-alone activities (non-hierarchy)



Figure 2 – Four possible organization designs.

Abusing notation, we denote  $m_j = m_j(s)$  unless confusion is possible. Manager  $m_j$  observes  $\theta_s$  with independent probability

$$p_j \in [0, 1].$$

As in our two-layer model we assume that the worker  $m_2$  is perfectly informed, that is  $p_2 = 1$ . If  $h_0 \neq 0$ , then the initial decision-right over  $a_s$  is owned by manager  $m_0$ . An uninformed  $m_0$ , however, may choose to delegate the decision right about  $a_s$  to  $m_1$  or  $m_2$ . When delegated authority, the middle manager  $m_1$  either selects  $a_s$  or delegates authority over  $a_s$  to the  $m_2$ . The lower-level manager  $m_2$  always selects  $a_s$  when delegated authority. If  $h_j = 0$  for all  $j < i$ , then the initial decision right over  $a_s$  is allocated to manager  $m_i \in \{m_1, m_2\}$ . Section 3.3 discusses the above assumptions in more detail, including how decision rights over activities can be conveyed through control over activity-specific, division-specific and organization-wide assets.

**Managerial Preferences:** Managers maximize the payoffs of the activities assigned to them when choosing  $a_s$ . Managers, however, are also power-hungry in that they derive a private benefit from choosing  $a_s$ . We denote by  $r_j = r_j(s)$  the private benefits to manager  $m_j$  associated with choosing action  $a_s$ . If  $m_j$  chooses  $a_s$ , then the rent  $r_j$  is i.i.d. with c.d.f  $F(\cdot)$  on support  $[0, R]$  or  $[0, \infty)$ . If  $m_j$  does not choose  $a_s$ , then  $r_j = 0$ . We refer to Section 2 for a discussion of these preferences. All decision rent draws are stochastically independent and are private information. Section 4.4.2 considers the special case where  $r_j$  is deterministic (and identical) for all managers. When deciding whether or not to delegate  $a_s$  to manager  $m_i$ , manager  $m_j$  takes into account the equilibrium strategies of all managers  $m_i$  with  $i > j$ , and behaves as if she maximizes the sum of her private benefits  $r_j$  and the expected payoffs of the activities  $s$  assigned to her.

**Organization Design:** Neither decisions themselves, nor the delegation of decisions are contractible. Moreover, managers do not respond to monetary incentives. The organization designer, however, can remove *layers of management*. We denote the optimal hierarchy by  $h^*$  where  $h_i^* = 0$  if layer  $i$  is inactive (no manager is assigned to layer  $i$ ). Without loss of generality, we assume that  $h_2 \neq 0$ . Hence, the smallest possible hierarchy is  $h^* = \{0, 0, m_2\}$ . As discussed above, agent  $m_2$  can be interpreted as a worker who operates activity  $s$ . As we discuss in Section 3.3, given that manager  $m_0$  is the only man-

ager who is assigned all activities  $s' \in S$ , removing  $m_0$  can be viewed as a de-integration decision.

### 3.2 Expected payoffs

Appendix 7.1 posits a quadratic “hit-the-state” payoff specification for  $\pi_s(\theta_s, a)$  which results in intuitive expressions for expected profits and which we will maintain throughout the paper. As in the model with two layers, this payoff specification is such that the optimal choice of  $a_s$  depends on  $\theta_s$  and on the magnitude of externalities with other activities  $s' \neq s$ , but not the actions  $a_{-s}$  associated with those other activities. Without loss of generality, we therefore focus our discussion and analysis on one generic activity  $s$  and associated action  $a_s$ , taking the action profile  $a_{-s}$  as given.

Let  $\Pi_{a_{-s}}(m_j)$  denote the expected *organizational payoffs* of all activities  $s' \in S$  when an *informed manager*  $m_j(s)$  chooses  $a_s$  and let  $\Pi_{a_{-s}}^*$  denote the first-best expected payoffs (both for some given action profile  $a_{-s}$ ). Since manager  $m_0$  maximizes the payoffs of all activities, it follows that

$$\Pi_{a_{-s}}(m_0) = \Pi_{a_{-s}}^*.$$

When an informed middle manager  $m_1$  or worker  $m_2$  selects  $a_s$  the pay-off specification in Appendix 7.1 implies that

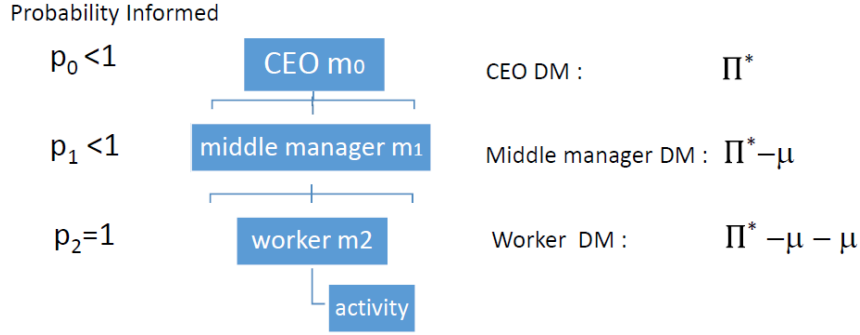
$$\begin{aligned}\Pi_{a_{-s}}(m_1) &= \Pi_{a_{-s}}^* - \mu_1 \\ \Pi_{a_{-s}}(m_2) &= \Pi_{a_{-s}}^* - \mu_1 - \mu_2,\end{aligned}$$

where the term  $\mu_1$  are the payoff losses due to externalities which are not internalized by the middle manager, and  $\mu_1 + \mu_2$  reflect the externalities not internalized by the worker. When an *uninformed manager*  $m_j$  selects  $a_s$ , our quadratic payoff specification results in expected organizational payoffs

$$\Pi_{a_{-s}}(m_j) - \sigma^2,$$

where  $\sigma^2$  is linear in the variance of the task-specific shock  $\theta_s$ . Hence  $\sigma^2$  reflects the uncertainty surrounding the optimal choice of  $a_s$ .

## Organizational Pay-offs (informed DM)



**Figure 3** – Expected organizational payoffs in a three-layer hierarchy given A2, when an informed manager  $m_i \in \{m_0, m_1, m_2\}$  is decision-maker (DM).

When deciding whether or not to delegate to the worker  $m_2$ , middle manager  $m_1$  only cares about the expected payoffs of the activities assigned to her. Let  $\Pi_{a-s}^1(m_j)$  denote the *expected payoffs of all the activities assigned to manager  $m_1$  when an informed manager  $m_j \in \{m_1, m_2\}$  chooses  $a_s$* . Our payoff specification implies that

$$\begin{aligned}\Pi_{a-s}^1(m_1) &\equiv \Pi_{a-s}^{1*} \\ \Pi_{a-s}^1(m_2) &= \Pi_{a-s}^{1*} - \mu_2.\end{aligned}$$

Instead, when an uninformed manager  $m_1$  chooses  $a_s$ , those payoffs equal  $\Pi_{a-s}^{1*} - \sigma^2$ . To simplify the exposition, we assume that the bias in decision-making increases linearly as one moves down the hierarchy:

**Assumption A1:**  $\mu_1 = \mu_2 = \mu$ .

In this paper, we study the consequences of managers inefficiently holding on to authority. To make this analysis relevant, we make the following assumption which implies that delegation is efficient:

**Assumption A2:**  $p_1\sigma^2 - \mu > 0$ .

Assumption A2 guarantees that in the absence of preferences for power, an uninformed top manager  $m_0$  is willing to delegate to the next-level manager  $m_1$ .

### 3.3 Discussion

**Delegation hierarchies, asset ownership and de-integration:** While alternative interpretations are possible, following the literature on incomplete contracts (Grossman and Hart (1986), Hart and Moore (1990)), one can think of decision rights in our model being conveyed through control or ownership of assets. Consider a number of activities  $s \in S$ , each of which is associated with a three-layer delegation hierarchy  $h(s) = (m_0, m_1(s), m_2(s))$ . Each activity  $s$  requires, at the minimum, the use of an activity-specific asset  $A_s \in \Omega_2$  which is operated by worker  $m_2(s)$ . The organization, however, has the option to integrate its activities in a number of divisions  $D = \{D_1, \dots, D_N\}$  by letting activities belonging to the same division  $D_i \in D$  use a common asset  $A_i \in \Omega_1$ . While this divisional asset does not directly affect payoffs, such integration allows the organization to convey the decision right over  $a_s$  to manager  $m_1(s)$  who operates this asset. Finally, independent of whether its activities are integrated into divisions or not, the organization can employ an organization-wide asset  $A_0$  which is required to operate all divisional assets  $A_i \in \Omega_1$  (if ‘active’) and all activity-specific assets  $A_s \in \Omega_2$ . This type of organization-wide integration therefore allows the organization to assign the decision rights over the full action profile  $a$  to a single manager  $m_0$ . Conversely, removing manager  $m_0$  in a delegation hierarchy is equivalent to a de-integration decision, where one hierarchy is replaced by several smaller hierarchies (if divisional assets are being used) or by a set of stand-alone assets (if no divisional assets are in use).

**Formal versus real authority:** In our delegation hierarchy, the initial decision-right over  $a_s$  is owned by manager  $m_0$ , the “top manager”. One can think of this as  $m_0$  having *formal authority* in the sense of Aghion and Tirole (1997). An uninformed  $m_0$ , however, may choose to delegate or “loan” the decision rights about  $a_s$  to a middle manager or worker  $m_j \in \{m_1(s), m_2(s)\}$ . One can view this as the delegation of “real authority” where an uninformed boss optimally refrains from overturning the actions of her subordinate.

As in Aghion and Tirole, but unlike in Dessein (2002), we implicitly assume that the activity  $s$  is sufficiently complex so that observing the choice of  $a_s$  by a middle manager or worker does not reveal the state of nature  $\theta_s$ .<sup>13</sup> Hence, in the absence of re-delegation,

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<sup>13</sup>Similarly, the choice of  $a_s$  by a subordinate does not reveal whether or not this subordinate was informed.

the top manager has no commitment problem when “loaning” or “delegating” a decision right to a middle manager. Ex ante, a top manager optimally allows a middle manager to re-delegate a decision right to the worker. Ex post, however, the top manager may have an incentive to reclaim the decision right if she observes re-delegation. Our model therefore implicitly assumes that a top manager cannot observe whether a decision is being re-delegated or not.<sup>14</sup> Alternatively, if who makes the final decision is observable, then the top manager must be able to build a reputation for not renegeing on delegation decisions, as in Baker, Gibbons and Murphy (1999).

## 4 Optimal hierarchical structure

Our model allows for four possible organization designs. The first is a *three-level hierarchy* where a top-manager sits above a middle manager, who in turn sits above a worker. We denote this organization  $h^* = (m_0, m_1, m_2)$ . A second possibility is an *integrated two-level hierarchy* where, relative to the first organization, the middle manager is removed so that the top-manager sits directly above the worker i.e.  $h^* = (m_0, 0, m_2)$ . A third possibility is a *non-integrated two-level hierarchy* where middle managers sit above workers and the CEO is removed i.e.  $h^* = (0, m_1, m_2)$ . Finally, it is possible to have *stand-alone activities*, where there is only the worker in the organization i.e.  $h^* = (0, 0, m_2)$ .

### 4.1 Road map

Our study of which of those four structures is optimal proceeds as follows. In Section 4.2, we first consider a natural benchmark in which managers do not have preferences for power ( $r_1 = r_2 = 0$ ). It is easy to show that more layers of management are always better, that is  $h^* = (m_0, m_1, m_2)$ .

When managers  $m_0$  and  $m_1$  do have preferences for power, Section 4.3 shows that  $h_i \neq 0$  if and only if  $p_i > p_i^*$ : power-hungry managers are part of an optimal hierarchy if they have sufficient expertise. An increase in preferences for power may then result in

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<sup>14</sup>Consistent with this assumption of non observability, it is often lamented that middle managers claim “ownership” for actions and accomplishments which are mainly achieved by their subordinates.

either delaying ( $h^* = (m_0, 0, m_2)$ ) or de-integration ( $h^* = (0, m_1, m_2)$ ) or  $h^* = (0, 0, m_2)$ , depending on  $\{p_0, p_1\}$ .

A central insight of Section 4.3, however, is that the moral-hazard-in-delegation problem is more severe for  $m_0$  than for  $m_1$ : an uninformed  $m_0$  is more likely to hoard decision rights than an uninformed  $m_1$ . Section 4.4 uses this insight to show that in a natural benchmark – ‘balanced expertise’, where  $m_0$  and  $m_1$  are equally good stand-alone decision-makers from the perspective of firm owners – preferences for power tend to result in the removal of the top manager  $m_0$  rather than the middle manager  $m_1$ . In other words, stronger preferences tend to lead to small non-integrated organizations rather than large-but-flat ones, i.e.  $h^* = (0, m_1, m_2)$  rather than  $h^* = (m_0, 0, m_2)$ . The same result is obtained if one restricts attention to deterministic private benefits of control, where  $r_1 = r_2 = r$ .

## 4.2 Benchmark: No preferences for power

Consider first a natural benchmark where managers do not have preferences for power:  $r_1 = r_2 = 0$ .

**Proposition 5.** *If there are no preferences for power, the optimal organization is  $h^* = (m_0, m_1, m_2)$ .*

Under this organizational design the top manager  $m_0$  holds the initial decision right over  $a_s$ . If  $m_0$  is uninformed then she delegates to the division manager  $m_1$ . Similarly, if  $m_1$  has been delegated the decision right by  $m_0$ , and she is uninformed herself, then  $m_1$  delegates to the worker  $m_2$ .

The top manager faces a relatively simple trade-off between the costs and benefits of delegation. The benefits of delegating to the division manager are that the division manager may: (a) become informed; or (b) delegate to the worker—who we have assumed is always informed. The costs of delegation are, of course, the bias that comes from delegation. Assumption A2 ensures that the informational benefits of delegation to the division manager always dominate. This leaves open the possibility, however, that it is optimal for the top manager to delegate directly to the worker. This cannot be optimal since the division manager is less biased than the worker and, given that there are no

preferences for power, the division manager always delegates to the worker if the top manager would do so herself.

Finally, the organization designer finds it optimal to assign the initial decision right to the top manager, rather than to the division manager. Again, because there are no preferences for power, there is no conflict between firm owners and the top manager. The top manager always delegates if she is uninformed, but is valuable in the event that she is informed.

### 4.3 Value of Managerial Layers

In contrast to our benchmark, when managers are power-hungry, three-level hierarchies are not necessarily optimal anymore. In what follows, we subsequently study the value of the middle layer (or middle manager) and the value of the top layer (or CEO).

#### 4.3.1 Value of a middle manager

When is the middle manager  $m_1(s)$  part of an optimal hierarchy  $h^*$ ? Note first that it does not matter whether the CEO or firm owners decide on the existence of a middle layer. Conditional on delegating authority, the CEO maximizes firm profits and her preferences are aligned with those of firm owner. It follows that  $h = (m_0, m_1, m_2)$  is strictly preferred over  $h = (m_0, 0, m_2)$  if and only if  $(0, m_1, m_2)$  is strictly preferred over  $(0, 0, m_2)$ .

Note further that the value of a middle manager  $m_1(s)$  in our three-level hierarchy is identical that off the boss in the two-level hierarchy analyzed in Section 2. Formally, an uninformed middle manager  $m_1(s)$  will (re-)delegate  $a_s$  to the worker  $m_2(s)$  if and only if

$$r_1(s) < \bar{r}_1 = \sigma^2 - \mu$$

It follows that a middle-manager is valuable if and only if

$$p_1\mu \geq (1 - p_1)(1 - F(\bar{r}_1))(\sigma^2 - \mu). \quad (3)$$

Intuitively, on the plus side (LHS of inequality), with probability  $p_1$ , the middle manager



is informed and internalizes within-division externalities  $\mu$ . On the minus side (RHS), with probability  $1 - F(\bar{r}_1)$ , an uninformed middle manager hoards decision rights because of her preference for power, and this creates an inefficiency loss equal to  $\sigma^2 - \mu$ . This leads to the following proposition:

**Proposition 6.** *A middle manager is valuable,  $h_1^* = m_1 \in M$ , if and only if  $p_1 > \bar{p}_1$ , with  $\bar{p}_1$  given by*

$$\bar{p}_1 \sigma_\theta^2 + (1 - \bar{p}_1) F(\bar{r}_1) (\bar{r}_1) = \bar{r}_1,$$

where  $\bar{r}_1 \equiv \sigma^2 - \mu$ .

Since the condition (3) for the value of a middle manager in a three-level hierarchy is identical to that of a boss in a two-layer hierarchy, we refer to Section 2.3 for a detailed discussion of the comparative statics. We content ourselves to remind the reader that a middle manager is more likely to be valuable when she is more knowledgeable (higher  $p_1$ ) or has weaker preferences for power (an upward shift in  $F(\cdot)$  reduces  $\bar{p}_1$ ). Counterintuitively, however, stronger externalities between activities (a larger  $\mu$ ), have an ambiguous impact on the value of a middle manager. As was also the case for the value of a boss in a two-layer hierarchy, when preferences for power are deterministic or uniformly distributed, middle managers are least likely to be valuable for intermediate values of  $\mu$ .

The analysis of the value of middle managers is of independent interest to that of the value of top managers. Indeed, in many organizations, top managers are entrenched and cannot be easily removed by firm owner (e.g. because boards are captive and/or shareholders are dispersed). Top managers, however, will not be shy to delayer the organizations by removing middle managers when those managers are often uninformed but fail to delegate efficiently because of preferences for power.

### 4.3.2 Value of a top manager

We now turn attention to the value of a top manager  $m_0$  from the perspective of the board/firm owner. In order to avoid inefficient centralization of decision rights, firm owners may opt to de-integrate organizations or put in place a holding structure in which central headquarters have very limited authority. Such a structure is often adopted,

for example, by business groups in Europe and Asia. Multi-nationals such as Philipps are also structured in a manner which authority is effectively decentralized to large business units for all but the most important decisions.

Consider first the incentives of the top manager to delegate. On the one hand, if the middle manager is not valuable,  $h_1^* = 0$ , then  $m_0$  can only delegate to  $m_2$  and will do so if and only if

$$r_0 \leq \tilde{r}_0 = \sigma^2 - 2\mu,$$

where  $r_0$  are the private benefits of control of the top manager. On the other hand, if the middle manager is valuable,  $h_1^* = m_1$ , then it must be that  $m_0$  prefers to delegate to  $m_1$  rather than  $m_2$  and she will do so if and only if

$$r_0 \leq \hat{r}_0 \equiv p_1\sigma^2 - \mu + (1 - p_1)F(\bar{r}_1)(\sigma^2 - \mu),$$

where  $\bar{r}_1 = \sigma^2 - \mu$ . In words, an uninformed top manager  $m_0$  will delegate to the middle manager  $m_1$  if her private benefits of control  $r_0$  are smaller than the sum of (1) the informational advantage of the middle manager  $p_1\sigma^2$ , (2) minus the loss  $\mu$  due to the fact that  $m_1$  does not internalize inter-divisional externalities, (3) plus a term which reflects the benefits of the middle manager delegating to the worker when uninformed. Note that even when  $\sigma^2 < 2\mu$  and  $m_0$  would never delegate herself to  $m_2$ , she still benefits from an uninformed  $m_1$  delegating to  $m_2$  provided  $\sigma^2 > \mu$ . Indeed an uninformed  $m_1$  deciding herself yields an expected payoff of  $\Pi^* - \sigma^2 - \mu$ , whereas an informed  $m_2$  deciding yields a payoff of  $\Pi^* - 2\mu$ .

We conclude that an uninformed top manager will delegate if and only if

$$r_0 < \bar{r}_0 = \max\{\hat{r}_0, \tilde{r}_0\}.$$

Comparing the expressions for  $\bar{r}_0$  and  $\bar{r}_1$  yields the following result.

**Proposition 7.** *Moral hazard in delegation is more severe at the top of the organization. An uninformed top manager,  $m_0$ , is less likely to delegate than an uninformed middle manager,  $m_1$ :  $F(\bar{r}_0) < F(\bar{r}_1)$ .*

The above proposition states that conditionally on being uninformed, manager  $m_0$

is more likely to (inefficiently) hoard decision rights than manager  $m_1$ . Importantly, the above result holds despite the fact that both managers have the same preferences for power, as characterized by  $F(\cdot)$ , and despite the fact that  $m_0$  has the option to delegate to either  $m_1$  or  $m_2$ , whereas  $m_1$  can only delegate to  $m_2$ .

What is the intuition for this result? Consider first the willingness to directly delegate to the worker,  $m_2$ . Both the top manager and the middle manager have the option to do so, but the worker is twice as biased from the perspective of  $m_0$  than from the perspective of  $m_1$ . Clearly,  $m_0$  is more reluctant to delegate to the worker than  $m_1$ . Consider next the willingness of both  $m_0$  and  $m_1$  to delegate to agent in the next layer (respectively  $m_1$  and  $m_2$ ). From the perspective of the delegator ( $m_0$  or  $m_1$ ) the delegee (respectively,  $m_1$  or  $m_2$ ) is equally biased, but the delegee is more likely to become informed if she is further down the hierarchy. As a result, the value of delegation is  $\bar{r}_1 = \sigma^2 - \mu$  to the middle manager, whereas the value of delegation to the top manager is at most

$$\bar{r}_0^{\max} \equiv p_1(\sigma^2 - \mu) + (1 - p_1)(\sigma^2 - 2\mu),$$

where  $\bar{r}_0^{\max}$  is reached if the middle manager always delegates when uninformed. While our assumption that the worker ( $m_2$ ) is perfectly informed is extreme, the result holds as long as  $p_2 > p_1$ .

While the top manager faces a larger temptation to hoard decision rights than the middle manager, this does not necessarily imply that she is less valuable as the middle manager is more biased when making a decision. In other words, while the middle manager is more likely to delegate efficient (she faces less of a moral hazard in delegation problem), the top manager is less biased when making the decision (she faces no agency problem as far as the decision itself is concerned). We now proceed by characterizing the value of a top manager from the perspective of firm owners. If firm owners delegate to the top manager, their payoffs equal

$$\Pi^* - \sigma^2 + p_0\sigma^2 + (1 - p_0)F(\bar{r}_0)\bar{r}_0$$

Instead, when firm owners directly delegate to the middle manager  $m_1$  (if  $h_1^* = m_1$ ) or

the worker  $m_2$  (if  $h_1^* = 0$ ), their payoffs equal

$$\Pi^* - \sigma^2 + \bar{r}_0.$$

It follows that delegation to the CEO,  $m_0$ , is preferred if and only if

$$p_0\sigma^2 + (1 - p_0)F(\bar{r}_0)\bar{r}_0 \geq \bar{r}_0.$$

We thus obtain the following result.

**Proposition 8.** *The top manager is valuable, that is  $h_0^* = m_0 \in M$ , if and only if  $p_0 > \bar{p}_0$ , with  $\bar{p}_0$  given by*

$$\bar{p}_0\sigma^2 + (1 - \bar{p}_0)F(\bar{r}_0)\bar{r}_0 = \bar{r}_0,$$

where

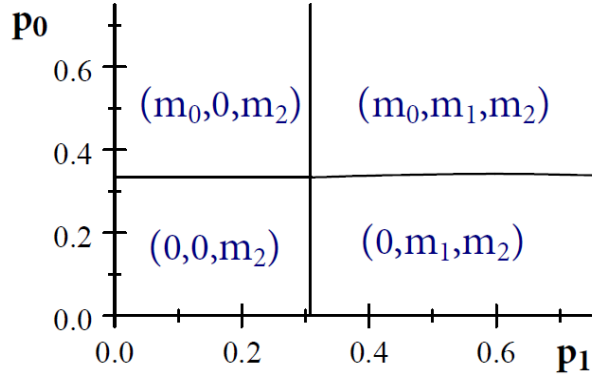
$$\bar{r}_0 \equiv \max \{ \sigma^2 - 2\mu, \quad p_1\sigma^2 - \mu + (1 - p_1)F(\sigma^2 - \mu)(\sigma^2 - \mu) \}.$$

As was the case for the middle manager, the top manager  $m_0$  is more likely to be valuable if  $p_0$  is higher—that is, if she is more likely to be informed. Recall that in the benchmark setting with no preferences for power, a top manager is always valuable since she internalizes externalities whenever she is informed, and delegates authority to the middle manager whenever she is uninformed. But once managers are power-hungry this need not be the case. If she is not sufficiently likely to be informed, it can be optimal to bypass her and give the initial decision rights to the middle manager or the worker. Also similar to the case of middle managers, comparative statics other than  $p_0$  are ambiguous.

Figure 4 plots the optimal hierarchy as a function of  $p_0$  and  $p_1$  for the case of our leading example (assuming  $\mu = 0.25$  and  $R = 0.9$ ):

#### 4.4 De-integration versus de-layering

Our analysis of the value of top- and middle managers raises the question whether organizations are more likely to de-integrate (remove the CEO) or delayer (remove the middle manager) when managers are power-hungry? In the absence of power rents,



**Figure 4** – Figure 4, plots the optimal hierarchy as a function of  $p_0$  and  $p_1$  when  $\mu = 0.25$ ,  $\sigma^2 = 1$  and  $r \sim U[0, R]$  with  $R = 0.9$

both the CEO and the middle manager are always part of the optimal hierarchy (given A1). Which managerial layer is most likely to disappear as preferences for power become more pronounced?

To answer this question, we now restrict our analysis to two special cases of our general framework: (1) A setting in which the bias of the middle-manager exactly compensates for her superior expertise (relative to the top manager) – a setting which we refer to as ‘balanced expertise’, (2) A setting in which the private benefits of control are deterministic.

#### 4.4.1 Balanced Expertise Case

As an interesting benchmark, consider first the case where  $m_0$  and  $m_1$  are equally good stand-alone decision-makers from the perspective of firm owners:

##### Condition C1 (Balanced Expertise)

*Managers  $m_0$  and  $m_1$  have balanced expertise:  $p_1\sigma^2 - \mu = p_0\sigma^2$*

Condition C1 levels the playing field between manager  $m_0$  and manager  $m_1$  : manager  $m_1$  is more biased, as she does not internalize all externalities, but her superior expertise ( $p_1 > p_0$ ) exactly compensates for this bias. Given Condition C1, firm owners are indifferent to whom to delegate decision-making authority in the absence of any hierarchy. Note that Condition C1 is equivalent to  $p_0\sigma^2 = p_1\sigma^2 - \mu$ . We further make the

following mild restriction on the distribution of decision rents.

**Condition C2:** *Smaller decision rents are weakly more likely:*  $f'(r_i) \leq 0$  for  $r_i \geq \sigma^2 - 2\mu$

Condition C2 is satisfied for our leading example (uniform distributions) and other natural distributions with support on  $[0, \infty)$  such as the exponential distribution. Condition C2 is a sufficient (but far from necessary) condition for the following result.

**Proposition 9.** *Assume Conditions C1 and C2 hold, then  $h^* \neq (m_0, 0, m_2)$ .*

**Proof** See Appendix A2.

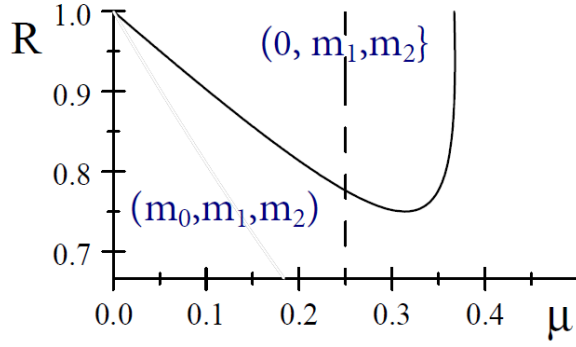
Proposition 9 formalizes the idea that when the managerial expertise and managerial bias in decision-making are in balance, de-integration is a better response to a lack of delegation in the hierarchy than de-layering. When preferences for power become more pronounced, we expect organizations to become smaller (more de-integrated) rather than flatter. Given balanced expertise, we do not expect to observe a hierarchy  $h = (m_0, 0, m_2)$ . Intuitively, while both  $m_0$  and  $m_1$  are equally power-hungry on average, the lack of delegation is more severe at the top than in the middle, as the delegee is less informed while equally biased (from the perspective of the delegator). The top manager is also less willing than the middle manager to delegate directly to better informed bottom layer, as the bottom layer is much more biased from her perspective than from the middle manager's perspective.

**Leading example** To illustrate Proposition 9, consider again our leading example, where  $r_1$  and  $r_2$  are uniformly distributed on  $[0, R]$ . Figure 5 plots the optimal hierarchies as function of  $R$  and  $\mu$  when  $p_1 = 1/2$  and  $p_0 = 1/4$ .<sup>15</sup> The dotted lines in the graph, which are values of  $\mu$  such that there is balanced expertise.

For the parameter range we consider ( $\mu \leq 1/2$ ), the middle-manager  $m_1$  is always valuable, but stronger preferences for power (an increase in  $R$ ) may result in the top manager  $m_0$  being removed. Counterintuitively,  $m_0$  may be removed and  $m_1$  may be given initial decision rights not only when expertise is balanced (dotted line) but even when  $m_0$  is a better stand-alone decision-maker than  $m_1$ . Indeed, consider the area on the figure *to the right of the dotted line*, where  $m_0$  is a *better stand-alone decision-maker*

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<sup>15</sup>Note that (A1) is always satisfied for these parameter values.



**Figure 5** – Figure 5 plots the optimal hierachies as function of  $R$  and  $\mu$  when  $p_1 = 1/2$  and  $p_0 = 1/4$ . To the right of the dotted line,  $m_0$  is a better stand-alone decision-maker than  $m_1$  yet  $(0, m_1, m_2)$  is often the optimal hierarchy.

than  $m_1$  :  $p_0\sigma^2 > p_1\sigma^2 - \mu$ . Even though the top manager  $m_0$  is a better stand-alone decision-maker than the middle-manager  $m_1$ , it is often the case that  $m_1$  is part of the optimal hierarchy but not  $m_0$  :  $h^* = (0, m_1, m_2)$ . The reason for this counterintuitive result is again our insight that moral hazard in delegation is more severe at the top of the organization.

#### 4.4.2 Deterministic decision rents

Next, consider the case where private benefits of control are deterministic and identical for all managers:  $r_0 = r_1 = r > 0$ . Consider the incentives of the middle manager  $m_1$  to delegate to the worker  $m_2$ . An uninformed  $m_1$  delegates to  $m_2$  if and only if

$$r < \bar{r}_1 \equiv \sigma^2 - \mu.$$

Next consider the incentives of the top manager  $m_0$  to delegate (to  $m_1$  or  $m_2$ ). We distinguish two cases:

(1) Assume first that  $m_1$  never delegates, that is  $r > \bar{r}_1$ . An uninformed  $m_0$  is then willing to delegate to  $m_1$  if and only if

$$r < \tilde{r}_0 \equiv p_1\sigma^2 - \mu.$$

Similarly, an uninformed  $m_0$  prefers to delegate directly to the worker  $m_2$  (rather than make an uninformed decision) if and only if

$$r < \hat{r}_0 \equiv \sigma^2 - 2\mu.$$

Since both  $\tilde{r}_0 < \bar{r}_1$  and  $\hat{r}_0 < \bar{r}_1$ , we conclude that if  $m_1$  never delegates, then also  $m_0$  never delegates.

(2) Second, assume that an uninformed  $m_1$  always delegates, that is  $r < \bar{r}_1$ . An uninformed  $m_0$  is then willing to delegate to  $m_1$  if and only if

$$r < \bar{r}_0 \equiv p_1(\sigma^2 - \mu) + (1 - p_1)(\sigma^2 - 2\mu).$$

Note further that it is never optimal to directly delegate to the worker  $m_2$ . Indeed,  $m_0$  prefers decisions made by an informed middle-manager over those taken by an informed worker, and an uninformed middle-manager always delegates to the worker. Formally, it is easy to verify that  $\bar{r}_0 > \hat{r}_0$ . The following result is now direct:

**Proposition 10.** *A top manager is less willing to delegate than a middle-manager:  $\bar{r}_0 < \bar{r}_1$ . For  $r \in (\bar{r}_0, \bar{r}_1)$ , an uninformed middle-manager always delegates whereas a top manager never delegates.*

We now make the following assumption which is strictly weaker than C1 (balanced expertise):

**Condition D1:** *A lone manager  $m_0$  who never delegates is dominated by a hierarchy  $(0, m_1, m_2)$  where  $m_1$  always delegates when uninformed:*

$$p_0\sigma^2 < p_1(\sigma^2 - \mu) + (1 - p_1)(\sigma^2 - 2\mu).$$

Note that a Condition D1 (balanced expertise) is a sufficient but not necessary condition for Condition D1 to hold. Indeed, D1 may be satisfied even though manager  $m_0$  is a better stand-alone manager than  $m_1$ . The following result holds.

**Proposition 11.** *Assume Condition D1 holds:*

1. *If  $r < \bar{r}_0$ , a three-layer hierarchy  $h = (m_0, m_1, m_2)$  is optimal.*



2. If  $r \in (\bar{r}_0, \bar{r}_1)$ , a two-layer hierarchy  $h = (0, m_1, m_2)$  is optimal..
3. If  $r > \bar{r}_1$ , no manager ever delegates, and the initial authority is delegated to the best stand-alone manger.

Intuitively, when  $r < \bar{r}_0$  the top manager,  $m_0$ , is not “too power-hungry” and is thus willing to delegate to the middle manager,  $m_1$ . And since there is a chance that she becomes informed, the top manager,  $m_0$ , adds value to the hierarchy, regardless of  $p_0$ . When preferences for power are in an intermediate range,  $r \in (\bar{r}_0, \bar{r}_1)$ , a two-layer hierarchy with a middle manager and a worker is optimal since the middle manager,  $m_1$ , is willing to delegate to the worker,  $m_2$ , but the top manager will not delegate, and thus is optimally excluded from the hierarchy. Finally, when preferences for power are very large,  $r > \bar{r}_1$ , the middle manager,  $m_1$ , will not delegate to the worker,  $m_0$ , even if the middle manager is uninformed. In that case it is optimal to allocate the initial decision right to the whomever is the best stand-alone decision maker.

A first corollary to Proposition 11 is that even when  $m_0$  and  $m_1$  have equal expertise, that is  $p_0 = p_1 = p$ , there exists a range of decision rents  $r$  such that  $h^* = (0, m_1, m_2)$  and thus  $h_0^* \neq m_0$  even though  $m_0$  is less biased than  $m_1$ . Indeed, Condition D1 then becomes

$$\mu < (1 - p)(\sigma^2 - \mu)$$

which will be satisfied if  $\mu$  and/or  $p$  are sufficiently small or  $\sigma^2$  sufficiently large. For intermediate values of decision rents, the top manager then never delegates whereas the middle-manager and the worker cooperate effectively and yield a decision of higher expected quality than the one made by the top manager by herself. More generally, the following corollary holds.

**Corollary 1.** *It is possible that  $h^* = (0, m_1, m_2)$  even when  $p_0 \geq p_1$  (and  $m_0$  has weakly more expertise than  $m_1$ ).*

A second corollary of Proposition 11 is that if the worker  $m_2$  is the best stand-alone decision-maker,<sup>16</sup> then managerial layers are decreasing in decision rents  $r$ . Hierarchies then become smaller and more de-integrated as managers are more power hungry.

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<sup>16</sup>That is  $\sigma^2 - 2\mu > \max \{p_0\sigma^2, p_1\sigma^2 - \mu\}$ .

While for a given number of layers, an increase in preferences for power reduces worker authority, stronger preferences for power also result in de-layering (in an optimal organization) and may therefore increase worker authority, defined as the probability that  $m_2$  chooses  $a(s)$ .

**Corollary 2.** *Assume  $m_2$  is the best stand-alone decision-maker.*

1. *For a given hierarchical structure,  $m_2$ -authority (the probability that  $m_2$  chooses  $a$ ) is decreasing in preferences for power  $r$ .*
2. *When hierarchical structure is optimally chosen,  $m_2$ -authority jumps discretely at  $r = \bar{r}_0$  and becomes complete when  $r > \bar{r}_1$ .*

Decision rents and preferences may vary depending on region (e.g. Asia versus US) or industry (e.g. non-profit versus for-profit). An implication of the above corollary is that empirical studies which study how lower-level decision-making authority varies as a function of decision rents may find different results depending on whether they control for organizational structure or treat this as an endogenous variable.

## 5 Multi-level hierarchies

We conclude our analysis by generalizing our insights to hierarchies with an arbitrary number of levels. To keep the analysis tractable, we assume that decision rents are deterministic.

### 5.1 Delegation hierarchies with multiple layers.

Our model can readily be generalized to an arbitrary number of layers, in which case each activity  $s \in S$  is assigned to a hierarchy of managers

$$h(s) = (h_0(s), h_1(s), \dots, h_N(s)).$$

where  $h_j(s) \in M \cup \{0\}$ . As before,  $h_j(s) = 0$  if no manager is assigned to level  $i$  and  $h_j(s) = m_j(s) \in M$  otherwise. As in our main model, each activity generates a pay-

off  $\pi_s(\theta_s, a)$  where  $a = (a_s, a_{-s})$  and  $\theta_s$  is an activity-specific shock which informs the optimal choice of  $a_s$ . Each manager  $m_j(s)$  observes  $\theta_s$  with independent probability  $p_j \in [0, 1]$  with  $p_N = 1$ .

When choosing  $a_s$ , a manager maximize the payoffs of the activities assigned to her. Lower-level managers (higher indices) are more specialized and, therefore, more biased. Formally, let  $D_j(s) \subset S$  be the set of activities assigned to manager  $m_j(s)$ , then  $D_j(s) \subset D_i(s)$  whenever  $j > i$ . We further posit that  $D_0(s) = S$  whereas  $D_N(s) = \{s\}$ . We can think of activities being partitioned into divisions, sub-divisions and so on, with  $m_j(s)$  being the manager of the level  $j$  (sub)division to which  $s$  belongs.

All managers, except for  $m_N(s)$ , also have the option to delegate  $a_s$ . When deciding whether or not to delegate  $a_s$  to manager  $m_l(s)$  with  $l > j$ , manager  $m_j$  takes into account the equilibrium strategies of all other managers  $m_i(s)$  with  $i > j$ , and behaves as if she maximizes the sum of her private benefits  $r_j(s)$  and the expected payoffs of the activities  $s' \in D_j(s)$  assigned to her.

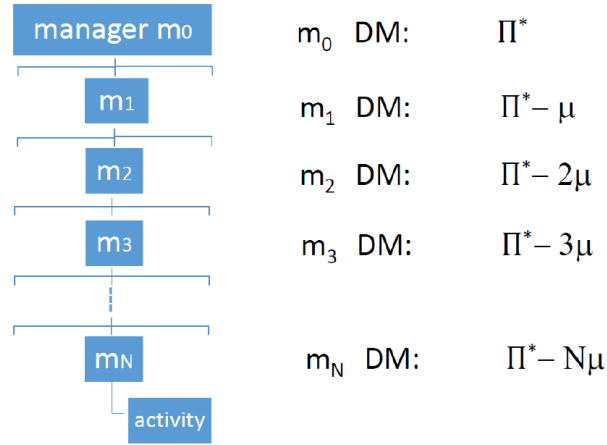
## 5.2 Expected payoffs (N possible layers)

We now generalize the (expected) profits of the organization under different scenarios regarding who is informed and who makes the decision. Appendix 7.1 posits a quadratic “hit-the-state” payoff specification for  $\pi_s(\theta_s, a)$ , with  $a = (a_s, a_{-s})$ , which results in intuitive expressions for expected profits. Those pay-offs  $\pi_s(\theta_s, a)$  are such that the optimal choice for  $a_s$  only depends on  $\theta_s$  and not on the action profile  $a_{-s}$ . As was the case with three hierarchical levels, we can therefore focus our analysis on one generic activity  $s$  and associated action  $a_s$  taking the action profile  $a_{-s}$  as given.

Consider first the *expected payoffs of all activities*  $S$ . Let  $\Pi_{a_{-s}}(m_j)$  denote those expected *organizational payoffs* when an informed manager  $m_j(s)$  chooses  $a_s$  and let  $\Pi_{a_{-s}}^*$  denote the first-best expected payoffs (both for some given action profile  $a_{-s}$ ). Since manager  $m_0$  maximizes the payoffs of all activities, it follows that  $\Pi_{a_{-s}}(m_0) = \Pi_{a_{-s}}^*$ . When an informed manager  $m_j$  selects  $a_s$  this specification implies that

$$\Pi_{a_{-s}}(m_j) = \Pi_{a_{-s}}^* - \sum_{k=1}^j \mu_k,$$

Payoffs top manager/organization (informed decisions)



**Figure 6** – Organizational payoffs as a function of whom is the decision-maker (DM). Pay-offs are for informed decisions – if decisions are uninformed, deduct  $\sigma^2$ .

where the terms  $\mu_1 + \dots + \mu_j$  are the payoff losses due to externalities which are not internalized by manager  $m_j$ . When an *uninformed manager*  $m_j$  selects  $a_s$ , our quadratic payoff specification results in expected organizational payoffs  $\Pi_{a-s}(m_j) - \sigma^2$ , where  $\sigma^2$  is linear in the variance of the task-specific shock  $\theta_s$ .

Consider now the *pay-offs of all the activities*  $D_i(s) \subset S$  assigned to manager  $m_i(s)$ . Let  $\Pi_{a-s}^i(m_j)$  denote those *divisional payoffs* when an informed manager  $m_j$  with  $j \geq i$  chooses  $a_s$ . Denoting  $\Pi_{a-s}^i(m_i) \equiv \Pi_{a-s}^{i*}$  our payoff specification implies that

$$\Pi_{a-s}^i(m_j) = \Pi_{a-s}^{i*} - \sum_{k=i+1}^j \mu_k.$$

Instead, when an uninformed manager  $m_j$  chooses  $a_s$ , those payoffs equal  $\Pi_{a-s}^i(m_j) - \sigma^2$ .

Finally, we generalize assumptions A1 and A2 from our model with three levels. First, the bias in decision-making increases linearly as we move down the organization:

**Assumption A1'**  $\mu_i = \mu$  for  $i = 1, \dots, N$

Second, when a manager is uninformed, delegation to the next layer is efficient:

**Assumption A2'**  $p_i \sigma^2 > \mu$  for  $i = 1, \dots, N$

### 5.3 Optimal hierarchical structure (N possible layers)

We solve now for the optimal hierarchy under the restriction that all managers obtain the same deterministic private benefits of control  $r$ . Consider therefore a hierarchy

$$h(s) = (0, \dots, 0, m_k, \dots, m_N).$$

with  $k \geq 0$ , consisting of  $N - (k + 1)$  consecutive levels management. Define  $\tilde{r}_i$  as the threshold for  $r$  below which an uninformed manager  $i$  is willing to delegate to manager  $i + 1$  provided all managers  $j > i$  also delegate to manager  $j + 1$  when uninformed. We now show that

$$\tilde{r}_i < \tilde{r}_{i+1}$$

so that (1) If  $r < \tilde{r}_i$ , all managers  $m_j$  with  $j > i$  delegate when uninformed, and (2) As decision rents  $r$  increase, the manager at the top of the hierarchy,  $m_k$ , is the first to stop delegating when uninformed.

Consider first the incentives of manager  $i < N - 1$  to delegate to manager  $i + 1$ . If all managers  $j > i$  delegate when uninformed, then an uninformed manager  $i$  delegates if and only if  $r < \tilde{r}_i$  where

$$\tilde{r}_i = p_{i+1}(\sigma^2 - \mu) + (1 - p_{i+1})(\tilde{r}_{i+1} - \mu). \quad (4)$$

Manager  $N - 1$ , finally, delegates to manager  $N$  when uninformed if and only if

$$r < \tilde{r}_{N-1} = \sigma^2 - \mu. \quad (5)$$

Since

$$\tilde{r}_{i+1} = p_{i+2}(\sigma^2 - \mu) + (1 - p_{i+2})(\tilde{r}_{i+2} - \mu),$$

and given  $p_{i+1} \leq p_{i+2}$  it follows that

$$\tilde{r}_{i+1} < \tilde{r}_{i+2} \implies \tilde{r}_i < \tilde{r}_{i+1}.$$

Using backward induction, this implies that  $\tilde{r}_0 < \tilde{r}_1 < \dots < \tilde{r}_{N-1}$  since

$$\begin{aligned}\tilde{r}_{N-2} &= p_{N-1}(\sigma^2 - \mu) + (1 - p_{N-1})(\tilde{r}_{N-1} - \mu) \\ &< \tilde{r}_{N-1} = \sigma^2 - \mu\end{aligned}$$

By our definition of  $\tilde{r}_i$ , an uninformed manager  $i$  delegates if and only if  $r < \tilde{r}_i$  provided all managers  $j > i$  also delegate when informed. Given that  $\tilde{r}_i < \tilde{r}_j$  for  $j > i$ , this is indeed the case. We conclude that manager  $m_i$  delegates to manager  $m_{i+1}$  if and only if  $r < \tilde{r}_i$ .<sup>17</sup>

The above analysis assumes that managers always delegate to the next level and that no other equilibria exist. In the Appendix, we show that skip-level delegation is never optimal with deterministic private benefits,<sup>18</sup> and that no other equilibria exist. We summarize as follows:

**Proposition 12.** *Assume decision rents  $r$  are deterministic and identical for all agents. Given a hierarchy  $h(s) = (0, \dots, 0, m_k, \dots, m_N)$  with  $k \geq 0$ , there exists a unique delegation equilibrium characterized by a set of cut-off values*

$$\tilde{r}_k < \tilde{r}_{k+1} < \dots < \tilde{r}_{N-1},$$

*defined by (4) and (5), where for  $i \geq k$ , an uninformed manager  $m_i$  delegates to manager  $m_{i+1}$  if and only if  $r < \tilde{r}_i$  and takes an uninformed decision if  $r > \tilde{r}_i$ .*

Proposition 12 generalizes the insight from our previous section that moral hazard in delegation is most severe at the top of the hierarchy. This insight is especially stark with deterministic decision rents. As decision rents  $r$  increase, manager  $m_0$  is the first to stop delegating, then manager  $m_1$ , then manager  $m_2$  and so on.

A direct implication of Proposition 12 is that if manager  $m_i \neq m_0$  is valuable than so are managers  $m_j$  with  $j > i$ . In other words, with deterministic decision rights, optimal hierarchies always consist of consecutive levels of management. Another implication of

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<sup>17</sup>Note that if  $r > \tilde{r}_i$ , manager  $i$  never delegates to manager  $i + 1$  regardless of the whether managers  $j > i$  delegate when uninformed.

<sup>18</sup>This stands in contrast with the case where private benefits are probabilistic and skip-level delegation may be optimal.

Proposition 12 is that top layers of management are the first to be removed as preferences for power become stronger.

The following proposition is almost a direct corollary of proposition 12:

**Proposition 13.** 1. If  $r < \tilde{r}_0$ , then the optimal hierarchy equals  $h(s) = (m_0, m_1, \dots, m_N)$  and all managers delegate when uninformed.

2. If  $\tilde{r}_{k-1} < r < \tilde{r}_k$  with  $k > 0$ , then the optimal hierarchy is either

(a)  $h(s) = (m_0, m_1, \dots, m_N)$  in which case  $m_0$  never delegates, or

(b)  $h(s) = (0, \dots, 0, m_k, \dots, m_N)$  in which case all managers delegate when uninformed.

In order to obtain slightly stronger result, we impose the following condition:

**Condition D1':** A lone manager  $m_0$  who never delegates is dominated by a team of managers  $h(s) = (0, \dots, 0, m_k, \dots, m_N)$  who always delegate when uninformed:

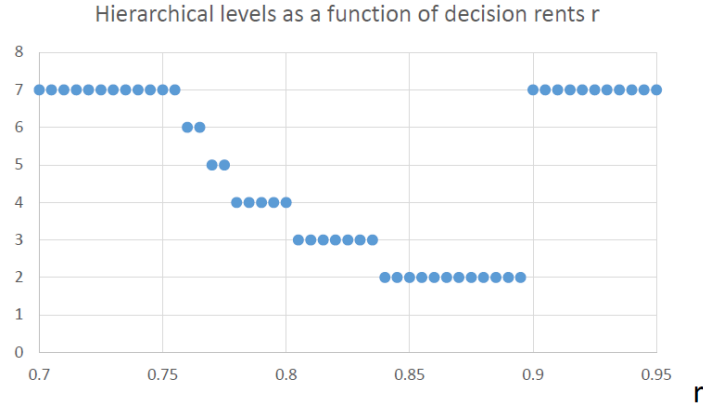
$$p_0\sigma^2 < p_k\sigma^2 - k\mu + (1 - p_k)\tilde{r}_k$$

Condition D1' is a generalization of Condition D1 in the previous section and is always satisfied when there is 'balanced expertise' (all managers are equally good stand-alone decision-makers).

**Proposition 14.** Assume Condition D1' holds. Then the number of hierarchical layers is decreasing in decision rents  $r$  with higher-level layers disappearing first. An increase in decision rents then always results in smaller, more dis-aggregated organizations.

Proposition 14 is stated in general terms, it implies that even if manager 1, 2, ...,  $N - 1$  all have equal expertise (e.g. all are informed with probability  $p < 1$ ) and even though managers at the top of the hierarchy are less biased than those lower in the hierarchy, it is the managers at the top which are the first to be removed from an optimal hierarchy (as preferences for power  $r$  become stronger).

Consider, for example, the case where  $h(s) = (h_1, \dots, h_6)$ , and all managers  $i \in \{1, 2, \dots, 5\}$  are equally likely to be informed except for the bottom-manager who is perfectly informed. If  $p_0 = \dots = p_5 = 0.6$  and the incremental pay-off loss per level is given



**Figure 7** – Number of hierarchical levels as a function of decision rents  $r$ , when  $p_0 = p_1 = \dots = p_5 = 0.6$  and the incremental bias per level is given by  $\mu = \sigma^2/10$ . Top layers of management disappear first.

by  $\mu = \sigma^2/10$ , then Condition D1' is satisfied<sup>19</sup> and the optimal hierarchy as a function of decision rents  $r$  is then given by<sup>20</sup>

$$\begin{aligned}
 h^* &= (m_0, m_1, m_2, m_3, m_4, m_5, m_6) & \text{if } r < 0.762 \\
 h^* &= (0, m_1, m_2, m_3, m_4, m_5, m_6) & \text{if } 0.762 < r < 0.769 \\
 h^* &= (0, 0, m_2, m_3, m_4, m_5, m_6) & \text{if } 0.769 < r < 0.782 \\
 h^* &= (0, 0, 0, m_3, m_4, m_5, m_6) & \text{if } 0.782 < r < 0.804 \\
 h^* &= (0, 0, 0, 0, m_4, m_5, m_6) & \text{if } 0.804 < r < 0.840 \\
 h^* &= (0, 0, 0, 0, 0, m_5, m_6) & \text{if } 0.840 < r < 0.9 \\
 h^* &= (m_0, m_1, m_2, m_3, m_4, m_5, m_6) & \text{if } r > 0.9.
 \end{aligned}$$

<sup>19</sup>The expected value of decision made by  $m_0$  is dominated by that of a hierarchy  $h = \{m_5, m_6\}$  which delegates efficiently if and only if

$$\begin{aligned}
 p_0\sigma^2 &< p_5\sigma^2 - 5\mu + (1 - p_5)(\sigma^2 - \mu) \\
 \Leftrightarrow &5\mu < 0.6(1 - \mu)
 \end{aligned}$$

which is indeed satisfied for  $\mu = 0.1$

<sup>20</sup>Threshold rounded to three decimals.



## 6 Concluding remarks

We have analyzed a model of organizational hierarchies with the novel, but realistic, ingredient that managers have preferences for making decisions themselves regardless of the decision itself. That is, they are power-hungry.

Our analysis shows that this assumption can yield strikingly different implications than in the received literature. One example is that an increase in externalities between activities can, in fact, lead to fewer managerial layers and, hence, less centralization. We also showed that hoarding of decision rights tends to be particularly acute at the top of the hierarchy. A consequence of this is that a hierarchy led by a top manager who is the organization's best stand-alone decision-maker may be dominated by a team of lower-level managers because of the relative proclivity of the top manager to fail to delegate. As a result, our model predicts optimal hierarchies to be smaller and more de-integrated in environments where preferences of power are more pronounced.

It is natural to think that there is heterogeneity in how power-hungry managers are across different environments. Political organizations, for-profit firms, and not for-profit firms might plausibly differ in how power-hungry their agents are. Our comparative static results shed light on some of the forces shaping the structure of these organizations. We also suggested in the introduction that developing countries may have different organizational forms, in part, due to differences in decision rents to those in developed countries.

Cultural differences, too, may be an important determinant of how much under-delegation there is in organizations. The world value service finds a large heterogeneity in attitudes towards authority. One major dimension of cross cultural variation in the world concerns traditional versus secular-rational values, where societies that embrace more secular values place much less emphasis on authority. Differences in religion provide a related proxy. Bloom, Van Reenen and Sadun (2008) suggest that the prevalence of hierarchical religions, such as Catholicism and Islam, may explain the lack of decentralization in certain countries compared to say Protestant countries as Sweden or the United States. Consistent with this premise, Bloom, Van Reenen and Sadun (2012) report startling differences in the cross-country decentralization of firms: those in the United States and Northern Europe appear to be the most decentralized and those in Southern

Europe and Asia are the most centralized.

A further empirical implication of our model is that studies seeking to relate certain organizational activities to the internal structure of firms may be flawed if they fail to control for decision rents. For instance, an influential paper by Garicano and Hubbard (2007) provides empirical evidence on the relationship between knowledge utilization and the hierarchical structure of firms using data on law offices from the 1992 Census of Services. Since decision rents affect hierarchy size, in the context of our model, even a flawless identification strategy that ignored decision rents would be subject to omitted variable bias.

Our model also shows that larger decision rents/stronger preferences for power affect decentralization of decision-making both directly, for a given organizational structure, and indirectly, by making smaller and more de-integrated firms optimal. Papers which, following the seminal work by Bloom and Van Reenen (2007), study management practices and the extent of delegation must therefore be careful when they control for organizational size and managerial layers.

The power-hungry assumption may also have implications in settings that do not involve “organizations” in the sense considered in this paper, and, further, where the “Hayekian” local-knowledge assumption may be inverted. To take just one example, the relationship between parent and child often involves a choice of how much authority is to be “delegated”, and where the parent may possess superior information about the correct choice. Our model may provide a framework for thinking about the demarcation between parent and child authority over different activities.

Furthermore, given the problems that hoarding decision rights can cause, it is natural to think that organizations would seek to develop ways of discouraging such behavior. The most obvious is a direct reward for delegation.<sup>21</sup> But, of course, there may be more complex and subtle ones. Understanding these mechanisms may help shed light on other features of organizational design and culture. Another fascinating venue for future research is the endogenous selection of managers into positions of power. When there is substantial (unobserved) heterogeneity among agents, one would expect the most power-hungry managers to devote most resources and effort to gain access to po-

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<sup>21</sup>Unless decision rents are deterministic, however, subsidizing delegation decisions provides only a partial solution and will unavoidably result in both over- and under-delegation in equilibrium.

sitions of power. Following this logic, it is likely the most power-hungry and, hence, least suitable agents who rise to the top of the hierarchy, exacerbating organizational inefficiencies.

Finally, our model speaks to a novel source of path dependence in organizations. Gibbons (2006) began a literature seeking to provide a theoretical foundation for the empirical fact that he called 'persistent performance difference among seemingly similar enterprises.' In our framework, firms can get 'stuck' with an inefficient governance structure. In our framework path dependences can stem from the fact that top managers themselves may be in control of organizational design. For instance if an organization begins with 2 layers being optimal, but then a change in the environment leads to 1 or 3 layers becoming optimal, the change will not occur because it is not in the interest of the top manager. That is, firm boundaries are path dependent. A top manager may resist both the break-up of the firm she leads as well as the take-over by another firm.

Of course, if an organizational designer realizes that the environment is subject to shocks, then they will account for this ex ante. This suggests to us that the dynamics of governance structures in settings where delegation decisions are not contractible is an interesting avenue for future work."

## 7 Appendix

### 7.1 Appendix 1: Micro-foundation of payoff structure

In this paper, we have considered an organization who is engaged in a set of activities  $s \in S$ . Each activity  $s$  is associated with an action choice  $a_s \in A$  and generates a payoff  $\pi_s(\theta_s, a)$  where  $a = (a_s, a_{-s})$  is the organization's action profile and  $\theta_s$  is an i.i.d. activity-specific shock with variance  $\sigma_\theta^2$ . Each activity  $s$  is assigned to a hierarchy of managers  $h(s) = (h_0(s), \dots, h_N(s))$  where  $h_i(s) \in M \cup \{0\}$ . We denote  $h_i(s) = 0$  if no manager is assigned to level  $i$  and  $h_i(s) = m_i(s) \in M$  otherwise.

In this Appendix, we provide micro-foundations for the expected organizational organizational payoffs  $\Pi_{a_{-s}}(m_j)$  when  $m_j = m_j(s)$  chooses  $a_s$  given some exogenously specified action profile  $a_{-s}$ . In our model section, we posited that

$$\Pi_{a_{-s}}(m_j) = \Pi_{a_{-s}}^* - \sum_{t \in \{1, \dots, j\}} \mu_t,$$

where  $\Pi_{a_{-s}}^* = \Pi_{a_{-s}}(m_0)$  are the first-best expected payoffs given some  $a_{-s}$  and where  $\mu_1, \dots, \mu_N$  characterize the externalities between the activities. If an uninformed manager  $m_j$  chooses  $a_s$ , we posited that expected profits are given by  $\Pi_{a_{-s}}(m_j) - \sigma^2$ , where  $\sigma^2$  is linear in  $\sigma_\theta^2$ . Note that in order to simplify the analysis and focus on the natural case where the agency conflict grows linearly as we move down the hierarchy, the model in the main text assumes that  $\mu_1 = \dots = \mu_N \equiv \mu$ .

#### 7.1.1 Three hierarchical levels

To illustrate the payoff structure, consider first a three-level hierarchy with four activities,  $S = \{1, 2, 3, 4\}$ , one top manager, two middle managers and four workers. Activities 1 and 2 share the same middle manager  $m_1(1) = m_1(2)$ , and activities 3 and 4 share the same middle manager  $m_1(3) = m_1(4)$ . Each activity  $s \in S$  is associated with a multi-dimensional action  $a_s = (a_{s,0}, a_{s,1}, a_{s,2})$  who must be responsive to the activity-specific shock  $\theta_s$ , but also take into account externalities  $\mu_2$  on the activity belonging to the same division (with the same middle manager) and externalities  $\mu_1$  on the activities belonging

to the other division (assigned to the other middle manager). Concretely, organizational payoffs are given by

$$\sum_{s=1,2,3,4} \left[ \sum_{j=0,1,2} (\theta_s a_{s,j} - \frac{1}{2} a_{s,j}^2) - \sqrt{\mu_1} a_{s,j} - \sqrt{\mu_2} a_{s,2} \right],$$

so that first-best actions are given by

$$a_s^* \equiv (a_{s,0}^*, a_{s,1}^*, a_{s,2}^*) = (\theta_s, \theta_s - \sqrt{\mu_1}, \theta_s - \sqrt{\mu_2}).$$

The payoffs of each individual activity  $s$ , however, are such that the middle manager  $m_1(s)$  chooses  $a_s$  as if  $\mu_1 = 0$  whereas the worker  $m_2(s)$  chooses  $a_s$  as if  $\mu_1 = \mu_2 = 0$ . In particular, let activities  $s$  and  $s'$  belong to one division (have the same middle manager  $m_1(s) = m_1(s')$ ) and let activities  $t \in S$  and  $t' \in S$  belong to the other division, then we posit that

$$\pi_s \equiv \pi(\theta_s, a) = \sum_{j=0,1,2} (\theta_s a_{s,j} - \frac{1}{2} a_{s,j}^2) - \frac{1}{2} \sqrt{\mu_1} (a_{t,2} + a_{t',2}) - \sqrt{\mu_2} a_{s',1}$$

and

$$\pi_{s'} \equiv \pi(\theta_{s'}, a) = \sum_{j=0,1,2} (\theta_{s'} a_{s',j} - \frac{1}{2} a_{s',j}^2) - \frac{1}{2} \sqrt{\mu_1} (a_{t,2} + a_{t',2}) - \sqrt{\mu_2} a_{s,1}$$

so that an informed middle manager  $m_1(s)$  would choose

$$(a_{s,0}, a_{s,1}, a_{s,2}) = (\theta_s, \theta_s, \theta_s - \sqrt{\mu_2}) \neq a_s^*,$$

whereas an informed worker  $m_2(s)$  would choose

$$(a_{s,0}, a_{s,1}, a_{s,2}) = (\theta_s, \theta_s, \theta_s) \neq a_s^*.$$

Since worker  $m_2(s)$  maximizes  $\pi_{s'}$ , she ignores both  $\mu_1$  and  $\mu_2$  when choosing  $a_s$ . Since middle manager  $m_1(s)$  maximizes  $\pi_s + \pi_{s'}$ , she ignores  $\mu_1$  when choosing  $a_s$  and  $a_{s'}$ .

It is now straightforward to verify that if an informed middle manager  $m_1(s)$  chooses  $a_s = (a_{s,1}, a_{s,2}, a_{s,3})$ , then this results in a payoff loss of  $\mu_1$  relative to first-best profits. Similarly, one can verify that delegating control over  $a_s$  to an informed worker  $m_2(s)$

results in a payoff loss of  $\mu_1 + \mu_2$  relative to first-best firm profits. Finally, from the perspective of an informed middle manager  $m_1(s)$ , who maximizes  $\pi_s + \pi_k$ , delegating  $a_s$  to an informed worker  $m_2(s)$  reduces divisional profits  $\pi_s + \pi_k$  by  $\mu_2$ .

Whenever an uninformed manager  $m_j(s)$  chooses  $a_s$  rather than an informed manager  $m_j(s)$ , then given the quadratic payoff specification, expected (firm or divisional) payoffs are reduced by  $\sigma^2 \equiv 3\sigma_\theta^2$ , where  $\sigma_\theta^2$  is the variance of  $\theta_s$ .

### 7.1.2 N hierarchical layers

The simple case above is readily extended to any number of organizational layers and managers. In an  $(N + 1)$ -level organization, each activity  $s \in S$  is associated with an  $(N + 1)$ -dimensional action  $a_s = (a_{s,0}, \dots, a_{s,N})$  and assigned (up) to  $N + 1$  managers  $m_j(s)$  with  $j \in \{0, 1, \dots, N\}$ . We denote by  $D_j(s) \subset S$  the sub-set of all activities which share the same level- $j$  manager as  $s$  and hence belong to the same level- $j$  division. By assumption,  $D_0(s) = S$  as all activities share the same top manager  $m_0$  and  $D_N(s) = \{s\}$  as the lowest level manager assigned only one activity.

Organizational profits are given by<sup>22</sup>

$$\sum_{s \in S} \left\{ \theta_s \cdot I \cdot a_s - \frac{1}{2} a_s \cdot a_s - \boldsymbol{\mu} \cdot a_s \right\}, \quad (6)$$

where  $I = (1, 1, \dots, 1)$  and  $\boldsymbol{\mu} = (\sqrt{\mu_0}, \sqrt{\mu_1}, \dots, \sqrt{\mu_N})$  with  $\mu_0 = 0$ . It is easy to verify that the first-best action  $a_s^* = (a_{s,0}^*, \dots, a_{s,N}^*)$  is characterized by  $a_{s,j}^* = \theta_s - \mu_j$ . The payoffs of each individual activity  $s$ , however, are such that manager  $m_j(s)$  chooses  $a_s$  as if  $\mu_k = 0$  for  $k \leq j$ . Concretely, the payoffs associated with each individual activity are given by

$$\pi_s(\theta_s, a) = \theta_s \cdot I \cdot a_s - \frac{1}{2} a_s \cdot a_s - \sum_{j=1}^N \left( \frac{1}{|D_{j-1}(s)| - |D_j(s)|} \sum_{t \in D_{j-1}(s) \setminus D_j(s)} \sqrt{\mu_j} a_{t,j} \right). \quad (7)$$

In expressions (6) and (7), the term  $\mu_j a_{t,j}$  is the aggregate externality imposed by activity  $t$  on all activities  $s$  that belong to the same level- $j$  division as  $t$  but not the same level- $(j + 1)$  division. It follows that total payoffs are still given by (6), but manager

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<sup>22</sup>To simplify notation, we drop the transponent in all vector expressions.

$m_j(s)$  chooses  $a_{s,k} = \theta_s$  for  $k \leq j$ , and  $a_{s,k} = \theta_s - \sqrt{\mu_j}$  for  $k > j$ .

The above payoff structure results in a tractable loss of control which increases linearly as decision-making moves down the hierarchy. In particular, if  $a_s$  is delegated to an informed manager  $m_j(s)$  then, fixing  $a_{-s}$ , expected profits equal

$$\Pi_{a_{-s}}(m_j) = \Pi_{a_{-s}}^* - \sum_{0 \leq k \leq j} \mu_k,$$

where  $\Pi_{a_{-s}}^*$  are first-best profits given action profile  $a_{-s}$ . If an uninformed manager  $m_j(s)$  chooses  $a_s$  then because of the quadratic payoff structure, this results in a expected payoff equal to  $\Pi_{a_{-s}}(m_j) - \sigma^2$ , where  $\sigma^2 \equiv N\sigma_\theta^2$ .

## 7.2 Appendix 2: Uniformly distributed decision rents

Consider the case where  $r_1$  and  $r_2$  are uniformly distributed on  $[0, R]$  with  $R < \sigma^2 = 1$ . The top manager delegates when uninformed if and only if  $r_0 \leq \bar{r}_0$  where

$$\begin{aligned} \bar{r}_0 &= 1 - 2\mu && \text{if } p_1 \leq \bar{p}_1 \text{ (and } h_1^* = 0) \\ \bar{r}_0 &= p_1 - \mu + (1 - p_1)(1 - \mu)^2/R && \text{if } p_1 \geq \bar{p}_1 > 0 \text{ (and } h_1^* = m_1 \in M) \\ \bar{r}_0 &= 1 - (2 - p_1)\mu && \text{if } R \leq 1 - \mu \text{ (and } \bar{p}_1 = 0) \end{aligned}$$

We distinguish two cases:

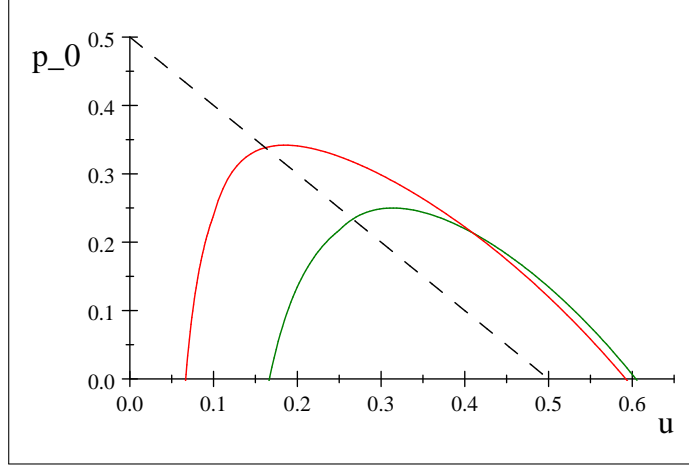
(1) If  $R < 1 - (2 - p_1)\mu$  both the top manager and the middle manager always delegate when uninformed,  $F(\bar{r}_0) = F(\bar{r}_1) = 1$ , so that

$$h^* = (m_0, m_1, m_2).$$

(2) In contrast, if  $R > 1 - (2 - p_1)\mu$ , we have that  $F(\bar{r}_0) < 1$  and

$$h_0^* \in M \iff p_0 \geq \bar{p}_0 \equiv \bar{r}_0 \frac{R - \bar{r}_0}{R - \bar{r}_0^2}. \quad (8)$$

Note that when  $1 - (2 - p_1)\mu < R < 1 - \mu$ , the middle manager always delegates when uninformed,  $F(\bar{r}_1) = 1$ , whereas the top manager hoards decision rights with positive probability,  $F(\bar{r}_0) < 1$ .



**Figure 8** – Assume  $r_i \sim U[0, R]$  and  $\sigma^2 = 1$ , then  $h_0^* = m_0 \in M \Leftrightarrow p_0 > \bar{p}_0$  as given by Proposition 8. Figure 8 plots  $\bar{p}_0$  as a function of  $\mu$  when  $p_1 = 1/2$ , and this for  $R = 0.9$  (red curve), and  $R = 0.75$  (green curve).  $h^* = (m_0, m_1, m_2)$  above the curve  $\bar{p}_0$ , whereas  $h^* = (0, m_1, m_2)$  below the curve.  $m_0$  is a better stand-alone decision-maker than  $m_1$  above the dashed black line, but there is still an area for which  $h_0^* \neq m_0$ .

Comparative statics other than  $p_0$  are ambiguous. Figure 5 (in the main text) and Figure 8 below illustrate the non-monotonic comparative statics with respect to  $\mu$  when  $p_1$  is such that  $h_1^* = m_1 \in M$ .

The top-manager is least likely to be valuable for intermediate values of  $\mu$ . Note that, unlike in standard delegation models (see, for example, Alonso, Dessein and Matouschek (2008)) for  $p_1$  small, an initial increase in externalities between activities, a characterized by an increase in  $\mu$ , results in a shift towards decentralization.

Beyond the impact of  $\mu$  and  $\sigma^2$ , also an increase in  $p_1$  – the presence of a more informed middle manager – has an ambiguous impact on whether the top manager is valuable. A more informed  $m_1$  increases both the the value  $\bar{r}_0$  of delegating the initial decision right to  $m_1$  and the probability  $F(\bar{r}_0)$  with which an uninformed top manager  $m_0$  will be delegating herself to  $m_1$ . This is also illustrated in Figure 8.

### 7.3 Appendix 3: Omitted proofs.

**Proposition 9.** Assume Conditions C1 and C2 hold, then  $h_0^* \in M \implies h_1^* \in M$ .

**Proof:** Without loss of generality, we normalize all parameters such that  $\sigma^2 = 1$ . If  $h_0^* \in$



$M$ , then from Proposition 8

$$p_0 \geq \bar{r}_0 \frac{1 - F(\bar{r}_0)}{1 - F(\bar{r}_0)\bar{r}_0} = \bar{r}_1 \frac{1 - F(\bar{r}_0)}{1 - F(\bar{r}_0)\bar{r}_0} - (\bar{r}_1 - \bar{r}_0) \frac{1 - F(\bar{r}_0)}{1 - F(\bar{r}_0)\bar{r}_0}$$

Recall that  $\bar{r}_1 \equiv \sigma^2 - \mu$  and

$$\bar{r}_0 = \max \left\{ \sigma^2 - 2\mu, \quad p_1 \sigma^2 - \mu + (1 - p_1) F(\sigma^2 - \mu)(\sigma^2 - \mu) \right\},$$

from which  $\bar{r}_1 - \bar{r}_0 \leq \mu$  and  $\bar{r}_0 < 1$ . It follows that

$$h_0^* \in M \implies p_0 > \bar{r}_1 \frac{1 - F(\bar{r}_0)}{1 - F(\bar{r}_0)\bar{r}_0} - \mu$$

Finally, we have that

$$\frac{\partial}{\partial r} \left( \frac{1 - F(r)}{1 - F(r)r} \right) < 0 \iff F(r)(1 - F(r)) - f(r)(1 - r) < 0$$

We have that  $F(r)(1 - F(r)) - f(r)(1 - r) = 0$  if  $r = 1$ . Moreover, for  $r \in (\bar{r}_0, 1)$

$$\frac{\partial}{\partial r} (F(r)(1 - F(r)) - f(r)(1 - r)) = 2f(r)(1 - F(r)) - f'(r)(1 - r) > 0$$

given condition C2. Since  $\bar{r}_0 < \bar{r}_1 < 1$ , it follows that

$$\frac{1 - F(\bar{r}_0)}{1 - F(\bar{r}_0)\bar{r}_0} > \frac{1 - F(\bar{r}_1)}{1 - F(\bar{r}_1)\bar{r}_1}$$

and

$$h_0^* \in M \implies p_0 > \bar{r}_1 \frac{1 - F(\bar{r}_1)}{1 - F(\bar{r}_1)\bar{r}_1} - \mu$$

So that if  $f'(\cdot) \leq 0$ , then whenever  $p_1 - \mu \geq p_0$ , we have that  $h_0^* \in M \implies h_1^* \in M$ . QED

**Proposition 12** *Assume decision rents  $r$  are deterministic and identical for all agents. Given a hierarchy  $h(s) = (0, \dots, 0, m_k, \dots, m_N)$  with  $k \geq 0$ , there exists a unique delegation equilibrium characterized by a set of cut-off values  $\bar{r}_k < \bar{r}_{k+1} < \dots < \bar{r}_{N-1}$  where an uninformed manager  $m_i(s)$  delegates to manager  $m_{i+1}(s)$  if and only if  $r < \bar{r}_i$ .*

**Proof:** Consider equilibria where manager  $m_i$  chooses  $a(s)$  or delegates to manager  $m_{i+1}$ . We will later verify that a manager  $m_i$  never has an incentive to delegate to manager  $m_{i+k}$  with  $k \geq 2$ .

Note first that fixing  $r$ , every manager  $m_i$  has a unique value of delegation  $\bar{r}_i(r)$  where she delegates if and only if  $r < \bar{r}_i(r)$ . There are no multiple equilibria. To see this, note that for manager  $m_i$  the value of delegation only depends on the delegation thresholds  $\bar{r}_j(r)$  of the managers  $j > i$ . Moreover, manager  $m_{N-1}$  has a unique value of delegation  $\bar{r}_{N-1}(r) = \bar{r}_{N-1}$  as her delegation decision is independent of the delegation decisions of any other manager. But this implies that, fixing  $r$ , there manager  $m_{N-2}$  also has unique delegation threshold  $\bar{r}_{N-2}(r)$ . By backward induction, the same is true for manager  $m_{N-3}$  and so on. We conclude that for each  $r$ , there exists a unique vector  $(\bar{r}_k(r), \bar{r}_{k+1}(r), \dots, \bar{r}_{N-1})$  such that manager  $m_i(s)$  delegates to manager  $m_{i+1}(s)$  if and only if  $r < \bar{r}_i(r)$ .<sup>23</sup>

Let us now define  $\tilde{r}_i$  as manager  $m_i$ 's delegation cut-off for  $r$  provided that all managers  $j > i$  delegate when uninformed. Since such delegation is efficient (Assumption A1-G), it must be that  $\bar{r}_i(r) \leq \tilde{r}_i$  and

$$\bar{r}_i(r) = \tilde{r}_i \Leftrightarrow r \leq \tilde{r}_j \text{ for all } j > i.$$

It follows that if

$$\tilde{r}_0 < \tilde{r}_1 < \dots < \tilde{r}_{N-1}, \tag{9}$$

then  $\bar{r}_i(r) = \tilde{r}_i$  if  $r < \tilde{r}_i$  and  $\bar{r}_i(r) \leq \tilde{r}_i$  if  $r > \tilde{r}_i$ . Hence, if (9) holds, every manager  $m_i(s)$  delegates when uninformed if and only if

$$r < \bar{r}_i = \tilde{r}_i.$$

In order to prove Proposition 12, we thus only need to show that (9) holds.

At the bottom of the hierarchy, an uninformed  $m_{N-1}$  delegates to  $m_N$  if and only if

$$r < \tilde{r}_{N-1} = \sigma^2 - \mu.$$

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<sup>23</sup>The same argument applies if manager  $m_i$  can delegate to any manager  $j > i$ .

One level up, provided  $m_{N-1}$  delegates when uninformed, an uninformed  $m_{N-2}$  delegates to  $m_{N-1}$  if and only if  $r < \tilde{r}_{N-2}$  where

$$\begin{aligned}\tilde{r}_{N-2} &= p_{N-1}(\sigma^2 - \mu) + (1 - p_{N-1})(\sigma^2 - 2\mu) \\ &= p_{N-1}(\sigma^2 - \mu) + (1 - p_{N-1})(\tilde{r}_{N-2} - \mu).\end{aligned}$$

More generally, provided all managers  $j \geq i$  delegate when uninformed, an uninformed  $m_{i-1}$  delegates to  $m_i$  if and only if  $r < \tilde{r}_{i-1}$  where

$$\tilde{r}_{i-1} = p_i(\sigma^2 - \mu) + (1 - p_i)(\tilde{r}_i - \mu).$$

Since

$$\tilde{r}_i = p_{i+1}(\sigma^2 - \mu) + (1 - p_{i+1})(\tilde{r}_{i+1} - \mu),$$

and since  $p_i \leq p_{i+1}$ , it follows that  $\bar{r}_i < \bar{r}_{i+1} \implies \tilde{r}_{i-1} < \bar{r}_i$ . As one can easily verify that  $\tilde{r}_{N-2} < \tilde{r}_{N-1}$ , we obtain (9):

$$\tilde{r}_0 < \tilde{r}_1 < \dots < \tilde{r}_{N-1}.$$

To conclude we verify that given (9), manager  $m_i$  strictly prefers to delegate to manager  $m_{i+1}$  rather than to any manager  $m_{i+k}$  with  $k \geq 2$  whenever  $r \leq \tilde{r}_i$ . Consider the trade-off between delegating to manager  $m_{i+1}$  versus manager  $m_{i+2}$  (the argument is easily extended to any manager  $m_{i+k}$ ). If informed, manager  $m_{i+1}$  will choose a better action than manager  $m_{i+2}$  (i.e. an action yielding a higher pay-off to  $m_i$ ). If uninformed, manager  $m_{i+1}$  will delegate to manager  $m_{i+2}$  given that  $r \leq \tilde{r}_i < \tilde{r}_{i+1}$ . It follows that manager  $m_i$  never gains, and sometimes loses by directly delegating to manager  $m_{i+2}$ . Skip-level delegation is never optimal. QED

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