The Economics of Wild Goose Chases

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Abstract

Empirical evidence consistently finds that incentive pay is more frequent when authority is delegated to workers than when their superiors hold authority. We provide a model where incentive pay results in the abuse of authority by their superiors, and (under reasonable conditions) implies that (i) incentive pay is higher when an agent holds control rights than when her principal has authority, (ii) effort is less responsive on the margin to incentive pay when the principal holds authority, and (iii) more incentive pay can reduce effort under authority, even on tasks that can be easily measured.

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Identifying the factors that constrain efficiency in firms has been a primary concern of agency theory for almost four decades. A significant part of that literature has been understanding the limits on the use of pay for performance. We argue here that the ability of firms to induce better performance through incentive pay may be constrained not by the usual candidates - measurement error or worker multi-tasking issues - but rather by the exercise of authority by their superiors. This is motivated by one of the few consistent findings on pay for performance: across many settings, workers are less likely to have incentive pay when supervisors have authority over them.

A common lens for viewing the impact of authority on incentive pay is Holmstrom and Milgrom, 1991. As in Holmstrom and Milgrom, this article takes a moral hazard multi-tasking approach to cast light on the impact of control rights for incentive pay. Instead of focusing on the incentives of only agents (as in Holmstrom and Milgrom), the novelty here is the claim that the incentives of principals to abuse authority may be relevant. We use familiar ingredients - multi-tasking concerns, team production, and asset allocation decisions - in order to interpret the evidence, and to offer other testable implications.

The model offered below has the following features. First, a firm produces outputs, and an agent exerts effort that affects their productivity. Pay for performance is used to induce effort exertion. Outputs vary on one important dimension: some activities can be contracted upon, whereas other activities have non-contractible returns. As an example, the contractible outcome could be sales with the non-contractible outcome the brand name capital of the firm. Second, effort is supplemented with assets where these assets are (potentially) complementary to effort. Third, authority is the right to assign these assets. Finally, the budget must balance.

A key assumption is that asset allocations cannot be contracted upon (as in Simon, 1951). Assets here refer to any supporting actions by superiors that are hard to specify ex ante. Relevant examples include marketing resources, the allocation of additional quality manpower, the right to assign the agent's time in future, or the willingness of superiors to incur political capital. The agency literature has a long history of addressing non-contractible performance measures: this article addresses the case where inputs provided by firms cannot be well contracted upon. The model also has the feature that when the agent exerts effort, she does not observe the principal's supporting assets. One plausible interpretation of this, as in Aghion and Tirole, 1997, is temporal. For example, agents exert effort on projects, incurring significant costs to get them off the ground. Only with appropriate support from superiors down the line will these projects come to fruition. These future supports are difficult to contract on ex ante, and the model deals with the concern that the agent will be sent on a "wild goose chase" by incurring costs on projects which are not later supported.

Assets should be assigned to equate marginal returns across activities. However, both the agent and the principal suffer from distorted incentives. The agent's incentives are distorted towards the well measured activities for the usual multi-tasking reason. By contrast, the principal's incentives are distorted towards the unmeasured activities, as the agent is not rewarded on the margin for these. These distortions depends on the incentive contract offered to the agent, and under reasonable conditions generate the outcomes below:

1. *Incentive pay is higher when the agent holds control rights than when the principal has authority.*

2. *Effort is less responsive on the margin to incentive pay when the principal holds authority.*

3. *More incentive pay can reduce effort, even on tasks that can be measured.*

Optimal incentive pay is determined by the multi-tasking concerns for each party. These multi-tasking issues involve both effort decisions and asset allocations. When authority is delegated to the agent, she assigns the assets to the task for which she is rewarded. Incentive pay is then the standard multi-task outcome given that asset assignment. When the principal holds authority, the calculus is more complicated. Higher pay for performance may induce more effort by the agent, but at a cost of distorting the assignment of complementary assets away from the well measured activities. Said another way, agents fear that the use of incentive pay reduces the asset support that they receive from the principal - the "wild goose chases" of the article's title.

All else equal, this effect reduces incentive pay with authority. However, optimal incentive pay is also affected by a Holmstrom and Milgrom multi-tasking discount. That discount depends on asset assignment, which itself depends on control rights. We show that a sufficient condition for pay for performance to be lower when the principal holds authority is that incentive pay weakly reduces output of the non-contractible task.

It has long been claimed in the human resources literature that workers have better incentives when they also control the environment in which they work (Hackman and Oldham, 1976). We provide an analog to this by arguing that the response of effort to incentive pay is heightened when agents have control rights. This arises here because under authority, higher pay for performance reduces asset support for the rewarded task, which reduces effort if efforts and assets are complements. This logic also underlies the potential for pay for performance to backfire by reducing effort, where asset support falls by so much with incentive pay increases to render effort exertion less worthwhile. This arises if the responsiveness of asset allocation to performance pay is sufficiently large.

The main body of the article treats control rights as parametric, and examines the implications of such control rights on incentive pay. The motivation for this is that in many firms, one actor often has a comparative advantage in assigning assets: often one party simply does not have the required information to make good decisions. However, we also consider the optimal allocation of authority. One reason for this is to to address a second empirical relationship on authority, namely, that delegation is more likely when performance is harder to measure. This also arises as an implication of the model.

There is a large literature on the interaction between authority and incentives, reviewed recently by Bolton and Dewatripont, 2010. Relatively little of this work has addressed the impact of authority on formal pay for performance. There are at least three relevant strands of the literature. The first is Holmstrom and Milgrom, which plays a prominent role below. Second, the set-up here is reminiscent of Aghion and Tirole, 1997, in that the choice of control rights trades off allocative inefficiencies against the desire to induce effort exertion. One difference between the two articles is that here the distortions derive from contractual sources rather than from private benefits, which allow implications for observed pay for performance. An interpretation of our results in a setting like Aghion and Tirole is provided below. Finally, the empirical evidence cited above is usually interpreted as supportive of Prendergast, 2002, who argues (i) that authority reduces formal incentives, and (ii) that authority will be delegated when uncertainty is high. The relationship to that work, and empirical interpretations of it, are discussed below.

We begin in Section 1 by outlining the model. Section 2 then describes the tradeoffs for each case and the resulting incentive pay outcomes. Section 5 addresses how the responsiveness of pay to performance depends on control rights, and how incentive pay can backfire by producing less effort. We then consider extensions and caveats in Sections 5 and 6. Section 7 addresses the choice of control rights, and other responses by firms. Section 8 concludes.

1 The Model

A profit maximizing principal (or firm) hires a risk neutral agent to produce outputs. The outputs of the firm are of two kinds: those that have contractible returns (such as sales or profits) and those which are intangible or non-contractible (such as the wellbeing of customers or the brand name image of the firm). The objective of the firm is to maximize the sum of expected output minus wage costs.[1]

Production also involves an agent, who has reservation utility normalized to 0. Output of each task depends both on effort exerted by the agent and assets (or capital) assigned. The agent exerts unobservable effort $e \geq 0$ at a cost $C(e)$, where $C' > 0$, $C'' > 0$, and $C(0) = 0$. The principal uses pay-for-performance to induce effort effort. As the agent is rewarded only for contractible outcomes below, effort refers to actions that the agent takes on the

[1] It is important to note here that the principal cares about outcomes other than "numbers". So for example, they must care about the brand name capital of the firm, perhaps as the receive private benefits from this, or have a longer term perspective than the agent.

contractible output. (Section 5 extends this to a case where separate efforts are exerted on both tasks.)

Output depends on asset assignments, and authority is the right to allocate the asset. The asset could be additional marketing or personnel resources, the ability to exceed budgets, or could be the right to allocate the agent's time across the two activities. The stock of the asset is normalized to 1. Whoever has control of the asset assigns $a \in (0,1)$ of the asset to the contractible task and $1-a$ to the non-contractible task. Asset allocations are non-contractible.

For the main body of the text, I consider two possibilities: either the agent chooses how to allocate the assets (*delegation*) or the principal has that right (*authority*). This is initially not a choice variable because often one party is more able to allocate resources than the other, so for the time being treat these as parametric. In effect, this considers the impact of different control rights for a given technology.[2] The endogenous choice of authority is addressed below.

Output in each task is either 0 or 1, and the probability of success at either depends on effort exerted and assets assigned. The probability of success in the contractible task is $x(a,e)$, whereas the probability of success in the non-contractible task is $y(1-a,e)$, so that expected output is $x(a,e)+y(1-a,e)$. To make more progress, we assume that the production functions have an affine structure

$$x(a,e) = eh_x(a) + \kappa_x(a) \tag{1}$$

and

$$y(a,e) = \rho e h_y(1-a) + \kappa_y(1-a) \tag{2}$$

We assume that $h_i \geq 0, h_i' \geq 0, h_i'' \leq 0, \kappa_i' > 0$ and $\kappa_i'' \leq 0$. Hence, more assets improve contractible performance as $x_1 > 0$ and $x_{11} \leq 0$ (where the subscript i refers to a derivative

[2]There is an older literature on the distinction between input monitoring and output monitoring, such as Brickley and Dark, 1987. This work addresses cases effort varies in its observability. This is not the interest of the article here.

with respect to the ith argument). Effort also increases output on the contractible task, $x_2 > 0$, and is weakly complementary to assets, $x_{12} \geq 0$.

The impact of effort on the non-contractible task is less clear. The ρ term in (2) picks up Holmstrom and Milgrom multi-tasking issues alluded to above, and plays a central role.[3] If effort on the contractible task is complementary to that on the non-contractible task then $y_2 > 0$, and so $\rho > 0$. On the other hand, the usual substitutes case implies $y_2 < 0$, where $\rho < 0$. Finally, independence (as would arise if the agent has no impact on non-contractible activities) implies $\rho = 0$.

We assume that $y_1 > 0$, which requires that $\kappa_y' + \rho e h_y' > 0$, implying a limit on the degree of substitutability between the two activities. To avoid corner solutions where all the asset should be assigned to one task, we assume that $x_1'(a,e) \to 0$ as $a \to 1$, $x_1'(a,e) \to \infty$ as $a \to 0$, $y_1(1-a,e) \to \infty$ as $a \to 1$, and $y_1(1-a,e) \to 0$ as $a \to 0$.

The agent is offered a contract where she is offered a bonus $\beta \geq 0$ if contractible output is a success.[4] Budget balance must be maintained, where after outputs are observed, the agent received β of any contractible output and the principal retains $(1-\beta)$ of that output plus all of any non-contractible output. For any assignment of authority, the two instruments chosen by the principal are the contract, β and a fixed fee β_0. There are no restrictions on the up-front transfers so that the principal chooses the contract to maximize ex ante surplus.

The timing for each control case is as follows. First, the principal offers the agent a contract with sharing rule β, a fixed fee β_0. If the agent rejects, the game ends. If she accepts, assets are allocated and effort exerted simultaneously. If the agent has authority, she assigns the assets whereas with the principal holding authority, he assigns the assets.[5] Following this, the output is then realized, and the agent is paid. At that point, the game

[3]As shown below, this is a reduced form for a model where the agent exerts effort on two separate tasks.

[4]Technically, β is any additional payment made to the agent if output is observed to be positive over being observed to be 0.

[5]This timing can either be simultaneous or where the principal follows. Later actions by the principal may be the most plausible interpretation empirically, where an agent exerts effort on a project not knowing if her efforts will be supported by later actions - marketing, personnel, or political - by her superior.

ends.

Finally, this article has features of a team production problem, where actors simultaneously take actions. Such models often have coordination failures as a possibility.[6] These are ignored here by considering the surplus maximizing Nash equlibria.

2 Authority and Incentives

The article's main interest is in understanding the implication of non-contractible authority. As a benchmark, it is useful to begin by considering the case where it is possible to commit to the assets assigned to each task. In this setting, the notion of control rights is irrelevant.

Contractible Assets: When assets are contractible, the agent chooses effort optimally given that contracted level of assets a, and chooses effort e^* given by $\beta x_2(a, e^*) = C'(e^*)$. The principal's optimal a^* solves $x(a^*, e^*) + y(a^*, e^*) - C(e^*)$, and is given by the solution to

$$x_1(a^*, e^*) - y_1(1 - a^*, e^*) + \frac{de^*}{da^*}(x_2(a^*, e^*) + y_2(1 - a^*, e^*) - C'(e^*)) = 0. \tag{3}$$

An important point for what follows is that when it is possible to commit to asset allocations, equilibrium choices of a affect effort decisions on the margin. As a result, the choice internalizes the effect of asset allocations on effort decisions. By substitution and totally differentiating the agent's first order condition becomes

$$x_1(a^*, e^*) - y_1(1 - a^*, e^*) + \frac{\beta^* x_{12}}{C'' - \beta^* x_{22}}((1 - \beta^*)x_2(a^*, e^*) + y_2(1 - a^*, e^*)) = 0. \tag{4}$$

Similarly, the optimal choice of incentive pay is given by $x_2 + y_2 = C'$ or

$$\beta^* = 1 + \frac{y_2(1 - a^*, e^*)}{x_2(a^*, e^*)} = 1 + \frac{\rho h_y(1 - a^*)}{h_x(a^*)}. \tag{5}$$

[6] For example, in the case where the principal holds authority, the agent could hold beliefs that the principal will supply no capital to the contractible good, and as a result exerts (almost) no effort. For some parameter values (where $\kappa_x(a) \approx 0$ for all a), this is a Nash equilibrium, even though there are Pareto superior outcomes.

Substituting (5) into (4) then yields the first order condition for asset allocations $x_1(a^*, e^*) = y_1(1 - a^*, e^*)$. In words, assets are efficiently allocated and incentives given by the Holmstrom Milgrom benchmark given this asset allocation. These benchmarks will be useful as comparisons to equilibrium choices below.

Now consider the implications of asset allocations being non-contractible. The identity of the party allocating the assets then becomes relevant. Consider each control case.

Delegation When the agent is delegated control, she chooses both a and e to maximize $\beta x(a, e) - C(e)$ and the principal takes no action other than to choose the contract. As the agent is only rewarded for contractible output and $x_1 > 0$, the agent chooses $a = 1$. Let the subscript d refer to outcomes with delegation, so effort is given by e_d where

$$\beta x_2(1, e_d) = C'(e_d). \tag{6}$$

Incentives are then chosen to maximize $x(1, e_d) + y(0, e_d) - C(e_d)$ subject to (6). Optimal incentives (proofs are in the Appendix) are given by

$$\beta_d^* = 1 + \frac{y_2(0, e)}{x_2(1, e)} = 1 + \frac{\rho h_y(0)}{h_x(1)}. \tag{7}$$

This is the Holmstrom-Milgrom multi-tasking benchmark evaluated at the capital allocation chosen by the agent.[7]

Authority As an alternative, the principal could allocate the assets himself. The contractible benchmark a^* above may not be feasible when the principal privately chooses a. Any deviation of equilibrium asset allocation from a^* above is referred to as *abuse of authority* and this section shows the sources of such abuse and how it affects equilibrium incentives. As actions are private, their choice depends on expectations about the other's actions. Let the subscript p refer to outcomes when the principal chooses how assets are allocated. The

[7] In the typically assumed case of substitutable efforts across tasks, $y_e < 0$ and so $\beta_d^* < 1$. If effort on the contractible task increases output on the non-contractible task, then $\beta_d^* > 1$. Finally if the actions are independent, then $\beta_d^* = 1$.

principal chooses a_p to maximize

$$(1-\beta)x(a_p, \tilde{e}_p) + y(1-a_p, \tilde{e}_p) \tag{8}$$

and the agent chooses e_p to maximize

$$\beta x(\tilde{a_p}, e_p) - C(e_p) \tag{9}$$

where the "tilde" variables are expectations about the other's action. As mentioned above, we focus on the most efficient outcome, where the principal can choose among Nash equilibria.

With private actions, the principal chooses a_p to maximize $(1-\beta)x(a_p, e_p) + y(1-a_p, e_p)$ for fixed e_p. As the choice is interior given the boundary assumptions, he chooses

$$(1-\beta)x_1(a_p, e_p) = y_1(1-a_p, e_p). \tag{10}$$

There are two distortions caused by the inability to commit. First, for a fixed level of effort, the principal assigns too many assets to the non-contractible task, as β is not part of surplus yet affects his decision. Second, the principal does not internalize the fact that choices of asset support affect effort decisions. As a result, the agent will be aware that her contractible tasks may not be supported by appropriate assets, and will change her effort accordingly. For a belief a_p, optimal effort is given by

$$\beta x_2(a_p, e_p) = C'(e_p). \tag{11}$$

The second order conditions trivially hold here. The results on the implications of non-contractible authority derive from these two conditions.

The remaining choice to be made by the principal is the incentive contract β_p. The incentive contract affects both worker effort and asset allocations. Totally differentiating (10) and (11), comparative statics are given by the solution to this pair of simultaneous equations

$$\frac{de_p}{d\beta} = \frac{x_2}{C''} + \frac{\beta x_{12}}{C''}\frac{da_p}{d\beta}, \tag{12}$$

and

$$\frac{da_p}{d\beta} = \frac{x_1}{(1-\beta)x_{11} + y_{11}} + \frac{y_{12} - (1-\beta)x_{12}}{y_{11} + (1-\beta)x_{11}}\frac{de_p}{d\beta}. \tag{13}$$

In words, the responsiveness of the inputs to incentive pay depends on the usual direct effects, but also indirect effects caused by changes to the other input.

Optimal incentive pay maximizes surplus subject to (12) and (13), and is given by

$$(x_2 + y_2 - C')\frac{de_p}{d\beta} + (x_1 - y_1)\frac{da_p}{d\beta} = 0. \tag{14}$$

Note the distinction from the case where the principal can commit in (5) where the second term is absent: in the contractible case there is no concern that more incentive pay will reduce asset support.

Here the agent knows that more incentive pay chokes off asset support: this reduces effort if the two instruments are complements in production. Intuitively, optimal incentives tradeoff the marginal surplus from each activity weighted by the responsiveness of the action to the price. Then as $\beta_p x_2 = C'$, (14) can be simplified to

$$\begin{aligned}\beta_p^* = 1 + \frac{y_2(1-a_p, e_p)}{x_2(a_p, e_p)} + (\frac{x_1 - y_1}{x_2})\left(\frac{da_p}{d\beta}\right)\left(\frac{de_p}{d\beta}\right)^{-1} \\ = 1 + \frac{\rho h_y(1-a_p)}{h_x(a_p)} + (\frac{x_1 - y_1}{x_2})\left(\frac{da_p}{d\beta}\right)\left(\frac{de_p}{d\beta}\right)^{-1}.\end{aligned} \tag{15}$$

The effect of authority on incentive pay is then a comparison of (7) and (15), and the empirical relationship above will be interpreted through this lens.

3 The Impact of Authority on Incentive Pay

From (7) and (15),

$$\beta_d^* - \beta_p^* = \rho\left(\frac{h_y(0)}{h_x(1)} - \frac{h_y(1-a_p)}{h_x(a_p)}\right) - (\frac{x_1 - y_1}{x_2})\left(\frac{da_p}{d\beta}\right)\left(\frac{de_p}{d\beta}\right)^{-1}. \tag{16}$$

Two factors distinguish incentive pay under delegation from that with authority: (i) differences in the multi-tasking discounts, and (ii) the marginal effect of incentive pay on mis-assignment of assets.

Consider the latter effect first. Incentive pay only affects asset allocation when the principal has authority. The marginal impact of this on equilibrium incentive pay is given by $(\frac{x_1-y_1}{x_2})\left(\frac{da_p}{d\beta}\right)\left(\frac{de_p}{d\beta}\right)^{-1}$. Note that as $\beta \geq 0$, $(x_1 - y_1) \geq 0$. It is shown in the Appendix that in equilibrium $\frac{da_p}{d\beta} < 0$ and $\frac{de_p}{d\beta} > 0$. Therefore $(\frac{x_1-y_1}{x_2})\left(\frac{da_p}{d\beta}\right)\left(\frac{de_p}{d\beta}\right)^{-1} \leq 0$, which offers the intuitive result that authority reduces optimal pay for performance, all else equal, as it causes distortions in asset assignments.

If this was the only difference between the two cases, incentive pay would be lower under authority. However, there is an additional effect: the multi-tasking benchmark may change with the allocation of control as h_i depends on a. Given Holmstrom and Milgrom, it should not be surprising that this potentially depends on whether the impact of effort on the non-contractible task is positive or negative.

Proposition 1 *A sufficient condition for $\beta_p^* < \beta_d^*$ is $\rho \leq 0$.*

In words, delegation of authority increases pay for performance if either multi-tasking influences can be ignored or the effect is negative. The following cases satisfy this:

No interaction: Consider the case where $\rho = 0$, where effort on the contractible task has no effect on the other task's productivity. Then

$$\beta_d^* - \beta_p^* = -(\frac{x_1 - y_1}{x_2})\frac{da_p}{d\beta}(\frac{de_p}{d\beta})^{-1} > 0. \tag{17}$$

The additively separable case: Now consider the case with $h_x = h_y = 1$, so $x(a,e) = e + \kappa_x(a)$ and $y(a,e) = \rho e + \kappa_y(1-a)$. Then

$$\beta_d^* - \beta_p^* = -(\frac{x_1 - y_1}{x_2})\frac{\frac{x_1}{(1-\beta)x_{11}+y_{11}}}{\frac{x_2}{C''}} = -\frac{C''\kappa_x'(\kappa_x' - \kappa_y')}{(1-\beta)\kappa_x'' + \kappa_y''} > 0. \tag{18}$$

Here the effort multi-tasking concern is independent of asset allocation, so the only difference between the two cases is the marginal impact of incentive pay on capital allocations.

Substitutes: Consider (16) for the case of $\rho < 0$. The multitasking discount then depends only on ρ and the relative assets assigned to each task. But as $\frac{h_y}{h_x}$ is lower under delegation, incentive pay declines under authority both because the multi-tasking concerns are greater and because of the marginal impact of incentive pay on asset allocations.

To summarize, this section argues that under reasonable conditions, the exercise of authority reduces incentive pay. This arises for two reasons. First, incentive pay under authority causes marginal distortions in capital assignments. Second, when efforts are substitutes and weakly complementary to assets assigned, it increases the multi-tasking discount. As a result, this article adds a new candidate to usual constraints on the use of incentive pay - risk aversion and agent multi-tasking - namely the harmful impact of authority on the assignment of supporting assets.

As support for the theory, there is strong empirical evidence that authority reduces the intensity and prevalence of pay for performance. This is described across a range of occupations and countries in Table 1. In each of these cases, less delegation of authority reduces pay for performance. In a field where there is little empirical evidence, this is one of the only consistent findings on pay for performance in firms.[8]

The interpretation of these data through the lens of the article is that (i) pay for performance harms asset support by superiors, and (ii) as a result, firms who use authority choose not to offer as much pay for performance. Part (ii) is clearly supported by the data. Direct evidence on (i) is much harder to obtain, but the article does at least offers a testable implication for future work: do firms that control asset allocations invest less when workers receive pay for performance?[9] One possible supporting example derives from Michael's, 1999, study of the relationship between advertising expenditures - a natural form of asset support - and organizational form. In many retail firms, they choose between franchising units and retaining them as company owned. Franchised outlets typically have much higher "pay for performance" than do company owned stores. Michael finds that franchising cuts advertising to sales ratios by 50% compared to company owned stores. Brickley and Dark,

[8]The empirical literature testing theories of pay for performance has had at best mixed success. See Prendergast, 2002, for example.

[9]The literature on the relationship between investment and taxes seems relevant, as it provides independent evidence on how firm behavior changes with prices. A commonly cited source of such estimates, Hassett and Hubbard, 2002, find large elasticities of investment to marginal prices, with estimates between -0.5 to -1.0, suggesting that firms respond to marginal incentives when making asset related decisions.

1987, report similar findings. This is consistent with the model's outcome, where principals reduce costly support for activities from which agents benefit on the margin: here higher marginal payments to franchisees result in lower advertising expenditures by firms.

4 Other Implications

This section addresses other potentially testable implications of the model.

The Response of Effort to Incentive Pay Much of the recent empirical work on agency issues has adressed the responsiveness of output to performance pay. Lazear, 2000, is the best known of these studies. This work offers an additional testable implication, namely how the relationship between pay and performance is mediated by control rights. Also related is Hackman and Oldham, 1976, perhaps the most used framework for addressing Human Resource issues outside of the economics paradigm. One of their principles is that employees are more motivated when they have control of their work environment. This article offers a variant on this, by arguing that (under reasonable conditions) pay for performance induces more effort on the margin in settings where agents can control complementary resources.

To illustrate this, we carry out the out-of-equilibrium exercise of marginally increasing β for an optimally chosen capital assignment. Note that

$$\frac{de_p}{d\beta} = \frac{h_x(a_p)}{C''(e_p)} + \frac{\beta h'_x(a_p)}{C''(e_p)}\frac{da_p}{d\beta} \tag{19}$$

and

$$\frac{de_d}{d\beta} = \frac{h_x(1)}{C''(e_d)}. \tag{20}$$

Conditions (19) and (20) offer two reasons why the agent responds less to incentive pay under authority. First, she perceives that the principal will likely withdraw valuable asset support when incentive pay rises. This is the second term in (19). If $h'_x > 0$, this reduces effort. Second, the level of capital assigned to the contractible task is lower with authority, so once again if $h'_x > 0$, there is less reason to exert effort. As an example, consider the case with quadratic effort costs $C(e) = \frac{\gamma e^2}{2}$. Then

$$\frac{de_d}{d\beta} - \frac{de_p}{d\beta} = \frac{h_x(1) - h_x(a_p)}{\gamma} + \frac{\beta h_x'}{\gamma}\frac{da_p}{d\beta} > 0 \tag{21}$$

if $h_x' > 0$.

There is of course, one caveat, as these outcomes are being evaluated at different effort levels. This does not matter if $C''' = 0$. However, if C''' is positive and sufficiently large, the fact that that these are being evaluated at different effort levels could overcome the effects above. Subject to this, this section once again offers a simple interpretation of how agency issues are affected by the use of authority: here the agent correctly fears that although higher pay for performance offers her a larger share, the likelihood of success falls as the principal withholds resources that make success more likely. Unfortunately, I know of no existing empirical work that tests this issue.

Incentive Pay Backfiring The model also allows the possibility of incentive pay backfiring. This is meant not in the usual multi-tasking sense of output on the non-contractible task being sufficiently harmed by incentive pay, but in the more direct sense of contractible output falling. This occurs here if the asset response is sufficiently elastic to pay for performance. Again consider the quadratic case above, where

$$\frac{de_p}{d\beta} = \frac{h_x(a_p)}{\gamma} + \frac{\beta h_x'}{\gamma}\frac{da_p}{d\beta} \tag{22}$$

Then if $\frac{h_x}{h_x'} < -\beta\frac{da_p}{d\beta}$, increased incentives reduce effort as the marginal support of capital falls by enough to make less effort optimal.

In order to directly relate this to the responsiveness of assets, consider a quadratic loss function for capital reallocation:

$$x(e, a) = e(a - \frac{\mu a^2}{2}) \tag{23}$$

and

$$y(e, a) = e(\overline{a} - a - \frac{\mu(1-a)^2}{2}) \tag{24}$$

Lower μ implies a more elastic response of capital. In order to guarantee that $x_1 > 0$ and $y_1 > 0$, assume that $\mu < 1$. This production function allows us to simply parameterize the ease with which assets can be reallocated across tasks through μ. (ρ has been ignored here simply to avoid the usual multitasking consideration.) With this technology, $\frac{da_p}{d\beta} = \frac{1-\frac{2}{\mu}}{(2-\beta)^2}$, which is decreasing in μ.

Proposition 2 *Assume that output is given by (23) and (24). Then if $a_p > 0$, effort is increasing in β if and only if*

$$\frac{a_p - \frac{\mu a_p^2}{2}}{1 - \mu a_p} > \frac{\beta(1 - \frac{2}{\mu})}{(2-\beta)^2}. \tag{25}$$

This condition is always violated if $a_p > 0$ and μ low enough.

Hence, sufficiently elastic ability to reallocate assets causes incentive pay to backfire.

5 Caveats

The claim above is that under reasonable conditions, delegation increases incentive pay. Yet models make assumptions, and in order to determine the robustness of the insights above, it is necessary to consider some cases where the results above need not hold:

Complements: It is not unusual following Holmstrom and Milgrom for incentive pay outcomes to be reversed when efforts are complements rather than substitutes. This can also be true here. Consider the case with $\rho > 0$, where assets are strict complements to effort exertion ($h_i' > 0$). The difference in multi-task discounts is given by

$$\rho\left(\frac{h_y(0)}{h_x(1)} - \frac{h_y(1-a_p)}{h_x(a_p)}\right) < 0. \tag{26}$$

If this effect is large enough, it can outweigh the direct effect of marginally distorting asset assignments when incentive pay is increased. As a result, there needs to be a limit to the degree of complementarity for the result above to hold.[10]

[10]The assumption of affine productions function also matter. Consider the case where $x(a,e) = \mu_x(e)h_x(a)$ and $y(a,e) = \rho\mu_y(e)h_y(1-a)$, where $\mu_i(e)$ is increasing and concave in e and $\rho < 0$. Then $\beta_d^* - \beta_p^* =$

Marginal distortions by the agent: It has been assumed so far that when the agent is delegated control, she assigns all assets to the contractible task. This implies that although there are distortions in asset allocations from delegation, there are no *marginal* distortions from higher incentive pay as the agent is already at the corner. Yet the Holmstrom and Milgrom influences when agents hold control rights revolves around such marginal distortions. This influence has been ignored here to highlight the novel influences of the article, motivated by the empirical relationship between authority and incentive pay.

This issue is addressed here by giving the agent a reason to care about the non-contractible output y. Assume that the agent has an intrinsic reason to increase output, say where she values total output at an intrinsic rate $v < 1$. As a result, when choosing both effort and asset allocations, she chooses them to maximize $(v+\beta)x(a,e) + vy(1-a,e) - C(e)$. With such intrinsic motivation, the choice of asset allocation is given by the first order condition $\left(\frac{\beta+v}{v}\right) x_1 = y_1$, and so some assets are assigned to y. The conceptual difference here is that incentive pay now affect both effort and asset allocations by the agent on the margin.

There is little surprising in adding this extension to the model. The one substantive change is that there is now a reason to constrain incentive pay with delegation for the same reasons enunciated above for the case with authority. If this effect is sufficiently large, the Holmstrom and Milgrom tendency towards lower incentive pay under delegation will arise.[11] With this extension, distortions decrease in v and obviously in the limit as $v \to 1$ the first best is achieved with delegation where $\beta = 0$. More generally, the result on delegation increasing pay for performance relies on the assumption that the agent's incentives are not sufficiently well aligned such that increases in β have significant marginal effects.

$\rho\left(\frac{\mu_y'(e_d)h_y(0)}{\mu_x'(e_d)h_x(1)} - \frac{\mu_y'(e_p)h_y(1-a_p)}{\mu_x'(e_p)h_x(a_p)}\right) - \left(\frac{x_1-y_1}{x_2}\right)\left(\frac{da_p}{d\beta}\right)\left(\frac{de_p}{d\beta}\right)^{-1}$. This cannot be signed without imposing more structure on the μ_i' functions.

[11] In general, the multi-tasking problem leads to balanced incentives, but as one activity here cannot be contracted upon, this implies lower incentives caused by agent multi-tasking on the asset side.

6 Other Interpretations

The central ingredient needed for the outcomes here is that the agent fears that authority will be abused when incentive pay is used. This section relaxes some modeling assumptions to allow other interpretations.

A Two-Effort Interpretation The model above has a single effort taken by the agent, where that effort parameterizes the impact on effort on the non-contractible task through ρ. This has largely been for expositional simplicity. To see this, consider a case where the agent exerts two efforts, e_x on the contractible tasks and e_y on the non-contractible task, where outputs are given by

$$x(a, e_x) = e_x h_x(a) + \kappa_x(a) \tag{27}$$

and

$$y(a, e_y) = e_y h_y(1 - a) + \kappa_y(1 - a). \tag{28}$$

The cost of effort is given by $C(e_x, e_y)$, where $C_{ii} > 0$, and C_{ij} can be positive or negative. To allow the usual Holmstrom Milgrom possibility of the agent exerting effort without incentive pay, we assume that $C_2(., 0) \leq 0$ so that positive effort can arise without explicit incentives. For any allocation of assets, the agent's efforts are given by $\beta x_2(a, e_x) = C_1(e_x, e_y)$ and $C_2(e_x, e_y) = 0$.

First consider the case with authority in the hands of the agent. Let e_i^d be the effort exerted on task i with delegation. She continues to allocate all the assets to the contractible task. Knowing this, the principal then chooses incentives to maximize $x(1, e_x^d) + y(0, e_y^d) - C(e_x^d, e_y^d)$ subject to the incentives above. The optimal choice of incentives solves

$$x_2(1, e_x^d)\frac{de_x^d}{d\beta} + y_2(0, e_y^d)\frac{de_y^d}{d\beta} = C_1(e_x^d, e_y^d)\frac{de_x^d}{d\beta} + C_2(e_x^d, e_y^d)\frac{de_y^d}{d\beta}. \tag{29}$$

Substituting for $C_1(e_x, e_y)$ and $C_2(e_x, e_y)$ yields

$$\beta_d^* = 1 + \frac{y_2(1, e_y^d)}{x_2(0, e_x^d)}\left(\frac{\frac{de_y^d}{d\beta}}{\frac{de_x^d}{d\beta}}\right). \tag{30}$$

But totally differentiating the agent's incentives to exert non-contractible effort $C_2(e_x, e_y) = 0$ yields $\frac{de_y^d}{d\beta} = \frac{-C_{12}}{C_{22}} \frac{de_x^d}{d\beta}$, and so optimal incentives simplify to

$$\beta_d^* = 1 - \frac{\frac{C_{12}}{C_{22}} h_y(0)}{h_x(1)}. \tag{31}$$

Comparing (31) to (7) shows that this is identical to the single effort parameterization above, where $\rho = -\frac{C_{12}}{C_{22}}$ picks up the cross partial in the agent's cost function. As in the usual multi-tasking logic, a positive cross partial reduces pay for performance.

Now consider the case where the principal has authority, where e_i^p is the effort exerted on task i in that case. Similar calculations show that in this case,

$$\beta_p^* = 1 - \frac{\frac{C_{12}}{C_{22}} h_y(1 - a_p)}{h_x(a_p)} + (\frac{x_1 - y_1}{x_2}) \left(\frac{da_p}{d\beta}\right) \left(\frac{de_x^p}{d\beta}\right)^{-1}. \tag{32}$$

Hence the model conceptually extends to a two effort case in an intuitive manner. The analog to (16) is now given by

$$\beta_d^* - \beta_p^* = \frac{-\frac{C_{12}(e_x^d, e_y^d)}{C_{22}(e_x^d, e_y^d)} h_y(0)}{h_x(1)} - \frac{-\frac{C_{12}(e_x^p, e_y^p)}{C_{22}(e_x^p, e_y^p)} h_y(1 - a_p)}{h_x(a_p)} - (\frac{x_1 - y_1}{x_2}) \left(\frac{da_p}{d\beta}\right) \left(\frac{de_p}{d\beta}\right)^{-1}. \tag{33}$$

As in the benchmark model, the capital allocation term $\frac{h_y}{h_x}$ is scaled proportionately, though here by $-\frac{C_{12}}{C_{22}}$. However, although the $\frac{C_{12}}{C_{22}}$ terms are identical in both cases, they are being evaluated at different effort levels. The results from the benchmark model hold exactly in the case where $\frac{C_{12}}{C_{22}}$ is independent of effort levels, which arises if the effort cost function is quadratic. Yet if third derivates are important, the caveat regarding non-affine technologies also applies here. Hence, conditional on third derivatives on the cost function being small, the results continue to hold.

Aghion and Tirole: Aghion and Tirole, 1997, present a theory of control that also exhibits a possible interaction between effort and authority.[12] In that work, an agent exerts effort to identify the returns to possible projects, and (with authority) the principal then

[12] See Levy, 2014, for an extension of this that allows testable comparative statics based on the kinds of managers and projects proposed.

responds by choosing which project to implement. As in this work, the returns to the agent's effort depends on how that authority will be exercised. (In Aghion and Tirole, the agent exerts effort in the expectation of receiving private benefits from a particular project.) The possibility that the principal uses his authority in a way that harms the agent acts as a disincentive for her to exert effort.

A simple parametrization of this model has a similar flavor. In Aghion and Tirole, exerting effort makes it more likely that each of two projects will create surplus. A benchmark case is where the returns to effort are symmetric across the two projects. Accordingly, using the notation of this model, assume that $x(e, a) = eh(a)$ and $y(e, a) = eh(1 - a)$, where h is strictly concave and where $h(0) = 0$. Hence, project success depends not just on agent effort but also supporting assets, but effort makes both outputs increase. In Aghion and Tirole, a discrete decision is made after effort is exerted, where one project is implemented. The flavor of this discreteness is captured here by discrete asset allocations. Specifically, the principal either allocates all the asset to one task ($a \in \{0, 1\}$), or to split them equally ($a = \frac{1}{2}$).[13]

First consider the case where the principal has control over the asset. The principal needs the agent to exert effort in order to generate surplus. This requires that, in equilibrium, at least some assets are assigned to the contractible task: otherwise, the agent exerts no effort. There are then two candidates: where the assets are split, or where they are all assigned to the contractible task. Consider the case where the optimum - ignoring the principal's incentives - is to split the assets equally. In such an equilibrium, the agent's effort is given by $\beta h(\frac{1}{2}) = C'(e_p^*)$. As the agent also generates returns on the non-contractible task, efficient effort requires that $2h(\frac{1}{2}) = C'(e_p)$. Hence all else equal, optimal incentives require $\beta_p^* = 2$.

However, $\beta_p^* = 2$ cannot be an equilibrium. It only arises if the principal is willing to assign half of the asset to the contractible task given that level of incentives. At the point of choosing, the return to the principal from doing so is $(1-\beta)x(e_p^*, \frac{1}{2}) + y(e_p^*, \frac{1}{2})$. If she instead deviates and allocates all to the non-contractible task, her return is $y(e^*, 1)$. She then only

[13]One interpretation of this is that an equal split renders both projects feasible (with lower probability), whereas allocating all to one tasks rules out success in the other.

splits the assets if $(1-\beta)x(e_p^*, \frac{1}{2}) + y(e_p^*, \frac{1}{2}) \geq y(e_p^*, 1)$ or

$$(2-\beta)h(\frac{1}{2}) \geq h(1). \tag{34}$$

By concavity, this is guaranteed for β low, but is violated for β sufficiently high. In this case, the maximum pay for performance that is consistent with effort exertion under authority is given by $\underline{\beta}_p = 2 - \frac{h(1)}{h(\frac{1}{2})} < 1$. In words, the exercise of authority by the principal constrains incentive pay below the efficient level. In this model, it is a discrete constraint unlike the continuous case above, but the logic is similar.

Note that so far we have assumed that the optimum is to split the assets. This is the only feasible equilibrium when the principal's incentives are taken into account. To see this, note that there is no equilibrium where all assets are allocated to the contractible task. For any possible equilibrium with positive effort, the principal benefits by deviating to $a = 0$ as he does not have to pay the agent for non-contractible output. As a result the only feasible equilibrium is to split the assets. Hence, surplus from the principal holding authority is $2e(\underline{\beta}_p)h(\frac{1}{2}) - C(e(\underline{\beta}_p))$, where $\underline{\beta}_p h(\frac{1}{2}) = C'(e(\underline{\beta}_p))$.

Now consider the case where control is delegated to the agent. She assigns all the asset to the contractible task, which is harmful for a fixed effort level by concavity of the h function. However, incentives need not be constrained. By contrast, efficient effort can be achieved by setting $\beta_d^* = 1$ under delegation. As $\underline{\beta}_p < 1$, once again pay for performance is lower with a principal holds authority. Hence one can interpret these results on formal contracting in a set-up with a similar spirit to Aghion and Tirole.[14]

7 Choosing control rights

So far, we have addressed the tradeoffs for each control rights case. In many instances, changing control rights is not a realistic option: often only one party has the relevant infor-

[14]An alternative way to induce congruence of interests, enunciated in Rotemberg and Saloner, 1994, is through a narrow business strategy, where principal commits to only choose from certain activities. In that work, congruence is improved not through contracts but through the limits of authority.

mation or skill to make appropriate changes (Rosen, 1982, Garicano, 2000). As an example, consider this in the context of a franchisee. An important input to this is company wide media advertising, which realistically cannot be delegated to an individual franchisee. Or a senior executive who is assigning budgets across divisions based on some larger company-wide strategic objective. These cases fits best the modeling above where we address the outcomes where either the principal makes all choices or the agent does so.

However, now consider the case where the principal chooses control rights as part of the contract with the agent. First consider the case where each party is able to assign the assets, but one party needs control over all them. For example, having one party assign all assets would be important when the assets are heterogeneous and need to be combined in unpredictable ways. Then the optimal choice is simply a comparison of the two cases above. The surplus from delegating to the agent is

$$S_d = x(e_d, 1) + y(e_d, 0) - C(e_d), \tag{35}$$

and the surplus from authority is

$$S_p = x(e_p, a_p) + y(e_p, a_p) - C(e_p). \tag{36}$$

The tradeoff is straightforward. Delegation distorts assets towards contractible outcomes, but has the advantage that incentive pay will likely be higher, resulting in higher effort. Authority has the advantage that it assigns assets to both activities (though too much is allocated to the non-contractible outcomes), but effort is likely lower.

One feature of contracting that looms large in the agency literature is the ability to monitor performance. This section offers an interpretation of this issue. Consider the case with $\rho \leq 0$, but where x is only observed with probability $m \leq 1$, where with probability $1-m$ observed performance is independent of e and a. (Measurement on the non-contractible task is irrelevant.) Technically, with probability $1-m$ "nothing" is observed from the contractible task, whereas with probability 1, "nothing" is observed from the non-contractible task. m here measures uncertainty in evaluation or monitoring error. The first order condition for the agent is now given by

$$m\beta h_x(a) = C'(e), \tag{37}$$

as output is only observed with probability m. Other than this, the problem is unchanged.

Imperfect monitoring does not affect maximum surplus achieved under delegation. If β_d^* is optimal without the monitoring problem, the optimal contract is now amended to $\frac{\beta_d^*}{m}$ and surplus is unchanged. As a result, worse monitoring makes no difference to allocations under delegation.

By contrast, poor monitoring reduces surplus under authority. This arises because (i) poor monitoring requires that incentive pay be scaled up proportionately to induce the same level of effort, and (ii) the distortions in asset allocations under authority are increasing in the level of β from (13). By a natural extension of (15), the first order condition for optimal β is now given by

$$\beta_p^* = \frac{1 + \frac{y_2}{x_2}}{m} + \frac{(x_1 - y_1)}{m x_2}\frac{da}{d\beta}(\frac{de}{d\beta})^{-1}. \tag{38}$$

This is increasing in m.[15] But the distortions from authority are increasing in the level of β so that increased monitoring, the surplus from authority falls with m. Hence delegation becomes more likely with worse monitoring, and the second empirical finding in this literature can be interpreted through the lens of the model above.

The typical way in which performance measurement issues are empirically tested is through measures of risk or uncertainty. The interpretation is that risk or uncertainty renders measurement of true performance more difficult. There is considerable empirical work identifying the relationship between such measures of risk and the likelihood that a firm delegates authority to workers. The evidence is provided in Table 2 and shows that delegation is a response to riskier settings. Interpreting risk as a measure of monitoring difficulties, this once again supports the predictions of the model.

[15] As an example, consider the additively separable case, $x(a,e) = e + \kappa_x(a)$ and $y(a,e) = \rho e + \kappa_y(1-a)$. Then $\beta_d^* - \beta_p^* = -\frac{C''\kappa_x'(\kappa_x' - \kappa_y')}{m((1-\beta)\kappa_x'' + \kappa_y'')}$, which is decreasing in m.

Divisible Assets So far, we have addressed instances where it is impossible to contract on how assets are used, but it is feasible to assign control over *all* the assets to one party is feasible. Now consider a case where it is possible to assign some assets to one party and the remainder to the other party, but where the parties hold discretion over how to allocate the assets under their control. As an example, the principal controls some marketing resources and the agent controls others. Or each is given control of some support staff. This section addresses how the divisibility of control rights can alleviate the concerns above. To give this possibility its best chance, assume that any asset can carry out each task equally, so all that matters for surplus is the total asset allocation to each task. (This would be the case where all assets are divisible and perfect substitutes.)

Consider this in a setting where where one party has a comparative advantage in the allocation of the assets. For illustrative purposes, consider instances where the principal is better able to allocate the assets. The payoffs to the principal allocating are as above, whereas the payoffs to the agent allocating are lower as she incurs a cost to acquire the skills to do so. Specifically, if the agent is assigned A assets to allocate, there is an additional cost $L(A)$, where $L' \geq 0$, $L'' \geq 0$. These could be fixed costs and/or marginal costs. (This interpretation is reminiscent of Levy, 2014, who addresses the exercise of authority in settings where a principal has a comparative advantage in overturning agent recommendations, though in his case this comparative advantage varies by the kind of projects proposed.)

When the assets are divisible, the agent is given A assets, and the principal retains $1-A$ to allocate, where A is chosen ex ante. The outcome here is straightforward. If both parties are close to equally well able to allocate assets (L' low) the first best can be (almost) attained by having the agent carry out a^* (which she will allocate all to the contractible task) and the principal will allocate the remainder to the non-contractible task. If $L(a^*)$ is higher, then the outcome either involves the agent being given some assets to allocate but below a^* with the principal retaining the residual, or if $L'(0)$ is sufficiently large, it involves the principal being assigned all the assets. In the former case, the marginal distortions from the principal's authority derives from how he allocates the residual $1 - A$, as his first order condition for allocating is now given by $(1-\beta)x_1(e, A+a) = y_1(1-A-a)$ or he assigns none of his residual assets to that task (if $(1-\beta)x_1(e, A) > y_1(1-A)$). Hence the model remains conceptually unchanged, but operates on the margin of the principal's residual authority. The same logic applies in reverse for the case were the agent has the comparative advantage.

Capital Budgets The previous subsection addresses a case where a fixed set of assets can be split. Here we address the case where assets have to be assigned to one party or the other, but the level of assets given is endogenous. The idea here is that firms typically also control capital budgets, and these could depend on control rights. As in the last section, we assume that a stock of assets can be assigned to a party, but how those assets are allocated is not contractible. As an example, everyone can see the number of employees under a manager's control, but how they are used is not contractible. To address this, consider a case where the principal can choose a stock of assets $\overline{a}$ which has marginal capital cost of r. The timing of the game changes only in one sense. As part of the contract, the principal now commits to a capital budget $\overline{a}$ which can depend on control rights. Optimal choices are then made subject to this level of capital.

The optimal choice of capital budget in either case is given by

$$x_1(a,e)\frac{da}{d\overline{a}} + y_1(\overline{a}-a,e)[1-\frac{da}{d\overline{a}}] + (x_2+y_2-C')\frac{de}{d\overline{a}} = r. \tag{39}$$

Thus, the capital budget affects not just direct marginal productivity (the x_1 and y_1 terms) but also affects effort.

Proposition 3 *Assume that the principal chooses $\overline{a}$.*

- *If control is delegated, the optimal capital budget is below the first best.*
- *If effort and assets are additively separable, and h_i are symmetric and quadratic, the capital budget is not only higher under authority but also exceeds the first best level.*

The logic behind the first part of this is straightforward. First, under delegation the agent assigns all assets to the contractible task. As a result, the agent should be assigned assets equal to the optimal level for that task, rather than for both tasks, which implies a lower capital budget. The only exception to this would be if a higher capital budget increases surplus through more effort. However, incentives are set such that effort is at its first best level under delegation, so that there is no benefit to increasing effort further. As a result, capital budgets are below first best levels under delegation.

It is hard to make conclusive statements about capital budgets when the principal holds authority. However, there are two factors which lead to higher budgets than with delegation. First, from (12), effort is increasing in a if $x_{12} > 0$. Then if $\frac{da}{d\bar{a}} > 0$ (as will generally be the case), a larger stock of assets can be used to induce effort exertion. Second, note that under authority, for a given asset budget, too few assets are assigned to the contractible task, and too many to the non-contractible task. Not surprisingly, increasing the asset budget results in more being assigned to both tasks. Moving along that expansion path can also increase welfare such that the optimal capital budget exceeds first best levels. This is shown to always be the case with symmetric quadratic returns to capital.

Budget Breaking In the model, the principal gains when the agent is not paid. If feasible, one solution to this problem could be budget breaking, as in Zabojnik, 1998, where the principal's rewards do not depend on wage payments. In this way, his incentive to cut wage payments can be eliminated. Of course, this solution also applies to many other literatures where firms are tempted to renege to save on wage payments. Realistically, however, selling the firm to all actors is difficult to implement.

8 Discussion

What constrains incentive pay? Two candidates have dominated the literature: measurement error and agent multi-tasking. This article argues that the strong empirical relationship between delegation of authority and incentive pay may reflect an additional constraint, namely, the potential abuse of authority resulting from incentive pay.

A common lens for viewing the impact of authority on incentive pay is Holmstrom and

Milgrom, 1991. Consider a setting where an agent carries out multiple activities, and where delegating authority to the agent allows her discretion over how to use her time. A problem then arises when some activities are monitored better than others, and all else equal would have higher incentive pay. When efforts are substitutes across tasks, delegation of control likely causes agents to substitute effort away from the low reward activities to the higher reward activities. If the agent retains these control rights, the firm mitigates this by balancing pay for performance across activities. In this setting, where one activity cannot be contracted upon, this would imply reducing pay for performance on the contractible task. Alternatively, the firms could take control rights away from the agent, say by banning some activities. In that case the firm needs not reduce pay for performance as much because the multitasking problem is reduced. Yet this suggests that delegation of authority for agents should be associated with less pay for performance, whereas the empirical evidence indicates the opposite.[16]

The evidence on the relationship between incentive pay and authority is typically argued to support the implications of Prendergast, 2002. The idea behind that work is as follows: a principal can either tell an agent which action to take, or can allow her to choose. If she specifies her action, no incentive pay is necessary. By contrast, delegation requires incentive pay as the agent is not trusted to carry out the correct action. The firm then delegates when it does not know the correct action for the agent to take. This arises when there is more uncertainty, and so (i) delegation is more likely when uncertainty is greater, and (ii) incentive pay is more likely with delegation. Both outcomes are empirically supported.

Note two features of that model. First, although pay for performance is lower under authority, in no sense does authority constrain the use of incentive pay: instead, it is simply not necessary as the principal tells the agent what to do and monitors that is has been done. By contrast, this article argues that incentive pay distorts the principal's actions.

[16] Of course, the Holmstrom-Milgrom setting is sufficiently flexible to allow many outcomes: in this case, it would require that efforts are complements across tasks, which is not the usual supposition made in this literature.

Second, a key assumption in Prendergast, 2002, is that only agents hold private information, and that their informational advantage increases with more uncertainty. However, there is no necessary link between uncertain environments and agents holding an informational advantage. In many settings, superiors know more about the environment than do agents; for example, the success of marketing plans, the actions of competitors, regulations that may be implemented, and so on. The logic of Prendergast, 2002, requires that with more uncertainty, the value of the agent's private information rises *relative to* any private information that the principal holds.

This would not be a major concern if the measures of uncertainty used in the empirical work were specifically about what agents know rather than their superiors. Yet uncertainty is typically measured through the standard deviation of sales or profits (see Table 2). These are not inherently local measures of uncertainty. The identifying assumption for these tests is that more of such uncertainty results in the agent becoming relatively more informed. So, for example, when a bank has riskier profits, it tilts the balance of private information towards individual bank managers rather than their superiors. This may not be true. For instance, randomness in the sales of the bank could have much more to do with aggregate shocks (interest rates, competitors actions, consumer confidence etc.) than the kinds of local branch level shocks which agents on the ground may have better information on. As such, these tests at times feel unpersuasive. The model here does not rely on such an assumption.

It is also important to note that the results rely heavily on the moral hazard nature of the decisions made by the principal. Specifically, the principal cannot commit to his asset allocation decisions. If he could, then many of the outcomes that arise here would not occur. When the principal can commit ex ante, strategic choice of the use of authority can help to induce effort exertion, in settings where effort decisions are made after assets are allocated. This insight arises in Zabojnik, 2002, Van Den Steen, 2010, and Marino, Matsusaka, and Zabojnik, 2012. Formally, this is excluded here by assuming simultaneous choices. In reality, the motivation is that the agent fears that after she exerts effort, supporting assets will simply be reallocated to other activities.

To conclude, this article provides an interpretation of a consistent empirical relationship between worker control rights and incentive pay. Since Simon, 1951, it has been known that the potential for abuse of authority can constrain efficiency. A contribution here is that such abuse of authority is exacerbated by incentive pay. Taking this lens allows us to interpret one of the few clear empirical facts in the literature on incentive contracting. Furthermore, the article offers auxiliary implications on the responsiveness of performance to pay that are potentially testable.

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9 Appendix A

Incentives with Delegation: For any sharing rule β, the agent chooses e_d where $\beta x_2(1, e_d) = C'(e_d)$. Incentives are then chosen to maximize $x(1, e) + y(0, e) - C(e)$ subject to (6). The optimal choice of incentives is given by $x_2(1, e_d) + y_2(0, e_d) = C'(e_d)$. Substituting for $C'(e_d)$ from above yields $\beta_d^* = 1 + \frac{y_2(0,e)}{x_2(1,e)}$.

Incentives with Authority: The principal chooses a to maximize $(1-\beta)x(a, e) + y(a, e)$ for fixed e. If the choice is interior, he chooses $(1-\beta)x_1(a, e) = y_1(1-a, e)$. The effort choice does not affect capital allocations, so optimal e is given by $\beta x_2(a, e) = C'(e)$. The second order conditions trivially hold here. Totally differentiating (10) and (11) with respect to β yields comparative statics given by the solution to this pair of simultaneous equations

$$\frac{de_p}{d\beta} = \frac{h_x}{C''} + \frac{\beta h'_x}{C''}\frac{da_p}{d\beta} \tag{40}$$

and

$$\frac{da_p}{d\beta} = \frac{x_1}{(1-\beta)x_{11} + y_{11}} + \frac{-(1-\beta)h'_x + \rho h'_y}{(1-\beta)x_{11} + y_{11}}\frac{de}{d\beta}. \tag{41}$$

By substitution,

$$\frac{de_p}{d\beta} = \frac{h_x + \frac{\beta h'_x x_1}{(1-\beta)x_{11}+y_{11}}}{C'' - \frac{\beta h'_x(ph'_y-(1-\beta)h'_x)}{(1-\beta)x_{11}+y_{11}}} \tag{42}$$

and

$$\frac{da_p}{d\beta} = \frac{\frac{x_1}{(1-\beta)x_{11}+y_{11}} + \frac{h_x(ph'_y-(1-\beta)h'_x)}{C''((1-\beta)x_{11}+y_{11})}}{1 - (\frac{\rho h'_y-(1-\beta)h'_x}{(1-\beta)x_{11}+y_{11}})\frac{\beta h'_x}{C''}}. \tag{43}$$

Optimal incentive pay is chosen to maximize surplus subject to (42) and (43), and the optimal choice of incentive pay is given by

$$(x_2 + y_2 - C')\frac{de_p}{d\beta} + (x_1 - y_1)\frac{da_p}{d\beta} = 0 \tag{44}$$

Finally, note that $\beta_p x_2(a_p, e) = C'(e)$ and so by substituting,

$$\beta_p^* = 1 + \frac{y_2(1-a_p, e)}{x_2(a_p, e)} + (\frac{x_1 - y_1}{x_2})\left(\frac{da_p}{d\beta}\right)\left(\frac{de_p}{d\beta}\right)^{-1}. \tag{45}$$

As $\beta \geq 0$, $(x_1 - y_1) \geq 0$. Furthermore, in equilibrium $\frac{da_p}{d\beta} < 0$. Assume otherwise. It can only be the case that $\frac{da_p}{d\beta} > 0$ if $\frac{de_p}{d\beta} > 0$ also. But if $\frac{da_p}{d\beta} > 0$ and $\frac{de_p}{d\beta} > 0$, equilibrium requires that $x_2 + y_2 - C' < 0$. But $x_2 + y_2 - C' < 0$ cannot be an equilibrium with $\frac{da_p}{d\beta} > 0$ and $\frac{de_p}{d\beta} > 0$ as surplus is increased by reducing β as effort falls and asset assignments become more efficient. Furthermore, the assumption that $y_1 = 0$ at $a = 0$ guarantees that values of a_p exist such that $\frac{da_p}{d\beta} < 0$. Hence equilibrium requires that $\frac{da_p}{d\beta} < 0$. However, if $\frac{da_p}{d\beta} < 0$, this additionally implies that $\frac{de_p}{d\beta} > 0$. Therefore, $(\frac{x_1-y_1}{x_2})\left(\frac{da_p}{d\beta}\right)\left(\frac{de_p}{d\beta}\right)^{-1} \leq 0$.

Proof of Proposition 1: Note that $\beta^*_d - \beta^*_p = \left(\frac{y_2(0,e)}{x_2(1,e)} - \frac{y_2(1-a_p,e)}{x_2(a_p,e)}\right) - (\frac{x_1-y_1}{x_2})\left(\frac{da_p}{d\beta}\right)\left(\frac{de_p}{d\beta}\right)^{-1}$. The second term is negative so a sufficient condition for $\beta^*_d - \beta^*_p > 0$ is that the first term is non-positive. If $y_e = 0$, then the first term is 0, and so the condition holds. This first term can be simplified to $p\left(\frac{h_y(0)}{h_x(1)} - \frac{h_y(1-a_p)}{h_x(a_p)}\right)$. As $h''_i < 0$, the term in brackets is negative. Hence if $\rho < 0$ the entire term is positive, as required.

Proof of Proposition 2: Note that asset allocations under authority are given by $a_p = \frac{1-\frac{\beta}{\mu}}{2-\beta}$, for low enough β and high enough μ, or $a_p = 0$ otherwise. The solution is interior if $\mu > \beta$. Note that $\frac{da_p}{d\beta} = \frac{1-\frac{2}{\mu}}{(2-\beta)^2} < 0$ if the outcome is interior. The marginal return to exerting effort rises in β only if $\frac{h_x}{h'_x} < \beta\frac{da_p}{d\beta}$ or

$$\frac{a_p - \frac{\mu a_p^2}{2}}{1-\mu a_p} > -\frac{\beta(1-\frac{2}{\mu})}{(2-\beta)^2}. \tag{46}$$

For μ small enough, $a_p = 0$, and as a result $e = 0$. In this case effort is independent of β. This arises if $\mu < \beta$. In order to consider the case where effort is still positive, consider the case where $\mu > \beta$ but is close to β, so that $a_p \approx 0$. Then (46) becomes (almost)

$$0 > -\beta(1-\frac{2}{\mu})\left(\frac{2-\mu}{2-\beta}\right) = \beta\frac{(2-\mu)^2}{\mu(2-\beta)}, \tag{47}$$

which is always violated. As a result, for μ small enough, yet where effort is positive, increased β reduces effort.

Proof of Proposition 3: The delegation case is straightforward. First note that $\frac{da}{d\overline{a}} = 1$ and $x_2 + y_2 = C'$ (as the optimal $\beta = 1 + \frac{y_2}{x_2}$) so that (39) simplifies to $x_1(\overline{a}^*_d, e^*_d) = r$, where effort is given by $x_2(\overline{a}_d^*, e_d^*) = C'$. First best allocations solve $x_2(\overline{a}_d^{**}, e_d^{**}) = C'$, $x_1(\overline{a}_{xd}^{**}, e_d^{**}) = r$, and $y_1(\overline{a}_{yd}^{**}, e_d^{**}) = r$, where the optimal budget is $\overline{a}_d^{**} = \overline{a}_{xd}^{**} + \overline{a}_{yd}^{**}$. As $y_1 \geq 0$, this implies that the optimal capital stock under delegation is below the first best level.

Authority If effort and assets are additively separable, then (39) simplifies to

$$x_1(e,a)\frac{da}{d\overline{a}} + y_1(e, \overline{a} - a))[1 - \frac{da}{d\overline{a}}] = r, \tag{48}$$

which can be simplified to

$$h_x'(a)\frac{h_y''}{h_y'' + (1-\beta)h_x''} + h_y'(\overline{a} - a))\frac{(1-\beta)h_x''}{h_y'' + (1-\beta)h_x''} = r. \tag{49}$$

The solution to this determines the optimal capital budget. If $\beta > 0$, there are two conflicting effects here. First, capital is poorly assigned, as $h_x'(a) > h_y'(\overline{a} - a)$ in equilibrium. The effect that this has on optimal budgets depends on the third derivative of the h_i functions. To ignore this effect, consider the quadratic case where $x(e,a) = e + a - \frac{\mu a^2}{2}$ and $y(e,a) = \rho e + \overline{a} - a - \frac{\mu(\overline{a}-a)^2}{2}$. (The optimal outcome implies $\overline{a} < \frac{2}{\mu}$, as marginal products would otherwise be negative for at least one of the activities.) The first best capital budget maximizes $\overline{a} - \mu\frac{\overline{a}^2}{2} - r\overline{a}$ and so $\overline{a}^* = \frac{2(1-r)}{\mu}$. Here simple computations show that $a = \frac{\mu\overline{a}-\beta}{\mu(2-\beta)}$. The optimal choice with $\overline{a}$ is the solution to

$$(1 - \mu a)\frac{da}{d\overline{a}} + (1 - \mu(\overline{a} - a))[1 - \frac{da}{d\overline{a}}] = r, \tag{50}$$

where $\frac{da}{d\overline{a}} = \frac{y_{11}}{y_{11} + (1-\beta)x_{11}} = \frac{1}{2-\beta}$. The solution to this equation is given by

$$\overline{a} = \frac{(2-\beta)^2(1-r) + \beta^2}{\mu(2 - 2\beta + \beta^2)} > \overline{a}^*, \tag{51}$$

for $\beta > 0$ as required. Hence in the example authority results in excessive capital budgets relative to the first best.

Table 1: The Relationship between Supervisor Authority and Worker Pay-For-Performance.

Authors	Occupation/Sample	Result
McLeod and Parent (1999)	National Survey (U.S.)	< 0
Nagar (2002)	Bank Branch Managers (U.S.)	< 0
Foss and Lauren (2005)	Managers (Denmark)	< 0
Wulf (2007)	Division Managers (U.S.)	< 0
De Varo and Kurtulus (2010)	National Sample (Britain)	< 0
Ghosh, Lafontaine, and Lo (2011)	Sales Force Workers (U.S.)	< 0
Ben Ner, Kong, and Lluis (2012)	Firms in Minnesota	< 0

Table 2: The Relationship between Supervisor Authority and Risk.

Authors	Relationship to risk	Risk Measure
Nagar (2002)	< 0	Standard Deviation of Income
Foss and Lauren (2005)	< 0	Standard Deviation of Profits
Wulf (2007)	< 0	Standard Deviation of Sales Growth
De Varo and Kurtulus (2010)	< 0	Market described as "turbulent"
Ghosh, Lafontaine, and Lo (2011)	< 0	Reported Difficulty of Supervision
Ben Ner, Kong, and Lluis (2012)	< 0	Volatility of Income