The international platform of Ludwig-Maximilians University's Center for Economic Studies and the Ifo Institute

CESifo Working Papers

www.cesifo.org/wp

# Optimal Contracting with Endogenous Project Mission

Lea Cassar

CESifo Working Paper No. 6181
Category 4: Labour Markets
November 2016



***ISSN 2364-1428***

CESifo
Center for Economic Studies & Ifo Institute

CESifo *Working Paper No. 6181*

# Optimal Contracting with Endogenous Project Mission

## Abstract

I analyze a model in which a principal offers a contract to an agent and can influence the agent's marginal return of effort by the choice of the project mission. The principal's and the agents' mission preferences are misaligned, and the agents have unobservable intrinsic motivation levels. I show that the non-contractibility of effort (asymmetric information) brings the mission closer to the agent's (principal's) preferences. Furthermore, when effort is non-contractible, the optimal mechanism i) has a "double distortion"' in the mission; ii) does not exclude low-types agents; and iii) can be implemented through a scoring auction. Several applications are discussed.

JEL-Codes: H410, D230, D820, M520.

Keywords: optimal contracting, non-monetary incentives, mission preferences, intrinsic motivation.

*Lea Cassar*
*University of Cologne*
*Albertus-Magnus Platz*
*Germany - 50937 Cologne*
*lcassar@uni-koeln.de*

November 2, 2016
I am particularly grateful to Konrad Mierendorff, Nick Netzer and Alexey Kushnir for their useful comments at different stages of the development of the project. I also would like to thank Gani Aldashev, Charles Angelucci, Mark Armstrong, Bjoern Bartling, Roland Benabou, Jean-Michel Benkert, Guillermo Caruana, Wouter Dessein, Florian Ederer, Florian Engl, Florian Englmaier, Matthias Fahn, Sebastian Findeisen, Maitreesh Ghatak, Marina Halac, Jasper Hansen, Holger Herz, Lea Heursen, Jacob Goeree, Igor Letina, Gerard Llobet, Bentley MacLeod, Ester Manna, Takeshi Murooka, Andrew Newman, Georg Nöldeke, Andrea Prat, Michael Powell, Maria Saez, Sarah Sandford, Klaus Schmidt, Ferdinand von Siemens, Marta Troya-Martinez, John Vickers, Roberto Weber, participants at the Workshop on Public Organizations, LSE N.G.O. workshop, Zurich Workshop of Economics, and European Public Choice Conference, for useful comments and suggestions. This paper has won the best paper award on "Public Organizations" sponsored by Unicredit & Universities Foundation.

# 1. Introduction

Empirical studies show that workers' motivation is often driven by the mission of their projects, in addition to financial rewards.[1] A project mission can be broadly defined as the overall project's design and characteristics: the type of good that is provided, how it is provided, to whom it is provided, and so on. For instance, the project mission can include the targeted beneficiaries of a social project, the political orientation of a journalistic project, the topic of a research project, or the teaching curriculum and the rules of conduct in an educational project. In companies, a mission may include not only the financial target of a project but also its social impact, e.g., through investments in corporate social responsibility. This evidence suggests that the project mission can be used as a contracting tool by both public and private organizations to incentivize and screen their workers. To date, however, we know little about the role of the mission in optimal contracting.

There are several reasons why the study of the mission is relevant for contracting. First, different actors involved in the provision of public goods, such as the procurer versus the executor, or the employer versus the worker, may have different views on how to design the project, i.e., different mission preferences. For example, an international aid contractor may have different views on the role of religion in a school curriculum compared to a local non-governmental organization (NGO) in a developing country (Besley and Ghatak, 1999, 2001, 2005). An editor and a journalist may disagree on what stories to cover or on the political orientation to give to an article. Government agencies and private foundations that fund research projects may have different research agendas, typically more policy oriented compared to those of scientists. In the case of companies, employees may care about CSR investments, while the firm may be focused solely on profit. Second, individuals vary in the extent to which they care about the mission, and this is usually not observable: some individuals may feel very strongly about the project mission, while others may care mostly about the financial compensation for doing the project. Third, in several contexts, such as in the provision of public goods, output is often not contractible and output-contingent rewards are rarely used (Francois and Vlassopoulos, 2008). Hence, the choice of the project mission, by affecting workers' intrinsic rewards for doing the project, becomes a crucial instrument to motivate effort.

The above-mentioned observations raise a number of interesting questions. How should a principal select the agent who carries the project? Should the project mission reflect the preferences of the principal or those of the agent? What is the effect of non-contractibility of effort and of informational asymmetries about agents' motivation on the optimal mechanism?

[1] See Cassar and Meier (2016) for a recent literature review.

To address these questions, I develop and analyze a model in which a principal offers a contract to an agent for the development of a project and can influence the agent's marginal return of putting effort into the project by the choice of the project mission. Indeed, both the principal and the agent derive an intrinsic benefit from pursuing certain (observable) missions and, therefore, from the project being designed in a certain way. The closer the project mission is to an agent's ideal mission, the higher the agent's marginal return of effort. However, the mission preferences of the principal and of the agents are misaligned, and the agents vary in how much they care about the mission, i.e., they have heterogeneous intrinsic motivation levels. I consider two variations of the model: i) whether effort is contractible or not and, ii) whether information about the agent's intrinsic motivation is complete or asymmetric. In the last part of the paper, I allow multiple agents and derive the optimal mechanism to select and incentivize an agent.

My findings suggest that the non-contractibility of effort brings the project mission closer to the agent's preferences, while asymmetric information about the agent's motivation brings the project mission closer to the principal's preferences. The intuition for the first result is that in addition to increasing the agent's intrinsic benefit from doing the project, and thus, to reducing his payment, the project mission acts as an incentive device when effort is non-contractible. In fact, the agent under-invests in effort compared to the first-best level. Hence, the principal extracts additional effort by moving the project mission towards the agent's preferences. The intuition for the second result is that by moving the project mission away from the agent's preferences, the principal makes the contract of lower-types less attractive for the higher types and thereby reduces their informational rents. Therefore, my model generates the predictions that projects' or organizations' missions will be closest to workers' (employers') preferences in sectors and industries where output is non-contractible (contractible) and where the uncertainty about workers' motivation is low (high), e.g., in sectors with high (low) competition and large (small) labor supply.

When effort is non-contractible, I also find the following results. First, the informational asymmetry leads to a "double distortion" in the optimal mission compared to the full-information optimum: a standard distortion that reduces the agent's intrinsic return of effort holding the agent's effort fixed, and an additional distortion that aims at reducing the agent's effort. In fact, when effort is contractible, this additional distortion of the mission is absent because the principal can directly distort the contracted effort level. This distortion in the contracted effort level contributes to reducing the informational rent that should be paid to the agents with higher intrinsic motivation. However, when effort is not contractible and, therefore, cannot be directly distorted, the principal needs to move the project mission even closer to her own preferences in order to induce the agent to exert less effort.

Second, contrary to a standard result in auction theory, it is not optimal to exclude low-types agents from the competition. When effort is non-contractible, the surplus of the agent is non-negative even for the lowest type because an agent has always the option of putting zero effort into the project. Hence, the optimal payment to the agent when effort is non-contractible is always non-positive,[2] and this can be shown to lead to a positive virtual total surplus for all types. On the contrary, when effort is contractible, the surplus of the lowest-type agent is negative because the latter is forced to exert more effort compared to the level that maximizes his utility. Hence, the participation constraint requires a positive financial compensation to the lowest type, which can lead to a negative virtual total surplus of the agents with low intrinsic motivation.

Third, I show that the optimal mechanism can be implemented through a scoring auction whose scoring rule–i.e., the rule that determines the auction's winner by assigning scores to all bidders–is equal to the principal's utility function plus two additional terms that induce the agents to bid on a project mission that is closer to the principal's preferences.

This paper belongs to the contract theory literature with motivated agents (Murdock, 2002; Francois, 2003; Benabou and Tirole, 2003, 2006; Besley and Ghatak, 2005; Chau and Huysentruyt, 2006; Delfgaauw and Dur, 2007, 2008; Prendergast, 2007, 2008). Among these studies, only Besley and Ghatak (2005) and Chau and Huysentruyt (2006) model mission preferences. Besley and Ghatak (2005) show that a principal can save on monetary incentives if he is matched with an agent who shares his same mission preferences. In their setting, however, the job mission is assumed to be exogenous;[3] there are no informational asymmetries, motivated agents vary in their ideal missions rather than in the intensity of mission preferences, and the authors do no derive the optimal allocation mechanism but focus on a stable matching analysis. Furthermore, instead of varying the contractibility of effort, the authors allow output-contingent rewards. Chau and Huysentruyt (2006) show that a competitive tender for the allocation of public funds between two non-profits leads to an ideological compromise between the missions of the principal and those of the contracted non-profit. However, their model and analysis are very different from the ones in this paper. First, their model assumes the presence of "externalities", namely that a non-profit derives a (positive or negative) utility even if the project is carried out by another organization. Second, in their model the agents' effort, and therefore the incentive effects, are absent. Third, the two non-profits vary in their costs rather than in their intrinsic motivation to provide the good. Finally, the authors do not derive the opti-

[2] In other words, it is the agent who pays the principal to run the project.

[3] The authors only briefly discuss the possibility of relaxing the assumption of exogenous job mission but leave the detailed analysis for future work.

mal mechanism but rather compare the outcomes from a given competitive tendering versus a cooperative bargaining solution.

The remainder of the paper is organized as follows. The next section describes the model. Section 3 characterizes the full information optimum under contractible and non-contractible effort. Section 4 does the same under the assumption of asymmetric information. Section 5 introduces multiple agents. Section 6 discusses applications and links to the empirical evidence. Section 7 concludes.

## 2. The Model

Consider the following environment: a principal (she) offers a contract to an agent (he) for the realization of a project. The contract specifies a project mission, $m$, a lump-sum payment, $p$ and, depending on the context, it can also specify the effort level, $e$, which the agent is required to put into the project.[4] If the effort level is not contractible, the agent first receives the contract $(m, p)$ and then decides how much effort to exert.

The agent and the principal derive an intrinsic benefit from pursuing certain missions. More specifically, the contracted project mission $m$ affects both the agent's and the principal's marginal return of effort. The closer the project mission $m$ is to the agent's (principal's) preferences, the higher his (her) marginal return of effort. The most interesting case, which will be the focus of this paper, arises when the agent's and the principal's mission preferences are misaligned, namely, when the agent and the principal disagree on what the mission of the project should be.

The extent to which the agent cares about the mission is measured by the exogenous parameter $\theta$, in other words, his intrinsic motivation level. Very intrinsically motivated agents care a great deal about the mission and have a high $\theta$. On the contrary, a standard agent with purely financial motives has a $\theta$ equal to zero.

Formally, the agents' and the principal's preferences can be represented as follows. The utility of the agent from contracting with the principal is given by

$$U = p + \theta G(m)e - C(e) \tag{1}$$

$G(m)$ represents the agent's intrinsic benefit from working in a project with mission $m$ and has properties $G > 0, G' > 0, G'' < 0$. Note the interaction between $\theta$ and $G(m)$. It means

[4] I assume the output of the project to be equal to the agent's effort. This coincides with assuming a linear production function $Y(e) = e$. Alternatively, $e$ can be interpreted as the probability of a high output. To avoid confusion, throughout the paper I will only refer to the agent's effort rather than to the project's output.

that the effect of the mission on the agent's marginal return of effort is increasing in $\theta$. The intuition behind this assumption is straightforward: the effort that a highly motivated agent is willing to put into the project is more sensitive to choice of the project mission than the effort of an agent who is mainly driven by money.[5] $C(e)$ is the standard disutility from effort, with properties $C' > 0, C'' > 0, C''' \leq 0$.

The principal's utility from contracting with the agent is

$$V = M(m)e - p \tag{2}$$

where $M(m)$ represents the principal's valuation of a project with mission $m$. $M(m)$ has properties $M > 0, M' < 0, M'' < 0$. The misalignment between the agent's and the principal's mission preferences is captured by the difference in the sign of the first derivative of $G$ and $M$. While the agent prefers larger values of $m$, the principal prefers smaller values. If no contract is concluded, both the principal and the agent get utility equal to zero.

# 3. Full information

### 3.1. First-best: contractible effort

Suppose that effort is contractible and that all information described in section 2 is common knowledge. The principal then chooses $m$ and $e$ that maximize total surplus and sets $p$ to make the participation constraint of the agent binding. It is straightforward to show that the solutions to the maximization problem yield the following results:

$$-M'(m^{FB}) = \theta G'(m^{FB}) \tag{3}$$

$$M(m^{FB}) + \theta G(m^{FB}) = C'(e^{FB}) \tag{4}$$

The first-best mission is the one that equalizes the agent's and the principal's marginal returns of effort. The first-best effort level is the one that equalizes the total marginal returns with the total marginal costs of effort under project mission $m^{FB}$. Because the agent's marginal return of effort is increasing in $\theta$, $m^{FB}$ and $e^{FB}$ are also increasing in $\theta$. That is, the higher the agent's intrinsic motivation level is, the closer the project mission to the agent's preferences and the higher the contracted effort level.

[5] This is a simplified version of a more general model with $G(m, \theta)$ and $G_{m\theta} > 0$ or of a model with $G(m, \theta, e)$ and $G_{em\theta} > 0$. The analysis and the results of this paper are not affected by this simplification. Notice also that the assumption of the concavity of $G$ means that small deviations from one's ideal mission has a small effect on the marginal return of effort, while small deviations starting from a very distant mission will have a larger effect. While it can be debated whether this is always the most realistic representation of mission preferences, such an assumption is very helpful in ensuring the existence and uniqueness of an internal solution to the problem.

### 3.2. Second best: non-contractible effort

Now suppose that effort is not contractible. After the agent receives the contract $(m, p)$, he decides how much effort to exert. Thus, when choosing $m$, the principal needs to take into account the agent's effort response. $p$ is again set to make the agent's participation constraint binding. Let $\tilde{S}(m, e, \theta)$ be the total surplus given $m$, $e$ and $\theta$, i.e., $\tilde{S}(m, e, \theta) = (M(m) + \theta G(m))e - C(e)$. The solution to the problem is summarized in the first proposition.

**Proposition 1** *The optimal project mission under full-information and non-contractibility of effort satisfies:*

$$-M'(m^{**})e^{**} = \theta G'(m^{**})e^{**} + \tilde{S}_e^{**} e_m^{**} \quad (5)$$

*The optimal effort level satisfies:*

$$\theta G(m^{**}) = C'(e^{**}) \quad (6)$$

**Proof.** See Appendix.

$\tilde{S}_e^{**}$ is the derivative of $\tilde{S}(m, e, \theta)$ with respect to $e$ evaluated at $(m^{**}(\theta), e^{**}(m^{**}(\theta), \theta), \theta)$ and $e_m^{**}$ is the derivative of $e^{**}$ with respect to $m$ evaluated at $(m^{**}(\theta), \theta)$. Note that $\tilde{S}_e^{**} = M(m^{**}) > 0$ and $e_m^{**} > 0$. Hence, the comparison between equations (3) and (5) clearly shows that $m^{**} > m^{FB}$. That is, when effort is non-contractible, it is optimal for the principal to distort the project mission towards the agent's preferences compared to the first best. The intuition for this result is simple: the principal uses the project mission as an incentive device to extract more effort from the agent. Indeed, the comparison between equations (4) and (6) suggests that, for any given mission, the agent under-invests in effort compared to the first best because he fails to internalize the preferences of the principal. The principal partially compensates for this lower effort by aligning the mission towards the agent's preferences. This additional "incentive effect" of the mission is captured by the term $\tilde{S}_e^{**} e_m^{**}$, namely the effect of the mission on the total surplus via an increase in effort.

Note that unlike the standard model, even if the agent is not risk-averse, here it is not possible for the principal to reach the first-best contract by selling the project to the agent. Given that the payoffs are intrinsic rather than monetary, they do not vary with ownership: even if the agent becomes the owner of the project, he will still want to exert an effort level equal to (6) rather than (4). The principal could induce the agent to exert the first-best effort level and to choose the first-best mission by setting the price of the project equal to her surplus, i.e., $p = M(m)e$, but this would only give her a payoff equal to zero. Hence, the first-best contract cannot be implemented when effort is not contractible.

Finally, note that the effect of $\theta$ on the optimal mission $m^{**}$ is not as unambiguous as under the first-best solution. While the RHS of equation (5) is increasing in $\theta$, the LHS is decreasing. On the one hand, the effect of a marginal increase in $m$ on the marginal surplus that can be extracted from the agent is increasing in $\theta$ (i.e, $\theta G'(m^{**})e^{**}_{\theta} + G'(m^{**})e^{**} > 0$). The more motivated an agent is, the higher the intrinsic utility that he derives from a better alignment between the project mission and his preferences. Hence, the minimum payment that makes him accept the contract also decreases with higher motivation. Furthermore, an increase in $\theta$ also increases the marginal effect of the mission on the principal's surplus via an increase in effort (i.e., $M(m^{**})e^{**}_{m\theta} > 0$). The more motivated an agent is, the higher the increase in effort–and thus in the principal's surplus–that results from an increase in $m$. On the other hand, however, the increase in effort generated by the increase in $\theta$ also increases the principal's marginal cost of compromising on the project mission (i.e., $M'(m^{**})e^{**}_{\theta} < 0$), which decreases the principal's surplus. Hence, the overall effect of $\theta$ on $m^{**}$ depends on the relative size of these counteracting forces.

**Corollary 1** *If $C'''$ is sufficiently small–such that $e^{**}_{m\theta}$ is sufficiently large–$m^{**}$ is increasing in $\theta$.*

**Proof.** See Appendix.[6]

According to Corollary 1, a sufficient condition for the optimal mission to be increasing in the agent's intrinsic motivation is that $C'''$ is small enough, such that the cross derivative of the agent's effort with respect to $m$ and $\theta$ evaluated at $(m^*(\theta), \theta)$, namely $e^{**}_{m\theta}$, is sufficiently large. If this is the case, the power of $\theta$ in increasing the marginal effect of the mission on the principal's surplus via the increase in effort (i.e., $M(m^{**})e^{**}_{m\theta} > 0$) will be large enough to dominate–along with the higher extractable surplus from the agent–the decrease in the principal's surplus due to the higher cost of compromising on the mission. Corollary 1 rests on the following basic intuition: if the power of the mission in motivating effort increases sufficiently with the degree of the agents' intrinsic motivation, agents with higher intrinsic motivation should be offered missions that are more aligned with their ideals, exert more effort and receive lower payments.

[6] In the more general versions of the model, it would have also been sufficient to assume that $G_{m\theta}$ or that $G_{em\theta}$ are large enough.

## 4. Asymmetric information

### 4.1. Contractible effort

Let's come back to the setting where the principal can contract the agent's effort level. However, now she cannot observe the agent's intrinsic motivation level and instead perceives the agent's type as being independently drawn from a distribution function $F(.)$ on the interval $[0, \overline{\theta}]$. $F(.)$ is assumed to satisfy the monotone hazard rate property, i.e., $\partial[(1 - F(\theta))/f(\theta)]/\partial\theta < 0$. It is easy to verify that the first-best contract is not feasible because the agent has an incentive to understate his intrinsic motivation level.

The principal's optimization problem under incomplete information and contractible effort is:

$$\max_{m(.),p(.),e(.)} E_\theta\Big(M(m(\theta))e(\theta) - p(\theta)\Big) \tag{7}$$

subject to

$$\theta \in \arg\max_{\hat{\theta}\in\Theta} U(\hat{\theta}, \theta) = p(\hat{\theta}) + \theta G(m(\hat{\theta}))e(\hat{\theta}) - C(e(\hat{\theta})) \tag{8}$$

$$U(\theta) \geq 0 \tag{9}$$

where $U(\hat{\theta}, \theta)$ is the agent's utility when he reports his intrinsic motivation level to be $\hat{\theta}$ and where $U(\theta)$ is the agent's utility when telling the truth. The incentive compatibility constraint in (8) then imposes that $U(\hat{\theta}, \theta)$ is maximized at $\hat{\theta} = \theta$, that is, it should be optimal for the agent to report his type truthfully. Equation (9) represents the participation constraint. The solution to this problem leads to the following proposition:

**Proposition 2** *The optimal project mission under asymmetric information and contractibility of effort satisfies:*

$$-M'(m^{SB}) = \Big(\theta - \frac{1 - F(\theta)}{f(\theta)}\Big)G'(m^{SB}) \tag{10}$$

*The optimal contracted effort level is:*

$$M(m^{SB}) + \Big(\theta - \frac{1 - F(\theta)}{f(\theta)}\Big)G(m^{SB}) = C'(e^{SB}) \tag{11}$$

*The optimal payment is:*

$$p^{SB}(\theta) = C(e(0)) + \int_0^\theta G(m(t))e(t, m(t))dt - \theta G(m(\theta))e + C(e) \tag{12}$$

**Proof.** See Appendix.

The term $\frac{1-F(\theta)}{f(\theta)}$ represents the standard distortion compared to the first-best solution. Hence, the optimal project mission under incomplete information is closer to the principal's preferences than under the first best. Similarly, the contracted effort level will be lower than under the first best. Given the regularity assumption about $F(.)$, the distortion in both the mission and contracted effort decreases in the intrinsic motivation of the agent (no distortion at the top). The intuition for such distortion is not new: by distorting the project mission towards her own preferences and by contracting a lower effort level, the principal makes the contract for low types agents less attractive to the agents with higher intrinsic motivation, thereby reducing the rent she has to pay to make them report their type truthfully. Finally, the regularity assumption about $F(.)$ ensures that both $m^{SB}$ and $e^{SB}$ are increasing in $\theta$, as it was the case under the first-best.

### 4.2. Non-contractible effort

If effort is not contractible, the principal faces the additional "effort constraint" described in equations (6) and (16). The maximization problem of the principal then becomes:

$$\max_{m(.),p(.)} E_\theta\Big(M(m(\theta))e^*(\theta) - p(\theta)\Big) \tag{13}$$

subject to

$$\theta \in \arg\max_{\hat{\theta}\in\Theta} U(\hat{\theta},\theta) = p(\hat{\theta}) + \theta G(m(\hat{\theta}))e^*(\hat{\theta}) - C(e^*(\hat{\theta})) \tag{14}$$

$$U(\theta) \geq 0 \tag{15}$$

$$\theta G(m(\hat{\theta})) = C'(e^*) \tag{16}$$

where the principal *does*no longer chooses $e$ but must take into account the optimal effort level in (16). Let $\tilde{V}(m,e,\theta)$ be the *virtual* surplus generated by a type-$\theta$ agent when the principal's mission choice is $m$, taking the agent's effort $e$ as given, i.e., $\tilde{V}(m,e,\theta) = \Big(M(m) + \Big(\theta - \frac{1-F(\theta)}{f(\theta)}\Big)G(m)\Big)e - C(e)$. Sufficient conditions for the problem above to be "well-behaved" are listed in the following assumptions:

**Assumption 1** *$C''' < \underline{C}$ such that $e^{**}_{m\theta} > \overline{e}$.*[7]

[7]See the proof of proposition 3 in the Appendix for the derivation of $\underline{C}$ and $\overline{e}$.

**Assumption 2** $\tilde{V}_e^*(m,\theta) \geq 0 \quad \forall \theta.$

where $\tilde{V}_e^*$ is the derivative of $\tilde{V}(m,e,\theta)$ with respect to $e$ evaluated at the optimal solution of the problem $(m^*(\theta), e^*(m^*(\theta),\theta),\theta)$, i.e., $\tilde{V}_e^* = \left(M(m^*) - \frac{1-F(\theta)}{f(\theta)}G(m^*)\right)$. In other words, Assumption 2 requires that the virtual surplus evaluated at the optimal mission is non-decreasing in effort, which naturally occurs if the principal cares enough about a project with mission $m^*$, namely if $M(m^*)$ is large. Assumptions 1 and 2 ensure that the optimal solution to the problem is monotonically increasing in $\theta$ and, therefore, that the single crossing differences condition $\partial^2 U^*/\partial\hat{\theta}\partial\theta > 0$ holds, which, in turn, guarantees that the incentive compatibility constraint in (14) is satisfied.

The next proposition describes the solution to the problem under these two assumptions:

**Proposition 3** *The optimal project mission under asymmetric information and non-contractibility of effort satisfies:*

$$-M'(m^*)e^* = \left(\theta - \frac{1-F(\theta)}{f(\theta)}\right)G'(m^*)e^* + \tilde{V}_e^* e_m^* \tag{17}$$

*where* $\tilde{V}_e^* = \left(M(m^*) - \frac{1-F(\theta)}{f(\theta)}G(m^*)\right)$. *The optimal payment is:*

$$p^*(\theta) = \int_0^\theta G(m(t))e(t,m(t))dt - \theta G(m(\theta))e + C(e) \tag{18}$$

**Proof.** See Appendix.

The expression in equation (17) has a natural economic interpretation: moving the mission marginally towards the agent's ideal, while holding the agent's effort fixed, reduces the principal's surplus by $-M'(m^*)e^*$, but it increases the capturable surplus of the agent by $\left(\theta - \frac{1-F(\theta)}{f(\theta)}\right)G'(m^*)e^*$. It also increases the agent's effort by $e_m^*$, which increases the virtual surplus, which the principal captures at the margin, by $\tilde{V}_e^*$. The role of Assumptions 1 and 2 becomes now evident: if the effect of the mission on the agent's effort is highly increasing in $\theta$ (Assumption 1) and the virtual surplus is increasing in effort (Assumption 2), the optimal mission will be increasing in $\theta$.[8]

It is easy to compare the optimality condition in (17) with the optimality condition under complete information, namely equation (5). For any given $m$, one can verify that $e^{**} = e^*$, $e_m^{**} = e_m^*$, $\tilde{S}_e^* > \tilde{V}_e^*$, and $\theta - \frac{1-F(\theta)}{f(\theta)} < \theta$, so it must be the case that $m^* < m^{**}$ for every $\theta < \overline{\theta}$. In other words, private information information about $\theta$ leads the mission choice to be closer to the

[8]Essentially, the intuition behind Assumptions 1 and 2 is the same as the intuition for Corollary 1. Again, in the more general versions of the model with $G(\theta,m)$ or $G(m,\theta,e)$ , Assumption 1 should be replaced by the assumption that $G_{m\theta}$ or $G_{em\theta}$ are positive and large enough.

principal's ideal. As we have seen in the previous subsection, this result also holds when effort is contractible. However, when effort is *not* contractible, the mission has a "double distortion": the first distortion of $m$, which is also present in equation (10), namely, $\frac{1-F(\theta)}{f(\theta)}G'(m)$, reduces the agent's marginal intrinsic benefit of effort while holding the agent's effort fixed. The second distortion of $m$, namely, $\frac{1-F(\theta)}{f(\theta)}G(m)$, is an "effort driven distortion", in the sense that it aims at reducing the agent's effort. When effort is contractible, this additional distortion of the mission is absent because the principal can directly distort the contracted effort level. However, when this is not possible, the principal needs to move the project mission even closer to her own preferences in order to induce the agent to exert less effort.

Thus, all together, Propositions 1-3 suggest that the non-contractibility of effort pushes the project mission towards the agent's preferences, while information asymmetries move the project mission towards the principal's preferences. Hence, the following corollary:

**Corollary 2** *The project mission is closest to the principal's mission preferences when effort is contractible and there is informational asymmetry about the agent's intrinsic motivation. The project mission is closest to the agent's mission preferences when effort is non-contractible and information is complete.*

## 5. Multiple agents: optimal mechanism

In this section I extend the model with asymmetric information and non-contractibility of effort to allow for multiple agents. The principal now faces the additional problem of having to select one out of $n$ motivated agents to whom to allocate the project. Without loss of generality, I restrict my attention to direct and incentive compatible mechanisms. That is, I look for a mechanism that specifies for each agent $i$, with $i = 1, ..., n$, a probability of winning the project $q_i(.)$, a project mission $m_i(.)$, and a payment $p_i(.)$ as functions of the agents' reported intrinsic motivation levels $(\hat{\theta}_1, ..., \hat{\theta}_n) = \hat{\theta}$ and that induces a truth-telling Bayesian Nash equilibrium, $\hat{\theta} = \theta$.

The principal's optimization problem is described below. As in the previous subsection, Assumptions 1 and 2 are sufficient conditions for the problem to be well-behaved.

$$\max_{q_i(.),m_i(.),p_i(.)} E_\theta\Big(\sum_{i=1}^{n} q_i(\theta)M(m_i(\theta))e_i^* - p_i(\theta)\Big) \tag{19}$$

subject to

$$\theta_i \in \arg\max_{\hat{\theta}_i\in\Theta} U_i(\hat{\theta}_i, \theta_i) = E_{\theta_{-i}}\Big(p_i(\hat{\theta}_i, \theta_{-i}) + q_i(\hat{\theta}_i, \theta_{-i})\theta_i G(m_i(\hat{\theta}_i, \theta_{-i}))e_i^* - C(e_i^*)\Big) \tag{20}$$

$$U_i(\theta_i) \geq 0 \tag{21}$$

$$\theta_i G(m(\hat{\theta}_i, \theta_{-i})) = C'(e_i^*) \tag{22}$$

$$\sum_{i=1}^{n} q_i(\theta) \leq 1 \text{ and } q_i(\theta) \geq 0 \text{ for any } \theta, \;\; i = 1, ..., n. \tag{23}$$

where $U_i(\hat{\theta}_i, \theta_i)$ is the expected utility of agent $i$ when he reports his intrinsic motivation level to be $\hat{\theta}_i$ and all the other agents report their intrinsic motivation levels truthfully, and where $U_i(\theta_i)$ is the agent's $i$ expected utility when telling the truth. The incentive compatibility constraint in (20) then imposes that $U_i(\hat{\theta}_i, \theta_i)$ is maximized at $\hat{\theta}_i = \theta_i$, that is, it should be optimal for agent $i$ to report his type truthfully. Equations (21), (22), (23) represent the individual rationality constraint, the agent's ex-post optimal level of effort, and the basic properties of the probability function, respectively. The solution to this problem leads to the next proposition:

**Proposition 4** *Under the optimal mechanism:*
*a)The project is always allocated to the agent with the highest intrinsic motivation:*

$$q_i^*(\theta) = \begin{cases} 1 & \textit{if } \theta_i > \max_{\forall j \neq i} \theta_j \\ 0 & \textit{otherwise} \end{cases} \tag{24}$$

*b)The optimal project mission $m_i^*(\theta)$ satisfies equation (17).*
*c)The optimal expected payment is:*

$$p_i^*(\theta_i) = \int_0^{\theta_i} E_{\theta_{-i}}\Big(q_i(t_i, \theta_{-i}) G(m_i(t_i, \theta_{-i})) e_i(t_i, m(t_i, \theta_{-i}))\Big) dt_i - E_{\theta_{-i}}\Big(q_i(\theta)\Big(\theta_i G(m_i(\theta)) e_i - C(e_i)\Big)\Big) \tag{25}$$

**Proof.** See Appendix.

Proposition 4 suggests that the project is always allocated to the one among $n$ agents who has the highest intrinsic motivation level. Hence, contrary to a standard result in auction theory, here it is not optimal for the principal to reduce the informational rents by excluding low types from the competition. The intuition for this finding lies on the non-contractibility of effort, which by the FOC in equation (22), ensures that the agent's surplus, and in turn the virtual surplus, is non-negative $\forall \theta$. To see this formally, let's reorganize the virtual surplus $V^*(m, e, \theta)$ generated by agent $i$ and evaluated at the optimal solution of the problem $(m^*(\theta), e^*(m^*(\theta), \theta), \theta)$ in the following way:

$$\theta_i G(m_i^*) e_i^* - C(e_i^*) + \Big(M(m_i^*) - \frac{1 - F(\theta_i)}{f(\theta_i)} G(m_i^*)\Big) e_i^* \geq 0 \tag{26}$$

The first two terms in (26) represent the agent's surplus, which must be non-negative by the FOC in (22). Thus, a sufficient condition for $V^*(m, e, \theta)$ to be non-negative $\forall\theta$ is that the last term in (26) is also non-negative $\forall\theta$. The latter is nothing but $\tilde{V}_e^* e^*$, which, by Assumption 2, is always non-negative. So essentially, in a setting where effort is non-contractible and the virtual surplus is increasing in effort, it is always optimal to allocate the project.

Note that if effort were contractible, the non-exclusion finding would not (necessarily) hold. As can be inferred from the FOC in (11), the surplus of the lowest-type agent, i.e., a standard profit-maximising agent with $\theta_i = 0$, is negative: he is forced to exert a positive amount of effort even though he does not derive any intrinsic benefit from it.[9] Hence, as can be seen in (12), in order to make type-0 agent participate, the principal needs to offer a payment that covers his effort costs, i.e, $p_i(0) = C(e(0))$. This term plays a similar role as an (endogenous) agent's outside option. So even if the virtual surplus is increasing in effort, it may not be positive for all types. To see this formally, please note that the virtual surplus when effort is contractible is equal to:

$$\Big(M(m_i^{SB}) + \Big(\theta_i - \frac{1 - F(\theta_i)}{f(\theta_i)}\Big)G(m_i^{SB})\Big)e_i^{SB} - C(e_i^{SB}) - C(e(0)) \tag{27}$$

While the sum of the first two terms must be positive from the FOC in (11), it is not necessarily larger than $C(e(0))$. Let equation (27) be equal to 0 for $\theta = \underline{\theta}$. Then, the principal will exclude all types $\theta < \underline{\theta}$.

Finally, notice that the optimal mission is the same as in the one-agent version of the model. This is the so-called "dichotomy property" by Laffont and Tirole (1987). To see the intuition for this result, notice that the maximization problem in (19) is the same as the one in (13) with the exception of having to choose the allocation rule $q_i(\theta)$, which is a simple weighting function and, therefore, does not affect the optimal solution of the mission compared to the model with one agent.

### 5.1. Implementation

The optimal mechanism can be implemented through a scoring auction:

**Proposition 5** *The optimal outcome can be implemented through a first- or second-score auction with scoring rule $S^*(m, p)$:*

$$S^*(m, p) \quad = \quad M(m)e^*(m) - p - \int_v^m \frac{1 - F(m_0^{-1}(s))}{f(m_0^{-1}(s))}(G'(s)e^*(s) + G(s)e_m^*(s))ds$$

[9]Note that the condition to have an internal solution of effort for the lowest type is equivalent to Assumption 2. If this condition does not hold, the problem is still well-behaved in this case, but the principal will want zero effort from type-0 agent and, thus, will exclude him from the competition.

*for* $m \in [m_0(0), m_0(\overline{\theta})]$ *and where* $m_0(.)$ *is the optimal mission in (17),* $e^*(m)$ *is the optimal effort in (22) and* $v$ *is any real number.*

**Proof.** See Appendix.

A scoring auction is a multi-dimensional auction where agents bid on both the price and the project mission, and bids are evaluated by a scoring rule designed and announced ex-ante by the principal. The bidder with higher total score wins. More specifically, under the first-score auction the winner develops the project with the offered mission at the offered price. In the second-score auction, the winner is required to match the highest rejected score in the auction with no additional constraints attached to the combination of mission-price.

The scoring rule in Proposition 5 can be rewritten as $S^*(m,p) = M(m)e^*(m) - p - \Delta(m)$. Hence, the scoring rule is equal to the principal's utility function minus the term $\Delta(m)$, which is increasing in $m$ and, therefore, induces the agents to bid a project mission that is closer to the principal's ideal mission than under the full information optimum with non-contractible effort. In other words, $\Delta(m)$ implements the distortion in the optimal project mission described in Proposition 3 and consists of two terms. The first term–i.e,$\int_v^m \frac{1-F(m_0^{-1}(s))}{f(m_0^{-1}(s))} G'(s)e^*(s)ds$–is the distortion that reduces the agent's intrinsic benefit from effort, holding effort fixed. The second element–i.e,$\int_v^m \frac{1-F(m_0^{-1}(s))}{f(m_0^{-1}(s))} G(s)e^*_m(s)ds$–is the distortion to induce a lower effort level. In a model in which the agent's effort is taken to be exogenous, as it is in Che (1993), $\Delta(m)$ consists only of the first term.

## 6. Applications

The analysis is relevant for a wide set of labor market environments where the mission of the job is part of the compensation package that a principal can use to select and motivate an agent. Below I discuss its application to the design of competitions for aid contracts, research funding, creative jobs and corporate social responsibility.

### 6.1. Competition for aid contracts

The model applies to the design and allocation of procurement contracts for the provision of social goods and services. Governments and aid agencies regularly face trade-offs like the one described in this paper: They need to select private organizations for the development of social projects but usually cannot observe the real motivation of these organizations. Furthermore, different actors in the development sector have often different views on how to implement aid projects (Besley and Ghatak, 1999, 2001), leading to ideological conflicts similar to the ones described above.

Consistent with the model presented in this paper, public and international organizations, such as EuropeAid, USAID, the UK's Department for International Development (DFID), and the World Bank's International Development Association, make extensive use of scoring auctions to allocate aid contracts. In practice, at the launch of the tender, these organizations release the project's "Terms of Reference" (TOR) along with the scoring rule that will be adopted to evaluate each bid. The TOR is a document that describes in detail the ideal project mission from these organizations' point of view. In terms of this model, it means that the principal's mission preferences are common knowledge. Then, each competing candidate bids a price and a proposal on the project's design and characteristics. Finally, the scoring rule assigns a score to the offered price and to each aspect of the proposal according to the extent to which it conforms with the specified TOR. The bidder with highest total score wins.

The study by Huysentruyt (2011) provides empirical evidence regarding the bidding strategies used by for-profits and non-profits in scoring auctions for the allocation of aid contracts by the DFID. The data set analyzed includes detailed information about all of the 457 aid service contracts that were allocated through scoring auctions between the period 1998 and 2003, including the terms of reference as well as the 1,222 bids that were made for these contracts. Among other things, the paper looks at how bidding strategies, contract outcomes and participation in specific tenders vary between profits and non-profits. Two results are particularly relevant for the present analysis. The author finds that, holding the tender constant, (1) non-profits make bids that score on average 4 to 6 percentage points worse on their compliance with the DFID's terms of reference (TOR) relative to for-profits; (2) the overall prices proposed by non-profits are approximately 60% cheaper, on average, than the prices proposed by for-profits.

These results are consistent with Propositions 3 and 4, if we reasonably assume that workers in non-profit organizations have on average a higher intrinsic motivation than workers in for-profit organizations. Agents with higher intrinsic motivation are willing to sacrifice financial gains in favor of a higher level of control over the project mission. Therefore, they will bid a lower price for developing the project and will bid a project mission that is more distant from the principal's ideal mission. On the other hand, agents with lower intrinsic motivation prefer to comply more with the principal's ideal mission in order to receive higher payments. As a consequence, they will bid a higher price for developing the project and will bid a project mission that is closer to the principal's ideal mission. Overall, highly motivated agents are more likely to score less on the mission dimension and more on the financial dimension than agents with low intrinsic motivation.[10]

Finally, the paper contributes to the longstanding debate on the desirability of public-private partnerships for the delivery of social goods by providing insights on whose values are more likely to dictate the provision of these goods and under which circumstances. As discussed in Chau and Huysentruyt (2006), one may be worried that public values, such as laicism, might be undermined by delegating the provision of social services to, for instance, religious organizations. On the other hand, there is the concern that the state may interfere with non-profits' goals and values, as the dependence on public funds is likely to make the non-profits vulnerable to political pressures. This paper shows that non-profits' missions are more likely to be compromised in the presence of informational asymmetries and when output (effort) is contractible (Corollary 2).

### 6.2. Competition for research funding

The model applies to the design and allocation of research grants. Academics and scientists who conduct research are often motivated by specific research agendas, addressing specific research questions with specific research methods. Typically, academics' and scientists' research agendas are targeted to making academic contributions, which usually require very rigorous analysis at the expense of the breadth of practical application. On the contrary, research funding agencies, such as government agencies and private foundations, are mostly interested in the policy relevance and societal impact of a research project, which often comes at the expense of rigorous and scientific analysis.

Such misalignment in research interests, along with the fact that there is heterogeneity in researchers' intrinsic motivation that is usually not observable by the funding agency, generates similar trade-offs as the one described in this paper: funding agencies have to choose a rule to allocate grants, the amount of the grants, and how many conditions to attach to the grant, knowing that the number of conditions and their level of detail will determine how much freedom the researchers will have to pursue their own research agendas, and in turn how much effort they will be willing to put into the project.[11].

---

[10]It is worth mentioning that this evidence does not prove that the DFID is actually using the *optimal* scoring auction. Other non-optimal scoring auctions may lead to similar results, as long as non-profits care more about the mission than for-profit organizations. Rather, this evidence suggests that my model gives a good representation of the trade-offs present in the aid contracting environment and of the preferences of the actors involved in that environment.

[11]Just recently, the Centre for Economic Policy Research (CEPR) under the cooperative action "Cooperation for European Research in Economics" (COEURE), financed by the European Commission, has launched a called for tender for the analysis of "research funding agencies in Europe, how research agendas are set; how priorities are decided; and what is the balance between top down and bottom up initiatives, between academic criteria and policy relevance/societal impact." The main goal of this project is to "suggest ways in which funding

Hence, applied to this setting, Propositions 3 predicts that because government agencies and private foundations cannot observe the intrinsic motivation of the researchers, the research projects that they fund through their grants are likely to be too "policy-oriented" and "less academic" compared to what would be socially optimal. Furthermore, Proposition 4 suggests that it is not optimal for the funding agencies to fix a maximum amount of the grant (i.e., a maximum $p$) because this would discourage researchers with low intrinsic motivation from applying. As shown in Proposition 4, it is not optimal to exclude low-types from the competition when effort is not contractible.

### 6.3. Creative jobs

More generally, this analysis applies to the design of contracts for jobs that involve a certain level of creativity from the agent, such as journalism, photography, architecture, computer programming, chefs, and so on. Workers in these professions usually care about the level of discretion they are given in solving their tasks. Journalists, for example, may be motivated to cover specific types of stories, they may have specific political orientations, or they may want to use specific writing styles. These preferences usually do not perfectly coincide with those of the editors.[12] Furthermore, the extent to which each worker cares about having discretion in designing a project is heterogeneous and unobservable by the employer. Hence, the contracting problem of theses types of jobs is analogous to the model presented in this paper.

The optimal contracts described in Propositions 2 and 3 suggest that an employer should offer workers a menu of contracts with different levels of wage and discretion (and effort, when contractible) and let the workers self-select into one of these contracts based on his intrinsic motivation level. In practice, offering such menu of contracts can be interpreted as offering the choice between freelancing contracts versus contracts for permanent positions. Workers with higher intrinsic motivation will then prefer the contracts designed for freelancers, which are usually less attractive financially but offer more flexibility in following one's personal passion and interests.[13]

mechanisms might evolve in the future to more effectively support frontier research." For more information visit $http://www.coeure.eu/call-for-interest/$

[12]Furthermore, even if a journalist had the exact same preferences as the editor of the newspaper at the time in which the contract is signed, at that point in time there is high uncertainty about what news will emerge in the future and, therefore, whether the journalist and the editor will always continue to perfectly agree on which stories to cover. Hence, even in such situations, the issues discussed in this paper will apply.

[13]For example, in the Freelance industry report of 2012, 83% of people list as main benefit of being a freelancer a non-monetary argument, such as being able to choose on which projects to work, greater flexibility and creative freedom, while only 7.5% of people gave a financial reason, such as higher income potential or higher income security. For more information visit $https://s3.amazonaws.com/ifdconference/2012report/FreelanceIndustryReport2012.pdf$

### 6.4. Corporate social responsibility

Finally, the analysis of this paper can be applied to model firms' investments in corporate social responsibility (CSR). Indeed, firms can use CSR to make their mission more pro-social and, in turn, to attract and incentivize more motivated employees. In such a model application, $M(m)e$ can be interpreted as a revenue function and $m$ as the choice of how much to invest in CSR, e.g., in the form of charitable donations or paid pro-bono work. Firms may indeed not care about CSR directly (i.e., $M' < 0$) but only as a way to increase their profit by increasing employees' motivation (i.e., by increasing $e$) and to save on wages (i.e., by reducing $p$). Recent empirical evidence has indeed revealed a negative correlation between firms' investments in CSR and wages (Nyborg and Zhang, 2013; Nyborg, 2014), which is consistent with all of the propositions presented in this paper. This paper contributes further to the literature on CSR by generating new testable predictions: CSR investments will be highest (lowest) in those industries and sectors where output is non-contractible (contractible) and where there is low (high) uncertainty about employees' intrinsic motivation–e.g., if the labor supply (i.e., number of agents) in that sector is sufficiently large, the uncertainty about the employees' motivation converges to zero as the employer knows she can attract the agent with the highest intrinsic motivation.

## 7. Conclusion

This paper analyzes, for the first time, an optimal contracting problem where the agents vary in their unobservable intrinsic motivation levels and are incentivized not by outcome-contingent rewards, but by the choice of the project mission. The model points to a different "hidden cost of control" which, contrary to Falk and Kosfeld (2006), Bartling et al. (2012, 2013), does not arise from the perception that the lack of discretion is a signal of the principal's distrust, but from the fact that workers have direct preferences on how to design their projects (i.e., on the project mission), and these preferences are not always aligned with those of their employers.

The analysis provides policy recommendations to governments, international agencies, and private organizations who pursue specific missions on how to optimally design competitions and contracts for allocating projects to motivated agents. I show that the non-contractibility of effort brings the project mission closer to the agent's preferences, while asymmetric information about the agent's motivation brings the project mission closer to the principal's preferences. I also find that when effort is non-contractible: i)the informational asymmetry leads to a double distortion in the optimal mission compared to the full-information optimum, a standard distortion that reduces the agent's intrinsic return of effort while holding the agent's effort fixed, and a second distortion that aims at reducing the agent's effort; ii) it is not optimal to exclude low-types agents from the competition; iii) the optimal mechanism can be implemented through a scoring auction whose scoring rule is equal to the principal's utility function plus two additional terms that induce the agents to bid on a project mission that is closer to the principal's preferences. These findings can be applied to the allocation of aid contracts, research finding, creative jobs and CSR investments.

# Appendix

**Proof of Proposition 1**

The maximization problem is

$$\max_{m(.)} M(m)e^{**} + \theta G(m)e^{**} - C(e^{**})$$

subject to

$$\theta G(m) = C'(e^{**})$$

which leads to the following FOC:

$$M'(m^{**})e^{**} + M(m^{**})e^{**}_m + \theta G'(m^{**})e^{**} = 0$$

The SOC requires:

$$M''(m^{**})e^{**} + \theta G''(m^{**})e^{**} + (2M'(m^{**}) + \theta G'(m^{**}))e^{**}_m + M(m^{**})e^{**}_{mm} < 0$$

The first two terms are negative by the assumption of concavity of $M$ and $G$, the third term is negative from the FOC, while the fourth term is ambiguous and depends on the sign of $e^{**}_{mm}$– which can be shown to be negative for sufficiently negative $G''$. Hence, sufficient conditions for the SOC to hold is that $M$ and $G$ are sufficiently concave.

**Proof of Corollary 1**

From the Implicit function theorem, $m^{**}(\theta)$ is increasing if $\partial FOC/\partial\theta > 0$, i.e, if

$$(M'(m^{**}) + \theta G'(m^{**}))e^{**}_\theta + G'(m^{**})e^{**} + M(m^{**})e^{**}_{m\theta} > 0 \tag{A-1}$$

where $e^{**}_{m\theta} = -\Big(C''(e^{**})\Big)^{-2} C'''(e^{**})\Big(C''(e^{**})\Big)^{-1} G(m^{**})\theta G'(m^{**}) + \Big(C''(e^{**})\Big)^{-1} G'(m^{**})$
The first term in (A-1) is negative from the FOC, while the second term is positive. Hence, a sufficient condition for the inequality in (A-1) to hold, is that $e^{**}_{m\theta}$ is positive and sufficiently large, which is the case if $C'''$ is sufficiently small.

**Proof of Proposition 2**

By applying the Envelope Theorem to the IC in (8), we get:

$$U'(\theta) = G(m(\theta))e(\theta)$$

$$U(\theta) = U(0) + \int_0^\theta G(m(t))e(t)dt$$

The payment is then

$$p(\theta) = p(0) + \int_0^\theta G(m(t))e(t, m(t))dt - \theta G(m(\theta))e + C(e)$$

The participation constraint is binding for the lowest type, thus $p(0) = C(e(0))$. This proves equation (12). Inserting the payment function into the objective function in (7) and maximizing with respect to $m$ and $e$ gives the FOCs described in (10) and (11). The SOCs require

$$-C''(e) < 0 \tag{A-2}$$

$$-C''(e)\Big(M''(m) + \Big(\theta - \frac{1-F(\theta)}{f(\theta)}\Big)G''(m)\Big)e - 2\Big(M'(m) + \Big(\theta - \frac{1-F(\theta)}{f(\theta)}\Big)G'(m)\Big) > 0 \tag{A-3}$$

Equation (A-2) is always satisfied by the assumption of convex effort cost. The second term in (A-3) is equal to zero at $m = m^{SB}$. Hence, the SOCs are always satisfied for sufficiently concave $M$.

To guarantee that the monotonicity condition is satisfied, we also need $m^{SB}$ and $e^{SB}$ to be increasing in $\theta$. By the Implicit function theorem, we know that the derivative of the FOCs in (10) and (11) wrt $\theta$ must be positive. Let $\lambda(\theta)$ define the hazard rate, the conditions are:

$$\frac{\partial FOC|_m}{\partial \theta} = G'(m)(1 - \lambda'(\theta)) > 0$$

$$\frac{\partial FOC|_e}{\partial \theta} = G(m)(1 - \lambda'(\theta)) > 0$$

which are always satisfied from the monotone hazard rate property, namely $\lambda'(\theta) < 0$.

**Proof of Proposition 3**

By applying the Envelope Theorem to the IC in (14), we get:

$$U'(\theta) = G(m(\theta))e^*(\theta) + (\theta G(m(\theta)) - C'(e^*(m(\theta), \theta)))e^*_\theta(m(\theta), \theta)$$

where the second term is equal to 0 from the FOC on effort. Thus, we have

$$U(\theta) = U(0) + \int_0^\theta G(m(t))e(t)dt$$

The payment is then

$$p(\theta) = p(0) + \int_0^\theta G(m(t))e(t, m(t))dt - \theta G(m(\theta))e + C(e)$$

The participation constraint is binding for the lowest type, thus $p(0) = 0$. This proves equation (18). Inserting the payment function into the objective function in (13) and interchanging the order of integration gives

$$E(V) = E_\theta\Big(\Big(M(m) + \Big(\theta - \frac{1 - F(\theta)}{f(\theta)}\Big)G(m)\Big)e^* - C(e^*)\Big)$$

Maximizing with respect to $m$ gives the FOC described in (17). The SOC is

$$\Big(M''(m) + \Big(\theta - \frac{1 - F(\theta)}{f(\theta)}\Big)G''(m)\Big)e^* + \theta G'(m)e^*_m + 2\Big(M'(m) - \frac{1 - F(\theta)}{f(\theta)}G'(m)\Big)e^*_m$$
$$+\Big(M(m) - \frac{1 - F(\theta)}{f(\theta)}G(m)\Big)e^*_{mm} < 0$$

The first term is negative for sufficiently concave $M$. The sum of the second and third term is negative from the FOC. The last term is negative by Assumption 2 if $e^*_{mm}$ is also negative, i.e., if $G$ is sufficiently concave. Next, for the FOC in (17) to be the solution of the problem in (13), $m^*$ must be increasing in $\theta$, i.e., $\partial FOC/\partial\theta$ must be positive. This condition is given by:

$$\Big(1 - \lambda'(\theta)\Big)G'(m)e^* + \Big(M'(m) + \Big(\theta - \frac{1 - F(\theta)}{f(\theta)}\Big)G'(m)\Big)e^*_\theta - \lambda'(\theta)G(m)e^*_m$$
$$+\Big(M(m) - \frac{1 - F(\theta)}{f(\theta)}G(m)\Big)e^*_{m\theta} > 0$$

The first and third terms are positive by the monotone hazard rate property. The second term is negative by the FOC. Hence, for the condition to be satisfied, it is sufficient that the last term is positive and sufficiently large, as stated in Assumptions 1 and 2. More specifically, we need

$$e^*_{m\theta} > \overline{e} = \frac{1}{\tilde{V}^*_e}\Big(\lambda'(\theta)G(m)e^*_m - \Big(1 - \lambda'(\theta)\Big)G'(m)e^* - \Big(M'(m) + \Big(\theta - \frac{1 - F(\theta)}{f(\theta)}\Big)G'(m)\Big)e^*_\theta\Big)$$

The above condition is satisfied as long as:

$$C'''(e^*) < \underline{C} = \Big(\Big(C''(e^*)\Big)^{-1}G'(m) - \overline{e}\Big)\Big(C''(e^*)\Big)^2 C''(e^*)\frac{1}{\theta G'(m)G(m)}$$

This completes the proof of Proposition 3.

## Proof of Proposition 4

For sake of notational simplicity, let $q_i(\theta_i)$, $m_i(\theta_i)$ and $p_i(\theta_i)$ define, respectively, $E_{\theta_{-i}}q_i(\theta)$, $E_{\theta_{-i}}m_i(\theta)$ and $E_{\theta_{-i}}p_i(\theta)$.

Applying the Envelope Theorem, as in the proof of Proposition 3, gives the expected payment to agent $i$ in (25)

$$p_i(\theta_i) = \int_0^{\theta_i} E_{\theta_{-i}}\Big(q(t_i,\theta_{-i})G(m_i(t_i,\theta_{-i}))e_i(t_i,m(t_i,\theta_{-i}))\Big)dt_i - E_{\theta_{-i}}\Big(q_i(\theta)\Big(\theta_i G(m_i(\theta))e_i + C(e_i)\Big)\Big)$$

Inserting the expected payment into the principal's expected utility and interchanging the order of integration gives

$$E(V) = \sum_{i=1}^{n} E_\theta\Big(q_i(\theta)\Big(\Big(M(m_i(\theta)) + \Big(\theta_i - \frac{1-F(\theta_i)}{f(\theta_i)}\Big)G(m_i(\theta))\Big)e_i^* - C(e_i^*)\Big)\Big)$$

which is maximized at $m_i^*(\theta)$ in (17)–indeed, it is clear that the allocation rule $q_i(\theta)$ is a simple weighting function and, therefore, does not affect the optimal solution of the mission compared to model with one agent.

Hence, the virtual surplus $V^*(m,e,\theta_i)$ generated by agent $i$ and evaluated at the optimal solution of the problem $(m_i^*(\theta), e_i^*(m_i^*(\theta),\theta_i),\theta_i)$ is equal to:

$$\Big(M(m_i^*) + \Big(\theta_i - \frac{1-F(\theta_i)}{f(\theta_i)}\Big)G(m_i^*)\Big)e_i^* - C(e_i^*)$$

which, if rearranged, gives equation (26) and, as explained in the main text, is always positive under Assumption 2. This non-exclusion results leads to the optimal allocation rule $q_i(\theta)$ in (24). Next, we need to check the monotonicity condition, namely that the virtual surplus is increasing in $\theta$. $V_\theta^*$ can be shown to be equal to

$$(1-\lambda'(\theta))G(m_i^*)e_i^* + \Big(M(m_i^* - \frac{1-F(\theta_i)}{f(\theta_i)}G(m_i^*)\Big)e_\theta^*$$

The first term is is always positive by the monotone hazard rate property. The second term, namely $V_e^* e_\theta^*$, is also always positive by Assumption 2. This completes the proof of Proposition 4.

## Proof of Proposition 5

Consider the scoring rule in Proposition 5, namely

$$S^*(m,p) = M(m)e^*(m) - p - \int_v^m \frac{1-F(m_0^{-1}(s))}{f(m_0^{-1}(s))}(G'(s)e^*(s) + G(s)e_m^*(s))ds$$

for $m \in [m_0(0), m_0(\bar{\theta})]$ and where $m_0(.)$ is the optimal mission in (17), $e^*(m)$ is the optimal effort in (22) and $v$ is any real number. From Lemma 1 in Che (1993), I know that under the first- and second-score auction with general scoring rule $S(m,p)$, each agent bids an $m$ that maximizes $Z(\theta_i, m) = S(m,p) + \theta_i G(m)e^* - C(e^*)$. Thus, with scoring rule $S^*(m,p)$ defined above, each agent chooses the mission that satisfies the following FOC:

$$\begin{aligned}\frac{\partial Z(\theta_i, m)}{\partial m} &= \Big(M'(m) + \Big(\theta - \frac{1 - F(m_0^{-1}(m))}{f(m_0^{-1}(m))}\Big)G'(m)\Big)e^* + \Big(M(m) - \frac{1 - F(m_0^{-1}(m))}{f(m_0^{-1}(m))}G(m)\Big)e_m^* \\ &= 0 \text{ if } m = m_0(\theta_i)\end{aligned}$$

where $m_0(\theta_i)$ is the mission rule that satisfies the FOCs in (17). Thus, I have shown that the optimal mission is implemented by the modified scoring rule $S^*(m,p)$. Since under the first- and second-score auction with scoring rule $S^*(m,p)$ both the allocation rule and the project mission are the same as under the optimal mechanism, the first- and second-score auctions with this optimal scoring rule give the same expected utility to the principal as the optimal mechanism.

# References


Bartling, B., E. Fehr, and K. M. Schmidt (2012). Screening, competition, and job design: Economic origins of good jobs. *American Economic Review 102*(2), 834–64.

Bartling, B., E. Fehr, and K. M. Schmidt (2013). Discretion, productivity, and work satisfaction. *Journal of Institutional and Theoretical Economics 169*(1), 4–22.

Benabou, R. and J. Tirole (2003). Intrinsic and extrinsic motivation. *The Review of Economic Studies 70*(3), pp. 489–520.

Benabou, R. and J. Tirole (2006). Incentives and prosocial behavior. *American Economic Review 96*(5), 1652–1678.

Besley, T. and M. Ghatak (1999). Public-private partnerships for the provision of public goods: Theory and an application to ngos. STICERD Development Economics Discussion Paper Series, DEDPS 17.

Besley, T. and M. Ghatak (2001). Government versus private ownership of public goods. *Quarterly Journal of Economics 116*(4), 1343–1372.

Besley, T. and M. Ghatak (2005). Competition and incentives with motivated agents. *American Economic Review 95*(3), 616–636.

Cassar, L. and S. Meier (2016). Non-monetary incentives and the quest for work meaning. Working paper.

Chau, N. H. and M. Huysentruyt (2006). Nonprofits and public good provision: A contest based on compromises. *European Economic Review 50*(8), 1909–1935.

Che, Y. (1993). Design competition through multidimensional auctions. *RAND Journal of Economics 24*.

Delfgaauw, J. and R. Dur (2007). Signaling and screening of workers' motivation. *Journal of Economic Behavior & Organization 62*(4), 605–624.

Delfgaauw, J. and R. Dur (2008). Incentives and workers' motivation in the public sector. *Economic Journal 118*(525), 171–191.

Falk, A. and M. Kosfeld (2006). The hidden costs of control. *The American Economic Review 96*(5), pp. 1611–1630.

Francois, P. (2003). Not-for-profit provision of public services. *The Economic Journal 113*(486), 53–61.

Francois, P. and M. Vlassopoulos (2008). Pro-social motivation and the delivery of social services. *CESifo Economic Studies 54*(1), 22–54.

Huysentruyt, M. (2011). Development aid by contract: Outsourcing and contractor identity. Working paper.

Laffont, J.-J. and J. Tirole (1987). Auctioning incentive contracts. *Journal of Political Economy 95*(5), 921–37.

Murdock, K. (2002). Intrinsic motivation and optimal incentive contracts. *The RAND Journal of Economics 33*(4), pp. 650–671.

Nyborg, K. (2014). Is corporate social responsibility associated with lower wages? *IZA World of Labor*.

Nyborg, K. and T. Zhang (2013). Is corporate social responsibility associated with lower wages? *Environmental and Resource Economics 55*(1), 107–117.

Prendergast, C. (2007). The motivation and bias of bureaucrats. *American Economic Review 97*(1), 180–196.

Prendergast, C. (2008). Intrinsic motivation and incentives. *American Economic Review 98*(2), 201–05.