Incentives to Motivate*

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July 6, 2012

Abstract

We present a model in which a motivator can take costly actions - or what we call motivational effort - in order to reduce the effort costs of a worker, and analyze the optimal combination of motivational effort and monetary incentives. We distinguish two cases. First, the firm owner chooses the intensity of motivation and bears the motivational costs. Second, another agent of the firm chooses the motivational actions and incurs the associated costs. In the latter case, the firm must not only incentivize the worker to work hard, but also the motivator to motivate the worker. We characterize and discuss the conditions under which monetary incentives and motivational effort are substitutes or complements, and show that motivational effort may exceed the efficient level.

*We would like to thank Fabian Frank, Hideshi Itoh, Frauke Lammers, Trond Olsen, Gaute Torsvik, and seminar and conference participants in Bergen, Berlin, Bern, Frankfurt, Magdeburg, Vienna, and Zurich for helpful comments. Financial support from the Norwegian Research Council (Grant # 196873) is gratefully acknowledged.

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"Leadership is based on a spiritual quality — the power to inspire, the power to inspire others to follow."

Vincent T. Lombardi

1 Introduction

The legendary football coach Vincent Thomas Lombardi was celebrated for his ability to motivate and inspire his players. Even though he achieved an amazing record of victories in a game where tactics and strategy matter, he is not so famous for his tactical skills. Lombardi is legendary for his coaching philosophy and motivational skills. He emphasized hard work and dedication, and players were wholeheartedly devoted to him.

Anyone who follows sports has a sense that it is not only the coach's knowledge of the game that matters, but also his or her ability to motivate and inspire the players with words and actions. This also applies to work life in general. Leaders continuously emphasize the importance of motivation in terms of "energizing people" or "challenging them to take those actions that will realize results" (Filson, 2004). If one googles "leadership and motivation" one finds an endless list of managerial words of wisdom such as "Great leaders motivate through inspiration", or "Leadership is Motivation, the Leader is a Motivator".[1]

From an economist's point of view, this looks more like a technological approach to motivation than an incentive approach. Indeed, economic theories of motivation have primarily focused on incentives, and have not considered motivation to be a kind of technology that helps workers perform better. But when a coach motivates her players or a leader motivates her workers, she may trigger the workers' effort without increasing their monetary incentives to exert effort. This is emphasized by two contemporary leadership theories in the field of organizational behavior: charismatic leadership and transformational leadership. According to these closely related theories,

[1] The quotes are from CEO Dov Seidman and leadership consultant James Chapman, respectively.

leaders inspire followers through their words, ideas, and behavior.[2] Several studies find a positive relationship between charismatic/transformational leadership, high performance, and job satisfaction, see Wang (2011) and Robbins and Judge (2013) for recent surveys and overviews.

But even though leadership has an impact on firm performance, a certain leadership style typically does not change a firm's production technology, i.e., how inputs and particularly work effort transform into output. The channel through which charismatic/transformational leadership affects productivity appears to be its effect on employees' (dis)utility of work. Effective leadership makes employees like their job better and, as a consequence, they work harder and perform in ways that benefit the organization. As Robbins and Judge (2013, p. 415) put it, "People working for charismatic leaders are motivated to exert extra effort and, because they like and respect their leader, express greater satisfaction." In a similar spirit, Harter et al. (2010) conclude, "Improving employee work perceptions can improve business competitiveness while positively impacting the well-being of employees."

Therefore, a natural way to model charismatic/transformational leadership in a principal-agent framework is to say that the leader or motivator reduces workers' effort costs. In this paper we make this plausible assumption. We assume that a motivator can take costly actions - or what we call motivational effort - to reduce the effort costs of a worker and analyze the optimal combination of motivational effort and monetary incentives. We distinguish two situations. First, the firm owner chooses the intensity of motivation and bears the motivational costs. Second, another agent of the firm chooses the motivational actions and incurs the associated costs. In the latter case, the firm must then not only incentivize the worker to work hard, but also the motivator to motivate the worker.

[2] Max Weber introduced the term "charismatic leadership" in his famous theory of authority (originally published posthumously in 1922). Robert House (1977) further developed Weber's concept in articulating a theory of charismatic leadership. Bernard Bass (1985) introduced the term "transformational leadership", contrasting it with transactional leadership: while transactional leaders emphasize rewards in exchange for satisfying performance, transformational leaders inspire their followers by articulating visions and challenging goals. Charismatic and transformational leadership are now often used synonymously.

Our model allows for a broader interpretation of motivational actions than what is typically emphasized in the literature on charismatic and transformational leadership. We are interested in any action that the leader can take in order to reduce the effort costs of the worker, and we sometimes refer to this as "motivational leadership".[3] The costs of motivational effort can also take many forms and our model allows for various interpretations. For example, the firm can invest in developing its managers' leadership qualities. Studies suggest that charismatic leaders are not only born but can also be made. Barling et al. (1996) conduct a field experiment with Canadian bank managers and find that branches whose managers underwent transformational leadership training performed better than branches whose managers did not receive such training. With appropriate forms of training, managers can also learn, e.g., how to better evaluate critical situations or improve their interpersonal skills. Large firms like BHP Billiton, Nokia, and Adobe hire personal coaches for their top executives to improve their leadership skills (Robbins and Judge, 2013, p. 430). According to the Harvard Business Review, US companies are spending more than $1.5 billion a year on coaching. Renton (2009) reports that about 40% of Britain's CEOs undergo coaching, as well as an increasing number of senior managers.

Motivational effort costs are also inflicted through communication, attention, or goal setting. Specifying goals that are in line with a worker's ambitions for personal development requires time-consuming and thus costly communication. Giving sound feedback and appraisals requires careful evaluation of employee performance. And importantly, motivational actions are often at the discretion of the worker's immediate superior, who is not the residual claimant of the production process but has to bear the costs of motivation. The firm owner then has to incentivize the motivator to motivate the worker, which is also costly.

The main insights of our analysis are as follows:

First, we show that higher-powered monetary incentives to the worker can reduce or enhance his responsiveness to motivational effort. The first

[3] The term "motivational leadership" is often used by consultants. "Charismatic leadership" and in particular "transformational leadership" are narrower academic terms.

case implies that incentives make motivational effort less effective and thus reflects a "hidden cost of reward". Because our motivational effort can be interpreted as an attempt to increase the worker's intrinsic motivation, this result is related to the well-known crowding-out argument for intrinsic motivation (Lepper and Green, 1978). Monetary incentives, however, can also complement and enhance the effect of motivational effort. We thus also identify a potential "hidden benefit of reward".

Second, we analyze the optimal motivation-incentive mix from the firm's point of view. Under unlimited liability of the worker, the firm provides first-best incentives that are equal to the marginal productivity of effort. The worker's bonus is then independent of motivation, because the latter only affects the worker's disutility of effort. If the worker is subject to limited liability, however, the firm can use incentives and motivation as substitutes as well as complements. The latter case occurs if the worker's motivation responsiveness increases with the strength of incentives. For example, this is possible when a harder working employee interacts with his superior more frequently and is therefore easier to inspire by charismatic leadership. We show that, in such a situation, motivational effort may even exceed the efficient level and occur in the second-best solution even when it is first-best not optimal to motivate. The reason is that motivational effort can reduce the worker's rent for each fixed effort level. In this respect, we provide a rather intuitive rationale for motivational effort.

Third, if we make a broader interpretation of motivational effort as any activity that lowers the worker's effort costs, e.g., a nice office, a car, or an iPad for that matter, the model can also illuminate the practice of using perks as a part of the worker's compensation. At first sight perks appear as rewards that increase the worker's rent. We show that perks can also be seen as a device that makes the worker work harder on lower rents.

Fourth, we find that a negative equilibrium relationship may occur between the motivator's bonus and her effort level. If the worker's effort becomes more productive (for exogenous reasons), the motivator's effort level will increase. Cet. par. it may in fact exceed the first-best level of motivation. The firm may then mitigate the motivational effort by lowering the motivator's incentives to motivate.

Finally, we identify a notable conflict of interest between motivator and worker. When the worker's rent is decreasing in motivational effort, he clearly prefers a higher bonus rather than more non-monetary motivation. But for a given level of worker effort, the lower-powered the worker's monetary incentives, the higher often is the motivator's bonus. Under limited liability, a low bonus to the worker may thus imply a higher rent to the motivator. Consequently, low-powered monetary incentives to the worker may be in the motivator's interest. Interestingly, we often see negative assessments of monetary incentives in the leadership and coaching literature.[4]

The rest of the paper is organized as follows. In Section 2 we discuss related literature. In Section 3 we present the basic model and characterize the first-best solution. In Section 4 we analyze the trade-off between motivational effort and monetary incentives in a setting where the firm owner is the motivator. We derive the optimal contract with limited and unlimited liability. The case where the firm needs to hire a motivator to induce motivation is analyzed in Section 5. Section 6 concludes.

2 Relationship to the Literature

In his celebrated book "The Modern Firm", John Roberts (2004) states that "Management (. . .) is vitally important, but it is not enough. Leadership is needed too (...). Leaders offer direction and then motivate others to believe and to follow." After the black box of the firm was opened in the 1970's, management has been intensively studied. But leadership has almost been ignored by economists, even though it is a significant subject in the less formal literature on organizational behavior (see e.g. House and Aditya, 1997, for an overview). Recently, however, a small economics literature on leadership has emerged, focusing on the leader as one who has followers because of superior skills or information, see Hermalin (1998, 2007), Komai et al. (2007), Komai and Stegman (2010) and Lazear (2010). But the

[4] See for instance the best seller "Drive - the surprising truth about what motivates us", by Daniel H. Pink (2009).

motivational part of leadership has been scantly treated in this literature. Notable exceptions are Van den Steen (2005), who shows how a manager with strong beliefs about the right course of action can attract employees with similar beliefs, and the works by Rotemberg and Saloner (1993, 1994, 2000), who consider the effect of visions and leadership style on employees' motivation to generate proposals for innovation adoption.

Closer to our approach, however, is the important work on identity by Akerlof and Kranton (2000, 2005). They assume that effort costs are a function of identity, and that the firm can take actions that affect the workers' identity. In particular they differentiate between insiders and outsiders, where only insiders identify with the firm/employer's values. Like them, we assume that the firm can affect the workers' effort costs, but we do not allow for discrete preference changes, and the trade-offs and interpretations we present are more in line with standard principal-agent terminology (discussing, e.g., marginal effects on motivation responsiveness). In this respect our paper is more related to Dur et al. (2010), who analyze a situation where the agent's marginal costs of effort are decreasing and the worker's well-being is increasing in the attention paid by the principal. In contrast to them, we allow for a more general effort cost function, which is crucial for deriving our main results. As another important difference, Dur et al. focus on a commitment problem on the side of the principal, which is not an issue in our setup. Neither Dur et al. nor Akerlof and Kranton study how the motivator should be incentivized. Moreover, Akerlof and Kranton do not consider limited liability and the rent extraction aspect, which is important in our paper.

When the firm needs to incentivize both a worker and a motivator, it faces a team incentive problem. Our paper is thus related to Itoh (1991a) who analyzes the incentives for workers to help each other, and in particular Itoh (1991b) who analyzes a situation where workers can socialize with each other and thereby affect each other's utility functions. Dur and Sol (2010) also study social interaction between workers and how it is affected by the financial incentive systems. But the literature on team incentives does not relate to the kind of motivational effort we discuss. In contrast to the standard team literature, we analyze a team incentive problem where the agents have very different roles: The team consists of an agent - the worker - who is essential for production, and another agent - the motivator - who can help the worker but cannot produce anything without him.

Finally, our paper is related to a recent literature on perks and benefits, in particular Oyer (2008) and Marino and Zabojnik (2008). Oyer studies how firm and worker characteristics may affect the trade-off between salaries and benefits, and models a situation where workplace benefits such as entertainment options and errand services lower the workers' effort costs. Benefit in his model could be reinterpreted as motivational effort, but Oyer does not consider the trade-off between benefits and monetary incentive provision, as he analyzes a full information model with no moral hazard problem. Marino and Zabojnik study the trade-off between work-related perks and incentive provision. In their model perks improve the worker's effort productivity, and the benefit from perks is positively related to the worker's effort level. We do not make such an assumption, which gives rise to different results concerning the interaction of perks and monetary incentives. In contrast to Marino and Zabojnik, we show that perks and monetary incentives can be substitutes as well as complements.

It can be instructive to position our approach within a simple taxonomy of motivation, see Table 1. The workers' utility from being motivated can be realized ex post or ex ante, and it can be monetary or non-monetary.

	Monetary	Non-monetary
Ex post	Standard principal-agent models	Behavioral agency models Intrinsic motivation, social esteem
Ex ante	Gift exchange models Reciprocal agents	Motivational leadership, coaching, identity

Table 1

The standard principal-agent approach is based on monetary rewards given ex post the worker's effort, such as bonuses. But economists have increasingly recognized the importance of non-material incentives, such as the intrinsic pleasure of doing a good job (see Benabou and Tirole, 2003; Besley and Ghatak, 2005), or the social esteem or respect that follows from good performance (see Ellingsen and Johannesson, 2008). Like the standard principal-agent models, the worker's utility from motivation is also here realized ex post. In contrast, the gift-exchange literature and its emphasis on reciprocal preferences has shown both theoretically and experimentally that workers can be motivated by ex ante material rewards. A worker that receives a higher fixed wage responds by exerting higher effort (see Falk and Fehr, 2000, for an overview).

Finally, the huge literature on organizational behavior and motivational leadership focuses to a large extent on ex ante non-material realization of motivational utility. The immediate payoff from being motivated by a leader is a reduction in non-material costs of exerting a given effort level. This effort cost reduction can of course then materialize in ex post rewards from higher effort. The novelty of our approach is to formalize motivational effort/motivational leadership, and to combine it with a standard principal-agent model with ex post material rewards.

3 The Model

We consider a model where a worker produces an output q for a firm. The output can be either high or low, i.e., $q \in \{q_L, q_H\}$ with $q_L < q_H$. The probability of producing high output q_H is given by the worker's effort level $e \in [0, 1]$, i.e., $\Pr[q = q_H|e] = e$. By exerting effort, the worker thus chooses the probability of high output. The worker's effort is non-observable, whereas output is observable and verifiable. The firm pays the worker a non-contingent fixed wage s and can provide him with monetary incentives by granting him a bonus b if output is high.

In addition, the worker can be motivated by motivational effort $a \geq 0$. We assume that, if the worker is exposed to motivational effort, he enjoys working more and also finds it less troublesome to increase his effort. Hence, the worker's private effort costs $C(e, a)$ are affected by the level of motivation that he experiences.[5] The function $C(e,a)$ is strictly increasing and strictly convex in e, i.e., $C_e(e,a) > 0$ and $C_{ee}(e,a) > 0$ for $e > 0$ and all a. Motivation reduces both the worker's absolute and marginal effort costs for all positive effort levels, i.e., $C_a(e,a) < 0$ and $C_{ea}(e,a) < 0$ for all $e > 0$ and all a. For $e = 0$, however, we assume that the worker's absolute and marginal effort costs are zero (i.e., $C(0,a) = C_e(0,a) = 0$ for all a), and thus cannot be further reduced by motivation, i.e., $C_a(0,a) = C_{ea}(0,a) = 0$ for all a.[6]

The costs of motivation are denoted by $K(a)$. They are strictly increasing and convex in the level of motivation, $K_a > 0$, $K_{aa} \geq 0$ for all $a > 0$. Zero motivational effort, $a = 0$, corresponds to a situation without motivation and, therefore, $K(0) = 0$. However, the marginal motivational costs at zero may be positive, i.e., $K_a(0) \geq 0$, which will imply that inducing motivation may be too costly to implement.[7] Both motivational effort and motivational costs are non-contractible.

We first consider a situation where the firm chooses a itself and bears the motivational costs. We can think of this as the firm owner being the motivator, or as motivation being delegated to a third party whose motivational actions are not subject to an incentive problem.[8] Alternatively, we can also allow for a broader interpretation of motivational actions such as the provision of perks or benefits by the firm.

[5] Even though monetary incentives are a source of motivation, we mainly reserve the term "motivation" when talking about motivational effort. We also use "motivational effort" and "non-monetary motivation" synonymously.

[6] An alternative modelling approach would be to say that work effort is costless up to a certain extent, and that motivation shifts the worker's cost function to the right. Then, the maximal costless effort level increases and the marginal costs for each costly effort level strictly decrease. This would lead to similar results as those we will present here.

[7] The reason could be that the motivator has high opportunity costs or, when the firm wants to hire a particularly charismatic manager, search costs are large.

[8] In the latter case, the firm owner could hire a particularly charismatic CEO, who naturally motivates other top executives just by interacting with them. However, the firm must offer higher compensation to a manager with extraordinary leadership qualities than to a less gifted manager because the latter has less attractive outside options on the labor market. The compensation differential then reflects the firm's motivational cost. As another example, the firm can invest in developing its managers' leadership qualities.

We denote the sum of work effort costs and motivational costs by

$$\Gamma(e, a) := C(e, a) + K(a) \tag{1}$$

and define H as the Hessian of $\Gamma(e, a)$,

$$H := \begin{pmatrix} C_{ee} & C_{ea} \\ C_{ea} & C_{aa} + K_{aa} \end{pmatrix}. \tag{2}$$

To ensure strict convexity of the total cost function $\Gamma(e, a)$, we assume that H is positive definite, i.e., $\det H = C_{ee}(C_{aa} + K_{aa}) - {C_{ea}}^2 > 0$ for all e and a. Note that the latter inequality implies that $C_{aa} + K_{aa} > 0$.

The worker has a reservation utility of zero and is risk neutral. He may, however, be protected by limited liability, meaning that all payments to him must be non-negative. We will analyze the firm's contracting problem in the case of both unlimited and limited liability of the worker.

Timing is as follows. First, the firm offers the worker a contract (s, b) and announces to exert motivational effort a. The worker can accept or reject the contract offer. If he accepts the contract, he enters the firm and the firm chooses the motivational effort $\hat{a}$ at cost $K(\hat{a})$. The worker observes $\hat{a}$ and can decide whether to stay with the firm or quit.[9] If the worker stays with the firm, he exerts effort e at cost $C(e, \hat{a})$. Finally, q is realized and the firm pays the worker.

3.1 First-Best Work Effort and Motivational Effort

Before we proceed to the contracting game, it is useful to consider the first-best effort levels as a benchmark. The first-best work effort e^{FB} and the

[9] Under unlimited liability, this interim participation decision will ensure that the firm can induce the first-best solution. Thus, allowing the worker to quit after observing the motivational level is in the interest of the firm. It serves as a self-commitment device. Under limited liability (or if the motivator is an agent of the firm), the interim participation decision will not be relevant for the results. In contrast to our model, Dur et al. (2010) assume that the worker cannot quit after observing the principal's action.

first-best motivational effort a^{FB} maximize the social surplus, i.e.,

$$(e^{FB}, a^{FB}) = \arg\max_{\substack{e\in[0,1]\\ a\geq 0}} q_L + e\cdot\Delta q - \Gamma(e,a), \tag{3}$$

where $\Delta q := q_H - q_L$. The assumption $C(0,a) = C_e(0,a) = 0$ implies that the efficient work effort is strictly positive, i.e., $e^{FB} > 0$. Whether the worker should be motivated ($a^{FB} > 0$) or not ($a^{FB} = 0$) depends on how work effort and motivational effort interact in the total cost function $\Gamma(e,a)$. We now derive sufficient conditions for either $a^{FB} > 0$ or $a^{FB} = 0$, which we will use later to compare first-best and second-best effort levels.

A sufficient condition to obtain $a^{FB} > 0$ is that, for each positive work effort, total costs are initially decreasing in a, i.e.,

$$\Gamma_a(e,0) < 0 \text{ for all } e > 0. \tag{4}$$

Because $e^{FB} > 0$, we must then also have $a^{FB} > 0$. More precisely, for $a^{FB} > 0$ it is already sufficient that $\Gamma_a(e,0) < 0$ holds at the work effort level that is optimal given that $a = 0$, which is

$$e_0^{FB} := \arg\max_{e\in[0,1]} e\cdot\Delta q - C(e,0). \tag{5}$$

Hence, a sufficient condition for $a^{FB} > 0$ is that

$$\Gamma_a(e_0^{FB}, 0) < 0. \tag{6}$$

The conditions (4) and (6) hold, e.g., if $K_a(0) = 0$.

By contrast, a sufficient condition to obtain $a^{FB} = 0$ is that an infinitesimal amount of motivation always increases total costs, i.e.,

$$\Gamma_a(e,0) \geq 0 \text{ for all } e. \tag{7}$$

Then, from $\Gamma_{aa} = C_{aa} + K_{aa} > 0$ it follows that $\Gamma_a(e,a) > 0$ for all e and $a > 0$. Hence, total costs are always increasing in a. Consequently, letting

$a^*(e)$ denote the optimal motivational effort for given work effort e,

$$a^*(e) = \arg\min_{a \geq 0} \Gamma(e, a), \tag{8}$$

we obtain $a^*(e) = 0$ for all e.

Thus, even though motivation always reduces the worker's effort costs, it is not necessarily efficient to induce motivation. The reason is that motivation might be too costly. Motivational effort can be positive in the first-best solution only if it initially reduces *total* costs for some work effort levels.

Assuming that problem (3) has an interior solution, i.e., $a^{FB} > 0$ and $e^{FB} < 1$, first-best effort levels are characterized by the first-order conditions

$$\Gamma_e(e^{FB}, a^{FB}) = C_e(e^{FB}, a^{FB}) = \Delta q, \tag{9}$$

$$\Gamma_a(e^{FB}, a^{FB}) = C_a(e^{FB}, a^{FB}) + K_a(a^{FB}) = 0. \tag{10}$$

In this case, we can determine how e^{FB} and a^{FB} respond if the marginal productivity of work effort, Δq, increases:

$$\frac{de^{FB}}{d\Delta q} = -\det \begin{pmatrix} -1 & C_{ea} \\ 0 & C_{aa} + K_{aa} \end{pmatrix} / \det H = (C_{aa} + K_{aa}) / \det H > 0 \tag{11}$$

$$\frac{da^{FB}}{d\Delta q} = -\det \begin{pmatrix} C_{ee} & -1 \\ C_{ea} & 0 \end{pmatrix} / \det H = -C_{ea} / \det H > 0 \tag{12}$$

Thus, because $C_{aa} + K_{aa} > 0$, both work effort e^{FB} and motivational effort a^{FB} are increasing in Δq.

The following proposition summarizes the results of this section.

Proposition 1 *First-best work effort e^{FB} is always positive. By contrast, first-best motivational effort a^{FB} may be zero. A sufficient condition for $a^{FB} = 0$ is that introducing an infinitesimal amount of motivation increases total cost, i.e., $\Gamma_a(e, 0) \geq 0$ for all e. First-best work effort e^{FB} is strictly increasing in Δq if $e^{FB} < 1$. First-best motivational effort a^{FB} is also strictly increasing in Δq if $a^{FB} > 0$.*

4 Monetary Incentives versus Motivational Effort

We now proceed to the contracting game where the firm's objective is to implement the profit-maximizing combination of work effort and motivational actions. We solve the game by backward induction and thus first analyze the worker's effort choice.

4.1 The Worker's Optimal Effort Choice

The worker chooses his effort given his bonus contract (s, b) and motivational effort a. The worker's optimal effort choice $e(a, b)$ maximizes his expected net payment, i.e.,

$$e(a,b) = \arg\max_{\hat{e}\in[0,1]} s + \hat{e}b - C(\hat{e}, a). \tag{13}$$

The first-order condition of this optimization problem yields the worker's incentive constraint,

$$b = C_e(e, a), \tag{IC}$$

which implicitly defines $e(a, b)$.[10] Equation (IC) describes the bonus that the firm has to offer to induce effort level e given motivation a. It also tells us how changes in monetary incentives or motivation affect the worker's effort choice. First, from (IC) we can derive the worker's incentive responsiveness e_b and his "motivation responsiveness" e_a, where

$$e_b = \frac{1}{C_{ee}} > 0 \text{ and } e_a = -\frac{C_{ea}}{C_{ee}} > 0. \tag{14}$$

Accordingly, the worker exerts more effort the higher his bonus and the higher the motivational effort. The latter observation follows from our assumption $C_{ea} < 0$ and is in line with the empirical studies indicating that

[10] It is easy to see that the first-order condition holds at the worker's optimal effort choice even if the firm wishes to induce the minimum or maximum effort, $e = 0$ or $e = 1$, respectively. To make the worker choose $e = 0$, the firm optimally sets $a = b = 0$. If the firm wants the worker to exert $e = 1$, it is not optimal to choose a and b such that the worker's expected net payment is still increasing at $e = 1$, i.e., it cannot be the case that $b - C_e(1, a) > 0$.

motivational leadership increases productivity, which we referred to in the introduction. The higher the incentive responsiveness (the lower C_{ee}), the higher is also the motivation responsiveness. Furthermore, the worker is more responsive to motivation than to incentives if $C_{ea} < -1$, i.e., if marginal effort costs are relatively elastic to motivational effort.

Next, we are interested in how the worker's motivation responsiveness changes when incentives increase, which is reflected by e_{ab}. From (14) we obtain

$$e_{ab} = -\frac{C_{eae} + C_{eee} e_a}{C_{ee}^2}. \tag{15}$$

Intuitively, with a higher bonus, the worker increases his effort for each given level of motivation, which changes the impact of motivation on his marginal effort costs (reflected by C_{eae}) and the difficulty of raising effort further (reflected by C_{eee}). Both effects jointly determine the sign of e_{ab}. Since $C_{ee}(e, a)$ denotes the worker's marginal bonus, the third derivatives $C_{eae} = C_{eea}$ and C_{eee} also indicate how the marginal bonus changes with higher motivation and higher effort, respectively. It seems reasonable to assume that $C_{eee} \geq 0$, i.e., to elicit marginally higher effort, the firm has to increase the bonus more strongly the harder the worker works.

However, motivation can affect the marginal bonus in different ways, making the sign of e_{ab} ambiguous. If $C_{eae} < 0$ and the firm increases motivational effort, it can achieve a marginal increase in work effort by a smaller bonus increase. If, in addition, C_{eee} is small, we obtain $e_{ab} > 0$, i.e., the worker's motivation responsiveness is increasing in the bonus. Such a case occurs for example if a harder working agent interacts with his motivator (e.g., superior) more frequently and is therefore more responsive to motivational effort. Alternatively, a worker who is more occupied with his job could also be more eager for his motivator's attention or feedback, which then also has a stronger effect on the worker's job satisfaction and, consequently, marginal disutility of effort. By contrast, if $C_{eae} > 0$, we are in a situation where $e_{ab} < 0$, i.e., motivation responsiveness is decreasing in monetary incentives. This case occurs if, after a bonus increase, the agent works at an intensity that makes it extremely difficult to further raise effort. Or, from a certain point on, the agent's opportunities to affect the realization of output are strongly limited (recall that effort is measured as the probability of high output in our model). Consequently, the agent is less responsive to motivational effort. Note that, because $C_{ea}(0,a) = 0$ and $C_{ea}(e,a) < 0$ for $e > 0$, C_{eae} must initially be negative. Thus, $C_{eae} > 0$ can indeed occur only if the worker's effort already is sufficiently high. Finally, the worker's motivation responsiveness could be independent of monetary incentives, i.e., $e_{ab} = 0$. For example, to increase the worker's job satisfaction, he may be allowed to occasionally work from home. This may increase the worker's effort because he voluntarily uses part of the saved commuting time to work. This effort increase could be independent of his previous effort intensity, at least within a certain range.[11]

Thus, whether a higher bonus makes motivation more or less effective depends on the type of motivation and the worker's scope to increase effort or, equivalently, affect output. The strength of our model is that it can capture this multi-faceted interaction in a simple way by considering a general function $C(e,a)$ that maps effort and motivation to (dis)utility from work. We thus provide a framework for thinking about the interaction between monetary incentives and motivational effort, where this framework allow us to apply standard economic analysis. To make specific predictions for individual employment relationships, empirical research is needed.

The next proposition summarizes the main results of this subsection.

Proposition 2 *The worker is more responsive to motivational effort than to monetary incentives if $C_{ea} < -1$. Furthermore, the worker's motivation responsiveness may be increasing, decreasing, or independent of his monetary incentives, i.e., the sign of e_{ab} is ambiguous.*

[11] It is straightforward to specify specific cost functions for the different situations. First consider a cost function of the type $C(e,a) = c(e)g(a)$. Our initial assumptions on C imply that $c_e, c_{ee} > 0$ and $g_a < 0$. We thus obtain $C_{eae} < 0$. Consequently, we have $e_{ab} > 0$ whenever $c_{eee} = 0$, which is the case for a quadratic function $c(e)$. In contrast, we obtain $C_{eae} > 0$ and $e_{ab} < 0$, e.g., for the cost function $C(e,a) = \frac{e^2}{2(t+a/e^2)}$ whenever $te^2 > a$. Finally, an example for $C_{eae} = 0$ and $e_{ab} = 0$ is $C(e,a) = e^2 + e(1-a)$ with $a \leq 1$.

Our result on the ambiguity of e_{ab} is related to the current controversial discussion on the effect of monetary incentives on intrinsic motivation. On the one hand, there is the well-known crowding out argument saying that higher-powered monetary incentives crowd out intrinsic motivation, also termed as the "hidden cost of reward" by Lepper and Greene (1978). Agency theory provides several versions of the argument: Monetary rewards may change the worker's preferences (Frey, 1997), undermine incentives for social esteem (Benabou and Tirole, 2006, and Ellingsen and Johannesson, 2008), or affect workers' perceptions of their tasks or own abilities (Benabou and Tirole, 2003). On the other hand, several organizational behavior papers find that more incentive pay leads to higher levels of intrinsic motivation for salespeople, see Babakus et al. (1996), Baldauf et al. (2002), Miao and Evans (2007), and DelVecchio and Wagner (2011). DelVecchio and Wagner argue that these results can be explained by the informative value of financial rewards. All forms of feedback, both verbal evaluation and financial rewards, gives the recipient knowledge about his or her competence and autonomy. Financial rewards may boost self-image and enhance the credibility and effect of non-monetary motivation.

In our model, motivational effort a can be interpreted as measures aimed at increasing the worker's intrinsic motivation (e.g., through organizational changes in job design). Even though a is not the *level* of intrinsic motivation, the assumption that higher a lowers effort costs may reflect a mapping between a and intrinsic motivation. The above literature shows that, depending on the specific characteristics of the employment relationship, monetary incentives can increase or decrease intrinsic motivation. Thus, effort aimed at enhancing intrinsic motivation should also be more or less effective in combination with monetary incentives.

As another relation to the literature on motivational crowding out, our model points out a new "hidden cost of reward": Monetary incentives may make an employer's attempts to increase intrinsic motivation or, more generally, utility from work, less fruitful ($e_{ab} < 0$). This conclusion also has a natural counterpart. Since $e_{ab} = e_{ba}$, it also says that if a worker is highly motivated by non-monetary motivational effort, he may respond less to monetary incentives. By contrast, if the worker's cost function is such that $e_{ab} > 0$, we have a "hidden benefit of reward" that has not been addressed in the economics literature so far. Monetary incentives then complement and enhance the effect of motivational effort and vice versa.

The organizational behavior literature provides further evidence for the existence of hidden benefits of rewards. One way to exert motivational effort is to formulate goals, either for each employee, for groups of employees or for the whole firm. Empirical evidence (see Locke and Latham, 2002) suggests that demanding but achievable goals have a motivating effect on workers. Locke and Latham (1984) show that goal-setting works even better when it is accompanied by financial incentives. This can be captured by $C_{eae} < 0$, meaning the impact of motivation on marginal effort costs is more pronounced when the worker exerts more effort, e.g., due to monetary incentives. As a consequence, $e_{ab} > 0$ becomes more likely.

Furthermore, the leadership literature contrasts charismatic-transformational leadership with transactional leadership. While transformational leaders inspire their followers by offering "a purpose that transcends short-term goals and focuses on higher order intrinsic needs" (Judge and Piccolo, 2004, p. 755), transactional leaders emphasize the exchange of resources such as (monetary) rewards or praise in return for satisfying performance. Recent work by organizational psychologists suggests that both leadership styles co-exist, complement, and reinforce each other (see Gürerk et al. 2009, p. 594, and further references therein). In our model, we can interpret monetary incentives as a form of transactional leadership, whereas our motivational effort may correspond to transformational actions. The complementarity of the two leadership styles is then reflected in our model by $e_{ab} > 0$.

4.2 The Firm's Contracting Problem

4.2.1 Optimal Contracting Under Unlimited Liability

We first solve the firm's contracting problem under unlimited liability, i.e., when there are no exogenously imposed lower bounds on the worker's wage payments. The solution proceeds in two steps: In a first step, we solve the firm's first-stage optimization problem, assuming that the firm can commit to the motivational effort a that it announces. In a second step, we show that, under the previously derived contract, the firm will indeed choose the motivational level announced at the first stage, i.e., $\hat{a} = a$.

The firm's first-stage optimization problem is:

$$\max_{e,a,b,s} \quad q_L + e\Delta q - (eb + s) - K(a) \tag{16}$$

$$\text{s.t.} \quad s + eb - C(e, a) \geq 0, \tag{PC}$$

$$b = C_e(e, a) \tag{IC}$$

Accordingly, the firm maximizes expected output net of wage costs and motivational costs, taking into account the worker's participation constraint (PC) and incentive constraint (IC).

Solving the firm's problem is straightforward. For any given bonus and level of motivation, the firm optimally chooses the fixed wage s such that (PC) is just binding. The firm's wage costs are thus equal to the worker's effort costs $C(e, a)$ and, consequently, the firm's total costs are equal to $\Gamma(e, a)$. It therefore implements the first-best motivational action a^{FB} and induces the worker to choose the first-best effort level e^{FB}. By equations (9) and (IC), the corresponding bonus for the worker is

$$b^{FB} = C_e(e^{FB}, a^{FB}) = \Delta q. \tag{17}$$

Intuitively, the worker's incentives are efficient when they make him internalize the impact of his effort on output. Therefore, his bonus b^{FB} is equal to the marginal productivity of work effort, Δq. In particular, this implies that b^{FB} is independent of the specific "motivation technology", i.e., how motivation affects the worker's effort cost function, the motivational cost function, and also the first-best motivational effort a^{FB}. The reason is that the motivation technology has no direct impact on the productivity of work effort.

It remains to verify that the firm indeed finds it optimal to exert $\hat{a} = a^{FB}$ after the worker has signed the contract and entered the firm. At this stage, the firm faces the following optimization problem:

$$\max_{\tilde{a}} q_L + e(\tilde{a}, b^{FB})(\Delta q - b^{FB}) - s - K(\tilde{a}) \tag{18}$$

$$\text{s.t. } s + e(\tilde{a}, b^{FB})b^{FB} - C(e, \tilde{a}) \geq 0 \tag{19}$$

Since the contract (s, b^{FB}) is designed such that (19) is binding for $\tilde{a} = a^{FB}$, the firm can ensure that the worker stays with the firm only by implementing $\hat{a} \geq a^{FB}$. Consequently, because the firm's motivational costs are lowest for $\hat{a} = a^{FB}$, it indeed exerts first-best motivational effort.[12]

4.2.2 Optimal Contracting Under Limited Liability

The contracting problem becomes more complex when the firm is not able to implement first-best effort levels. To consider such a situation, we use the work-horse model of limited liability where the firm cannot impose negative wages.[13] The central questions we want to answer in this section are: How does motivation affect the firm's wage costs under limited liability? Will there be too much or too little motivational effort in the second-best solution compared to the first-best solution?

As under unlimited liability, we first solve the firm's problem assuming that it will adhere to the motivational effort announced at stage 1. Then, we will check that this is indeed true. At the first stage, the firm thus solves the problem:

$$\max_{e,a,b,s} \quad q_L + e\Delta q - (eb + s) - K(a) \tag{20}$$

$$\text{s.t.} \quad s + eb - C(e, a) \geq 0, \tag{PC}$$

$$b = C_e(e, a), \tag{IC}$$

$$s, s + b \geq 0 \tag{LL}$$

[12] Note that, if the worker is not allowed or able to leave the firm after he observes the level of motivation, the firm would not invest in motivation at all given that the bonus is $b = b^{FB}$. Such a situation is analyzed by Dur et al. (2010).

[13] Limited liability may arise from liquidity constraints or from laws that prohibit firms from extracting payments from workers.

The last line of the optimization problem contains the limited liability constraints, which ensure that the payment to the worker is non-negative for both output realizations. From the worker's incentive constraint (IC), we see that the bonus b is always non-negative. Given an arbitrary non-negative bonus and the worker's optimal effort response, the worker's expected bonus payment net of effort costs, $eb - C(e, a)$, must be at least zero.[14] Thus, to satisfy the participation constraint (PC) and the limited liability constraints (LL), the firm optimally sets the fixed wage s equal to zero. As a result, the firm's wage costs for inducing a fixed effort level e are equal to the expected bonus payment to the worker, $eb = eC_e(e, a)$. Because $eC_e(e, a) > C(e, a)$ for all $a \geq 0$ and $e > 0$, the expected bonus payment exceeds the worker's effort costs for all strictly positive effort levels, implying that the worker earns a rent. By the foregoing explanations, the firm's optimization problem can be simplified to

$$\max_{e,a} q_L + e(\Delta q - C_e(e, a)) - K(a). \tag{21}$$

We assume that the objective function in (21) is strictly concave[15] and denote the solution of (21) by (e^{SB}, a^{SB}). The bonus is $b^{SB} = C_e(e^{SB}, a^{SB})$. It remains to check that the firm will indeed exert motivation $\hat{a} = a^{SB}$. At the corresponding stage, the firm solves

$$\max_{\tilde{a}} q_L + e(\tilde{a}, b^{SB})(\Delta q - b^{SB}) - K(\tilde{a}) \tag{22}$$

$$\text{s.t. } e(\tilde{a}, b^{SB})b^{SB} - C(e, \tilde{a}) \geq 0 \tag{23}$$

The worker's interim participation constraint is satisfied for all $\tilde{a}$. Thus, the firm chooses $\hat{a}$ such that

$$e_a(\hat{a}, b^{SB})(\Delta q - b^{SB}) - K'(\hat{a}) = 0. \tag{24}$$

[14] The worker can always ensure himself a payoff of zero by exerting zero effort.

[15] This is the case if the Hessian of $eC_e(e, a) + K(a)$ is positive definite, i.e., $2C_{ee} + eC_{eee} > 0$ and $(2C_{ee} + eC_{eee})(eC_{eaa} + K_{aa}) - (C_{ea} + eC_{eea})^2 > 0$.

However, the firm's first-stage optimization problem can also be written as

$$\max_{a,b} q_L + e(a,b)(\Delta q - b) - K(a), \tag{25}$$

implying that $e_a(a^{SB}, b^{SB})(\Delta q - b^{SB}) - K'(a^{SB}) = 0$ and thus $\hat{a} = a^{SB}$.

To characterize the solution (e^{SB}, a^{SB}), we can first observe that, as under unlimited liability, the firm always induces positive work effort, $e^{SB} > 0$. The reason is that both the expected bonus and the marginal expected bonus[16] are zero for $e = 0$. In contrast to unlimited liability, however, when deciding whether the worker should be motivated or not, the firm now considers the effect of motivation on the worker's expected bonus $eC_e(e,a)$ rather than his effort costs $C(e,a)$. By assumption, the worker's marginal effort costs are decreasing in motivation, $C_{ea} < 0$. Consequently, the bonus $C_e(e,a)$ that is necessary to induce a fixed effort level e becomes smaller if there is more motivation. Thus, as under unlimited liability, engaging in motivation always lowers the firm's wage costs for inducing a given effort level. To determine whether this effect is more or less pronounced compared to the case of unlimited liability, we rewrite the expected bonus as

$$eC_e(e,a) = R(e,a) + C(e,a). \tag{26}$$

Here, $R(e,a) = eC_e(e,a) - C(e,a)$ denotes the worker's rent when he exerts effort e given that the level of motivation is a. By assumption, motivation decreases the worker's effort costs $C(e,a)$. Motivation also lowers the worker's rent if

$$R_a(e,a) = eC_{ea}(e,a) - C_a(e,a) < 0. \tag{27}$$

Hence, if this condition is satisfied, motivation has a stronger impact on the firm's wage costs under limited liability than under unlimited liability because is does not only lower the worker's effort costs but also his rent.

Condition (27) holds for all levels of effort and motivation if $C_a(e,a)$ is a

[16] We have $\frac{\partial(eC_e)}{\partial e}(0,a) = C_e(0,a) + 0 \cdot C_{ee}(0,a) = 0$.

concave function of e, i.e., $C_{aee}(e,a) < 0$ for all e and a. As explained in Section 4.1, $C_{aee} = C_{eae} < 0$ means that the impact of motivation on marginal effort costs is stronger when the worker exerts more effort or, equivalently, the worker's marginal bonus $C_{ee}(e,a)$ is decreasing in motivation. In other words, a worker who experiences more motivation reacts more strongly to a bonus increase. Therefore, the rent he earns for exerting a given effort level decreases in motivation. As argued in Section 4.1, whether more motivation makes a higher bonus more or less effective ($C_{eea} < 0$ or $C_{eea} > 0$, respectively), should depend on the specific situation. If, however, the former holds, motivation has an additional benefit for the firm under limited liability.

As the next proposition shows, this additional benefit may make the firm invest more heavily in motivation than is efficient. Analogous to (6), a sufficient condition for $a^{SB} > 0$ is that the firm's expected costs decrease in motivation at the effort level e_0^{SB} that is optimal if $a = 0$, i.e.,

$$e_0^{SB} C_{ea}(e_0^{SB}, 0) + K_a(0) < 0, \tag{28}$$

where $e_0^{SB} = \arg\max_e e(\Delta q - C_e(e, 0))$.

Proposition 3 *It is possible that the firm motivates under limited liability even though motivation is inefficient, i.e.,* $a^{SB} > 0$ *and* $a^{FB} = 0$.

The proof is given in the Appendix. It shows by example that total costs $\Gamma(e,a)$ may always be increasing in a and, yet, the firm engages in motivation because condition (28) is satisfied. Comparing (28) with (7), the condition for $\Gamma(e,a)$ being increasing in motivation, yields that $e_0^{SB} C_{ea}(e_0^{SB}, 0) < C_a(e_0^{SB}, 0)$ must hold in such a situation. The last inequality implies that the worker's rent is decreasing in motivation at $e = e_0^{SB}$ (compare (27)).

Now assume for the remainder of this section that the firm motivates the worker, i.e., $a^{SB} > 0$. The optimal effort levels (e^{SB}, a^{SB}) are then characterized by the first-order conditions

$$\Delta q - C_e(e^{SB}, a^{SB}) - e^{SB} C_{ee}(e^{SB}, a^{SB}) = 0, \tag{29}$$

$$e^{SB} C_{ea}(e^{SB}, a^{SB}) + K_a(a^{SB}) = 0. \tag{30}$$

From these conditions, we can learn more about the characteristics of the second-best solution. Given that the worker exerts effort e, the *conditional efficient* level of motivation $a^*(e)$ is the one that minimizes total costs, i.e.,

$$a^*(e) = \arg\min_a C(e, a) + K(a). \tag{31}$$

If $a^*(e) > 0$, this is equivalent to $C_a(e, a^*) + K_a(a^*) = 0$. Comparing the latter equation with (30), second-best motivation a^{SB} is inefficiently high conditional on $e = e^{SB}$ (i.e., $a^{SB} > a^*(e^{SB})$) if and only if

$$e^{SB} C_{ea}(e^{SB}, a^{SB}) < C_a(e^{SB}, a^{SB}). \tag{32}$$

This condition is equivalent to the worker's rent being decreasing in motivation at $e = e^{SB}$ (compare (27)). The firm thus has an additional benefit from increasing a besides lowering the worker's effort costs. It therefore chooses a motivational effort-level exceeding the efficient level. By contrast, if the worker's rent is increasing at $e = e^{SB}$, the motivational action is below the efficient level $a^*(e^{SB})$.

On the other hand, given the motivational level a, the conditional efficient work effort is

$$e^*(a) = \arg\max_e e\Delta q - C(e, a), \tag{33}$$

which is equivalent to $\Delta q - C_e(e^*, a) = 0$. This implies together with (29) that $e^{SB} < e^*(a^{SB})$. Intuitively, holding the motivational effort fixed, the firm induces an inefficiently small effort level by choosing an inefficiently low bonus to keep the rent payment to the worker low.[17] These results are summarized in the following proposition.

[17] Note that the worker's rent is increasing in effort, $R_e = eC_{ee} > 0$ for all $e > 0$.

Proposition 4 *Conditional on work effort being $e = e^{SB}$, the firm's motivational effort a^{SB} is inefficiently high if and only if the worker's rent is decreasing in motivation at $e = e^{SB}$. Conditional on the motivational level being $a = a^{SB}$, the firm induces an inefficiently low work effort e^{SB}.*

Building on our discussion in Section 4.1, the firm invests too much in motivation if the worker is more responsive to, e.g., charismatic leadership, feedback, or attention the harder he works. By contrast, in a situation where the worker finds it especially hard to increase effort or to affect the probability of high output, the firm motivates too little.

It is worthwhile to note that, even if the worker's rent is decreasing in motivation for each *fixed* effort level, this does not mean that the worker does not benefit from motivation. When we compare the setting $(e_0^{SB}, 0)$, where the firm does not motivate, with the second-best setting (e^{SB}, a^{SB}), the worker's rent will usually be larger in the latter. When the firm motivates the worker, it typically also pays a (weakly) higher bonus[18] and induces a higher effort level than without motivation ($e^{SB} > e_0^{SB}$). The reason is that motivation makes monetary incentives more effective and less costly to the firm. The worker's rent thus increases because he has lower effort costs and obtains a higher bonus.

4.3 Optimal Interaction of Motivation and Incentives

In this section, we analyze the optimal interaction of motivation and monetary incentives and, in particular, whether the firm employs these two instruments as complements or substitutes. Furthermore, we discuss another application of our model, namely, the optimal provision of perks.

We have shown in Section 4.2.1 that, in the case of unlimited liability, the worker's optimal bonus does not depend on the motivation technology. The firm thus sets incentives independent of its motivational effort. To investigate the more complex case of limited liability, we now assume that motivational costs have the specific form $K(a) = \gamma k(a)$, with $\gamma > 0$. Our

[18] For example, if $C(e, a) = \frac{ce^2}{2(1+a)}$ and $K(a) = \frac{k}{2}a^2 + ta$, $t > 0$, as in the proof of Proposition 3, the bonus is $b = \Delta q/2$ both in the setting with and without motivation.

purpose is to analyze how a decrease in the parameter γ, reflecting that implementing motivation becomes less costly to the firm, affects the optimal level of motivation and the worker's bonus. Motivation gets less costly, e.g., when the motivator is less occupied with other tasks and thus his opportunity costs of time fall, or when costs of leadership training decrease, or when technological or organizational changes make it easier to implement more attractive job characteristics such as more task variety, flexible working hours, or work from home.

We first rewrite the firm's problem (21) in terms of b and a,

$$\max_{b,a} e(a,b)(\Delta q - b) - \gamma k(a). \tag{34}$$

Using the first-order conditions of (34), it is straightforward to verify that a decrease in γ entails a rise in the intensity of motivation, i.e., $da^{SB}/d\gamma < 0$. For the effect on the bonus b^{SB}, we obtain

$$\text{sign}\left(\frac{db^{SB}}{d\gamma}\right) = -\text{sign}\left(e_{ba}[\Delta q - b^{SB}] - e_a\right). \tag{35}$$

Intuitively, increasing motivation has two effects on the optimal bonus: First, the worker's incentive responsiveness e_b changes, making a bonus increase more or less effective ($e_{ba} \lesseqgtr 0$).[19] Second, the worker's effort increases ($e_a > 0$). Consequently, any bonus has to be paid more often, which favors a smaller bonus. Thus, the overall effect on b^{SB} is ambiguous, which leads to the following result.

Proposition 5 *Assume that $K(a) = \gamma k(a)$ and γ decreases, i.e., motivation becomes less costly. Then, the firm increases the intensity of motivation. If the worker's incentive responsiveness is decreasing in motivation ($e_{ba} \leq 0$), higher motivation is accompanied by lower monetary incentives. If, however, the worker's incentive responsiveness increases in motivation ($e_{ba} > 0$), the worker may obtain stronger monetary incentives.*

[19] Note that $\Delta q > b^{SB}$. Because the worker's effort is inefficiently low given that $a = a^{SB}$, his monetary incentives must also be inefficiently small.

Thus, motivation and monetary incentives are substitutes whenever $e_{ba} < 0$. However, if $e_{ba} > 0$, motivation and incentives may also be complements.[20]

As discussed in the introduction, we can make a broader interpretation of a as any actions or investments the firm can undertake to lower the effort costs of the worker. A particularly interesting interpretation is to let a stand for perks or work place benefits. Oyer (2008) convincingly argues that perks and benefits such as free meals, free parking, electronic equipment, or the provision of "concierge services" may be seen as an effort to lower employees' effort costs. Perks and benefits are obviously an important part of compensation, but formal analyses of the relationship between perks and monetary incentives are scarce. To our knowledge Marino and Zabojnik (2008) are the first to incorporate perks in an otherwise standard principal-agent model. They show, among other things, that the firm can use perks to reduce the worker's monetary incentives. Unlike us, they focus on a situation in which perks increase the productivity and the utility of a risk-averse agent without affecting his effort costs. They find that offering perks then allows the firm to decrease the agent's bonus and, consequently, his risk premium.

Similarly, our Propositions 3 and 4 show that, under limited liability, the firm can use perks to reduce the worker's rent. A crucial assumption in Marino and Zabojnik (2008) is that the benefit from perks increases in the worker's effort. We do not make this assumption, instead we characterize the conditions for *when* perks reduce worker's rent. In particular we show that the firm's optimal mix of perks and monetary incentives depends crucially on how perks affect the worker's incentive responsiveness e_b. In Marino and Zábojnik (2008), the firm always uses perks to lower the worker's monetary incentives. Therefore, perks and incentives are substitutes. By contrast, our model shows that, when perks increase the incentive responsive of the worker ($e_{ba} > 0$), the firm may also employ the two instruments as complements. Analogous to our argumentation in Section 4.1, $e_{ba} = e_{ab} > 0$ is more likely to occur when higher effort (due to a higher bonus) enhances the cost-

[20] It is also possible that the optimal bonus is independent of motivation. For example, if $C(e,a) = \frac{e^2}{2(1+a)}$ the optimal bonus is $b^{SB} = \Delta q/2$.

reducing effect of perks on the worker's marginal effort cost even further. For example, the worker could realize higher benefits from an innovative electronic device when he spends more time using it, thereby learning about additional features that facilitate work.

To summarize, the previous analysis has shown that a firm may overinvest in motivation or perks to decrease the worker's rent. Nevertheless, given the motivation the worker receives, he always works too little. However, this is optimal from the firm's point of view because it thereby also avoids excessive rent payments to the worker. Furthermore, we contribute to the literature on perks by showing that perks may not only be used as an alternative to monetary incentives.

5 The Motivator as an Agent of the Firm

We now consider a situation where the motivational actions are not chosen by the firm owner but by another agent of the firm, who also bears the costs of motivation. We can think of the motivator as a leader or someone above the worker in the hierarchy.[21] The motivator's effort level is not observable to the firm, so that the firm must contract on the worker's output to incentivize the motivator. It pays the motivator a bonus b_M if the worker's output is high. In addition, the motivator receives a non-contingent fixed payment s_M. Like the worker, the motivator is risk neutral, has a reservation utility of zero, and may be protected by limited liability.

Timing of the contracting game is now as follows: First, the firm offers the motivator a contract (s_M, b_M) and the worker a contract (s, b). The parties observe each other's contracts and decide whether to accept or reject. If both parties accept, the motivator chooses her motivational effort a at cost $K(a)$. Afterwards, the worker chooses his effort at cost $C(e, a)$. Next, output is realized and the firm pays the motivator and the worker.

We again solve the model by backward induction. We have already analyzed the last stage of the game where the worker chooses effort (Section

[21] If the motivator performs other tasks besides motivation within the firm, we neglect those tasks and the corresponding compensation schemes in our analysis.

4.1). We can therefore proceed to analyze how the motivator responds to given contracts (s, b) and (s_M, b_M).

5.1 The Motivator's Optimal Effort Choice

The motivator chooses her motivational effort given the contracts (s, b), (s_M, b_M) and anticipating the worker's effort choice $e(a, b)$ as implicitly given by (IC). The motivator's optimal effort $a(b, b_M)$ is thus determined by

$$a(b, b_M) = \arg\max_{\hat{a}} s_M + e(\hat{a}, b)b_M - K(\hat{a}). \tag{36}$$

We assume that the motivator's problem is concave in a, i.e.,

$$e_{aa}(a, b)b_M - K_{aa} < 0 \text{ for all } a \geq 0. \tag{37}$$

Thus, the optimal motivational effort $a(b, b_M)$ is implicitly defined by

$$e_a(a, b)b_M = K_a(a). \tag{IC-M}$$

We can observe that the motivator's responsiveness to her own monetary incentives, a_{b_M}, is always positive,

$$a_{b_M} = -\frac{e_a}{e_{aa}(a, b)b_M - K_{aa}} > 0. \tag{38}$$

Furthermore, the worker's bonus b also affects the motivator's effort level,

$$a_b = -\frac{e_{ab}b_M}{e_{aa}(a, b)b_M - K_{aa}}. \tag{39}$$

The relationship between the worker's incentives and the motivator's effort is ambiguous because $sign(a_b) = sign(e_{ab})$. By equation (15), $sign(e_{ab})$ can be positive or negative. If $e_{ab} > 0$, i.e., the worker's motivation responsiveness increases in his monetary incentives, the motivator will choose higher motivational effort when the worker receives a larger bonus. If, however, $e_{ab} < 0$, the motivator exerts less effort when the worker is provided with higher-powered incentives. In other words, when the worker's motivation responsiveness decreases in his bonus, the provision of stronger incentives to the worker reduces the motivational effort.

Proposition 6 *The motivator's effort is increasing in his bonus b_M. Moreover, his effort is increasing in the worker's bonus b if and only if $e_{ab} > 0$, i.e., if the worker's motivation responsiveness increases in b. Otherwise, the motivator's effort decreases in the worker's bonus.*

We see that when monetary incentives to the worker amplify the effect of motivational effort (i.e., $e_{ab} > 0$ as discussed in Section 4.1), it also increases the motivator's effort level. In contrast, if there is a hidden cost of reward (i.e., $e_{ab} < 0$), then higher monetary incentives to the worker do not only crowd out the effect of motivational effort. It also crowds out motivational effort. The interaction between non-monetary motivation and incentives thus transmits to the effort-level chosen by the motivator - which is illuminating, but not surprising. By equation (15) and the subsequent discussion, we obtain $e_{ab} < 0$ whenever $C_{eae} > 0$, i.e., when the worker already exerts sufficiently high effort and/or finds it particularly hard to affect output. Our model thus predicts that motivators of such agents should exert less motivational effort when monetary incentives to the worker increase.

5.2 The Firm's Contracting Problem with a Motivator

5.2.1 Optimal Contracting Under Unlimited Liability

We first analyze the firm's contracting problem under unlimited liability. In this case, the firm's optimization problem is:

$$\max_{\substack{e,a,\beta,b \\ s,s_M}} \quad q_L + e\Delta q - [e(b + b_M) + s + s_M] \tag{40}$$

$$\text{s.t.} \quad s + eb - C(e, a) \geq 0, \tag{PC}$$

$$s_M + eb_M - K(a) \geq 0, \tag{PC-M}$$

$$\text{(IC),(IC-M)}$$

Accordingly, the firm maximizes expected output net of wage costs. Thereby, it has to take into account the worker's and motivator's participation constraint (PC) and (PC-M), respectively, and each party's optimal effort choice for given bonuses, (IC) and (IC-M), respectively.

Solving this problem is straightforward. The firm optimally chooses the fixed wages s and s_M such that (PC) and (PC-M) are just binding. Consequently, the firm's wage costs are equal to the total costs $\Gamma(e, a)$. The firm therefore induces the worker and the motivator to exert first-best effort levels (e^{FB}, a^{FB}). As in the case where the firm motivates the worker itself, the worker's optimal bonus is $b^{FB} = \Delta q$ (compare equation (17) in Section 4.2.1). By (IC-M), if $a^{FB} > 0$, the motivator's optimal bonus is given by

$$b_M^{FB} = \frac{K_a(a^{FB})}{e_a(a^{FB}, \Delta q)}. \tag{41}$$

The motivator's bonus is thus determined by the ratio of marginal motivational costs and the agent's motivation responsiveness e_a at $a = a^{FB}$ and $b = b^{FB} = \Delta q$. Consequently, the motivator's bonus crucially depends on the characteristics of the worker's effort cost function $C(e, a)$.

We can conclude from Proposition 1 that, when the first-best motivational effort is positive and the marginal productivity of work effort, Δq, increases, both the worker and the motivator exert more effort. We now investigate how, in such a situation, the firm optimally adopts the contracts to induce higher effort levels. Obviously, the worker's bonus $b^{FB} = \Delta q$ will increase when his effort becomes more valuable to the firm. The effect on the motivator's bonus, however, is ambiguous. From (41), we obtain

$$\frac{db_M^{FB}}{d\Delta q} = \frac{K_{aa} \frac{da^{FB}}{d\Delta q} e_a}{e_a^2} - \frac{K_a \left(e_{ab} + e_{aa} \frac{da^{FB}}{d\Delta q} \right)}{e_a^2}. \tag{42}$$

There are two effects on b_M^{FB}. First, the motivator needs to be incentivized to incur higher marginal effort costs, which favors a higher bonus. This is reflected by the first, positive term on the right-hand side of (42). Second, the higher worker bonus and the increased level of motivation changes the worker's motivation responsiveness (e_a) and, thereby, the effectiveness of motivation. This effect is given by the second term on the right-hand side of (42), whose sign is undetermined because both e_{ab} and e_{aa} can be negative or positive.[22] Consequently, if e_{ab} and/or e_{aa} are positive, implying that the worker responds more strongly to motivation if his bonus and/or motivation increases, the overall effect on b_M^{FB} may be negative. Thus, even though the motivator works harder as Δq increases, she may obtain a lower bonus. In such a situation, the motivator increases her effort because she anticipates that the worker will respond more intensely to motivation.

Proposition 7 *Assume that the marginal productivity of work effort, Δq, increases. Then, both the worker's bonus and the motivator's effort increase. However, the motivator may receive a lower bonus. This is the case if and only if*

$$\frac{K_{aa} a_q^{FB} e_a}{e_a^2} - \frac{K_a \left(e_{ab} + e_{aa} a_q^{FB}\right)}{e_a^2} < 0. \tag{43}$$

We may thus have a negative equilibrium relationship between the motivator's effort and the bonus she receives. One way to express the intuition is as follows: If the worker's responsiveness to monetary incentives and/or motivation increases in the level of motivation, then a higher productivity, cet. par, may lead to an inefficiently high level of motivation ($a > a^{FB}$). The firm will then reduce the motivator's incentives to motivate.

5.2.2 Optimal Contracting Under Limited Liability

In this section we assume that both the motivator and the worker are protected by limited liability. When we analyzed the limited liability case without a motivator (Section 4.2.2), we found that the firm, under certain conditions, chooses an inefficiently high motivational effort level in order to reduce the worker's rent. A question now is whether this result continues to hold when the firm hires a motivator. Inducing motivation now entails a rent payment to the motivator and, therefore, becomes more costly to the firm.

[22] From (14) we obtain $e_{aa} = -\frac{(C_{eaa}+C_{eae}e_a)C_{ee}-(C_{eea}+C_{eee}e_a)C_{ea}}{C_{ee}^2}$.

Our main questions are: Will limited liability make it less likely that the firm induces motivation? Can we still have excessive motivational effort in the second-best solution when the firm must leave a rent to the motivator? And how is the motivator's and worker's rent affected by the bonuses they receive?

The firm's optimization problem now reads as

$$\max_{\substack{e,a,b,b_M\\ s,s_M}} \quad q_L + e\Delta q - [e(b+b_M) + s + s_M] \tag{44}$$

$$\text{s.t.} \quad s + eb - C(e,a) \geq 0, \tag{PC}$$

$$s_M + eb_M - K(a) \geq 0, \tag{PC-M}$$

$$\text{(IC)},\text{(IC-M)},$$

$$s, s_M, s+b, s_M+b_M \geq 0. \tag{45}$$

The last line ensures that the payments to both the worker and the motivator are always non-negative. From the worker's and motivator's incentive constraint (IC) and (IC-M), respectively, we see that the bonuses b and b_M must be non-negative. Furthermore, given arbitrary bonuses and their optimal effort response, the worker's and the motivator's expected bonus payment net of effort costs, $eb - C(e,a)$ and $eb_M - K(a)$, respectively, must be at least zero.[23] Thus, to satisfy the participation constraints (PC), (PC-M) and the limited liability constraints (45), the firm optimally sets the fixed wages s and s_M equal to zero. As a result, the firm's wage costs are equal to the expected bonus payments and its optimization problem can thus be simplified to

$$\max_{e,a,b,b_M} \; e(\Delta q - \beta - b) \tag{46}$$

$$\text{s.t.} \;\; b = C_e(e,a), \;\; b_M = \frac{K_a(a)}{e_a(a,b)}. \tag{47}$$

Defining $\Psi(e,a)$ as the bonus offered to the motivator, $\Psi(e,a) := \frac{K_a(a)}{e_a(a,C_e(e,a))}$,

[23] Each party can ensure itself such a payoff by exerting zero effort.

we can further rewrite the firm's problem as

$$\max_{e,a} e\left(\Delta q - C_e(e,a) - \Psi(e,a)\right). \tag{48}$$

We again assume that the objective function is strictly concave[24] and denote the solution to (48) by (e_M^{SB}, a_M^{SB}). First, we can observe that the firm still induces a positive work effort, $e_M^{SB} > 0$. When deciding whether the worker should be motivated or not, the firm trades off the benefit of lowering the worker's expected bonus payment against the costs of motivation. These costs are now equal to the motivator's expected bonus payment. Because worker and motivator earn a rent when they exert positive effort, the firm's wage costs always exceed the total costs $\Gamma(e,a)$. A sufficient condition for $a_M^{SB} > 0$ is that the firm's expected costs decrease in a for each positive effort level:

$$e(C_{ea}(e,0) + \Psi_a(e,0)) < 0 \text{ for all } e > 0 \tag{49}$$

$$\Leftrightarrow C_{ea}(e,0) + \Psi_a(e,0) < 0 \text{ for all } e > 0 \tag{50}$$

The second inequality shows that the expected wage costs are decreasing in a whenever the sum of the bonuses decreases in motivation. More specifically, recalling that e_0^{SB} denotes the work effort that is optimal given that $a = 0$, for $a_M^{SB} > 0$ it is sufficient that the sum of the bonuses is decreasing in motivation at e_0^{SB}, i.e.,

$$C_{ea}(e_0^{SB}, 0) + \Psi_a(e_0^{SB}, 0) < 0. \tag{51}$$

As the next proposition shows, even though motivation now entails a rent payment to the motivator, the firm may still induce more motivation than is efficient.

[24] This is the case if the Hessian L of $e(C_e + \Psi)$ is positive definite, i.e., $2C_{ee} + eC_{eee} + \Psi_e + \Psi_{ee} > 0$ and $\det L > 0$ with

$$L = \begin{pmatrix} 2C_{ee} + eC_{eee} + \Psi_e + \Psi_{ee} & C_{ea} + eC_{eea} + \Psi_a + \Psi_{ea} \\ C_{ea} + eC_{eea} + \Psi_a + \Psi_{ea} & e(C_{eaa} + \Psi_{aa}) \end{pmatrix}.$$

Proposition 8 *When having to incentivize a motivator, it is possible that (i) the firm induces motivation only under unlimited liability, i.e.,* $a^{FB} > 0$ *and* $a_M^{SB} = 0$*. However, it is also possible that (ii) motivation occurs only under limited liability, i.e.,* $a^{FB} = 0$ *and* $a_M^{SB} > 0$*.*

The proof is given in the Appendix. For case (i), it shows that, even if exerting an infinitesimal amount of motivation is costless for the motivator ($K_a(0) = 0$), the firm may decide against motivation. If the firm could motivate the worker itself, it would do so. However, incentivizing a motivator is too costly because of the rent she earns. As the proof shows, such a case can occur if marginal motivational effort costs are large relative to the impact that motivation has on the worker's costs. Then, the motivator's bonus increases more sharply in motivation than the worker's bonus decreases. However, as case (ii) shows, there may also be situations where the firm hires a motivator even though motivation is inefficient. Then, motivation has a stronger advantageous effect on the wage paid to the worker than it increases the wage paid to the motivator.

Finally, it is interesting to analyze the relationship between the worker's and the motivator's rent. To do so, we consider a situation where the firm wishes to induce *a fixed work effort* e. This work effort can be implemented by all combinations of a and b satisfying the worker's incentive constraint (IC). The question we want to answer is: How do the worker's and the motivator's rent change under the different feasible combinations and, consequently, what combination does each party prefer? Assume that, starting from a certain combination $a = a_1$ and $b = b_1$ that induces e, the firm decides to marginally increase motivation. This requires to adjust the bonuses b_M and b such that the motivator is willing to exert more effort, while the worker's effort level remains constant. The motivator's initial bonus is

$$b_M = \frac{K_a(e, a_1)}{e_a(a_1, C_e(e, a_1))}. \tag{52}$$

If the firm wishes to increase a, holding e constant (by decreasing $b =$

$C_e(e, a_1)$), the motivator's bonus changes as follows:

$$\frac{\partial b_M}{\partial a} = \frac{K_{aa} e_a - (e_{aa} + e_{ab} C_{ea}) K_a}{e_a^2} = \frac{K_{aa} e_a - e_{aa} K_a - e_{ab} C_{ea} K_a}{e_a^2} \qquad (53)$$

The term $K_{aa} e_a - e_{aa} K_a$ is positive because, by the second-order condition for the motivator's problem, (37), we have $\frac{K_{aa}}{e_{aa}} > b = \frac{K_a}{e_a}$. The sign of the term $e_{ab} C_{ea} K_a$, however, depends on e_{ab}. If $e_{ab} \geq 0$, a lower bonus for the worker leads to lower motivation responsiveness, which in turn has a negative effect on the motivator's incentive to motivate (see Proposition 6). Thus, it is clear that the motivator's bonus must increase. Consequently, the motivator's rent,

$$R^M(e, a) = e(a, C_e(e, a)) \frac{K_a(e, a)}{e_a(a, C_e(e, a))} - K(a), \qquad (54)$$

also gets larger. The reason is that, with the higher bonus, the motivator would earn a higher rent than before if she still chose $a = a_1$. However, she prefers to exert higher motivational effort. Consequently, this higher effort must entail an even larger rent. If, however, $e_{ab} < 0$, the worker is more responsive to motivation after a bonus decrease. When this effect dominates in (53), the motivator's bonus actually decreases in motivation. Because motivational costs increase, the motivator's rent is also lower. Thus, the motivator prefers a lower bonus for the worker and more motivation if $e_{ab} \geq 0$, but may favor a higher worker bonus and less motivation if $e_{ab} < 0$.

From the analysis in Section 4.2.2, we can infer the interests of the worker: He prefers a higher bonus and less motivation if and only if his rent $R(e, a)$ is decreasing in motivation, i.e., if $C_{eea} < 0$. This is always the case if $e_{ab} > 0$. Consequently, we obtain the following result.

Proposition 9 *If $e_{ab} > 0$, there always is a conflict of interest between worker and motivator: To be incentivized to exert a given effort level, the worker prefers stronger monetary incentives and less motivation, whereas the motivator prefers lower monetary incentives and more motivation for the worker. If $e_{ab} < 0$, there is a conflict of interest between the two parties* *if and only if* $K_{aa}e_a - (e_{aa} + e_{ab}C_{ea})\,K_a > 0$ *and* $C_{eea} < 0$ *(the motivator prefers more motivation and the worker less) or* $K_{aa}e_a - (e_{aa} + e_{ab}C_{ea})\,K_a < 0$ *and* $C_{eea} > 0$ *(the motivator prefers less motivation and the worker more).*

If the worker's motivation responsiveness is increasing in incentives ($e_{ab} > 0$), motivator and worker would never agree on a motivation-incentive mix: The motivator then always advocates relatively more motivation and the worker less. However, if $e_{ab} < 0$, the interests of the two parties may be aligned. Interestingly, the motivator may then even favor lower motivation and higher incentives for the worker. This is the case when a small bonus makes the worker highly responsive to motivation. A high bonus to the worker then acts as a self-commitment device for the motivator not to increase motivational effort even if her own bonus decreases. The worker does not like a higher bonus when $C_{eea} > 0$. As argued in Section 4.1, such a case can occur only if the worker already works quite hard. Motivation then lowers his effort costs so strongly that he is willing to accept a lower bonus in return.

6 Concluding Remarks

In this paper we take a technological approach to motivation by modeling "motivational effort" as something that reduces other workers' effort costs. A worker can get motivated by visionary talks, pats on the back, or just mere attention, making effort more enjoyable and less costly.

Our simple framework makes it possible to study important details on the interaction between monetary incentives and non-monetary motivation. We can distinguish between incentive responsiveness and motivation responsiveness, and we can characterize the conditions under which monetary incentives and motivational effort are substitutes or complements in the firm's optimal motivation-incentive mix. Under unlimited liability of the worker, the firm provides first-best incentives. Since those are equal to the marginal productivity of effort, the optimal bonus is independent of the optimal level of motivation. Things are different, however, when the worker is protected by limited liability. The reason is that, in this case, the firm induces motivational effort not just in order to reduce the worker's effort costs but also to affect the worker's rent and thus his bonus. Under limited liability, motivation and incentives are substitutes if higher-powered incentives to the worker reduce his responsiveness to motivational effort, which constitutes a new "hidden cost of reward". Since motivational effort can be interpreted as an attempt to increase the worker's intrinsic motivation, this result is related to the well-known crowding out argument for intrinsic motivation. But motivation and incentives can also be complements because bonus payments may enhance the effect of motivational effort. We thus demonstrate that there can be a "hidden benefit of reward", which finds empirical support in the organizational behavior literature. In such a situation, we can equivalently speak of a "hidden benefit of motivation" because higher motivation also makes bonus payments more effective in increasing effort and, consequently, motivation decreases the worker's rent. We show that the firm may then even implement excessive motivation.

Thus, a practical implication of our model is that firms have to pay particular attention to the motivation-incentive mix when workers earn rents. Rents cannot only occur when employees are protected by limited liability, but also when they are wealth-constrained or receive a minimum wage as a fixed wage. We find that, under a binding wage floor constraint, monetary incentives cannot be chosen independently of motivation. By contrast, if an employee's participation constraint is binding, the optimal bonus does not change with motivation. Participation constraints can also be binding when wage floors such as liability limits or minimum wages exist, but the worker's reservation utility is high. More able or better qualified workers typically have higher reservation utilities because they can easily find another well-paid job outside their current firm. Our model suggests that, ceteris paribus, such workers tend to obtain stronger monetary incentives than colleagues with less attractive outside options. Moreover, these high-powered incentives do not vary with the firm's motivational effort (as long as effort costs do not decrease so strongly with higher motivation that the participation constraint is no longer binding). Our model also implies that the firm is more likely to overinvest in motivation for workers who have less attractive outside options, e.g., workers on lower hierarchy levels who obtain minimum wages as fixed compensation.

When another agent of the firm motivates the worker, we show that high-productive workers may trigger the motivator's effort to such an extent that the firm may want to mitigate motivation by lowering the motivator's bonus. This may create a negative equilibrium relationship between the motivator's bonus and her effort level. We also identify a potential conflict of interest between motivator and worker. Motivators may have an interest in low-powered incentives (and low rents) to the workers they motivate, because this raises the need for higher bonuses (and thus higher rent) to the motivator. This can contribute to explain why motivators and authors of popular management books so often emphasize the importance of non-monetary motivation, and why leaders often have higher-powered incentives than lower-level employees. The latter can also be explained by the fact that the ability to motivate is a scarce resource. If the motivator cannot herself be motivated by a motivator, she has to be motivated by money. However, if the worker responds much more strongly to motivation when his bonus is low, the motivator can also prefer a high bonus for the worker to avoid being driven to provide high motivational effort. Moreover, the worker may prefer motivation to monetary incentives if he already works quite hard.

Our model shows that different (conflicting) insights gained in fields such as management, leadership and organizational behavior can be understood and analyzed within a simple microeconomic framework. Jobs differ in their characteristics and employees have different preferences for leadership styles and work environments. Thus, motivation has a different impact in different employment relationships. For example, studies show that charismatic leadership is more effective if the subordinate's task has an ideological component, the work environment is subject to stress and uncertainty, or the firm is small (Robbins and Judge 2013, p. 415 and 419). According to the GLOBE study by House et al. (2004), employees from different cultures have distinct preferences for leadership styles. Our model not only suggests that multinational firms should adapt their motivational effort to individual tastes for leadership. They should also offer different compensation packages when first-best monetary incentives are not feasible, e.g., due to wage floors. Even if motivational effort cannot be perfectly tailored to individual employees, individually adapted incentive pay can mitigate this problem. Companies have already realized that it is important to learn what motivates an individual employee. Large firms such as Kraft Foods or Deutsche Telekom use the so-called "Reiss Motivation Profile" to find out more about their employees' preferences.[25]

The model captures differences in the effectiveness of motivation and its optimal interaction with monetary incentives by the worker's effort cost function $C(e, a)$. We show that, to assess the usefulness of motivation and to determine the optimal motivation-incentive mix, it is essential for a firm to know whether motivational effort becomes more or less effective in increasing work effort with stronger monetary incentives (i.e., whether $C_{eae} < 0$ or $C_{eae} > 0$ holds, respectively). Our analysis thus illuminates potential empirical strategies to better understand the interaction of motivation and incentives. The main challenge for empirical and/or experimental work is to determine the situation-specific interaction of monetary incentives and motivation. So far, empirical studies have shown that different leadership styles or leadership training have an impact on firm performance. Our model highlights that it is also crucial to determine whether and how this impact depends on the strength of monetary incentives provided to those affected by motivation. If performance responds less to motivational effort under higher-powered incentives, then the firm should use motivation and incentives as substitutes. Otherwise, it may be optimal to use incentive and motivation as complementary devices, and the firm may benefit from implementing excessive motivation.

We have incorporated motivational effort as a device to reduce a worker's effort cost in a simple principal-agent model of (un)limited liability. One could argue that our motivational effort is hard to distinguish from many

[25] See "Gesucht: Der perfekte Kollege", *Die Zeit, 21.06.2012, p. 75.* The Reiss Profile was developed and publicised by Prof. Steven Reiss, Emeritus Professor of Psychology and Psychiatry at Ohio State University (USA), see, e.g., Reiss (2002).

other production inputs since there are many kinds of inputs that may lower the worker's effort costs. Still, we believe our modeling approach and interpretation is worthwhile. First, it clarifies how "technological motivation" in terms of, e.g., inspiration or visions relates to standard incentive models of motivation. Second, it opens for a new incentive problem that is not relevant for other kinds of production inputs, namely how to incentivize the motivator. The model can of course be extended in various ways, to include incomplete (relational) contracting, multitasking and/or imperfect performance measures. Motivational effort may in fact be an important response to incentive problems when good performance measures are not available. To get a fuller understanding of leadership one should also study the relationship between two distinct aspects of it; namely the ability to make decisions (as in Lazear 2010), and the ability to motivate, as introduced here.

7 Appendix

Proof of Proposition 3. The proof is by example. Assume that $C(e,a) = \frac{ce^2}{2(1+a)}$ and $K(a) = \frac{k}{2}a^2 + ta$, $t > 0$.[26] By (7), a sufficient condition for $a^{FB} = 0$ is that

$$C_a(e,0) + K_a(0) = -\frac{ce^2}{2(1+0)^2} + k \cdot 0 + t \geq 0 \text{ for all } e. \tag{55}$$

Since $e \leq 1$, this condition is satisfied if $t \geq \frac{c}{2}$. Now consider the case of limited liability. We have

$$e_0^{SB} = \arg\max_{e \in [0,1]} e\Delta q - ce^2. \tag{56}$$

[26] In the motivational cost function, we need the a^2-term to ensure convexity of the total cost function and the ta-term to ensure that $K_a(0) > 0$ and, hence, $a^{FB} = 0$ is possible.

Assuming that this problem has an interior solution, we obtain $e_0^{SB} = \frac{\Delta q}{2c}$ for $\Delta q < 2c$. By (28), it holds that $a^{SB} > 0$ if

$$e_0^{SB} C_{ea}(e_0^{SB}, 0) + K_a(e_0^{SB}, 0) = -\left(\frac{\Delta q}{2c}\right)^2 \frac{c}{(1+0)^2} + t < 0 \Leftrightarrow t < \frac{1}{c}\left(\frac{\Delta q}{2}\right)^2. \tag{57}$$

Furthermore, we have

$$t = \frac{c}{2} < \frac{1}{c}\left(\frac{\Delta q}{2}\right)^2 \Leftrightarrow \sqrt{2}c < \Delta q. \tag{58}$$

It follows that $a^{SB} > 0$ for, e.g., $t = c/2$ and $\Delta q \in \left(\sqrt{2}c, 2c\right)$. ■

Proof of Proposition 8. The proof is by example. An example for case (i) is $C(e,a) = \frac{e^2}{2(1+ca)}$ and $K(a) = k\frac{a^2}{2}$. From (4) and $K_a(0) = 0$, we obtain $a^{FB} > 0$. Next, we verify that the sum of the bonuses, $C_e(e,a) + \Psi(e,a)$, is increasing in a for all e and, consequently, $a_M^{SB} = 0$. We have $e(a,b) = (1+ca)b$. Thus, recalling that $\Psi(e,a) = \frac{K_a(a)}{e_a(a, C_e(e,a))}$, the sum of the bonuses is

$$\frac{e}{1+ca} + \frac{ka}{c\frac{e}{(1+ca)}} = \frac{e}{1+ca} + \frac{k}{ce}a(1+ca). \tag{59}$$

This sum is increasing in a if

$$-\frac{ce}{(1+ca)^2} + \frac{k}{ce}(1+2ca) > 0 \Leftrightarrow (1+2ca)(1+ca)^2 > \frac{c^2}{k}e^2. \tag{60}$$

The last inequality holds for all $a \geq 0$ and $e \in [0,1]$ if $k > c^2$.

As an example for case (ii), consider $C(e,a) = \frac{ce^2}{2(1+a)}$ and $K(a) = \frac{k}{2}a^2 + ta$, as in the proof of Proposition 3. We thus already know that $a^{FB} = 0$ if $t \geq \frac{c}{2}$. Furthermore, for the limited liability case, we have $e_0^{SB} = \frac{\Delta q}{2c}$ if $\Delta q < 2c$. Since $e(a,b) = \frac{1}{c}(1+a)b$, the motivator's bonus and marginal bonus is $\Psi(e,a) = \frac{ka+t}{\frac{1}{c}\frac{ce}{(1+a)}} = \frac{(1+a)(ka+t)}{e}$ and $\Psi_a = \frac{ka+t+k(1+a)}{e} = \frac{t+k(1+2a)}{e}$, respectively. By (51), we obtain $a_M^{SB} > 0$ if

$$C_{ea}(e_0^{SB}, 0) + \Psi_a(e_0^{SB}, 0) = -\frac{\Delta q}{2c}\frac{c}{(1+0)^2} + \frac{t+k}{\frac{\Delta q}{2c}} < 0 \tag{61}$$

$$\Leftrightarrow t < c\left(\frac{\Delta q}{2c}\right)^2 - k. \tag{62}$$

Furthermore,

$$t = \frac{c}{2} < c\left(\frac{\Delta q}{2c}\right)^2 - k \Leftrightarrow 2c\left(\frac{1}{2} + \frac{k}{c}\right)^{1/2} < \Delta q \tag{63}$$

It follows that $a_M^{SB} > 0$ for, e.g., $t = c/2$ and $\Delta q \in \left(2c\left(\frac{1}{2} + \frac{k}{c}\right)^{1/2}, 2c\right)$, which is possible if $\frac{1}{2} + \frac{k}{c} < 1$. ■

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