Are Delegation and Incentives Complementary Instruments?

Lando, Henrik

Document Version
Final published version

DOI:
10.2139/ssrn.534706

Publication date:
2004

Are Delegation and Incentives Complementary Instruments?*

Professor Henrik Lando
Department of Industrial Economics and Strategy,
Copenhagen Business School,
Denmark
e-mail: hl.ivs@cbs.dk

April 22, 2004

Abstract

It is natural to suppose that delegation and incentives are complementary both in the sense that when more decisions are delegated to a lower level of an organizational hierarchy, more use should be made of incentives at that level, and in the sense that more use of incentives should be accompanied by more delegation. This issue is analyzed within a Principal-Agent framework in which there are two decisions to be made: an effort decision which can only be made by the Agent, and some other decision which can be made by either the Principal (i.e. be centralized) or by the Agent (i.e. be delegated). Within this framework it is shown that delegation and incentives are not necessarily complementary instruments; some decisions should be centralized when incentives are introduced.

*I wish to thank Bengt Holmstrøm and Thomas Sjøstrøm for helpful conversations. Errors are, of course, mine.

Introduction

How to allocate decision rights and how to establish incentives within an organization are interdependent choices, and it may be natural to suppose that when one delegates decision rights to a lower level of a hierarchy, one should also apply more high-powered incentive schemes at that level. Conversely, it seems plausible that more high-powered incentives should be accompanied by more delegation. In the words of Milgrom and Roberts ([16], p. 549):

> 'The point that a manager with broader authority should be given stronger incentives is an application of the incentive intensity principle. For example, a division manager who controls sales and marketing as well as production has more ways available in which to improve unit performance and can be profitably given more intense incentives. The relationship, however, is one of complementarity so the reverse implication also holds: the greater be the manager's financial incentives, the greater the proper scope of the manager's authority'.

However, as will be argued in this article, the claim that delegation and incentives go together is not universally true. This article analyzes the relationship between delegation and incentives in the simplest possible Principal-Agent setting by assuming that, apart from the effort choice a, there is one other decision, p, that may be made by either the Principal (the case of centralization) or by the Agent (the case of delegation). When p is centralized, the problem is one of two-sided moral hazard, since both the Principal and the Agent will then make decisions that influence the outcome, whereas when p is delegated, the problem is one of one-sided moral hazard. Assuming there is only one performance measure, x, (such as profits) to control both actions, the question to be analyzed is when rewarding the Agent more strongly as a function of x, should be accompanied by centralization or delegation of p.

To be able to derive explicit analytical results, a specific counter-example to the general claim of complementarity will be analyzed. Thus, it will be assumed that the assumptions of the Milgrom-Holmstrøm model of (linear) performance pay apply, and it will be assumed that p concerns the riskiness of projects undertaken by the Agent. Given these assumptions, the model will be used to analyze whether more high powered incentives call for delegation or centralization of project choice, when the Principal and the Agent's risk preferences differ and when projects differ in terms of risk and expected return. While the analysis will hence be concerned with a specific example, it will become clear from the analysis that the example reveals a more general pattern. Hence, analyzing the example will reveal an interrelationship between delegation and incentives, based on the following three realizations: First, that externalities arise both under delegation and centralization, since both the manager (the Agent) and the owner (the Principal) will tend to exercise authority over p in self-interested fashion, without taking the other's interest fully into account. Second, that both these externalities may be exacerbated by more high-powered incentives (the Agent may e.g. be reluctant to accept a high-powered incentive scheme, when he knows that his performance can be influenced by decisions made by the Principal), and which of the two externalities is more exacerbated may determine whether delegation or centralization should accompany higher powered incentives. And third, that which externality is more aggravated by high-powered incentives may depend on the parameters of the situation. These three insights will structure the analysis of the example below.

While the model will analyze a particular counter-example, it is worth stressing that the non-complementarity applies to a broad set of circumstances. Take, for example, the situation where the owner (the majority shareholder) of a company introduces an incentive system that links the manager's pay to the stock-value of the firm. It is possible to point to several kinds of decisions that should then, under certain circumstances, be centralized. This may e.g. be the case for the decision concerning the amount of resources invested into an ongoing project, since if the manager controls the flow of resources into a project, he may be able to hide the fact that the project is not performing, while if the owner is in control, the outcome of the project may be more informative of the quality of the manager's effort. In other words, delegating the control of resources may lower the informativeness of the performance measure[1]. As another example, it may be naturally be worth centralizing decisions concerning accounting practices when incentives are strenghtened. Obviously, when a manager's salary is highly dependent on the market value of a company, his incentive to manipulate financial accounts may be strong.

These examples illustrate different reasons why delegation and incentives

[1]The idea is that this problem may become larger when incentives become more high-powered.

may not be complementary. In the example to be analyzed in the model, the lack of complementarity arises even though the performance measure (profits) reflects all which the owner is assumed to care about. Thus, the problem will arise not because the performance measure excludes one or more of the owner's concerns, but because risk preferences differ. In the example concerning resources invested into projects, the lack of complementarity is a consequence of the fact, well known from the theory of moral hazard, that the efficiency of an incentive scheme depends on the informativeness of the signal of effort; since it is hard to generalize about when a signal will be more or less informative, one should not expect a general and robust relationship of complementarity between delegation and incentives. And in the final example, the problem is that the performance measure does not adequately reflect all of the owner's concerns, and that the delegated decision may then be more distorted, the more the manager's pay is related to the performance measure. The distortion is of course extreme in the case where the performance measure itself can be manipulated, but the problem may arise also in a less extreme form, as in the example which Milgrom and Roberts invoke to illustrate the complementarity of delegation and incentives (as quoted above): if the salary of the manager of the sales and marketing division is tied to stock-market performance in the relatively short run, it is clear that he may attempt to inflate the current stock price through aggressive marketing or sales-efforts, assuming that the stock-market does not have enough information to evaluate the adverse long run effects on the firm's reputation (and hence the adverse long-run effects on the stock-price). The more high-powered the incentive scheme, the more central management may therefore insist on having the right to e.g. choose between new sales-campaigns.

Effects of the kind just mentioned are of course not new to the incentive literature, and the contribution of this paper lies not in pointing to these effects but in analyzing the issue of the relationship between delegation and incentives in the simplest possible setting.

To review the literature on delegation and incentives, it is worth distinguishing two strands. One that concerns the (pure) theory of delegation and incentives, and another that analyzes concrete real world situations, where questions concerning delegation and incentives arise.

One of the questions analyzed in the theory of delegation is what the inherent advantages and disadvantages are of delegation. A fundamental answer to this question is that delegation makes better use of local information, but incurs a control loss relative to centralization (see e.g. Melumad, Mookherjee and Reichelstein [12])[2]. Thus, this answer relies on the existence of asymmetric or local information. In contrast, the present article will assume that the Principal and the Agent are *equally informed* about all factors relevant to the situation (with the exception that the decisions may be unobservable), and it may be worth explaining that this assumption is not based on a view that the basic rationale of delegation just mentioned is incorrect. Clearly, how information is distributed between e.g. central and local management is often of crucial concern for who should make a given decision. However, this paper focuses on the relationship between delegation and incentives *per se*, and the (simplifying) assumption of symmetric information is made both in order to study this relationship in isolation and for the sake of simplicity.

Another issue addressed in the theory of delegation is when it is possible, through design of contracts and mechanisms, to achieve outcomes that are optimal (in a second-best sense, i.e. relative to the information structure). For example, Melumad and Reichelstein [13] analyze when delegation incurs a control loss. They show that under certain idealized conditions there is no control loss: The main difference to this paper is that Melumad and Reichelstein assume the decision p to be contractible both in the sense that P can commit to a choice of p, and in the sense that under delegation, the Agent's incentive scheme can be made contingent on the Agent's choice of p. Given this assumption, they can show that there may be no advantage to centralizing p: the incentive scheme may be made to punish any deviation from the optimal choice of p by simply penalising it. In the model of the present paper, since p is not verifiable, the incentive scheme cannot depend on it[3].

In the same vein, Gupta and Romano [6], David, Perez and Stadler [20] and Demski and Sappington [4] analyze how the problem of double moral hazard may be solved through clever mechanism design, when both a and p are unverifiable. However, the mechanisms suggested rely on certain assumptions that will not be made in the present paper. For example, Gupta and Romano

[2]Another aspect is analyzed by Aghion and Tirole [1], who stress the effect of delegation on incentives to acquire information concerning projects' viability. The literature on strategic delegation, e.g. Melumad and Mookherjee [11], should also be mentioned.

[3]Lal [10] studies whether pricing decisions can be delegated to the salesforce and shows, like Melumad and Reichelstein, that if the incentive scheme can be made contingent on the choice of p (the pricing decision), delegation may do as well as centralization, but that delegation may do better if the sales agent is better informed.

and David, Perez and Stadler introduce a third party into the mechanism; this will, in the present paper, simply be assumed to be too costly. Likewise, Demski and Sappington's solution to the double moral hazard problem hinges on the assumptions that the manager is not wealth-constrained (he can buy the whole project), and that the parties can commit to not reneging on the initial contract (when this is in their mutual interest); neither of these two assumptions will be made below.

In the other strand of literature, which analyzes actual situations of double moral hazard, the article by Baiman and Rajan [2] is closely related to the present. They analyze whether capital investment decisions should be made by central or local management, and view this question as linked to the issue of the incentive scheme of local management. They stress that both central management (the owner) and local management may make choices that are distorted from the point of view of the organization's objectives; in their model, the problem with owner-control is lack of commitment, which leads to hold-up: the local manager invests resources in acquiring knowledge about a projects' profitability, and because the owner cannot commit to rewarding the local manager as a function of the information provided, the owner may be free to choose projects that yield little reward (quasi-rents) to the manager[4]. Since this lowers the manager's effort in acquiring knowledge about a projects' profitability, the owner may prefer to delegate the choice of project to the manager. On the other hand, if the choice is delegated to the manager, the manager earns informational rent. In contrast, the present article assumes no firm-specific investment or hold-up; in this sense, the present model is simpler[5].

The relationship between the present analysis and Milgrom and Holmstrøm's multi-task principal-agent theory [15] should also be mentioned. Milgrom and Holmstrøm show that if p is not well governed by a given performance measure (as in the example mentioned above where management inflates short run performance at the expense of long-term reputation), then establishing high-powered incentives to increase effort may be undesirable, because of the distortionary effect on the other decision. Milgrom and Holmstrøm argue that the Principal may then monitor the Agent instead, and they suggest this as an explanation why centralized control and low powered incentives go together

[4]The same point is made by Aghion and Tirole [1].

[5]See also Romano [19] for an analysis of a double moral hazard in a wholesaler-retailer relationship.

in the conventional employment contract. As such, the Milgrom-Holmstrøm theory lends support to the view that delegation and incentives are complementary. In contrast, the present article suggests that when p is centralized, it may be possible to maintain high-powered incentives; i.e. that centralization may be a prerequisite for the use of high-powered incentives.

Finally, a set of empirical papers analyze whether incentives and delegation go together in reality (e.g. Prendergast[18] and Nagar [17]). Interestingly, this literature often does not find there to be complementarity between delegation and incentives. Thus, Nagar writes (p.380):

> 'On the other hand, in contrast with principal-agent theory, I find no evidence that the extent of incentive compensation plays a significant role in explaining the extent of delegation'.

This lack of evidence lends support to the main argument of this paper, which means that the lack of evidence should hence not be seen as incompatible with Principal-Agent theory.

The following sections introduce and analyze the model. In the main part of the analysis, only the Agent's ex-ante participation constraint will play a role, but the issue will also be analyzed, in a separate section, whether the ex-post participation constraint can be used strategically as a commitment device for the Principal.

The Model

Consider as the Principal a risk-neutral owner, who proposes an incentive scheme to the Agent, a risk-averse manager, whose effort level a is unobservable to the owner[6]. Assume that the cost of effort to the manager is $C(a) = a^2/2$. The performance of the manager is measured by the profitability x, which is verifiable to a court. Profits depend on the effort a and on a random component $p\theta$:

$$x = a + p\theta$$

where p is an index of the degree of the riskiness of the project, and $\theta \sim N(k, 1)$, where $k > 0$ is the expected reward from taking risk. p is assumed to take values in the interval $[0, 1]$. When delegated, p is chosen by the manager, while

[6]It is assumed that the central manager cannot undertake the effort herself due to the time-constraint.

when centralized, it is chosen by the owner. As is the case with a, throughout most of the analysis p will be assumed to be unobservable. However, the case where p is observable but not verifiable will be analyzed in a section below, which analyzes the strategic use of the ex-post participation constraint.

As an assumption that will be discussed below, the incentive scheme which links the manager's pay, w, to performance, x, is linear[7]:

$$w = \alpha + \beta x$$

where α is the base salary and β is the power of the incentive scheme. Furthermore, the manager's utility-function is exponential:

$$U_A = -e^{-(w-c(a))}$$

and the manager' reservation certainty equivalent is $\widehat{CE}$.

The game is assumed to be the following:

1. The owner and the manager write a contract in which both decision rights and the parameters of the incentive scheme, α and β, are fixed. It is assumed that the owner has all the bargaining power[8].

2. The choices of a and p are carried out simultaneously, and will be determined in a Nash-equilibrium[9].

3. x is realized and w is paid by the owner to the manager as a function of x.

To simplify the owner's maximization problem, it is worth deriving the manager's certainty equivalent, since this determines how much the owner needs to pay the manager: The manager receives the uncertain or stochastic income $w = \alpha+\beta(a+p\theta)$, which is normally distributed with mean $\alpha+\beta a+\beta pk$ and variance equal to $\beta^2 p^2$. Given that his utility function is $U_A = -e^{-(w-c(a))}$,

[7]This assumption will be discussed below.

[8]But in this model, this is only a question of the size of the manager's reservation certainty equivalent; more bargaining power to the manager has the same implications as an increase in his reservation utility.

[9]In the present model, it will follow from the independence of a from p, that the Stackelberg equilibrium yields the same outcome as the Nash equilibrium.

the certainty equivalent (CE) of the normally distributed random variable can be expressed as,

$$CE = \alpha + \beta E(x) - \beta^2 p^2/2 - C(a)$$

as first shown by Milgrom and Holmstrøm [15].

Given that the owner has all the bargaining power, the manager's certainty equivalent will be equal to his reservation certainty equivalent $\widehat{CE}$, from which the base salary α can be calculated as:

$$\alpha = \widehat{CE} - \beta E(x) + \beta^2 p^2/2 + C(a)$$

The owner maximizes expected net profits $E(x - w)$, which rewritten equals $(1-\beta)E(x) - \alpha$, since $E(w) = \alpha + \beta E(x)$. Using the expression for α above, net profits, $(1-\beta)E(x) - \alpha$, hence equal

$$(1-\beta)E(x) - \widehat{CE} + \beta E(x) - \beta^2 p^2/2 - C(a) = E(x) - \widehat{CE} - \beta^2 p^2/2 - C(a)$$

Since $\widehat{CE}$ is a constant and $E(x) = a + pk$, it follows that the owner's maximization problem can be written as

$$Max_{\beta,\alpha,a,p} : a + pk - \beta^2 p^2/2 - C(a)$$

subject to the IC-constraints. In the following, let $C(a) = \frac{a^2}{2}$.

First, it is useful first to analyze what level of p would be decided on if p were contractible, i.e. to establish the second-best outcome.

The Benchmark Case Where p Is Contractible

If the owner could commit to some level of p, she would solve the following maximization problem:

$$Max_{\beta,\alpha,p} \quad : \quad a + pk - \beta^2 p^2/2 - \frac{a^2}{2}$$

s.t.

$$C'(a) = \beta$$

Maximizing the Lagrangian, one obtains the condition for an inner maximum of p :

$$p_{optimal} = k/a^2$$

From the second-order condition, it can be verified that the second-best level for p equals $\min\{1, k/a^2\}$.

Let us now consider the three insights mentioned in the introduction, that structure the analysis.

Externalities Arise Both under Delegation and Under Centralization

It will now be shown that under delegation, the manager will, given the level of a, tend to choose p too low (take on too much risk), while under centralization, the owner will take too much risk.

To see this, note that when the manager chooses a and p given α and β, he maximizes the certainty equivalent:

$$CE = \alpha + \beta E(x) - \beta^2 p^2/2 - \frac{a^2}{2} = \alpha + \beta(a + pk) - \beta^2 p^2/2 - \frac{a^2}{2}$$

which yields the first-order conditions:

$$\begin{aligned} a &= \beta \\ p &= k/\beta \text{ when } k/\beta < 1 \\ p &= 1 \text{ when } k/\beta \geqq 1 \end{aligned}$$

Thus, under delegation,

$$p = \min\{k/a, 1\}$$

Under centralization, when the owner chooses p after the manager's incentive contract has been signed, the owner maximizes $(1-\beta)a - \alpha + (1-\beta)pk$, which means that she sets p equal to 1. The owner will take the full risk. So, if p_d denotes the manager's choice under delegation and p_c denotes the owner's choice under centralization,

$$p_d \leq p_{optimal} \leq p_c = 1$$

since $k/a^2 > k/a$ when $0 < a < 1$ (and $a > 1$ will not be optimal since marginal cost of effort which equals a is higher than marginal productivity which equals 1, when $a > 1$), and since $k/a^2 < 1$ when $k < a^2$.

The result that the manager will take too little risk and the owner too much risk is not surprising: when the decision is delegated to the manager, he will lower the risk imposed on him by the incentive scheme, and does not internalize the full cost of lowering the risk, since he only receives the fraction β of profits. On the other hand, when p is centralized, the owner will disregard the interests of the manager, and will therefore impose the full risk on him. The optimal committed chocie of p, $p_{optimal}$, strikes a middle ground between these two distorted choices.

Both Externalities May Be Exacerbated by an Increase in the Power of Incentives

This follows from the fact that both the distance between p_d and $p_{optimal}$ and the distance between $p_{optimal}$ and p_c may be increasing in a. Thus, the difference between p_d and $p_{optimal}$ is $\frac{k}{a} - \frac{k}{a^2}$, when solutions are interior, and this difference is increasing in a when $a \leq 1$, and the difference between $p_{optimal}$ and $p_c = 1$ is also increasing in a when the optimal solution is interior, since $\frac{k}{a}$ is decreasing in a. In the case of delegation, when incentives are increased (when β and hence a is increased), the manager protects himself against risk by lowering p_d. Note that while this is itself costly for the owner, it has the positive consequence that the cost to the manager of the higher powered incentives is lowered, which means that the fixed salary to the manager can be lowered. In the case of centralization, when the power of incentives increases, the optimal level of p may fall (when the solutions is interior) because the cost to the manager of risky projects increases. However, the owner cannot commit to choosing a lower p, and will hence impose a high cost on the manager, who will require compensation for this ex-ante.

It remains to be shown that which of these increased externalities is more serious depends on the parameters of the situation, in this case on the reward for taking risk, k.

Which Externality is More Costly Depends on k

This can be seen from the proof of the following propositions, that are central to this article:

Proposition 1 *For low values of k, delegation is optimal and incentives are higher under delegation than under centralization.*

Proof: When p is delegated, the owner's maximization problem is:

$$Max_{\beta,\alpha,a,p} : a + pk - \beta^2 p^2/2 - a^2/2$$

s.t.

$$\begin{aligned} a &= \beta \\ p &= k/\beta \text{ when } k/\beta < 1 \\ p &= 1 \text{ when } k/\beta \geqq 1 \end{aligned}$$

The problem can be rewritten

$$Max\ (a + pk - \frac{1}{2}a^2 p^2 - a^2/2) \tag{1}$$

s.t.

$$p = \min\{k/a, 1\}$$

$W_d\ (a)$ – the utility for the owner under delegation– is then given by

$$\begin{aligned} W_d(a) &= a + k^2/a - \frac{1}{2}k^2 - a^2/2 \text{ when } k/a < 1 \\ W_d(a) &= a + k - a^2 \text{ when } k/a \geq 1 \end{aligned}$$

There are two possibilities:

a) $a \in [0; k]$. Then $W_d(a) = a + k - a^2$. Two possibilities arise; $k \geq \frac{1}{2}$ or $k < \frac{1}{2}$. When $k \geq \frac{1}{2}$ and $a = \frac{1}{2}$, the requirement $a \leq k$ is fulfilled, and since $a + k - a^2$ is maximized for $a = \frac{1}{2}$, $a = \frac{1}{2}$ is a candidate-solution within the interval $[0; k]$. Note that $W_d(\frac{1}{2}) = \frac{1}{4} + k$. When, as the other possibility, $k < \frac{1}{2}$, a candidate solution is $a = k$, given that $a \in [0; k]$, since $a + k - a^2$ is increasing in a in the interval $[0; k]$. This yields $W_d(a) = 2k - k^2$. So, in the interval $a \in [0; k]$, the candidate solutions yield the utilities:

$$\begin{aligned} W_d(\frac{1}{2}) &= \frac{1}{4} + k \text{ when } k \geq \frac{1}{2} \\ W_d(k) &= 2k - k^2 \text{ when } k < \frac{1}{2} \end{aligned}$$

These utilities must be compared to the maximal utilities obtained when $a > k$. In this case, $p = k/a$ under delegation and $W_d(a) = a + k^2/a - \frac{1}{2}k^2 - a^2/2$. Deriving $W_d(a)$ with respect to a and setting equal to zero yields the condition:

$$1 - \frac{k^2}{a^2} - a = 0 \Rightarrow k^2 = a^2 - a^3 \Longrightarrow k = (a^2 - a^3)^{0.5}$$

The points (a, k) that fulfill this equation are potential candidates for an inner optimum.

Graphically, the candidate-points (a, k) are as shown on Figure 1 :

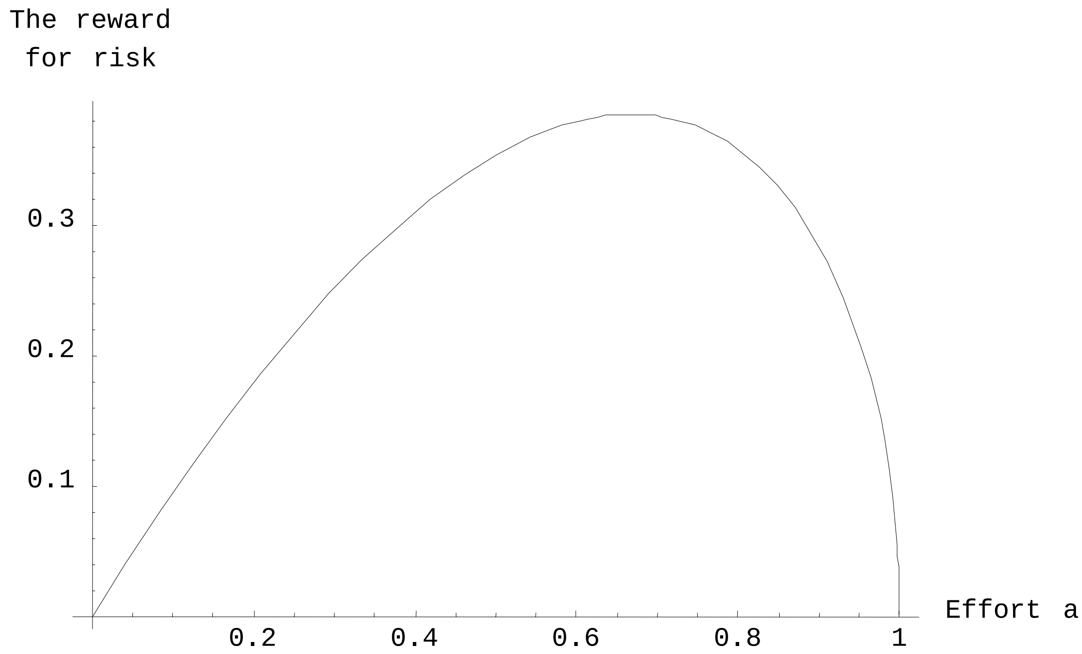

Figure 1

Note that the condition $a > k$ is fulfilled for all the points on the graph except origo. The function $(a^2 - a^3)^{0.5}$ is maximized for $a = 2/3$, at which point $k = .38$. Thus, for $k > .38$, there is no inner optimum for k. This means that when $k > .38$, there is no candidate for a solution within the open interval $a > k$. When, on the other hand, $k < .38$, for each k on the y-axis, there are two values of a, a higher and a lower, that may represent the maximum. By inserting $k = (a^2 - a^3)^{\frac{1}{2}}$ into the expression $W_d(a) = a + \frac{k^2}{a} - \frac{k^2}{2} - \frac{a^2}{2}$, one obtains,

$$W_d(a) = a + (a^2 - a^3)/a - (a^2 - a^3)/2 - a^2/2$$

which is shown on Figure 2.

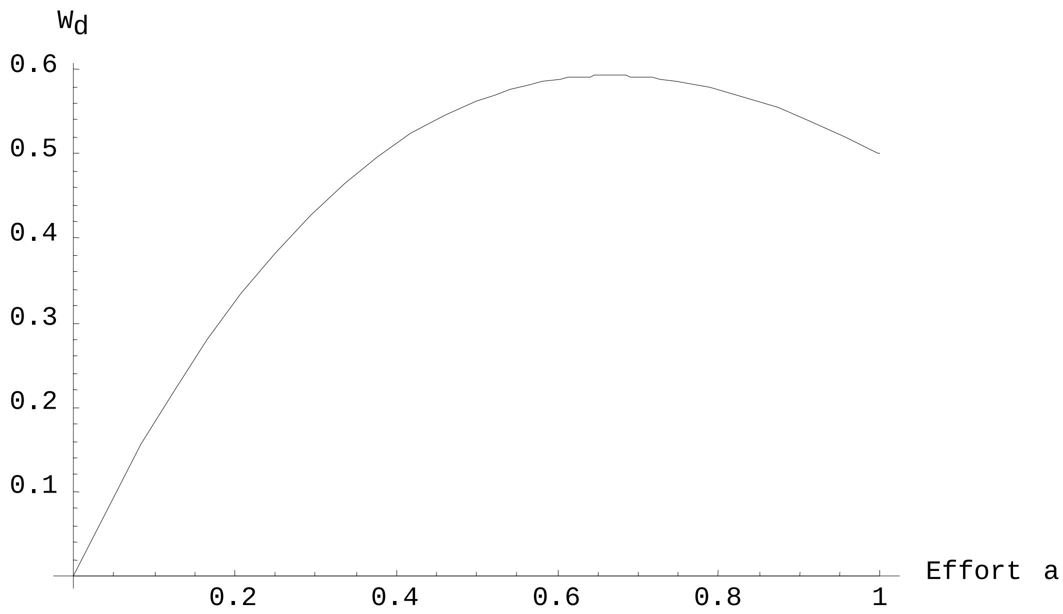

Figure 2

From the two figures, it is possible to find the highest attainable utility in the set $a > k$. Given some value $k < 0.38$, one finds the two possible inner optima from Figure 1, and from Figure 2, one finds out whether it is the lower or the higher value of a, which yields the higher utility for P.

We now compare this highest utility with that under centralization, $W_c(a)$.

Under centralization, the maximization problem can be written:

$$\begin{aligned} Max_{\beta,\alpha,a,p} &: \quad a + pk - \beta^2 p^2/2 - \frac{a^2}{2} \\ & \quad s.t. \\ a &= \beta \\ p &= 1 \end{aligned}$$

By inserting the IC-constraint into the criterion function, $a+pk-\beta^2p^2/2-\frac{a^2}{2}$, one obtains:

$$W_c(a) = a + k - a^2$$

Differentiating $W_c(a)$ with respect to a and setting equal to zero yields[10]: $a = \frac{1}{2}$. Hence, $\beta = C'(\frac{1}{2}) = \frac{1}{2}$, and $W_c(\frac{1}{2}) = \frac{1}{4} + k$.

To see that for low values of k, delegation may be optimal and may be associated with higher β and hence higher a than centralization, consider the interval where $k \in [0; 0.2]$. There are two cases to consider under delegation:

a) $a \leq k$: In this case, since $k < \frac{1}{2}$, the maximal utility is obtained for $a = k$ and equals $2k - k^2$. Since $2k - k^2$ is increasing in the interval $[0; 0.2]$, the maximal value is no higher than $0.4 - 0.04 = 0.36$.

b) $a > k$: It can be seen from Figure 1 and Figure 2 that among the two optima in the interval $a > k$, it is the higher value of a which maximizes utility. Thus, when e.g. $k = 0.2$, the solution to the equation $0.2 = (a^2 - a^3)^{\frac{1}{2}}$ is either $a = .23$ or $a = .96$, and as is clear from Figure 2, utility is higher when $a = .96$ than when $a = .23$[11]. Note also from Figure 1 that the higher value of a is greater than $\frac{1}{2}$ which is the optimal a under centralization. From Figure 2 it is clear that W_d is higher than 0.36 for the higher value of a, since $W_d = .5$, for $a = 1$.

Under centralization, $a = \frac{1}{2}$ and maximal utility is $\frac{1}{4} + k$ which is lower than the maximal utility under delegation for all values of k, since $.5 > .45$.

QED.

Proposition 2 *There exists an interval for intermediate values of k for which centralization is preferable to delegation, and for which incentives are higher under centralization than under delegation.*

Proof: Take the interval $k \in \left]0.39; \frac{1}{2}\right[$. Under delegation there exists no inner optimum for $a > k$, as can be seen from Figure 1. Thus, since $k < \frac{1}{2}$, the optimum under delegation is $a = k$ and $W_d = 2k - k^2$. a is then lower under delegation than under centralization (where $a = \frac{1}{2}$),and since $2k - k^2 < k + \frac{1}{4}$ when $k \in \left]0.39; \frac{1}{2}\right[$, centralization is preferable to decentralization.

QED

The intuition is as follows: Under delegation, the manager will choose a low p in order to avoid risk, and while this problem is exacerbated by high-powered incentives (high β and hence high a), the low value of p means that high

[10]The more general expression is the well-known : $\beta = \frac{1}{1+C''(a)}$, see e.g. Milgrom and Roberts.

[11]This can also be verified directly: $W_d(.96) = .52$, while $W_d(.23) = .36$.

powered incentives impose little risk on the manager. Thus, under delegation *the manager can lower the cost of high powered incentives through the choice of p, and when k is low, this costs the owner little in terms of a lower expected return.* However, when k is higher, this cost of not taking risk is higher, and so the manager's ability to protect himself against risk becomes an argument not for (as when k is low) but against introducing a high-powered scheme. Or, in other words, when the power of incentives when incentives increase, the externality which the two impose on each other also increases both under delegation and under centralization, but when k is high (low) the increased externality which the manager imposes on the owner under delegation is more (less) costly than the increased externality that the owner imposes on the manager under centralization.

Finally, contrast these two propositions with the two claims by Milgrom and Roberts quoted in the introduction. The first claim was that there will be more delegation when the possibility of introducing an incentive-scheme arises. It follows from the second proposition above that the answer is: not necessarily. When β is zero, delegation and centralization yield the same utility for the owner, while when β can be set freely, centralization will be preferable to delegation when k is sufficiently high. This is the case where an incentive scheme can be efficiently employed under centralization whereas, under delegation, incentives induce too little risk-taking. The second claim was that delegation implies more high-powered incentives. And again, the answer is that while that may be the case (when k is low), it is not necessarily true. As stated above, for intermediate values of k, incentives may be higher under centralization than under delegation.

Strategic Use of the Ex-post Participation Constraint

In the analysis above, it was assumed that p was not observable to A, who could then not leave as a reaction to the P's choice of p. However, it may be argued that p is often observable to A, and that observability opens up the possibility of using the ex-post participation constraint stratetigically. The idea is that when p is observable to A, P may in her choice of p be restricted by A's threat of leaving. While it is true that, in the analysis above, the agent's participation constraint holds when P chooses $p = 1$, since A realizes ex-ante that P will choose $p = 1$, and hence requires a high α to compensate for this, the possibility exists that something better can be achieved under centralization if

A's participation constraint is used as a way for P to commit not to choose p too high[12]. It may even be possible to manipulate A's participation constraint by paying A part of his fixed salary during or before the period in which A exercises effort and P chooses p. This may lower A's tolerance of P's choice of p, since A will then not fear losing all of the fixed salary for the given period by leaving in the middle of it. It will now be shown that this is, at least in theory, a forceful device. It may be possible hereby to achieve the second-best outcome, i.e. the outcome which maximizes P's utility subject only to A's incentive constraint. To see this, let the second-best level of a equal a^*, and note that the second-best level of p is given as min $\{1, k/(a^*)^2\}$, as derived above. A's ex-post incentive constraint is then:

$$\alpha_1 + a^*(a^* + pk) - (a^*)^2 p^2/2 - a^2/2 = \widehat{CE}$$

where $\beta = a^*$ has been inserted. If α_1 is set as that value which ensures that the equality holds when $p = \min\{1, k/(a^*)^2\}$, the question is whether P will choose $p = \min\{1, k/(a^*)^2\}$. It is clear that P will choose the highest possible p, so the crucial question is whether A's utility is decreasing for $p \geq k/(a^*)^2$ when $k/(a^*)^2 < 1$. If so, P cannot choose a higher level of p, since the participation constraint is then exactly fulfilled for $p = k/(a^*)^2$, and for higher values of p, A's utility will be lower, inducing him to leave. The derivative of A's utility with respect to p is $a^*k - (a^*)^2 p$, which is negative when $p > k/a^*$. However, when $p = \min\{1, k/(a^*)^2\}$, p will in fact be greater than k/a^*, since $a^* < 1$ (the marginal productivity equals the marginal cost at $a = 1$, and the fact that incentives can only be created through imposing risk on A means that it is preferable to set a lower than 1). This reveals that the ex-post participation constraint may conceivably be used as a way of ensuring the second-best outcome.

The strategic use of A's participation constraint, and the possibility of manipulating it by timing salary-payments (which must be done without risking that A leaves the relationship after receiving part of the salary) only re-inforces the point made in this paper, since it strengthens the case for centralization. When P can commit through A's participation constraint, this adds a reason why centralization may go together with high-powered incentives.

Discussion

[12] As when an employer is restrained in the exercise of authority by the fear that employees will leave.

One of the model's assumptions is worth mentioning in particular, namely the linearity of the *the incentive scheme.* It is well-known that a linear incentive scheme is optimal when the utility-function is the one assumed (the negative exponential function), and a is the only action (see Milgrom-Holmstrøm [15]). But the linear scheme may not be optimal under centralization when both A and P make decisions[13], and it may not be optimal when A choose both a and p, and when p affects the variance of the performance measure. When the Agent's risk-aversion is at the root of the distortion under delegation, it may be optimal to induce the Agent to take risks by offering a non-linear scheme, e.g. by offering a bonus- or an option-scheme.

However, in defense of the linear scheme, it should be noted that it is robust over time, leading the Agent neither to relax when the target is met or when the target becomes unreachable. In a dynamic setting, the optimal scheme may for this reason be close to linear to keep a constant intensity over time[14].

Furthermore, as mentioned, the main purpose of this paper is to suggest a view of the relationship between delegation and incentives which qualifies the intuition that delegation and incentives are always complementary, and this view may be presented without fully endogenizing the incentive scheme[15].

Conclusion

This article argues that delegation and higher powered incentives do not always go together, i.e. that the general claim of complementarity does not hold. This was illustrated in a counter-example in which one decision (effort) could only be taken by the Agent, while the other decision, the choice of project, could be taken by either the Principal or the Agent. Given different preferences with respect to risk, it was established that:

- When an incentive scheme is introduced, or made steeper, it may be optimal to centralize project choice at the same time.

[13]See Kim and Wang [8].

[14]An option scheme may also be excluded if it is perceived to provide too strong an incentive for the Agent to distort the performance measure, e.g. accounting profits.

[15]Also, in a former version of this paper (Lando [9]), examples were constructed where delegation and incentives were not complementary, and in these examples, no restriction was made to linear schemes.

- When the Principal delegates the decision concerning project choice, it may be optimal for her to lower the power of incentives at the same time.

This example illustrates a general reason why delegation and incentives may not be complementary: higher incentives may increase not only the externality which the Principal imposes on the Agent, but also the externality which the Agent imposes on the Principal, when one performance measure cannot adequately control two decisions by the Agent.

Moreover, when the Agent's threat to leave can be used to constrain the Principal in her exercise of authority[16], this was shown to render the second-best outcome achievable under centralization. This provides a further reason why strong incentives for the Agent may be compatible with centralization of certain decisions.

References

[1] Aghion, P. and Tirole, J.: *Formal and Real Authority in Organizations*, Journal of Political Economy; Feb97, Vol. 105 Issue 1, p1, 29p.

[2] Baiman, S. and Rajan, M.: *Centralization, Delegation, and Shared Responsibility in the Assignment of Capital Investment Decision Rigths*, Journal of Accounting Research, vol. 33, pages 135-164, 1995.

[3] Bhardwaj, P.: *Delegating Pricing Decisions,* Marketing Science, Spring2001, Vol. 20 Issue 2, p143, 27p.

[4] Demski, J. and Sappington, D: *Resolving Double Moral Hazard Problems with Buy-out agreements*, Rand Journal of Economics, vol 22, no. 2 summer 1991

[5] Grossman S. and Hart O.: *An Analysis of the Principal-Agent Problem*, Econometrica Jan83, Vol. 51 Issue 1, p7.

[6] Gupta,-Srabana; Romano,-Richard-E: *Monitoring the Principal with Multiple Agents,* RAND-Journal-of-Economics; 29(2), Summer 1998, pages 427-42.

[16]Naturally, the Agent may similarly be constrained by the Principals's threat to leave (i.e. to fire the Agent) in case of delegation.

[7] Holmstrøm, Bengt: *Moral Hazard in Teams*, Bell Journal of Economics, 13, 1982.

[8] Kim,-Son-Ku; Wang,-Susheng: *Linear Contracts and the Double Moral-Hazard,* Journal-of-Economic-Theory; 82(2), October 1998, pages 342-78.

[9] Lando H. : *Centralization and Decentralization: Control Allocation in the Moral Hazard Model,* Working paper, Institute of Finance, Copenhagen Business School, 95-06, see http://www.cbs.dk/staff/hlando/

[10] Lal, R.: *Delegating Pricing Responsibility to the Sales Force,* Marketing Science; Spring86, Vol. 5 Issue 2, p159, 10p

[11] Melumad, N., Mookherjee, D.: *Delegation as commitment: the case of income tax audits*, RAND Journal of Economics; Summer89, Vol. 20 Issue 2, p139, 25p.

[12] Melumad, N., Mookherjee, D., Reichelstein, S.: *Contract Complexity, Incentives, and the Value of Delegation*, Journal of Economics and Management Strategy; Summer97, Vol. 6 Issue 2, p257, 33p.

[13] Melumad, N., Reichelstein, S.: *Centralization Versus Delegation and the Value of Communication*, Journal of Accounting Research; 1987 Supplement, Vol. 25 Issue 3, p1, 18p.

[14] Milgrom *P*. and Holmstrøm B.: *Aggregation and Linearity in the Provision of Intertemporal Incentives,* Econometrica 55 1987

[15] Milgrom *P*. and Holmstrøm B. : *Multi-task Principal-Agent Analyses* Journal Of Law, Economics and Organization 7, 1991.

[16] Milgrom P. and Roberts, J.: *Economics, Organization and Management,* Prentice Hall, 1992

[17] Nagar, V.: *Delegation and Incentive Compensation*, The Accounting Review, vol. 77, no.2, April 2002, pages 379-395.

[18] Prendergast, C.: *The Tenuous Trade-off Between Risk and Incentives*, Journal of Political Economy, 110 (5), pages 1071-1102.

[19] Romano, R: *Double Moral Hazard and Resale Price Maintenance*, Rand Journal of Economics, 1993.

[20] Macho-Stadler,-Ines; Perez-Castrillo,-J.-David: *Double risque moral et delegation.* (With English summary.) Recherches-Economiques-de-Louvain; 57(3), 3rd Trimester 1991, pages 277-96.