Review of
ECONOMICS and
INSTITUTIONS

Review of Economics and Institutions
ISSN 2038-1379 DOI: 10.5281/zenodo.5380761

Vol. 12 – No. 1, Spring 2021 – Article 1

www.rei.unipg.it

Cultural Norms and Financial Incentives: A Model of How to Fund Universities

Trude Gunnes✉
Statistic Norway

Abstract: This paper derives the optimal compensation contract when two asymmetrically verifiable tasks are tied together, a cultural norm of behaviour coexists with a financial incentive, and public funding is also a concern. To formulate ideas, we restrict the attention to higher education. The model generates at least three results: First, the monetary incentive for research crowds out the social teaching norm, i.e., peer pressure. Second, increased intrinsic motivation in teaching induces a social multiplier effect on the teaching effort. Third, the government under-funds the university if the teaching standard is lower than that of the government to implement its standard.

JEL classification: D82, I23, I28
Keywords: Principal-Agent Theory; Peer Pressure; Intrinsic Motivation; Higher Education; Public Funding

Acknowledgments: I like to thank two anonymous reviewers, Hans Bonesrønning, Jocelyn Donze, Robert Gary-Bobo, and Halvor Briseid Storrøsten for their valuable comments. The usual disclaimer applies.

✉ Address: Statistics Norway, research department, postbox 2633 St. Hanshaugen, NO-0131 Oslo. Mail: trude.gunnes@ssb.no.

Recommended Citation
Gunnes, T. (2021). Cultural Norms and Financial Incentives: A Model of How to Fund Universities. *Review of Economics and Institutions, 12*(1), Article 1. doi: 10.5281/zenodo.5380761
Retrieved from http://www.rei.unipg.it/rei/article/view/320

"In ancient times scholars worked for their own improvement; nowadays they seek only to win the approval of others."

Confucius, Analects 14.24 (551-479 BCE).

1 Introduction

One of the most prevailing characteristics of modern universities is their dual mission of teaching and research. Historically, these tasks were complements: research was brought into universities as an input to instruction while instruction was supposed to fuel research.[1] Nowadays, we question this relationship. The trade-off between research and teaching also relates to a broader spectrum of institutional issues. In particular, European universities are said to suffer from poor governance, insufficient autonomy, and often inadequate incentives and funding (Aghion *et al.*, 2010; Gary-Bobo and Trannoy, 2009).

In general, university professors are motivated agents exerting more than the required minimum effort level (*e.g.*, Besley and Ghatak, 2005, 2008; Delfgaauw and Dur, 2008). However, exerting effort is a question of intensity and allocation between tasks (Holmström and Milgrom, 1991).[2] Because teaching is harder to assess relative to research, and promotion decisions mainly hinge on research performance, it is common for professors to focus on research at the expense of teaching. Furthermore, research is a self-promoting investment, visible for the scientific community and the public, whereas the teaching activity is less tangible, a more local good.[3] Designing adequate incentives in such an environment is not straightforward.

[1] See Goldin and Katz (1999) for this historical development in the United States.
[2] Kerr (1975) revealed the multitask problem but not in a principal-agent framework.
[3] One could argue research provides private returns (academic authorship), while teaching is a public good.

Both theoretical- and empirical research confirm the problem of multitasking: people respond too well to monetary incentives, making it difficult to provide financial incentives for a bundle of tasks. The reason is twofold. First, encouraging effort in one activity crowds out effort in the other, *i.e.*, *the effort substitution problem*. Hence, the principal must balance incentives across tasks for the agent to exert a dual effort. Second, the principal can only offer high-powered financial incentives if the two tasks are equally and easily measured. If *outputs are asymmetrically measured*, the agent will game the system and ignore the less/non-observable activity. At the extreme, if the principal cares about both tasks, it may be best to offer no financial incentives at all.

The standard multitask model ignores that cultural norms of behavior - developed over time - also influence the agent's effort provision. Effort provision may stem from many sources, such as interests, ability, health, and moral incentives (Delfgaauw and Dur, 2007). This paper focuses on how colleagues influence the conduct of the agent. The existence of a social norm implies that the agent's effort converges towards the level of effort established by peers (Kandel and Lazear, 1992). Cultural and social incentives, defined as the shared body of beliefs in an organization, can be engineered - and motivate - in the same manner as financial incentives. Hence, there are several alternative incentive schemes whose efficiency and adequacy ought to be considered.[4]

In this paper, we analyze how a university with a limited budget should exploit the existence of a teaching norm to install a financial research incentive and thereby motivate professors to allocate effort into teaching and

[4] Holmström and Milgrom (1994) argue that incentives within an organization create a system. Academia is a prominent example of such as it gathers many types of incentives whose interplay shapes professors.

research. Put differently, we inquire about how to modify a moral hazard incentive contract when a cultural norm secures the provision of the non-financial and non-contractual task, and the allocation of public funds is also a concern.

To analyze these issues, we consider a framework with three participants: the government, the university, and a group of identical professors (*i.e.,* the agent). The university observes the agent's research production but not the teaching output.[5] There is a norm for teaching with two sources: the agent's *intrinsic motivation* and a *social component* in terms of peer pressure given by the average teaching effort exerted by peers (Ficher and Huddart, 2008). Whereas a research norm may coexist, we focus on how a norm-driven and non-contractual task (teaching), based on intrinsic motivation and peer pressure, can secure the use of a financial incentive attached to the observable and contractual activity (research).

The government funds the university. The university then pays each professor a fixed base wage and a marginal reward, depending on the research production. We assume the (public) university maximizes the research production under the constraint that the norm-driven teaching activity reaches a certain standard.[6] Teaching standards may reflect different higher education systems, *e.g.,* full-time teaching, full-time research, or teaching plus research.

We first study the problem of the agent. We show that the research incentive crowds out the teaching norm. A higher research incentive diverts the

[5] In compulsory education, teacher pay may depend on student achievement (*e.g.,* Lavy, 2009). However, in higher education, professors provide two tasks, and students indulge in self-learning (Rosen, 1987), making it harder to assess the agent's contribution. Even though evaluations of teaching may exist, research outcomes are more tangible than teaching outcomes.

[6] Although private universities maximize profit, a teaching standard could also exist in private universities. We neglect the direct role of students. The quality of teaching, however, is regulated by the teaching standard.

agent away from teaching, and in turn, lowers the social component of the teaching norm. That is, both effort substitution and a lower peer pressure diminish the agent's teaching effort. For low levels of the research incentive, a reduced social norm outweighs the benefit of a higher financial incentive. Hence, the agent's utility declines because the teaching norm is negatively affected.

We then consider the problem of the university, *i.e.*, the design of the optimal contract. First, the university needs a minimum amount of public funds for the agent to participate. Once attained this minimum, we show that the agent's research production increases with the funds available. At first, the professor produces too much teaching relative to the teaching standard and too little research. The university cannot change the situation because of the low funding. As the funding increases, the university can augment the marginal research reward. Hence, the professor's teaching effort decreases and comes closer to the teaching standard, while the effort devoted to research increases. Also, we show that the university can induce the agent to exert a higher research effort when the agent's intrinsic motivation in teaching increases. The university can transform the agent's higher intrinsic teaching motivation into a higher research effort by decreasing the base wage and increasing the marginal research reward, making the university better off. The agent otherwise exerts too much teaching effort relative to the teaching standard. However, the rise in the explicit research incentive cannot compensate for the total increase in the agent's intrinsic teaching motivation if the university is budget constrained. If constrained by the budget, the agent's teaching effort also increases. The teaching effort increases beyond the teaching standard due to a social multiplier effect driven by peer pressure and effort substitution.

Finally, we examine the problem of the government. The government has the same objective as the university but may target a different teaching standard. We show that if the government's teaching standard is higher than that of the university, the government under-funds the university to implement its standard. If, on the other hand, the university's teaching standard is higher than that of the government, the government funds the university so that the agent exerts the research effort compatible with the university's teaching standard (hence, also the government's standard). Note there is no asymmetric information between the university and the government regarding the teaching standard(s).

There has been a substantial body of research on multitasks issues in the wake of Holmström and Milgrom's (1991) seminal article. Some scholars focus on reinstating high-powered incentives and balancing incentives among tasks with opposite characteristics (Sinclair-Desgagné, 1999; Auriol *et al.*, 2002; Canton, 2005). We follow this line by scrutinizing how a cultural norm of behavior can buffer against a high-powered financial incentive in a multitask environment with asymmetrically verifiable tasks. Note that the multitask theory also includes task separation and the optimal clustering of activities (*e.g.,* Dewatripont *et al.*, 2000). We do not address these issues here as we focus on the two tasks tied together.

The paper proceeds as follows: Section 2 presents the norm-based multitask moral hazard model. Section 3 derives the optimal compensation contract the university should offer the agent and indicates how the government should fund the university. Section 4 concludes.

2 The model

We analyze a principal-management-agent model where the government is the principal, the university is the management, and professors are agents. They are all risk-neutral. Agents are often risk-averse in principal-agent models. However, to focus on the interplay between the norm and the financial incentive, we assume risk-neutral agents.

There is a unit mass of identical agents (professors). Each agent supplies a two-dimensional effort allocated to teaching and research, where e_r represents the agent's research effort, and e_t represents the agent's teaching effort. The efforts are not observable to the university. Moreover, outputs are random. We denote y_r the agent's stochastic production in research and y_t the agent's stochastic production in teaching. We assume expected outputs are $E(y_r) = e_r$ and $E(y_t) = e_t$.

As moral hazard may occur, the management (university) opts to design an optimal reward schedule, offering a linear contract to the agent. We assume the agent's research production is measurable while the agent's teaching production is unverifiable, hence cannot be contracted.[7] We assume that teaching is a norm-driven, non-financial task.[8] Thus, the university can write a contract of the form $m = \alpha y_r + w$, where w is the agent's base wage, and α is the performance-related component associated with the

[7] An unverifiable task means that there exists no hard measure to assess it. Thus, it cannot be contracted upon as courts of law cannot resolve any dispute between parties.

[8] Several scholars study the non-measurable aspects of teaching. Holmström and Milgrome (1991) study agents teaching basic skills and high-order thinking skills. The latter cannot be measured. Hence, there are two activities, but only one is observable. They show when inputs are substitutes, to provide incentives for the non-measured activity, the reward for the other task must be reduced. Sinclair-Desgagné (1999) considers a nonlinear performance scheme. There is one supervised activity (*e.g.,* education), whereas the other activity is subject to auditing (*e.g.,* research). The principal audits the agent only if the performance of the supervised task is good. The agent obtains a bonus if audited and performing well.

agent's research production. The agent has a reservation utility, U_0^A. The agent accepts the contract if the (expected) utility from participation outweighs the reservation level.

The compensation scheme depends on public funding from the principal: the university pays each professor a fixed base wage and a marginal research reward given the funding m from the government. A university is often a utility-maximizing entity subject to a *budget constraint,* whereas the government, presented with a social welfare function, behaves analogously. In this model, we incorporate a *teaching standard* as part of the objective function of both the university and the government (see sections 3.2 and 3.3). The teaching standard of the university and the government may differ. Teaching standards reflect different higher education systems, *e.g.,* full-time teaching, full-time research, or teaching plus research. Note, there is no asymmetric information between the government and the university regarding the teaching standard(s).[9]

In contrast to the standard multitask model, the agent derives utility from a norm.[10] We will study if the norm fuels the non-contractual activity and permits a financial incentive of the contractual activity. The agent's (expected) utility function reads:

$$u^A(\alpha, w, n, e_r, e_t) = \alpha e_r + w + n e_t - \frac{1}{2}e_r^2 - \frac{1}{2}e_t^2 - k e_r e_t \tag{1}$$

α is the marginal research reward; e_r determines the research production;

9 Since the need for more complex hierarchical structures than the standard two-tiered organization, principal-agent models have incorporated a supervisor who monitors the agent. These models introduce the possibility of collusion between the supervisor and the agent, *e.g.,* Tirole (1986). We do not study collusion. We focus on the funding role of the government.

10 In a standard multitask model, there are two tasks and two financial incentives. In this model, one financial incentive and one cultural norm.

w is the base wage; n is a norm for teaching (more on this below), and e_t determines the teaching production. The cost function captures the agent's disutility of effort and consists of quadratic costs plus an interaction term: $\frac{1}{2}e_r^2$ reflects the cost of producing research and $\frac{1}{2}e_t^2$ reflects the cost of producing teaching. The two efforts are weak substitutes, $0 < k < 1$: raising effort on one task increases the marginal cost of effort on the other task, *i.e.,* the effort substitution problem. We assume no task-specific abilities. In other words, the agent performs no task more efficiently than the other. Hence, the agent's effort costs are equal for the two tasks.[11] We define the maximum value of u^A as:

$$U^A(\alpha, w) = u^A(\alpha, w, n^*(\alpha), e_r^*(\alpha), e_t^*(\alpha)) \tag{2}$$

Note * indicates the endogenous values of the norm and the two efforts.

2.1 The norm

Elster (1989) argues that an individual's action emanates from self-interest and norms. A norm may emerge from: cognitive aspects - people may invest in some understandings of themselves and wish to preserve these images for themselves and others; innate preferences - individuals may like to conform to the behavior of their peer group; or social interactions and power relations (Akerlof and Kranton, 2010). In this paper, we assume that the agent is conforming with peers. Kandel and Lazear (1992) note that sociologists have long been aware of the importance of peer pressure and reference groups. The social-psychological literature underscores that peo-

[11] The marginal effort cost may depend on ability, aptitude, and other attributes. To focus on reinstating high-powered incentives in a multitask environment with asymmetrically measured tasks, we assume the agent's task abilities are symmetric concerning costs. See Thiele (2010) for task-specific abilities in a multitask principal-agent model.

ple have strong preferences to behave similarly to those around them (*e.g.*, Asch, 1951).

Incorporating a norm into a multitask environment of asymmetric measured activities means that in addition to the contractual research output (where α and w are the contract parameters), the agent gets valuable non-contractual payoff regarding teaching. Consistent with the social identity theory of Tajfel and Turner (1979), we assume that the agent adheres to a personal effort target and a social peer norm. Hence, the agent derives utility from intrinsic motivation in teaching (exogenous) and peer pressure (endogenous). Formally, we build on Ficher and Huddart (2008). They incorporate norms into a principal-agent model, studying how norms influence organizational boundaries - not how they shape the optimal incentive scheme. The teaching norm reads:

$$n = \lambda t + (1 - \lambda)\, \overline{e_t} \tag{3}$$

λ $(0 < \lambda < 1)$ represents the weight the agent puts on the effort target, t, relative to the average teaching effort of peers, $\overline{e_t}$.[12] The norm function n (which is differentiable) is hence a weighted average of the agent's (exogenous) intrinsic teaching motivation and the (endogenous) social teaching norm related to peer pressure. A higher level of either type inclines the agent to work harder in teaching (for a given level of the financial incentive), although the source of motivation is different. A higher λ indicates that the agent puts more emphasis on implicit teaching motivation. A lower λ implies that the agent chooses a higher teaching effort in response to an

[12] The exogenous personal teaching target, t, may be thought of as intrinsic motivation in teaching, a morally desirable action, altruism toward students, or status concern for the profession.

increased teaching effort of peers. We make the following assumptions:

Assumption 1: $\lambda > k$. The agent's weight on the personal effort target in teaching is larger than the substitution of effort.

Assumption 2: The agent is a norm-taker, *i.e.,* each professor is atomistic and takes the social teaching norm as given. The agent observes and correctly anticipates the way of behaving in his or her peer group.

Assumption 1 says that the extent to which the effort in one task crowds out the effort in the other task (k) must be smaller than the importance of the intrinsic motivation of the norm-based activity (λ). It makes sense that the weight on the exogenous part of the norm is higher than the effort substitution when the two tasks are tied together: it enables the agent to provide a dual effort. Only in this way can the cultural norm (for teaching) buffer against the financial (research) reward. Empirically, it is demanding to specify the levels of λ and k. We assume that teaching and research are weak substitutes. Hence, k is low. Assumption 2 underscores that one professor alone is not the norm-maker: the agent adheres to the effort norm established by peers. We assume the agent observes the *average* teaching effort exerted by colleagues. That is, correctly anticipates the behavior of his or her reference group. In contrast, as already noted, the university (*i.e.,* the management) cannot observe effort. Assumptions 1 and 2 make intuitive the interplay between the norm (n) and the financial incentive (α). If they do not hold, the teaching norm cannot secure the provision of the research incentive, and the agent cannot, in an easy way, internalize the social norm component into his or her utility function.

3 The Optimal Compensation Contract

First, we derive the agent's optimal effort levels (conditional on accepting the offer). Then, we solve the maximization problem of the university: We derive the optimal base wage and the optimal marginal research reward (conditional on the university received funding from the government). Finally, we study how the government should fund the university.

3.1 *The Effort Choice of the Agent*

Maximizing the agent's utility (expression (1)) with respect to efforts yields the following system of equations:

$$e_r^* = \alpha - k e_t^* \tag{4}$$

$$e_t^* = n - k e_r^* \tag{5}$$

Naturally, the agent's research effort increases with the monetary incentive, α, whereas the agent's teaching effort increases with the norm, n. The negative cross-partial derivatives are associated with the technological dependence of the two tasks: the effort in one task crowds out the effort in the other task, *i.e.*, the effort substitution problem.

As agents are identical, they provide the same teaching effort at equilibrium.[13] In consequence, the average teaching effort of the agent's peers, *i.e.*, the social component of the norm, is equal to the agent's teaching effort: we have $\overline{e_t^*} = e_t^*$. Using that the endogenous value of the norm function

[13] Introducing heterogeneous agents (along t) made the analytical solution impossible. See Donze and Gunnes (2018) for a norm-based one-task model with heterogeneous agents.

equals $n^* = \lambda t + (1-\lambda)\, e_t^*$, we rearrange equations (4) and (5) and obtain the agent's optimal effort levels:

$$\left(e_r^*(\alpha), e_t^*(\alpha)\right) = \begin{cases} (0,t) & if \quad \alpha \leq tk \\ \left(\frac{\lambda\alpha-\lambda tk}{\lambda-k^2}, \frac{\lambda t-\alpha k}{\lambda-k^2}\right) & if \quad \alpha \in \left[tk, \frac{\lambda t}{k}\right] \\ (\alpha, 0) & if \quad \alpha \geq \frac{\lambda t}{k} \end{cases} \tag{6}$$

Expression (6) indicates that the agent provides effort in both tasks when $\alpha \in \left[tk, \frac{\lambda t}{k}\right]$. For $t = 0$, there exists a symmetric Nash equilibrium where the optimal teaching effort, $e_t^*(\alpha)$, is zero. Thus, to exert teaching effort, the agent must be endowed with a positive level of t. A large body of literature suggests that individuals find interest in their work and derive satisfaction from it (Ryan and Deci, 2000; Stern, 2003; Canton, 2005; Aghion *et al.*, 2008; Besley and Ghatak, 2005, 2008; Fehr and Falk, 2008). Hence, a positive t is plausible.[14]

In the following, we study two mechanisms embedded in the model. They emerge because the substitution of effort (k) and the social component of the teaching norm ($\overline{e_t^*} = e_t^*(\alpha)$) break the non-separability of the two efforts. Together, resulting in a *crowding-out effect* (a higher financial research incentive reduces the teaching effort, due to effort substitution, and in turn also the endogenous peer norm which lowers the agent's teaching effort even further) and a *social multiplier effect* (a higher intrinsic teaching motivation increases the teaching effort by more than the increase in intrinsic motiva-

[14] How to select intrinsically motivated professors and regulate the social norm are beyond the scope of this paper. See Delfgaauw and Dur (2007) for the screening of worker motivation and Donze and Gunnes (2018) for how to regulate a social norm.

tion due to peer pressure and effort substitution).

3.1.1 Crowding-out Effect

We first study the effect on the optimal efforts $(e_r^*(\alpha), e_t^*(\alpha))$ of modifying the marginal research incentive, α, when the two tasks are tied together, *i.e.*, for $\alpha \in \left[tk, \frac{\lambda t}{k}\right]$. Recall, for a lower (higher) power of the financial incentive, the agent only provides effort in teaching (research). According to (6), the agent's optimal research effort is increasing in the financial research incentive, $\partial e_r^*(\alpha)/\partial\alpha > 0$, whereas the agent's optimal teaching effort is decreasing in the financial research incentive, $\partial e_t^*(\alpha)/\partial\alpha < 0$, as $k > 0$. Hence, effort devoted to research increases as research becomes more rewarding, whereas effort devoted to teaching decreases because of the substitution of effort. More surprisingly, an increase in the financial research incentive crowds out the endogenous teaching norm:

$$\frac{\partial n^*(\alpha)}{\partial\alpha} = -\frac{(1-\lambda)k}{\lambda - k^2} < 0 \tag{7}$$

for $1 > \lambda > k > 0$. The crowding-out of the endogenous teaching norm, $n^*(\alpha)$, by the financial research incentive, α, stems from the substitution of effort, measured by k, and the social component in $n^*(\alpha)$, *i.e.*, $\overline{e_t^*} = e_t^*(\alpha)$. First, a higher financial research incentive diverts the agent away from teaching due to $k > 0$. Then, the substitution of effort lowers the social norm, *i.e.*, the peer pressure for teaching. Thus, the agent's teaching effort decreases further. The crowding-out effect is larger for a smaller λ. The more weight the agent puts on the social incentive, the more the teaching effort diminishes due to decreased peer effort. If teaching and research were technologically independent tasks ($k = 0$), there would be no crowding-out effect. If technological complements rather than substitutes ($k < 0$), there would be a crowding-in effect instead.

For low values of α (albeit higher than tk), the crowding-out effect generates an undesirable effect on the agent's utility. To understand why we use the envelope theorem to obtain:

$$\frac{dU^A}{d\alpha} = \frac{\partial U^A}{\partial n}\frac{\partial n^*(\alpha)}{\partial \alpha} + \frac{\partial U^A}{\partial \alpha} \tag{8}$$

At equilibrium $\frac{\partial U^A}{\partial n} = e_t^*(\alpha)$, $\frac{\partial n^*(\alpha)}{\partial \alpha}$ is given by (7), and $\frac{\partial U^A}{\partial \alpha} = e_r^*(\alpha)$. For a low α, the utility loss associated with a less powerful teaching norm, $\frac{\partial U^A}{\partial n}\frac{\partial n^*(\alpha)}{\partial \alpha}$, is more important than the increase in utility due to a higher financial research incentive, $\frac{\partial U^A}{\partial \alpha}$. That is, the loss due to a less gratifying teaching environment outweighs the extra benefit of a higher financial research incentive. Hence, U^A decreases for a low α. U^A reaches a minimum at:

$$\hat{\alpha} = \frac{\lambda tk\left(1-k^2\right)}{\lambda^2 + k^2 - 2\lambda k^2} \tag{9}$$

One can verify that $\hat{\alpha} \in \left[tk, \frac{\lambda t}{k}\right]$. To the right of $\alpha = tk$ and until $\hat{\alpha}$, U^A decreases in α. From $\alpha = \hat{\alpha}$, the benefit associated with a higher financial incentive exceeds the utility loss generated by the decreased norm. We sum up the results in the following proposition.

Proposition 1 *Conditional on contract acceptance:*

1. *The teaching norm, $n^*(\alpha)$, decreases in the explicit research incentive $\alpha \in \left[tk, \frac{\lambda t}{k}\right]$.*

2. *For any base wage, $w(\alpha)$:*

   - *Maximum agent utility $U^A(\alpha, w)$ decreases in the explicit research incentive for $\alpha \in [tk, \hat{\alpha}]$.*

- *Maximum agent utility $U^A(\alpha, w)$ increases in the explicit research incentive for $\alpha \geq \hat{\alpha}$.*

Proposition 1 states that an increase in the marginal research reward crowds out the social teaching norm, and for certain low levels of the monetary incentive, it has an undesirable effect on the agent's utility. Usually, crowding-out effects stem from a financial incentive eroding the agent's implicit motivation. In this model, the crowding-out effect manifests itself through the effort substitution and a subsequent reduction in peer pressure. Note there would be no crowding-out effect in a one-task version of this norm-based principal-agent model, indicating that the substitution of effort initiates the crowding-out.

3.1.2 The Social Multiplier Effect

We now study the effect on the optimal efforts $(e_r^*(\alpha), e_t^*(\alpha))$ of modifying the agents personal teaching target t (or the weight λ on t in the teaching norm) when the two tasks are tied together, *i.e.*, $\alpha \in \left[tk, \frac{\lambda t}{k}\right]$. Note that t is not a contract parameter. A modified t represents a change in the type of agent. According to (6), increasing t (or λ) increases the optimal teaching effort ($\partial e_t^*(\alpha)/\partial\lambda > 0$; $\partial e_t^*(\alpha)/\partial t > 0$) and decreases the optimal research effort ($\partial e_r^*(\alpha)/\partial\lambda < 0$; $\partial e_r^*(\alpha)/\partial t < 0$) due to effort substitution (*i.e.*, $k > 0$). Moreover, an increase in the agent's intrinsic motivation creates a multiplier effect on the teaching effort:

$$\frac{\partial e_t^*(\alpha)}{\partial t} = \frac{1}{1 - k^2/\lambda} > 1 \tag{10}$$

The multiplier augments as λ decreases, *i.e.*, when the weight is redistributed away from the personal teaching target to the social teaching norm. It also increases with the substitution of effort, k. There is a large literature on social multipliers (*e.g.,* Huck *et al.*, 2012). However, few papers are concerned with a social multiplier in a multitask environment. To understand the underlying mechanisms driving the multiplier, suppose t increases by $\triangle t$. In a first-round, the teaching norm, whose endogenous value equals $n^* = \lambda t + (1-\lambda)\, e_t^*$, increases by $\lambda \triangle t$. In turn, e_t^* increases by the same amount. This increase has two consequences in a second round. First, the teaching norm increases by $(1-\lambda)\lambda\triangle t$. Second, the research effort, $e_r^* = \alpha - ke_t^*$, decreases by $k\lambda\triangle t$, allowing for a subsequent increase in e_t^* by substitution. Hence, in total, an increase by $(1-\lambda)\lambda\triangle t + k^2\lambda\triangle t$ in the second round. Anew, e_t^* increases by the same amount. Summing the successive increases, we obtain:

$$\triangle e_t = \left[\lambda + \lambda((1-\lambda)+k^2) + \lambda((1-\lambda)+k^2)^2 + ...\right] \triangle t = \frac{\lambda}{\lambda - k^2}\triangle t \quad (11)$$

Expression (11) indicates that the multiplier expands with the weight on the peer norm. Whereas the agent's teaching effort increases with λ, the social multiplier effect is amplified if the agent adheres to peer pressure, *i.e.,* if the agent has a low λ. First, an increase in t augments the agent's effort e_t^*. Then, there is an additional effect through the rise in the teaching effort of peers. This second effect influences the agent more the lower the agent's λ. The effort substitution also amplifies the multiplier: an increase in t increases e_t^*, which reduces e_r^*, and by substitution increases e_t^* again. Although the substitution of effort increases the social multiplier effect, it is not the catalyst. There would be a social multiplier effect also in a one-task version of this norm-based principal-agent model.

3.2 *The Maximization Problem of the University*

We assume the university targets a certain standard in teaching. As long as the agent's teaching effort is below this threshold, the university does not attach any importance to research. If attaining the minimum level, the university starts appreciating the agent's research effort but not the teaching effort beyond the standard, indicating the university's objective is to maximize the expected research effort under the constraint that the teaching effort cannot fall below a certain level. The university's utility reads:

$$\underset{\alpha}{max}\, U^U = \mathbf{1}_{\left(e_t^*(\alpha)<\underline{e}_t^U\right)} \left[e_t^*\left(\alpha\right)\right] + \mathbf{1}_{\left(e_t^*(\alpha)\geq\underline{e}_t^U\right)} \left[\underline{e}_t^U + e_r^*\left(\alpha\right)\right] \tag{12}$$

where $\mathbf{1}$ is the indicator function, and $\underline{e}_t^U$ is the teaching standard of the university.

In addition to the standard of the norm-driven task, the university faces a budget constraint. It receives public funds equal to m from the government and must allocate it between the fixed and the variable parts of the agent's compensation scheme, $\alpha e_r^*\left(\alpha\right) + w \leq m$. The university chooses the lowest base wage compatible with the agent's participation. The base wage providing the agent with his or her reservation utility, $w_0\left(\alpha\right)$, is defined as the solution in w to the implicit equation $U_0^A = U^A(\alpha, w)$. For the agent to participate and secure that the agent will attain the teaching standard, $e_t^*\left(\alpha\right) \geq \underline{e}_t^U$, we make the following assumption:

Assumption 3: (i) $m \geq U_o^A - \frac{1}{2}t^2 > 0$ and (ii) $t \geq \underline{e}_t^U$.

The first part of Assumption 3 indicates that the university needs a minimum amount of public funds to make the agent participate. The university must, at least, cover the agent's base wage when the agent is only providing the norm-based task, *i.e.*, teaching. Assumption 3 guarantees that $w_0(\alpha) \geq 0$ when α is not too high.[15] The Appendix provides the expression of $w_0(\alpha)$. The second part of Assumption 3 indicates that the agent's intrinsic teaching motivation, t, must be higher or equal to the university's teaching standard. Put differently: The university relies on intrinsic motivation to attain the teaching standard. If $t < \underline{e}_t^U$, the agent cannot reach the university's minimum required teaching effort. Recall, the maximum teaching effort is t (for $m = U_0^A - \frac{1}{2}t^2$ and $\alpha = tk$).

To maximize its objective function, the university chooses a financial research reward that satisfies the teaching standard and the budget constraint (imposed by the government). We first study the constraint related to the university's teaching standard. Let us denote $\overline{\alpha}_t$ the solution in α to $\underline{e}_t^U = e_t^*(\alpha)$. That is, $\overline{\alpha}_t$ is the financial research incentive yielding the teaching effort required by the standard. Given (6), $\overline{\alpha}_t$ is the solution in α to:

$$\underline{e}_t^U = \frac{\lambda t - \alpha k}{\lambda - k^2} \tag{13}$$

which implies that

$$\overline{\alpha}_t = \frac{\lambda t - \underline{e}_t^U (\lambda - k^2)}{k} \tag{14}$$

To induce the agent to provide an teaching effort at least equal to $\underline{e}_t^U$, the university should choose a financial research incentive no higher than $\overline{\alpha}_t$.

[15] For $\alpha \geq \lambda t/k$, that is, when $e_t^*(\alpha) = 0$, U^A increases without bound.

The higher the teaching standard, $\underline{e}_t^U$, the lower the financial research incentive $\overline{\alpha}_t$ due to effort substitution. One can verify that $\overline{\alpha}_t = tk$ when $\underline{e}_t^U = t$ while $\overline{\alpha}_t = \lambda t/k$ when $\underline{e}_t^U = 0$. Hence, $\overline{\alpha}_t \in [tk, \lambda t/k]$.

$\overline{\alpha}_t$ is increasing in λ and t. The intuition is as follows: For a low λ, that is, the agent is more focused on the social (endogenous) component of the teaching norm relative to the implicit (exogenous) teaching motivation, the teaching effort is more sensitive to the power of the research incentive due to the higher importance of peer pressure. Choosing a high research incentive would result in a low teaching effort, not sufficiently compensated by a higher research effort. For a high λ, *i.e.*, the agent is more devoted to intrinsic motivation than the social component of the norm, the teaching effort is less sensitive to the power of the financial incentive due to lower weight on peer pressure. Choosing a high-powered research incentive would trigger a higher research effort without reducing the teaching effort too much. In short, a higher λ decreases the importance of the crowding-out effect previously explained.

When t increases, the agent is more intrinsically motivated for teaching, so the agent's participation constraint is relaxed (see Assumption 3). In consequence, the university can offer a lower base wage and a higher financial research incentive: we have $\partial\overline{\alpha}_t/\partial t > 0$.[16] We study this relationship in detail in the subsequent sub-section. It is worth noting that we avoid the standard trade-off between risk and incentives as we assume risk-neutral agents.

We now examine the optimal α given the budget constraint. We denote $\overline{\alpha}_m$

[16] Intrinsic motivation is additively separable in the agent's utility function, so the university always prefers the agent to be intrinsically motivated as it increases the marginal utility from the transfer. (It is equivalent to a reduction in the disutility of effort).

the solution in α to the implicit equation $\alpha e_r^*(\alpha) + w_0(\alpha) = m$. That is, $\overline{\alpha}_m$ corresponds to the situation where the university is budget-constrained and spends m financing the agent's base wage and the marginal research reward. Assumption 3 guarantees that $\overline{\alpha}_m$ exists. The expression of $\overline{\alpha}_m$ is given in the Appendix. Note that $\overline{\alpha}_m$ is non-decreasing in m.

Given the budget constraint and the teaching standard of the university, the optimal financial research incentive is:

$$\alpha^*(m) = min(\overline{\alpha}_m, \overline{\alpha}_t) \tag{15}$$

In other words, the optimal research reward must ensure that the university can finance the contract and yield at least the teaching effort required by the teaching standard.

Let $\overline{m}$ denote the amount of public funds such that $\overline{\alpha}_m = \overline{\alpha}_t$. We have two constrained cases (for a given teaching standard and budget). When $m < \overline{m}$, *the university is budget constrained*. In this case, the university can provide $\overline{\alpha}_m$ to the agent where $\overline{\alpha}_m < \overline{\alpha}_t$. In turn, the agent exerts an effort in teaching above the university's minimum teaching standard. When $m \geq \overline{m}$, *the teaching standard restricts the university*. In this case, the university can provide a higher financial research incentive to the agent but not beyond $\overline{\alpha}_t$, *i.e.*, $\overline{\alpha}_m = \overline{\alpha}_t$. In turn, the agent exerts an effort in teaching equal to the minimum standard of the university. We summarize the results in the following proposition.

Proposition 2

1. $\overline{\alpha}_m$ *is non-decreasing in* m. *However, as* $\underline{e}_t^U \geq 0$, $\alpha^*(m)$ *cannot go beyond*

$\overline{\alpha}_t$.

2. *If* $\overline{\alpha}_t > \hat{\alpha}$ *(i.e.,* $\underline{e}_t^U$ *is low),* $w^* = w_0 (\alpha^* (m))$ *is first increasing then decreasing in* m.

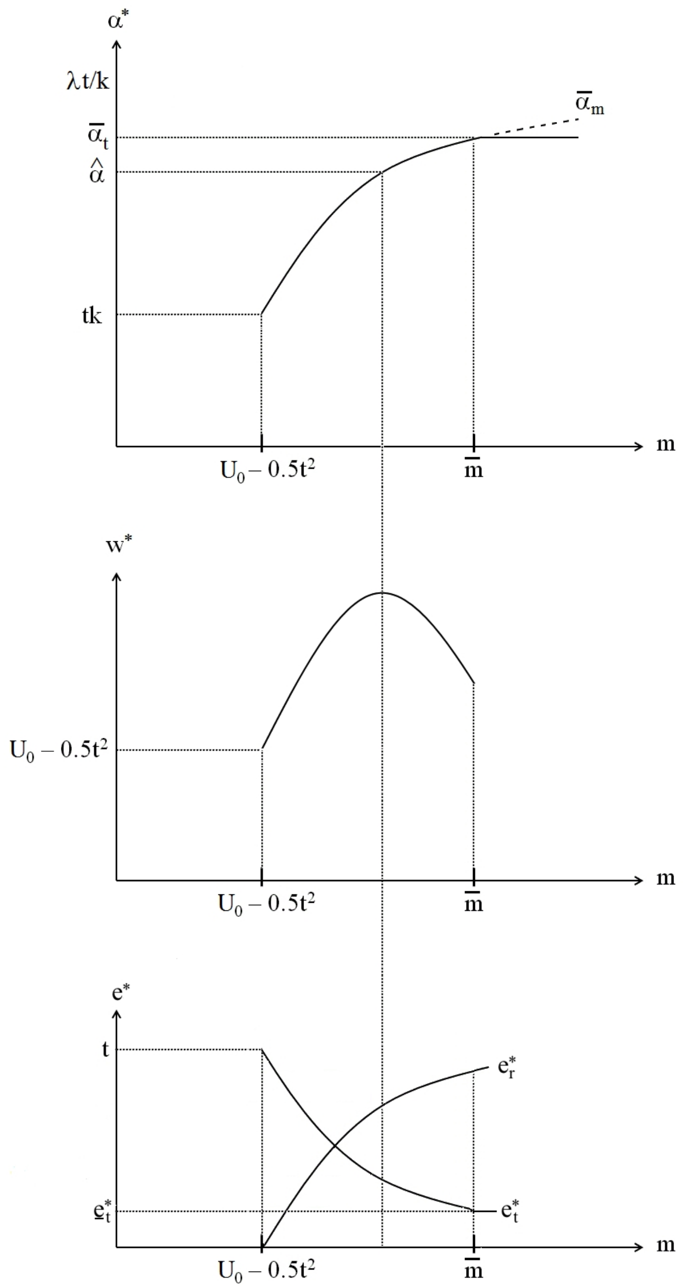
3. *If* $\overline{\alpha}_t \leq \hat{\alpha}$ *(i.e.,* $\underline{e}_t^U$ *is high),* $w^* = w_0 (\alpha^* (m))$ *is monotonically increasing in* m.

Proposition 2 states that the optimal marginal research reward, $\alpha^* (m)$, increases with the government funding m if the agent is attaining the teaching standard, *i.e.,* $e_t^* (\alpha^* (m)) \geq \underline{e}_t^U$. The teaching standard represents the type of university: $\underline{e}_t^U = 0$ represents a full-time research university, whereas $\underline{e}_t^U = t$ represents a full-time teaching university. We focus on the two tasks tied together, *i.e.,* the university provides both research and teaching, hence $\alpha^* (m)$ cannot go beyond $\overline{\alpha}_t$. Regarding the optimal base wage, w^*, recall U^A reaches a minimum at $\hat{\alpha}$. For a low teaching standard, the university must, as m increases, first provide the agent with a higher base wage to compensate for the lower social teaching norm, *i.e.,* the crowding-out effect. Then, as m increases further, $\alpha^* (m)$ becomes sufficiently high (*i.e.,* $\alpha^* (m) > \hat{\alpha}$) to allow for a decrease in the base wage. For a high teaching standard, the university attains $\overline{m}$ quickly as m increases due to the high standard, so $\alpha^* (m)$ cannot become sufficiently powerful to allow for a decrease in the base wage (*i.e.,* $\alpha^* (m) < \hat{\alpha}$). Figure 1 sums up for $m \leq \overline{m}$ and $\overline{\alpha}_t > \hat{\alpha}$, *i.e.,* the university is budget-constrained and the teaching standard is low.

3.2.1 Comparative statics: Increased intrinsic motivation

The agent generates valuable non-contractual payoff to the university in terms of teaching due to the norm, *i.e.,* intrinsic motivation in teaching and peer pressure. We now study how increased intrinsic motivation in teaching

Figure 1. The model for $m \leq \overline{m}$ ***and*** $\overline{\alpha}_t > \hat{\alpha}$



affects the optimal financial research incentive $(\alpha^*(m))$ and the two optimal effort levels $(e_t^*(\alpha^*(m)), e_t^*(\alpha^*(m)))$. Note that t is not a contract parameter. A modified t represents a change in the type of agent. We consider the case where $m \leq \overline{m}$ (hence, $\overline{\alpha}_m \leq \overline{\alpha}_t$), *i.e.*, the university is budget-constrained and induces the agent to exert too much effort in teaching relative to its teaching standard.

When t increases, the agent is more intrinsically motivated for teaching and the participation constraint is relaxed. In consequence, the university can offer a lower base wage, w^*, and a higher financial research incentive: we have $\frac{\partial \alpha^*(m)}{\partial t} > 0$.[17] The expression of $\alpha^*(m)$ when $\overline{\alpha}_m \leq \overline{\alpha}_t$ is given in the Appendix. We can verify that $\frac{\partial \alpha^*(m)}{\partial t} \in \left[k, \frac{\lambda}{k}\right]$. When $\underline{e}_t^U = t$, $\frac{\partial \alpha^*(m)}{\partial t} = k$. When $\underline{e}_t^U = 0$, $\frac{\partial \alpha^*(m)}{\partial t} = \frac{\lambda}{k}$. That is, the lower the teaching standard of the university, $\underline{e}_t^U$, the higher the $\frac{\partial \alpha^*(m)}{\partial t}$.

Regarding the two effort levels, we start with the teaching effort. Differentiating $e_t^*(\alpha^*(m), t)$ with respect to t, we obtain:

$$\frac{de_t^*(\alpha^*(m), t)}{dt} = \frac{\partial e_t^*}{\partial \alpha}\frac{d\alpha^*(m)}{dt} + \frac{\partial e_t^*}{\partial t} = -\frac{k}{\lambda - k^2}\frac{d\alpha^*(m)}{dt} + \frac{\lambda}{\lambda - k^2} \tag{16}$$

The second term in (16) is the social multiplier from expression (11). As $\frac{\partial \alpha^*(m)}{\partial t} \leq \frac{\lambda}{k}$, the positive effect of the social multiplier on the agent's teaching effort outweighs the negative impact on the agent's teaching effort caused by the rise in $\alpha^*(m)$. We therefore have $\frac{de_t^*(\alpha^*(m),t)}{dt} > 0$.

[17] The ability to transform increased implicit teaching motivation into higher research effort lies upon the assumption that the agent has no task-specific abilities. With asymmetric effort costs, this transformation may have been harder to achieve.

Differentiating $e_r^*(\alpha^*(m), t)$ with respect to t, we obtain:

$$\frac{de_r^*(\alpha^*(m), t)}{dt} = \frac{\partial e_r^*}{\partial \alpha}\frac{d\alpha^*(m)}{dt} + \frac{\partial e_r^*}{\partial t} = \frac{\lambda}{\lambda - k^2}\frac{d\alpha^*(m)}{dt} - \frac{\lambda k}{\lambda - k^2} \tag{17}$$

As $\frac{\partial \alpha^*(m)}{\partial t} \geq k$, the positive effect on the agent's research effort due to an increase in $\alpha^*(m)$ outweighs the negative impact on the agent's research effort caused by the rise in t. We therefore have $\frac{de_r^*(\alpha^*(m),t)}{dt} > 0$. We summarize the results in the following proposition.

Proposition 3

Consider the case where $m \leq \overline{m}$. If the agent's intrinsic motivation in teaching increases, the university can augment the financial research incentive: $\frac{\partial \alpha^*(m)}{\partial t} > 0$. The agent then exerts a higher research effort, $de_r^*(\alpha^*(m), t)/dt > 0$, but also a higher teaching effort, $de_t^*(\alpha^*(m), t)/dt > 0$.

Proposition 3 stems from an initial situation where $m \leq \overline{m}$, *i.e.*, the university is budget constrained. When t increases, the university can transform the agent's higher intrinsic teaching motivation into increased research effort by modifying the contract (increasing $\overline{\alpha}_m$ and decreasing w^*). This makes the university better off: otherwise, the agent exerts too much effort in teaching relative to the teaching standard. Put differently, there is a *crowding-in* effect of the agent's higher intrinsic teaching motivation on the agent's research effort. There are two things worth noting: First, the increase in $\overline{\alpha}_m$ cannot completely compensate for the rise in t because of the low budget m, *i.e.*, $\overline{\alpha}_m \leq \overline{\alpha}_t$. In consequence, the agent's teaching effort, notably due to the social multiplier effect, also increases despite not being valued by the university. Second, the amount of public funds $\overline{m}$ required to attain $\overline{\alpha}_m = \overline{\alpha}_t$ increases with t. That is, the amount of public funding required for the teaching effort to fall to the university's teaching standard increases when t augments. In fact, $\overline{\alpha}_t$ increases with t and $\overline{m}$ is increasing in $\overline{\alpha}_t$. Hence, $\overline{m}$ is also increasing in t.[18] (See Figure 1.)

3.3 The Funding from the Government

The government chooses its funding policy: it allocates m to the university.[19] The objective of the government is the same as the one of the university, but its teaching standard, $\underline{e}_t^G$, is not necessarily the same as the teaching standard of the university, $\underline{e}_t^U$. We have:

$$\underset{m}{max}\, U^G = \mathbf{1}_{\left(e_t^*(\alpha^*(m))<\underline{e}_t^G\right)} \left[e_t^*\left(\alpha^*\left(m\right)\right)\right] + \mathbf{1}_{\left(e_t^*(\alpha^*(m))\geq\underline{e}_t^G\right)} \left[\underline{e}_t^G + e_r^*\left(\alpha^*\left(m\right)\right)\right] \tag{18}$$

where $\alpha^*\left(m\right)$ is given by (15).

Proposition 4

If the teaching standard of the university is lower than that of the government, $\underline{e}_t^U \leq \underline{e}_t^G$, the government chooses a lower allocation than $\overline{m}$, i.e., $m^* \leq \overline{m}$. In doing so, the government induces the university to choose its standard$\underline{e}_t^G$. If the teaching standard of the university is higher than that of the government, $\underline{e}_t^U \geq \underline{e}_t^G$, the government chooses an allocation equal to $\overline{m}$, i.e., $m^* = \overline{m}$. The government then induces the agent to exert the maximal research effort compatible with the

[18] Note that $\overline{m} = U_0^A + \frac{1}{2}(e_r^*(\overline{\alpha}_t))^2 - \frac{1}{2}(e_t^*(\overline{\alpha}_t))^2$. As $\frac{1}{2}(e_r(\overline{\alpha}_t))^2 - \frac{1}{2}(e_t(\overline{\alpha}_t))^2$ is increasing in $\overline{\alpha}_t$ and $\overline{\alpha}_t$ is increasing in t, then $\overline{m}$ is also increasing in t.

[19] Several papers study funding. De Fraja (2016) studies how funds should be distributed among research institutions with unobserved and varying productivity. Gary-Bobo and Trannoy (1998) examine a principal-agent relationship where a university has a local monopoly of higher education provision. Del Rey (2001) considers a two-stage game between two universities that maximize student productivity and utility derived from research. Four types of equilibria, differing according to preferences, technologies, and public policy, are identified: full-time teaching, full-time research, selective teaching plus research, and mass teaching plus research.

teaching standard of the university $\underline{e}_t^U$ *(and hence* $\underline{e}_t^G$*).*

To attain the teaching standard, the government has no interest in providing a higher financial research incentive than that offered by the university.

4 Conclusion

We introduce a norm into a multitask moral hazard model and apply it to academia. The cultural norm fosters effort in teaching (non-contractual activity), whereas a financial incentive encourages research effort (contractual task). We study the interplay between the cultural norm and the financial incentive and determine the optimal compensation contract the university should offer professors when the provision of public funds is also a concern.

Incorporating a norm into a multitask model with asymmetrically measured tasks leads to different results than the standard multitask model with two financial incentives. According to our norm-based model, academia may benefit from offering a financial research incentive if a cultural teaching norm exists. We add three assumptions regarding the norm-driven teaching activity. Intrinsic motivation and the importance of peers for compliance to a social norm, together with a financial incentive, can motivate professors to exert a dual effort, thereby promoting efficiency in higher education institutions. That is, although incentives still must be balanced across tasks, an effort norm can work in tandem with a financial incentive.

The model generates at least three results. First, increasing the marginal research incentive crowds out the social teaching norm. For low levels of the financial incentive, the agent's utility decreases. The reduction in peer pressure outweighs the gain from a higher monetary reward. Hence, for the research incentive to be effective, a certain level of public funds is required to go against the crowding-out effect. Second, if the intrinsic teaching motivation increases, the university can induce the agent to exert a higher research effort. The university can transform the higher teaching motivation into a higher research effort by decreasing the agent's base wage and increasing the research incentive. Converting implicit teaching motivation into explicit research motivation is more facile with increased public funding. If budget constrained, the rise in the financial incentive cannot compensate for the increased intrinsic motivation. Hence, the agent's teaching effort, notably due to a social multiplier effect, also increases. Third, if the university's teaching standard is lower than that of the government, the government under-funds the university. By doing so, the government implements its teaching standard. If, on the other hand, the university's teaching standard is higher than the government's teaching standard, the government funds the university so that the agent exerts the maximal research effort compatible with the university's teaching standard (and hence the government's standard). Note that whereas many papers study crowding-out and social multiplier effects, they are seldom examined in a multitask framework. In this model, the substitution of effort, *i.e.,* the key ingredient in a multitask model, fuels both effects.

The model consists of two stylized facts: individuals respond to incentives, and contracts govern economic relationships. Testable implications are to compare the effectiveness of different incentive schemes. Notably, do universities that offer financial research incentives and rely on a teaching norm perform better (conditional on the existence of a teaching norm and funding)?

The model captures the interplay between a cultural norm and a financial incentive and inquires how a teaching standard and the funding affect the optimal contract. It would be interesting to extend the model to consider asymmetric information between the government and the university, study different reference groups for peer pressure, and inquire how the university should regulate the social norm(s).

References

Asch, S. E., 1951. Effects of group pressure upon the modification and distortion of judgment. In: Guetzkow, H. (Eds.), Groups, Leadership, and Men. Carnegie Press, Pittsburgh.

Aghion, P., Dewatripont, M., Hoxby, C., Mas-Colell, A., Sapir, A., 2010. The governance and performance of universities: Evidence from Europe and the US. Economic Policy 25, 7-59.

Aghion, P., Dewatripont, M., and Stein, S., 2008. Academic freedom, private-sector focus, and the process of innovation. Rand Journal of Economics 39, 3, 617-635.

Akerlof, G., Kranton, R., 2010. Identity economics. Princeton University Press, Princeton.

Auriol, E., Friebel, G., Pechlivanos, L., 2002. Career concerns in teams. Journal of Labor Economics 20, 2, 289-307.

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

Besley, T., Ghatak, M., 2008. Status incentives. American Economic Review 98, 2, 206-211.

Canton, E., 2005. Power of incentives in public organizations when employees are intrinsically motivated. Journal of Institutional and Theoretical Economics 161, 4, 664-680.

De Fraja, G., 2016. Optimal public funding for research: A theoretical analysis. Rand Journal of Economics 47, 3, 498-528.

Delfgaauw, J., Dur, R., 2007. Signaling and screening of workers' motivation. Journal of Economic Behavior and Organization 62, 4, 605-624.

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

Del Rey, E., 2001. Teaching versus research: A model of state university competition. Journal of Urban Economics 49, 356-373.

Dewatripont, M., Jewitt, I., Tirole, J., 2000. Multitask agency problems: Focus and task clustering. European Economic Review 44, 869-877.

Donze, J., Gunnes, T., 2018. Becoming "We" instead of "I": Identity management and incentives in the workplace. Journal of Economic Behavior and Organization 148, 105-120.

Elster, J., 1989. Social norms and economic theory. Journal of Economic Perspectives 3, 4, 99-117.

Fehr, E., Falk, A., 2008. Psychological foundations of incentives. European Economic Review 46, 687-724.

Fischer, P., Huddart, S., 2008. Optimal contracting with endogenous social norms. American Economic Review 98, 1459-75.

Gary-Bobo, R., Trannoy, A., 1998. L'economie politique simplifiée du mammouth: Sélection par l'echec et financement des universités. Revue Francaise d'Economie 13, 85-126.

Gary-Bobo, R., Trannoy, A., 2009. Professeur d'université, profession liberal d'Etat. Commentaire 127.

Goldin, C., Katz, L.F., 1999. The shaping of higher education: The formative years in the United States 1880-1940. Journal of Economic Perspectives 13, 1, 37-62.

Holmström, B., Milgrom, P., 1991. Multitask principal-agent analysis: Incentive contracts, asset ownership, and job design. Journal of Law, Economics, and Organization 7, 24-52.

Holmström, B., Milgrom, P., 1994. The Firm as an incentive system. American Economic Review 84, 4, 972-991.

Huck, S., Kübler, D., Weibull, J., 2012. Social norms and economic incentives in firms. Journal of Economic Behavior and Organization 83, 2, 173-185.

Kandel, E., Lazear, E.P., 1992. Peer pressure and partnerships. Journal of Political Economy 100, 801-817.

Kerr, S., 1975. On the folly of rewarding A, while hoping for B. The Academy of Management Executive 9, 1, 7-14.

Lavy, V., 2009. Performance pay and teachers' effort, productivity, and grading ethics. American Economic Review 99, 5, 1979-2011.

Rosen, S., 1987. Some economics of teaching. Journal of Labor Economics 5, 561-575.

Ryan, R. M., Deci, E. L., 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist 55, 68-78.

Stern, S., 2004. Do scientists pay to be scientists? Management Science 50, 6, 835-853.

Sinclair-Desgagné, B., 1999. How to restore higher-powered incentives in multitask agencies. Journal of Law, Economics, and Organization 15, 2, 418-433.

Tajfel, H., Turner, J.C., 1979. An integrative theory of intergroup conflict. In: Austin, Worchel (Eds.), The social psychology of intergroup relations. Brooks-Cole, Monterey.

Thiele, V., 2010. Task-specific abilities in multi-task principal-agent relationships. Labour Economics 17, 4, 690-698.

Tirole, J., 1986. Hierarchies and bureaucracies: On the role of collusion in organizations. Journal of Law, Economics, and Organization 2, 2, 181-214.

Appendix

The agent's base wage

Let Assumptions 1 and 2 hold. The university chooses the lowest base wage, $w_0(\alpha)$, compatible with participation, *i.e.*, $U_0^A = U^A(\alpha, w)$. That is, $w_0(\alpha) = U_0^A - U^A(\alpha, 0)$. For a given α, the agent attains his or her reservation utility, U_0^A, with the following base wage:

For $\alpha \in [tk, \lambda t/k]$, that is, when the two tasks are tied together, we have:

$$w_0(\alpha) = U_0^A + \frac{0.5\left(\alpha\lambda - kt\lambda\right)^2}{\left(\lambda - k^2\right)^2} + \frac{0.5(\lambda t - \alpha k)^2}{\left(\lambda - k^2\right)^2} + \frac{k\left(\lambda t - \alpha k\right)\left(\alpha\lambda - kt\lambda\right)}{\left(\lambda - k^2\right)^2} - \frac{\alpha\left(\alpha\lambda - kt\lambda\right)}{\left(\lambda - k^2\right)} - \frac{\left(\lambda t - \alpha k\right)\left(\lambda t + \frac{(1-\lambda)(\lambda t - \alpha k)}{\left(\lambda - k^2\right)}\right)}{\left(\lambda - k^2\right)}$$

- $w_0(\alpha) = U_0^A - \frac{1}{2}t^2$ if $\alpha \leq tk$. That is, when $e_r^*(\alpha) = 0$ and $e_t^*(\alpha) = t$ (*i.e.*, $\underline{e}_t^U = t$). Hence, for the agent to participate it must be the case that $m \geq U_0^A - \frac{1}{2}t^2 > 0$.
- $w_0(\alpha) = U_0^A - \frac{1}{2}\alpha^2$ if $\alpha \geq \lambda t/k$. That is, when $e_r^*(\alpha) = \alpha$ and $e_t^*(\alpha) = 0$ (*i.e.*, $\underline{e}_t^U = 0$). As U^A increases without bound when $\alpha \geq \lambda t/k$, we have: $w_0(\alpha) = max\,(U_0^A - \frac{1}{2}\alpha^2, 0)$.

The optimal marginal research reward: $\overline{\alpha}_m$

Let Assumptions 1-3 hold. $\overline{\alpha}_m$ is the optimal marginal research reward when the university spends its entire budget m. $\overline{\alpha}_m$ is derived by solving the following expression (where $m = w_0(\alpha) + \alpha e_r^*(\alpha)$; $e_r^*(\alpha)$ is given by (4); and $w_0(\alpha)$ is defined above):

$$m = U_0^A + \frac{\alpha^2\left(\lambda^2 - k^2\right) + 2\alpha\lambda tk\left(1 - \lambda\right) - \lambda^2 t^2\left(1 - k^2\right)}{2\left(\lambda - k^2\right)^2}$$

We find:

$$\overline{\alpha}_m = \frac{-\lambda\left(1 - \lambda\right)tk + \sqrt{\triangle}}{\left(\lambda^2 - k^2\right)}$$

where

$$\triangle = \lambda^2\left(1 - \lambda\right)^2 t^2 k^2 + \left(\lambda^2 - k^2\right)\left[\lambda^2 t^2\left(1 - k^2\right) + 2\left(\lambda - k^2\right)^2\left(m - U_0^A\right)\right]$$

Note that $\overline{\alpha}_m \geq tk$ and that $\overline{\alpha}_m$ is non-decreasing in m.
See Figure 1 for an illustration.

The optimal marginal research reward: $\overline{\alpha}_m \leq \overline{\alpha}_t$

Let Assumptions 1-3 hold. We consider the case where $m \leq \overline{m}$. That is, $\overline{\alpha}_m \leq \overline{\alpha}_t$. Let $\alpha^*(m)$ be the solution in α to

$$m = U_0^A + \frac{1}{2}(e_r^*(\alpha))^2 - \frac{1}{2}(e_t^*(\alpha))^2$$

where $e_r^*(\alpha)$ and $e_t^*(\alpha)$ are given by (4) and (5). We have:

$$\alpha^*(m) = \frac{-\lambda(1-\lambda)tk + (\lambda - k^2)\sqrt{\lambda^2 t^2 + 2(\lambda^2 - k^2)(m - U_0^A)}}{\lambda^2 - k^2}$$

and

$$\frac{\partial \alpha^*(m)}{\partial t} = \frac{-\lambda(1-\lambda)k + \lambda^2 t(\lambda - k^2)\left(\lambda^2 t^2 + 2(\lambda^2 - k^2)(m - U_0^A)\right)^{-1/2}}{\lambda^2 - k^2}$$

Note that $\frac{\partial \alpha^*(m)}{\partial t}$ is decreasing in $m - U_0^A$. When $m - U_0^A = \frac{1}{2}\left(\frac{\lambda t}{k}\right)^2$ (which corresponds to the case where $\underline{e}_t^U = 0$ and $\overline{\alpha}_t = \frac{\lambda t}{k}$), $\frac{\partial \alpha^*(m)}{\partial t} = \frac{\lambda}{k}$. When $m - U_0^A = -\frac{1}{2}t^2$ (which corresponds to the polar case where $\underline{e}_t^U = t$ and $\overline{\alpha}_t = kt$), $\frac{\partial \alpha^*(m)}{\partial t} = k$.