Delegating a Risky Project to a Risk-Averse Agent

Andreas Roider*
University of Bonn, IZA, and CEPR

December 2006

Abstract

This paper studies how the underlying riskiness of projects affects a principal's decision to delegate authority to a risk-averse agent. We consider a partial-contracting model, where the agent may invest before a certain project has to be selected and where there is a risk-return trade-off: projects promising a higher expected return are more risky. We find that for low values of exogenous risk the risk-neutral principal retains control. However, if risk is sufficiently large, it is strictly optimal to delegate authority to the risk-averse agent, i.e., there is a positive relationship between exogenous risk and delegation. Furthermore, even endogenous risk might be higher when the agent has authority.

Keywords: delegation, authority, partial contracting, risk, project selection.
JEL-Classification: D86, D21, D23, G34, L14.

---

*Mailing address: University of Bonn, Wirtschaftspolitische Abteilung, Adenauerallee 24-42, 53113 Bonn, Germany; roider@uni-bonn.de. I would like to thank Hans Hvide, Gerd Muehlheusser, Patrick Schmitz, and Stefan Reichelstein for helpful discussions. The hospitality of Stanford Graduate School of Business, where part of this research was conducted, is gratefully acknowledged. I would also like to thank the German Science Foundation for financial support through SFB/TR 15 "Governance and the Efficiency of Economic Systems" and through a research fellowship.

1 Introduction

Motivation This paper studies the role of risk in a partial-contracting model in which a principal decides whether to delegate authority over decision-making to an agent. The agent is needed to provide some effort before some decisions have to be made later on. Perhaps surprisingly, we find that, for sufficiently low levels of exogenous risk, the risk-neutral principal should retain control over decisions. However, for sufficiently large levels of exogenous risk it is strictly optimal to delegate authority to the risk-averse agent, i.e., there is a positive relationship between risk and delegation: a relationship that is indeed frequently observed in practice. Central to our model is the idea that by dictating the decision the principal imposes risk on the agent; thereby reducing his effort incentives.

To illustrate what we have in mind consider a historic example discussed in their textbook by Milgrom and Roberts (1992) and more recently by Roberts (2004) who use it to highlight the importance of organizational design for firm performance: the Hudson's Bay Company case. In 1670, Hudson's Bay Company (henceforth, HBC) was granted a royal monopoly for trade with all lands draining into the Hudson Bay. Having approximately fifteen times the size of the UK, at that time Hudson Bay was a trackless wilderness sparsely populated by some aboriginal people, but rich in animal fur, which was in high demand in Europe. Fur trade was HBC's main business. HBC had set up half a dozen forts on the shores of Hudson Bay waiting for customers seeking European-made goods in exchange for their furs. In the course, it amassed huge profits. Then, in 1779 the North West Company of Montreal (henceforth, NWC) entered the market, but initially this did not seem to be a threat because NWC faced a huge cost disadvantage. Due to HBC's royal monopoly, NWC could not ship goods through Hudson Bay. Instead, it was forced to first transport goods and furs over land to Montreal; resulting in costs twice as high as HBC's. Nevertheless, by 1809 NWC had an 80% market share, was immensely profitable, and HBC was near bankruptcy.

How did this come about? To this end, it is important to note that, while being in the same business, HBC's and NWC's organizational design differed markedly. In the case of HBC, decision-making (for example, on prices and on how business was to be conducted) was centralized in headquarters in London.[1] Moreover, given the geography and climate of Hudson Bay, there was only very limited possibility for communication between local

[1] This form of governance was meant to counter the perceived danger of its (far away) employees frittering away or misappropriating profits.

employees and London: ships were able to bring in goods (and new instructions) from Europe only once a year. This lack of flexibility to conduct business as they saw fit stifled the local employees' initiative to trade with people far from the bay: given the wilderness and the uncertainties of demand and supply, such trade involved huge risks. In contrast to HBC's approach, NWC had erected dozens of trading posts inland right where the furs where collected. In addition, decision-making was delegated to local "Nor'Westers"; thereby giving them the opportunity to better adjust to the perceived risks and giving them an incentive to actually go to the remote areas.

Initially, HBC was slow to react to NWC's challenge, but eventually it simply copied NWC's organizational design and - given its cost advantage - by 1820 had absorbed NWC through a merger. Hence, the Hudson's Bay Company case illustrates that in risky environments, for the sake of initiative (and ultimately, profitability), it might be optimal to allow agents to reduce their risk exposure through delegating authority to them.

At a more systematic (and more recent) level, while delegation data are frequently difficult to obtain, various econometric studies have also uncovered a positive relationship between risk and the incidence of delegation of authority. For example, Nagar (2002) documents that high-growth, volatile, and innovative retail banks delegate more authority to branch managers. Lafontaine (1992) considers the decision of franchisors to either directly operate a given store (i.e., to keep it company-owned) or to franchise it, where a franchisees has considerably greater autonomy in terms of decision-making. Looking at a variety of industries (such as fast-food restaurants, business aids and services, construction and maintenance, and nonfood retailing), she finds that the higher is risk (measured by the average proportion of discontinued outlets), the more likely is a given store to be franchised.[2] Finally, in a similar spirit, looking at three large datasets of French and British firms, Acemoglu, Aghion, Lelarge, VanReenen, and Zilibotti (2006) find that firms that face greater uncertainty (i.e., firms that are closer to the technological frontier, firms in more heterogenous environments, and younger firms) are more likely to decentralize decision-making.

Framework We study a model that is meant to formalize our main idea spelled out above in the simplest possible fashion. A risk-neutral principal has to rely on a risk-averse agent to conduct some project. The agent (and only the agent) may provide some (unobservable)

[2]For a survey of empirical studies on franchising with similar results, see e.g., Lafontaine and Bhattacharyya (1995).

effort before some allocative decision (e.g., project choice) is taken. Only then uncertainty relating to the state of the world is resolved and the payoffs of the parties are realized. The decision may be made by either the principal or the agent; the central question of the model being under which circumstances the principal does find it optimal to delegate authority over the decision to the agent. Besides the effort level, all variables are observable to the parties. In line with the literature on partial contracting (see e.g., Aghion, Dewatripont, and Rey, 2002), we assume that only control over the decision (but not the decision itself) is contractible.[3] All other variables (in particular, the payoffs of the parties) are not verifiable, and hence not contractible.[4] To focus on the effect of risk and risk attitudes on the delegation decision, we assume that, for a given effort level and a given decision, the parties obtain identical private benefits from the project (where the agent evaluates his payoff with a concave utility function).

Results and intuition Our results are as follows. First, we show that the risk-neutral principal is more likely to delegate decision-making to the risk-averse agent, the higher the level of exogenous risk (respectively, the more risk-averse the agent is). Second, hence, we provide a rationale for allowing the agent to choose risk-reducing measures: while he may select a less ambitious project, given that he has authority he shows more initiative. Third, it turns out that not only exogenous risk but also the endogenously determined equilibrium project risk (measured by the variance of the project return) might be higher in settings where it is optimal to grant authority to the risk-averse agent. In general, however, there is an ambiguous relationship between equilibrium project risk and the incidence of delegation. Finally, we show that the above results continue to hold if, in addition, the agent is wealth-constrained.

[3] For example, given the remoteness of Hudson Bay from civilization, it is doubtfully whether headquarters could have credibly committed to certain decisions.

[4] The assumption that the payoffs of the parties are not contractible mainly serves to simplify the analysis. In particular, it renders profit-sharing infeasible. Interestingly, in his study of the banking sector, Nagar (2002) reports that the extent of incentive compensation plays no significant role in explaining the extent of delegation. In a similar spirit, Lafontaine (1992) makes two interesting observations. First, she finds that franchisors react to differences in risk by relying on franchising to varying degrees rather than by adjusting the contract terms (i.e., the lump-sum franchise fee and the royalty rate (as proportion of sales) that franchisees are required to pay). Second, at a given point in time both the franchise fee and the royalty rate do not seem to vary across potential franchisees. Moreover, Lafontaine and Shaw (1999) find that for a given firm, both the franchise fee and the royalty rate are very persistent over time: for example, in their sample 58% of the firms observed two consecutive years or more never change their royalty rate. Hence, at least in the franchising context, delegation respectively company-ownership seem to be the primary way to adjust to differences in risk.

The remainder of the paper is structured as follows. In Section 2, we discuss the related literature. The model is introduced in Section 3, and Section 4 contains our main results. In Section 5, we show that our results generalize to the case of a wealth-constrained agent. Section 6 concludes. All proofs are relegated to an appendix in Section 7.

2 Relation to the Literature

The present paper is part of the large literature on delegation (for recent surveys, see e.g., Mookherjee, 2006; Poitevin; 2000). First, in terms of methodology our paper builds on the emerging partial-contracting approach to delegation (see e.g., Aghion, Dewatripont, and Rey, 2002, 2004). By focussing on settings where only control over decisions, but not the decisions themselves, are contractible (or at least transferable), this literature is able to discuss control structures in a simple, consistent way; avoiding the foundational problems that the earlier incomplete-contracting literature has encountered (see e.g., Grossman and Hart, 1986; Tirole, 1999). Somewhat surprisingly, while in many real-world settings it will be the case that a risk-neutral principal and a risk-averse agent interact, the partial-contracting literature has not studied the role of risk and risk attitudes on optimal assignments of authority. The present paper represents a step in filling this gap.[5] Thereby, we incorporate ideas from the literature on project selection into a partial-contracting framework. The literature on project selection has extended the standard moral-hazard framework by allowing for the possibility that after effort provision some allocative decisions have to be made. As in the present paper, it is common in this literature to allow for a risk-return trade-off (see e.g., Hirshleifer and Suh, 1992; Demski and Dye, 1999; Core and Qian, 2002).[6] However, in terms of both assumptions and questions the present paper differs substantially from the literature on project selection, which mainly aims to derive optimal incentive contracts under the assumption of verifiable signals of the project return. Importantly, delegation is in general not an issue in this literature as it is assumed that it is always the agent who selects the project.[7]

Second, our paper is part of the strand of the delegation literature that explains delegation

[5] Note that our model also deviates in other ways from the partial-contracting literature. For example, this literature frequently assumes that there is incomplete information over players' types and that decisions have to be taken at the beginning of the game.

[6] While these papers assume that the principal is risk-neutral, Ou-Yang (2003) extends Holmstrom and Milgrom (1987) by considering a risk-averse agent who also controls the diffusion rate (see also Sung, 1995).

[7] For an exception, see Dutta and Reichelstein (2002).

through its function as a commitment device. As has already been pointed out by Schelling (1960), for a principal it might be beneficial to delegate authority to an agent who credibly behaves differently than the principal would. Thereby, the principal might be able to reduce time-consistency problems (where she prefers some behavior ex-ante, to which she, however, cannot commit ex-post). On the one hand, such delegation might be beneficial for strategic reasons (i.e., it might improve the principal's position in interactions with third parties).[8] On the other hand, like in the present paper, in Aghion and Tirole (1997) delegation might be optimal because it convinces *the agent* that the principal will not interfere ex-post; thereby raising the agent's incentives ex-ante.[9] While Aghion and Tirole (1997) consider a similar sequence of events,[10] they study a problem of information acquisition, where both a principal and an agent may acquire information before a project is selected. Moreover, in contrast to the present paper, they assume that projects are indistinguishable ex-ante, and they also do not study the effect of project risk on the decision to delegate authority.

Third, some earlier work has shown that a positive relationship between risk and the incidence of delegation might arise. This literature, however, is mainly motivated by the puzzling empirical finding of a positive relationship between risk and pay for performance incentives: standard principal-agent theory would predict exactly the opposite, i.e., a negative risk-incentive trade-off. To explain this puzzle, various authors have extended the standard principal-agent framework by explicitly allowing for the possibility of delegation of authority (see e.g., Prendergast, 2002; Bester, 2003).[11] However, these papers differ in important ways from the present paper. For example, it is generally assumed that verifiable signals of profit are available, and a positive risk-delegation relationship emerges through the interplay of the optimal extent of profit sharing and delegation. For example, in Prendergast (2002) an agent has to specialize in one out of many tasks and subsequently chooses a variable effort. In contrast to the present paper, the agent is assumed to be risk-neutral,

[8] This has, for example, been illustrated by Melumad and Mookherjee (1989) for the case of a government wishing to conduct tax audits and by Vickers (1985) and Fershtman and Judd (1987) for the case of a firm competing in an oligopoly. While in these papers the difference in behavior is induced by the appropriate choice of an incentive contract for the agent, as in the present paper other authors have shown that it might be optimal to delegate authority to an agent whose exogenously given preferences differ from those of the principal (see e.g., Rogoff, 1985, and Sappington, 1986, in the contexts of monetary policy and regulation, respectively).

[9] See also Burkart, Gromb, and Panunzi (1997).

[10] The same holds true for Dewatripont and Tirole (1994), Legros and Newman (2004), and Hart and Moore (2005). However, these papers differ in other important aspects from the present paper.

[11] A positive relationship between risk and pay for performance might also emerge through other channels (see e.g., Guo and Ou-Yang, 2006; Baker and Jorgensen, 2003; Raith, 2003; Core and Qian, 2002).

he has private information about the riskiness of output, and costly input and output monitoring by the principal are feasible. Prendergast (2002) shows that the principal prefers to retain control if risk is low (i.e., it is rather clear what the right task is), in which case the principal will ensure that the agent focuses on the desired task through input monitoring. On the other hand, if risk is high (i.e., if it is unclear what the right task is), it is better for the principal to delegate to the better informed agent and to motivate him through pay-for-performance. In a similar vein, in Bester (2003) a principal decides both on the optimal allocation of authority and an optimal incentive contract.[12] His main interest is not in the role of risk (the riskiness of the project return is exogenous in his model), but in the role of externalities that are caused by a certain allocation of authority. Similar to the present paper Bester (2003) assumes that larger projects (which are preferred by the principal) impose higher (exogenously given) cost on the agent. In the present paper such "costs" arise through the risk-return trade-off in project choice. Under special circumstances a positive relationship between exogenous risk and delegation may emerge in Bester's (2003) model.[13]

Finally, it has frequently been argued that allowing (risk-averse) managers to reduce risk is not in the interest of (presumably well-diversified) shareholders because this might lead managers to turn down projects that, while being profitable, might be perceived as too risky by managers. Similarly, it has been argued that conglomerate mergers (which frequently have turned out to be unprofitable) might be initiated by managers concerned about reducing their undiversifiable "employment risk". For empirical evidence on these issues, see e.g., May (1995) and Amihud and Lev (1981). In contrast, in the present paper delegating authority to the agent (and thereby allowing him to select the low-risk project he prefers) provides the agent with larger incentives to expend effort ex-ante, which might be desirable from the principal's perspective.[14]

[12]The effort choice is made after some project has been selected.

[13]In particular, he considers a setting where both the project choice and the effort choice are binary, and where some additional assumptions are met. Bester (2003) also considers a simplified version of his model, where the agent's effort choice is absent. In this setting a negative relationship between the risk and delegation obtains. See also Bester (2005), who also abstracts from an effort choice and additionally rules out incentive contracts. However, the main interest of this paper is in the role of asymmetric information in determining an optimal allocation of authority.

[14]For other papers that show that allowing the agent to reduce risk might be beneficial, see e.g., DeMarzo and Duffie (1995). They consider a model where an agent might engage in financial hedging, which results in profits that are more informative of project quality; thereby allowing better termination decisions by the principal.

3 The Model

A risk-neutral principal P and a risk-averse agent A to conduct some project. We consider the following sequence of events, which is illustrated in Figure 1.

At date 0 the principal (she) offers the agent (he) a contract. Which contracts are feasible is explained in more detail below. At date 1 the agent may provide some unobservable effort $e \geq 0$, where, for simplicity, the disutility from effort is given by $\frac{1}{2}e^2$. At date 2 some decision $x \in [0,1]$ (e.g., project choice) has to be taken. In the following, we will equivalently speak of x as the decision respectively the project choice. While only A is able to provide effort, we assume that the decision can in principle be taken by either party. Finally, at date 3 uncertainty is resolved, i.e., a random variable u is realized.

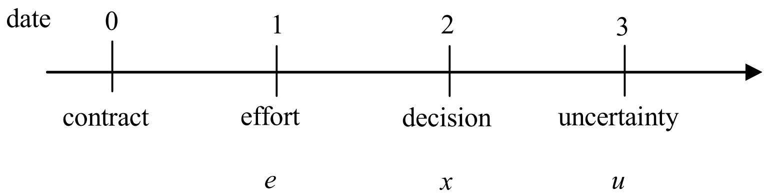

Figure 1: Sequence of events

Information and contracts In line with the literature on partial contracting we assume that neither the decision nor the payoffs of the parties (to be specified below) are verifiable, but that *control* over the decision is contractible. That is, the principal P (who has control over the decision initially) may decide to transfer the authority to choose x to the agent A. Hence, initial contracts take the form $C = [t, j]$, where t denotes a transfer payment form A to P, and where $j = A, P$ denotes which of the parties has authority over the decision.

Payoffs of the parties In the following, we explain our assumptions with respect to the payoffs that the parties derive from conducting some project.

First, as laid out in the introduction, we are interested in how the underlying riskiness of projects influences the decision of the principal to delegate authority to the agent. In order to focus on the role of risk (and to rule out other conflicts of interest between the parties), we assume that, for given e, x, and u, the risk-neutral principal and the risk-averse agent derive identical private benefits (the "project return") from conducting a certain project and that they only differ in their risk attitudes.[15] Second, in many settings A's incentives to exert effort will depend on which project will be conducted later on, and consequently, we assume that both the return to A's effort and its riskiness depend on the choice of x. If A's return to effort were independent of x, the principal would never find it optimal to delegate authority to the agent. Finally, we assume that there is a risk-return trade-off: a larger project (i.e., a higher x) yields a higher expected return, but at the same time renders the project return more risky (i.e., increases its variance).

Formally, the private benefit that each of the parties derives is given by $e \cdot (x + u)$.[16] One possible interpretation of this payoff structure is that e determines the "scale" of the project: for example, a given project x may be conducted in more than one market or region. Under this interpretation, a larger e corresponds to a higher number of markets where for analytical convenience e is assumed to be continuous.[17] We assume that $u \sim N(0, x^\gamma \cdot r)$, where the parameter $r > 0$ will serve as our measure of exogenous risk: the larger r, the more risky is the project return. The parameter $\gamma > 1$ parametrizes the degree of the risk-return trade-off: the larger γ, the larger the risk associated with a given project x.

As P is risk-neutral the above discussion implies that her expected payoff from the project (gross of the transfer payment) is given by

$$\pi(e, x) \equiv E[e \cdot (x + u)] = e \cdot x. \tag{1}$$

As the agent is risk-averse, he is not interested in the expected value, but the expected utility of the project return $e \cdot (x + u)$. In the following, we aim to derive conditions under which the principal prefers to delegate authority to the agent (which requires to solve for x and e both if P has authority and if A has authority). Hence, in line with much of the literature on the principal-agent problem for tractability we assume that A has exponential utility with constant absolute risk aversion $\rho > 0$, which allows to obtain closed-form solutions. Consequently, A's utility can be represented by its certainty equivalent, which (net of effort costs, but gross of the transfer payment) is given by

$$a(e, x) \equiv [e \cdot x - \frac{1}{2} \cdot \rho \cdot e^2 \cdot x^\gamma \cdot r] - \frac{1}{2} e^2. \tag{2}$$

[15] In particular, this implies that, if the projects would not differ in their riskiness, the agent would select the same project as the principal.

[16] For papers that consider a similar payoff structure (where effort and uncertainty interact multiplicatively), see e.g., Guo and Ou-Yang (2006), Baker and Jorgensen (2003), and Sung (1995).

[17] Hence, while ceteris paribus a higher e raises the project return, it also makes it more risky. Moreover, given sufficiently negative realizations of u, being active in more markets (i.e., a larger e) might lead to a lower (i.e., more negative) project return.

The reservation utility of A is assumed to be equal to zero.

4 Delegation of Project Choice

When deciding about which contract to offer to the agent (in particular, whether to delegate authority), the principal aims to maximizes his expected payoff subject to the participation constraint of the agent. Intuitively, because the principal cannot commit not to behave opportunistically at the decision stage (i.e., not to select the most risky project), she faces the following trade-off. On the one hand, if the principal has authority (*P-control*), she will select a large x promising her a high expected return. However, as the (risk-averse) agent anticipates that, as a consequence, his payoff will be relatively risky, his incentive to provide effort will be low. On the other hand, if the agent is granted authority (*A-control*), he may find it optimal to choose a project that, while promising only a moderate return, at the same time exposes him to less risk. As a consequence, while under A-control the agent may distort the decision (relative to the preferred decision of the principal), this will leave him with higher effort incentives than under P-control.

In particular, in the following we show that for large enough levels of exogenous risk r, it is optimal to delegate authority to the risk-averse agent. To do so, we consider P-control and A-control in turn. In a first step, we derive the equilibrium decisions $x^j(e)$ and effort choices e^j given j-control, where $j = P, A$. This immediately allows to determine the optimal transfer payments t^j, where the principal will always set the (fixed) transfer payment such that the agent is left with his reservation utility of zero, i.e., given j-control, we have

$$t^j = a(e^j, x^j(e^j)) \tag{3}$$

for $j = P, A$. Note that $t^j \geq 0$ (because A always has the option to choose $e = 0$), which may be interpreted as that by paying t^j ex-ante the agent acquires the right to participate in the project. In a second step, we compare the principal's payoff under each of the two regimes.

***P*-control** First, consider the case that P retains authority over the decision. In this case, it follows from (1) that at date 2 the principal will always choose the largest project (i.e., $x^P(e) = 1$ for all $e > 0$). Anticipating that the principal will aim for the most risky project, it follows from (2) that the agent selects his effort level such that

$$e^P = \arg\max_e \ \{a(e,1)\} = \frac{1}{1+\rho r}, \tag{4}$$

where A's effort level e^P is decreasing in exogenous risk r. These results are summarized in the following lemma.

Lemma 1 (equilibrium outcome under P-control) *Suppose the principal has authority. In this case, she selects the most risky project (i.e., $x^P(e^P) = 1$), and the agent anticipating this selects an effort level given by $e^P = \frac{1}{1+\rho r}$.*

***A*-control** Now suppose that the principal has decided to delegate authority over project selection to the risk-averse agent. This implies that at date 2 the agent will select a project that maximizes the certainty equivalent (2), and hence he may deviate from the project preferred by the principal. In particular, depending on the effort level e he will select a project $x^A(e)$ such that

$$x^A(e) \in \arg\max_x \ \{a(e,x)\}, \tag{5}$$

where it follows from (2) that the respective first-order condition is given by

$$e - \frac{1}{2} \cdot \rho \cdot e^2 \cdot \gamma \cdot x^{\gamma-1} \cdot r = 0. \tag{6}$$

Inspecting (6) reveals that A's disutility from implementing a more risky project is the larger, the larger his effort level e. Intuitively, the larger his (earlier) effort, the more is the agent inclined to insure himself later on by selecting a less risky project. Consequently, there exists a threshold level such that for sufficiently low effort levels the implied risk is sufficiently small, such that (just as the principal) A prefers to conduct the most risky project $x = 1$. In particular, (6) implies that this is the case if $1 - \frac{1}{2} \cdot \rho \cdot e \cdot \gamma \cdot r \geq 0$ holds. However, for levels of e sufficiently large, A finds it optimal to distort x downwards in order to reduce his risk-exposure. This discussion immediately implies the following result.[18]

Lemma 2 (project choice under A-control) *Suppose the agent has authority. For sufficiently low levels of effort, the agent makes the same project decision as the principal. However, given sufficiently large effort levels, the agent prefers to downward distort the project choice. Formally, for $e > \widehat{e}$ we have $x^A(e) = \sqrt[\gamma-1]{\frac{\widehat{e}}{e}} < 1$ and $x^A_e(e) < 0$, and $x^A(e) = 1$ otherwise, where $\widehat{e} \equiv \frac{2}{\gamma \rho r}$.*

[18] Throughout subscripts denote partial derivatives.

Let us now turn to the agent's effort choice at date 1, which solves

$$e^A \in \arg\max_e \left\{a(e, x^A(e))\right\}. \tag{7}$$

Lemma 2 raises the question under which circumstances the agent will indeed find it optimal to choose an effort level sufficiently large to imply a subsequent downward distortion of the project choice. Only in this case A-control and P-control will lead to different equilibrium outcomes.

Intuitively, if the risk-return trade-off is relatively weak (i.e., if an increase in the expected project return is only accompanied by a moderate rise in its riskiness), the ex-post incentives of the agent and the principal will be aligned: just as the principal, the agent will prefer to select the project promising the highest expected return. Now suppose that the risk-return trade-off is sufficiently pronounced (i.e., assume that γ is sufficiently large). First, if the level of exogenous risk r is relatively low, the threshold value $\widehat{e}$ is relatively large (see Lemma 2). In this case, a rather high effort level is required to make a downward distortion of the project choice desirable for the agent. As effort costs are convex, choosing such a high effort level will not be optimal for A, and as a consequence A-control will lead to the same equilibrium outcome as P-control. Second, if, however, r is relatively large, $\widehat{e}$ will be small. In this case, the agent will find an effort level above $\widehat{e}$ profitable, and A-control will lead to a different outcome than P-control: the agent chooses a project smaller and an effort level higher than what would have resulted had P retained authority over project choice.

Lemma 3 (equilibrium outcome under A-control) *Suppose the agent has authority. If the risk-return trade-off is sufficiently pronounced and exogenous risk is sufficiently large, then, compared to P-control, equilibrium effort is larger, but the equilibrium project is smaller. Formally,*

i) if $\gamma > 2$ and $r > \widehat{r}$, then $e^A > e^P$ and $x^A(e^A) < x^P(e^P)$, where $e^A = \left(\frac{\gamma-2}{\gamma}\right)\left(\frac{\widehat{e}\gamma}{\gamma-2}\right)^{\frac{1}{\gamma}}$ and $\widehat{r} \equiv \frac{2}{\rho(\gamma-2)}$,

ii) otherwise, we have $e^A = e^P$ and $x^A(e^A) = x^P(e^P) = 1$.

Proof. See the Appendix. ■

Hence, Lemma 3 implies that if $\gamma > 2$ and $r > \widehat{r}$ hold, the equilibrium project choices and effort levels under P-control and A-control differ (i.e., only in such cases there is an *ex-post conflict of interest* between P and A).

Optimal allocation of control Having derived the equilibrium effort levels and project choices under both P-control and A-control, we are now able to investigate under which circumstances the principal finds it optimal to delegate authority to the risk-averse agent.[19] P will delegate authority to A whenever she obtains a higher total payoff from doing so, i.e., if and only if

$$\pi(e^A, x^A(e^A)) + t^A > \pi(e^P, x^P(e^P)) + t^P, \tag{8}$$

which, by Lemma 3 and (3), can only be the case if there is an ex-post conflict of interest between the parties.

Indeed, in the following we show that *whenever* there is such a conflict, the principal prefers to delegate authority to the agent. To see this, first note that in this case we have $t^A = a(e^A, x^A(e^A)) > a(e^P, x^P(e^P)) = t^P$ because under A-control the agent chooses both e and x, and hence under this regime his equilibrium utility (gross of the transfer payment) is higher than under P-control. Second, it turns out that, despite the fact that a smaller project is selected under A-control, the increase in effort is sufficiently large such that also the expected return of the project goes up, i.e., $\pi(e^A, x^A(e^A)) > \pi(e^P, x^P(e^P))$ holds.

Proposition 1 (optimal allocation of control) *If the risk-return trade-off is sufficiently pronounced, then for sufficiently high levels of exogenous risk the risk-neutral principal finds it strictly optimal to delegate project choice to the risk-averse agent. Otherwise, the principal retains control. Formally, A-control is strictly optimal if both $\gamma > 2$ and $r > \widehat{r}$ hold.*

Proof. See the Appendix. ■

Finally, the threshold value $\widehat{r}$ (beyond which A-control is optimal) is a decreasing function of both the agent's degree of risk aversion ρ and the degree γ of the risk-return trade-off.

Equilibrium project risk Proposition 1 identifies conditions under which there is a positive relationship between exogenous risk and a transfer of control to the agent: only if exogenous risk is sufficiently high, the risk-averse agent receives control. While this relationship is clear-cut, in equilibrium the agent responds to exogenous risk through a certain choice of project and effort level. Consequently, the *equilibrium* riskiness of the project (i.e., the equilibrium variance of the project return) is endogenous.

[19] We assume that if the principal is indifferent, she retains control. For example, assume that she derives some (arbitrarily small) private benefit of control (that is independent of both e and x).

In the following, we investigate how the equilibrium variance of the project return varies with exogenous risk (and hence, with the incidence of delegation). The equilibrium variance of the project return is given by

$$V^* \equiv Var(e^j \cdot (x^j(e^j) + u)) = Var(e^j \cdot u) = (e^j)^2 \cdot x^j(e^j)^\gamma \cdot r, \tag{9}$$

where $j = A$ if $\gamma > 2$ and $r > \widehat{r}$, and $j = P$ otherwise.

Suppose that $\gamma > 2$ such that it indeed depends on the level of exogenous risk which allocation of control is optimal. In the following, we will show that there is a hump-shaped relationship between exogenous risk r and the equilibrium variance of the project return.

First, consider sufficiently low levels of r such that P-control is optimal. As in this parameter range we have $x^P(e) = 1$ for all $e > 0$, it follows that $V^* = (e^P)^2 \cdot r$. Hence, while an increase in r has a direct positive effect on V^*, at the same time, indirectly, larger values of r lead the agent to reduce his effort level (see Lemma 3), which reduces the equilibrium variance of the project return. As we will show below, for low levels of r the former effect dominates, and endogenous risk is increasing in r. However, for sufficiently high values of r the reduction in the effort level is sufficiently pronounced to lead to a negative relationship between r and endogenous risk.

Second, consider sufficiently high levels of r such that A-control is optimal; implying that $V^* = (e^A)^2 \cdot x^A(e^A)^\gamma \cdot r$. As it turns out, in this parameter range the equilibrium variance of the project return is a decreasing function of the level of exogenous risk. Intuitively, note that the agent's equilibrium choice of x is decreasing in the level of exogenous risk. In particular, given the equilibrium effort level, the agent reacts to larger levels of r by reducing x such that $x^A(e^A)^\gamma \cdot r$ remains constant. This observation in combination with the fact that the equilibrium effort level is decreasing in r implies the result. The above discussion is summarized in Proposition 2 and illustrated in Figure 2.

Proposition 2 (equilibrium variance of the project return) *Suppose* $\gamma > 2$. *The equilibrium variance of the project return is a hump-shaped function of exogenous risk. In particular, this implies that, while exogenous risk is larger under A-control, the relationship between endogenous risk under P-control and A-control is ambiguous. Formally,* $V_r^* > 0$ *for all* $r < \min\{\frac{1}{\rho}, \widehat{r}\}$, *and* $V_r^* < 0$ *for all* $r > \min\{\frac{1}{\rho}, \widehat{r}\}$, *where* V^* *is a continuous function of* r *and where* $\frac{1}{\rho} \leq \widehat{r}$ *if and only if* $\gamma \leq 4$.

Proof. See the Appendix. ■

Interestingly, while Proposition 1 implies that in situations with larger exogenous risk it is more likely that authority is delegated to the risk-averse agent, Proposition 2 shows that an analogous positive relationship might exist with respect to endogenous risk and the incidence of delegation. It might very well be the case that (as illustrated by points x and y in Figure 2) the observed variance of the project return is larger in cases where A has authority than in cases where the risk-neutral principal retains control.

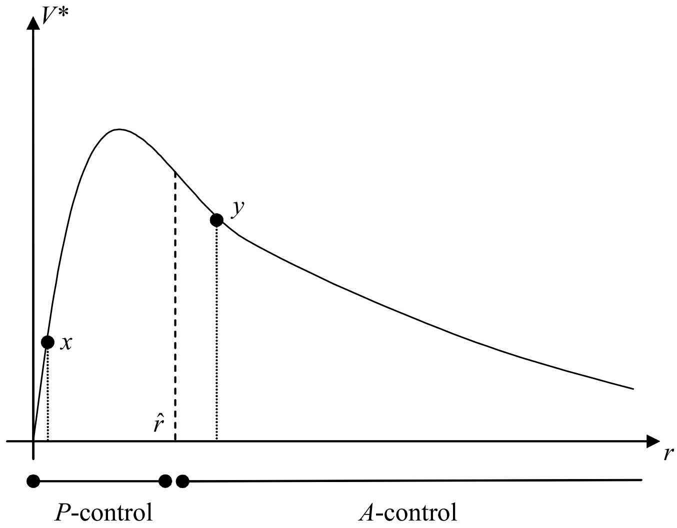

Figure 2: Equilibrium variance of the project return.

5 Extension: A Wealth-Constrained Agent

Sofar, we have assumed that the agent has sufficient wealth to be able to make the required transfer payments to the principal. However, it immediately follows from the discussion above that our results continue to hold if the agent only possesses some limited initial wealth $w \geq 0$. To see this, note that in this case the optimal transfer payment given j-control is given by $t^j = \min\{\ a(e^j, x^j(e^j)),\ w\ \}$ for $j = P, A$. Hence, whenever there is an ex-post conflict of interest between P and A, even if the agent is wealth-constrained, we still have $t^A \geq t^P$. Moreover, as shown in the proof of Proposition 1, whenever A-control is strictly optimal we have $\pi(e^A, x^A(e^A) > \pi(e^P, x^P(e^P))$, which, in combination with (8), implies the following result.

Proposition 3 (wealth-constrained agent) *Even if the agent has only some limited wealth*

$w \geq 0$, the results on the optimal allocation of control and on endogenous risk stated in Propositions 1 and 2, respectively, continue to hold.

Hence, while the presence of a wealth-constraint might imply lower transfer payments, the results derived in Section 4 continue to hold.

6 Conclusion

In a partial-contracting framework, we explore the effects of an agent's risk-aversion on the potential delegation of authority by a principal. Our main result is to show that it is strictly optimal to delegate authority to the risk-averse agent if and only if exogenous risk is sufficiently large.

In the model, while only the agent is able to provide effort, subsequent decisions (still in the face of uncertainty) may be made either by the principal or the agent. However, only control over the decisions, but not the decisions themselves are contractible; implying that the principal cannot commit to a certain course of action ex-ante. To isolate the effect of risk and risk preferences, we assume that, beyond their differing risk preferences, there is no conflict of interest between the parties with respect to the choice of decision. Importantly, there is a risk-return trade-off, i.e., if a project promises a higher expected return, the project return also has a higher variance. This gives rise to the following trade-off for the principal when deciding whether to delegate authority. If the principal keeps authority, she will select the project yielding the highest expected return. However, thereby, she exposes the agent to a lot of risk, which reduces his effort incentives. If the agent has authority, on the one hand, he will select a lower-risk project (which, because of the lower expected return, the principal dislikes). On the other hand, thereby the agent has higher effort incentives; making delegation potentially profitable for the principal.

We also show that, while there is a clear-cut positive relationship between exogenous risk and delegation, the relationship with respect to endogenous risk in non-monotonic. This might explain some of the contradictory findings in the empirical literature on risk and delegation.

From a theoretical point of view, we combine element of the recent literature on partial-contracting, which highlights commitment problems to explain delegation, and the (more traditional) literature on project selection, where a risk-neutral principal and a risk-averse agent interact.

7 Appendix

7.1 Proof of Lemma 3

(a) In a first step, we prove that $e^A = e^P$ and $x^A(e^A) = x^P(e^P) = 1$ if $\gamma \leq 2$. To this end, we first show that in this parameter range some $e^A > \widehat{e}$ cannot be optimal. Define $a^A(e) \equiv a(e, x^A(e))$. Lemma 2 and (2) imply

$$\begin{aligned} a^A(e) &= [e \cdot x^A(e) - \tfrac{1}{2} \cdot \rho \cdot e^2 \cdot \left(x^A(e)\right)^\gamma \cdot r] - \tfrac{1}{2}e^2 = \\ &= e^{\left(\frac{2-\gamma}{1-\gamma}\right)} \cdot \left[\widehat{e}^{\left(\frac{1}{\gamma-1}\right)} - \tfrac{1}{2} \cdot \rho \cdot r \cdot \widehat{e}^{\left(\frac{\gamma}{\gamma-1}\right)}\right] - \tfrac{1}{2}e^2 \\ &= e^{\left(\frac{2-\gamma}{1-\gamma}\right)} \cdot \left[\widehat{e}^{\left(\frac{1}{\gamma-1}\right)} - \tfrac{1}{\gamma} \cdot \widehat{e}^{\left(\frac{1}{\gamma-1}\right)}\right] - \tfrac{1}{2}e^2 \\ &= e^{\left(\frac{2-\gamma}{1-\gamma}\right)} \cdot \widehat{e}^{\left(\frac{1}{\gamma-1}\right)} \cdot \left(\tfrac{\gamma-1}{\gamma}\right) - \tfrac{1}{2}e^2, \end{aligned} \tag{10}$$

and hence

$$a_e^A(e) = -\left(\frac{2-\gamma}{\gamma}\right) \cdot e^{\left(\frac{1}{1-\gamma}\right)} \cdot \widehat{e}^{\frac{1}{\gamma-1}} - e. \tag{11}$$

Consequently, if $\gamma \leq 2$, we have $a_e^A(e) < 0$ for all $e > \widehat{e}$, which implies $e^A \leq \widehat{e}$. From Lemma 2 we know that $x^A(e) = 1$ for all $e \leq \widehat{e}$. Hence, the agent chooses the effort level that maximizes $a(e, 1)$ subject to the constraint $e \leq \widehat{e}$, where $a(e, 1)$ is strictly concave in e. Consequently, we have $e^A = e^P$ if $e^P = \frac{1}{1+\rho r} \leq \frac{2}{\gamma\rho r} = \widehat{e}$ holds, which is indeed the case.

(b) In a second step, we consider the parameter range $\gamma > 2$. To prove the result we show that it depends on the sign of $a_e(\widehat{e}, 1) = a_e^A(\widehat{e}) = 1 - \widehat{e}(1 + \rho r)$ whether e^A lies above or below $\widehat{e}$. From (a) we know that $a(e, 1)$ is strictly concave in e. Moreover, (11) implies that

$$a_{ee}^A(e) = -\underbrace{\left(\frac{2-\gamma}{\gamma}\right)}_{<0} \cdot \underbrace{\left(\frac{1}{1-\gamma}\right)}_{<0} \cdot e^{\left(\frac{\gamma}{1-\gamma}\right)} \cdot \widehat{e}^{\frac{1}{\gamma-1}} - 1 < 0, \tag{12}$$

and hence $e^A > \widehat{e}$ if and only if $a_e(\widehat{e}, 1) = 1 - \widehat{e}(1 + \rho r) > 0 \iff 1 - \frac{2}{\gamma\rho r} \cdot (1 + \rho r) > 0 \iff r > \frac{2}{\rho(\gamma-2)} \equiv \widehat{r}$. In this case, it follows from (11) that $e^A = \left(\frac{\gamma-2}{\gamma}\right)\left(\frac{\widehat{e}\gamma}{\gamma-2}\right)^{\frac{1}{\gamma}}$. If, however, $r \leq \frac{2}{\rho(\gamma-2)}$, by the same argument we have $e^A = e^P$. It remains to show that $e^A > e^P$ holds in the relevant parameter range (i.e., where $\gamma > 2$ and $r > \widehat{r}$). Note that $a_e(\widehat{e}, 1) > 0$ implies $e^A, e^P > \widehat{e}$. Hence, as under both P-control and A-control the agent faces a concave problem, in order to prove the claim it suffices to show that $a_e^A(e) > a_e(e, 1)$ holds for all

$e > \widehat{e}$. Definition (2) and the Envelope-Theorem imply

$$\begin{aligned} & a_e^A(e) > a_e(e,1) && (13) \\ \iff\ & x^A(e) - x^A(e)^\gamma \rho r e > 1 - \rho r e \\ \iff\ & \tfrac{1}{2}\rho r e \underbrace{[1 - x^A(e)^\gamma]}_{>0} > [1 - 1^\gamma \tfrac{1}{2}\rho r e] - [x^A(e) - x^A(e)^\gamma \tfrac{1}{2}\rho r e] \end{aligned}$$

which is satisfied for all $e > \widehat{e}$ because Lemma 2 implies that the left-hand side is strictly positive, while (5) and (2) imply that the right-hand side is strictly negative.

7.2 Proof of Proposition 1

A-control can only be strictly optimal if it leads to a different equilibrium outcome than P-control, i.e., if both $\gamma > 2$ and $r > \widehat{r}$ (see Lemma 3) hold, which we assume in the following. First, note that $t^A = a(e^A, x^A(e^A)) > a(e^P, x^A(e^P)) \geq a(e^P, 1) = t^P$. Second, we show that $\pi(e^A, x^A(e^A)) > \pi(e^P, x^P(e^P))$ holds as well, which in combination with (8) implies the result. Lemma 1 implies $\pi(e^P, x^P(e^P)) = \frac{1}{1+z}$, where $z \equiv \rho r$. Moreover, Lemma 2 implies

$$x^A(e) = \sqrt[\gamma-1]{\frac{\widehat{e}}{e}} = \left(\frac{2}{e\gamma z}\right)^{\frac{1}{\gamma-1}} = \left(\frac{2}{\gamma z}\right)^{\frac{1}{\gamma-1}} \cdot e^{-\left(\frac{1}{\gamma-1}\right)}, \tag{14}$$

which in combination with Lemma 3 implies

$$x^A(e^A) \cdot e^A = \left(\frac{2}{\gamma z}\right)^{\frac{1}{\gamma-1}} \cdot (e^A)^{\left(\frac{\gamma-2}{\gamma-1}\right)} = \left(\frac{1}{z}\right)^{\frac{2}{\gamma}} \cdot \left(\frac{2}{\gamma}\right)^{\frac{2}{\gamma}} \cdot \left(\frac{\gamma-2}{\gamma}\right)^{\left(\frac{\gamma-2}{\gamma}\right)}. \tag{15}$$

Hence, we have

$$\begin{aligned} & \pi(e^A, x^A(e^A)) > \pi(e^P, x^P(e^P)) && (16) \\ \iff\ & x^A(e^A) \cdot e^A > x^P(e^P) \cdot e^P \\ \iff\ & \left(\tfrac{1}{z}\right)^{\frac{2}{\gamma}} \cdot \left(\tfrac{2}{\gamma}\right)^{\frac{2}{\gamma}} \cdot \left(\tfrac{\gamma-2}{\gamma}\right)^{\left(\frac{\gamma-2}{\gamma}\right)} > \tfrac{1}{1+z} \\ \iff\ & \left[z^{-\frac{2}{\gamma}} + z^{\frac{\gamma-2}{\gamma}}\right] \cdot \underbrace{\left[\left(\frac{2}{\gamma}\right)^{\frac{2}{\gamma}} \cdot \left(\frac{\gamma-2}{\gamma}\right)^{\left(\frac{\gamma-2}{\gamma}\right)}\right]}_{>0} > 1. \end{aligned}$$

Define $f(z) = z^{-\frac{2}{\gamma}} + z^{\frac{\gamma-2}{\gamma}}$. Note that at the boundary of the parameter range under consideration (i.e., at $r = \frac{2}{\rho(\gamma-2)} \iff z = \frac{2}{\gamma-2}$), Lemma 3 implies that the left-hand side of the above inequality is equal to 1. Hence, the above inequality is satisfied for all $z > \frac{2}{\gamma-2}$ if $f_z(z) > 0$ for all $z > \frac{2}{\gamma-2}$:

$$\begin{aligned} & f_z(z) > 0 \quad (17) \\ \Longleftrightarrow \quad & -\tfrac{2}{\gamma} \cdot z^{-\frac{2}{\gamma}-1} + \left(\tfrac{\gamma-2}{\gamma}\right) \cdot z^{\left(\frac{\gamma-2}{\gamma}\right)-1} > 0 \\ \Longleftrightarrow \quad & -\tfrac{2}{\gamma} \cdot z^{-1} + \left(\tfrac{\gamma-2}{\gamma}\right) > 0 \\ \Longleftrightarrow \quad & z > \tfrac{2}{\gamma-2}, \end{aligned}$$

which concludes the proof.

7.3 Proof of Proposition 2

First, for $r = \widehat{r}$ we have $V(e^P, x^P(e^P)) = V(e^A, x^A(e^A))$. Second, consider the case that P-control is optimal (i.e., $r \leq \widehat{r}$), where Lemma 1 and (9) imply that

$$V^* = \frac{1}{(1+\rho r)^2} \cdot r, \quad (18)$$

and

$$V_r^* = \frac{1}{(1+\rho r)^2} - \frac{2\rho r}{(1+\rho r)^3} = \left(\frac{1}{1+\rho r}\right)^2 \cdot \left(1 - \frac{2\rho r}{1+\rho r}\right) = \left(\frac{1}{1+\rho r}\right)^2 \cdot \left(\frac{1-\rho r}{1+\rho r}\right). \quad (19)$$

Hence, $V_r^* > 0 \Leftrightarrow r < \frac{1}{\rho}$, and $\widehat{r} \geq \frac{1}{\rho} \Leftrightarrow \frac{2}{\rho(\gamma-2)} \geq \frac{1}{\rho} \Leftrightarrow \gamma \leq 4$. Finally, if A-control is optimal (i.e., if $r > \widehat{r}$), it follows from Lemmata 2 and 3 that

$$V^* = \left(\frac{2}{\gamma\rho}\right)^{\frac{\gamma+2}{\gamma}} \cdot \left(\frac{\gamma-2}{\gamma}\right)^{\frac{\gamma-2}{\gamma}} \cdot r^{-\frac{2}{\gamma}}, \quad (20)$$

and hence in this parameter range we have $V_r^* < 0$ and $V_{rr}^* > 0$.

References

ACEMOGLU, D., P. AGHION, C. LELARGE, J. VANREENEN, AND F. ZILIBOTTI (2006): "Technology, Information, and the Decentralization of the Firm," *CEP Discussion Paper No 722.*

AGHION, P., M. DEWATRIPONT, AND P. REY (2002): "On Partial Contracting," *European Economic Review*, 46(4-5), 745–753.

——— (2004): "Transferable Control," *Journal of the European Economic Association*, 2(1), 115–138.

AGHION, P., AND J. TIROLE (1997): "Formal and Real Authority in Organizations," *Journal of Political Economy*, 105(1), 1–29.

AMIHUD, Y., AND B. LEV (1981): "Risk Reduction as a Managerial Motive for Conglomerate Mergers," *Bell Journal of Economics*, 12(2), 605–617.

BAKER, G., AND B. JORGENSEN (2003): "Volatility, Noise, and Incentives," *mimeo, Harvard University.*

BESTER, H. (2003): "Externalities and the Allocation of Decision Rights in the Theory of the Firm," *CEPR Discussion Paper No. 3276.*

——— (2005): "Externalities, Communication, and the Allocation of Decision Rights," *mimeo, FU Berlin.*

BURKART, M., D. GROMB, AND F. PANUNZI (1997): "Large Shareholders, Monitoring, and the Value of the Firm," *Quarterly Journal of Economics*, 112(3), 693–728.

CORE, J., AND J. QIAN (2002): "Project Selection, Production, Uncertainty, and Incentives," *mimeo, University of Pennsylvania.*

DEMARZO, P., AND D. DUFFIE (1995): "Corporate Incentives for Hedging and Hedge Accounting," *Review of Financial Studies*, 8(3), 743–771.

DEMSKI, J., AND R. DYE (1999): "Risk, Return, and Moral Hazard," *Journal of Accounting Research*, 37(1), 27–55.

DEWATRIPONT, M., AND J. TIROLE (1994): "A Theory of Debt and Equity: Diversity of Securities and Manager-Shareholder Congruence," *Quarterly Journal of Economics*, 109(4), 1027–1054.

DUTTA, S., AND S. REICHELSTEIN (2002): "Controlling Investment Decisions: Depreciation and Capital Charges," *Review of Accounting Studies*, 7, 253–281.

FERSHTMAN, C., AND K. JUDD (1987): "Equilibrium Incentives in Oligopoly," *American Economic Review*, 77, 927–940.

GROSSMAN, S. J., AND O. D. HART (1986): "The Costs and Benefits of Ownership - A Theory of Vertical and Lateral Integration," *Journal of Political Economy*, 94(4), 691–719.

Guo, M., and H. Ou-Yang (2006): "Incentives and Performance in the Presence of Wealth Effects and Endogenous Risk," *Journal of Economic Theory*, 129, 150–191.

Hart, O., and J. Moore (2005): "On the Design of Hierarchies: Coordination Versus Specialization," *Journal of Political Economy*, 113(4), 675–702.

Hirshleifer, D., and Y. Suh (1992): "Risk, Managerial Effort, and Project Choice," *Journal of Financial Intermediation*, 2, 308–345.

Holmstrom, B., and P. Milgrom (1987): "Aggregation and Linearity in the Provision of Intertemporal Incentives," *Econometrica*, 55, 303–328.

Lafontaine, F. (1992): "Agency Theory and Franchising: Some Empirical Results," *Rand Journal of Economics*, 23, 263–283.

Lafontaine, F., and S. Bhattacharyya (1995): "The Role of Risk in Franchising," *Journal of Corporate Finance*, 2, 39–74.

Lafontaine, F., and K. Shaw (1999): "The Dynamics of Franchise Contracting: Evidence from Panel Data," *Journal of Political Economy*, 107(5), 1041–1080.

Legros, P., and A. Newman (2004): "Competing for Ownership," *mimeo, Boston University.*

May, D. (1995): "Do Managerial Motives Influence Firm Risk Reduction Strategies," *Journal of Finance*, L(4), 1291–1308.

Melumad, N., and D. Mookherjee (1989): "Delegation as Commitment: The Case of Income Tax Audits," *Rand Journal of Economics*, 20, 139–163.

Milgrom, P., and J. Roberts (1992): *Economics, Organization and Management.* Prentice Hall, Englewood Cliffs, N.J.

Mookherjee, D. (2006): "Decentralization, Hierarchies, and Incentives: A Mechanism Design Perspective," *Journal of Economic Literature*, 44(2), 367–390.

Nagar, V. (2002): "Delegation and Incentive Compensation," *Accounting Review*, 77(2), 379–395.

Ou-Yang, H. (2003): "Optimal Contracts in a Continuous-Time Delegated Portfolio Management Problem," *Review of Financial Studies*, 16(1), 173–208.

Poitevin, M. (2000): "Can the Theory of Incentives Explain Decentralization?," *Canadian Journal of Economics*, 33(4), 878–906.

Prendergast, C. (2002): "The Tenous Tradeoff Between Risk and Incentives," *Journal of Political Economy*, 110, 1035–1070.

Raith, M. (2003): "Competition, Risk and Manegerial Incentives," *American Economic Review*, 93, 1425–1436.

Roberts, J. (2004): *The Modern Firm.* Oxford University Press, Oxford.

Rogoff, K. (1985): "The Optimal Degree of Commitment to an Intermediate Monetary Target," *Quarterly Journal of Economics*, 100, 1169–1189.

Sappington, D. (1986): "Commitment to Regulatory Bureaucracy," *Information Economics and Policy*, 2, 243–258.

Schelling, T. (1960): *The Strategy of Conflict.* Harvard University Press, Cambridge.

Sung, J. (1995): "Linearity with Project Selection and Controllable Diffusion Rate in Continuous-Time Principal-Agent Problems," *Rand Journal of Economics*, 26(4), 720–743.

Tirole, J. (1999): "Incomplete Contracts: Where Do We Stand?," *Econometrica*, 67(4), 741–781.

Vickers, J. (1985): "Delegation and the Theory of the Firm," *Economic Journal*, 95, 138–147.