Non-Production-Related Effort and the Limits of Contracting

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Abstract

Empirical and behavioral research suggests that workers don’t always see work only as a means of obtaining income in return for production-related effort. Rather, they also exert non-production-related effort in order to obtain greater control over their jobs, achieve balance with non-work activities and to further such personal goals as flexibility, self-growth and job-satisfaction. By contrast, the large accounting literature on incentive mechanism design has focused solely on production-related effort, making the implicit assumption that omitting non-production-related effort is without loss of generality. In this paper we develop a model with both types of effort in order to endogenously determine whether non-production-related effort impacts the ability of the firm to achieve its goal through incentive contracts. We show that while introducing non-production-related effort to the principal/agent model limits the power of contracting – meaning that the firm cannot guarantee that it can achieve its desired production-related effort and profit goals – that is not to say that the firm will always be worse off. Depending on the nature of the interaction between the two kinds of effort and their impact on the worker’s utility, it is also conceivable that both firm and worker become better off than the standard principal/agent model would predict.

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1. Introduction

“I hope that those companies that remind their workers not to use the company computer for personal business also post signs at their exits reminding employees not to think about work once they leave the office.

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I’ll be the first to admit that I write personal e-mails, shop and look for information on hobbies while I’m at work. I frequently think about the best way to handle work issues while I swim after I leave the office. Employers need to be realistic about human nature, and to keep their focus on whether employees are getting the job done, not how they go about doing it.”


This quote illustrates the richness of the relationships in the workplace between employers, workers and the nature of the work that they do that is often missing in the economic modeling of those relationships. The management accounting literature, in particular, focuses its analysis more narrowly on the design of contracts between principals and agents in a setting with information asymmetry. And while powerful insights have been obtained from that literature, it is also undoubtedly the case that much of the complexity of the real workplace is omitted from the models analyzed in those papers. This paper introduces into the standard principal-agent model some of the characteristics of the modern workplace that are mentioned in this quotation but which have not received sufficient attention in the research literature, in particular, a lack of knowledge and understanding by managers and workers of the priorities and concerns of the other (“Employers need to be realistic about human nature”) and the fact that not everything workers do in the workplace is related to production, but that instead workers value flexibility in what they do and when they do it in order to maximize both their welfare and the demands of their employer (“focus on whether employees are getting the job done, not how they go about doing it”).

Our analysis of what we call “non-production-related effort” and the ability of firms to control its impact on the workplace is not an end in itself. It is also a means towards gaining a better understanding of the large literature on contracting in a principal/agent setting, and what we may have lost with its focus on contract design at the expense of a richer modeling of workplace relationships. Our focus is on whether acknowledging the importance of non-production-related effort limits the efficacy of those contracts as a way of resolving the problems imposed on firms by information asymmetry with their workers. If that is the case, it implies that accounting researchers, just like the employers in the quote, will need to be more realistic about human nature.

We begin our model development with a detailed examination of the literature in both economics and accounting on pay-for-performance contracting and the nature of effort and its control in the workplace. Since our motivation is to examine the limitations of the modeling choices of that literature, it is important that we develop our own model in relation to the standard way in which principal/agent relationships have been analyzed. In section 2 we also examine other analytic papers that have attempted to expand the standard model and discuss why we feel that what they do, while valuable, does not go far enough. Having established the basis for our extension of the standard model, in section 3 we revisit that standard principal/agent model of incentive compensation with only production-related effort, and its well-known results of what happens with and without incentive schemes, in order to serve as a benchmark for our own analysis. In section 4 we extend the standard model to introduce non-production-
related effort, and in section 5 we discuss the worker’s perspective on incentive contracting. Comparing the results from sections 3 and 5 leads to the conclusion that non-production-related effort cannot be omitted from the standard principal/agent model of section 3 without loss of generality. Moreover, including it leads to a far richer and more empirically valid model. We conclude with a numerical example of our extended model in section 6, to develop further insights into the substitution between production-related and non-production-related effort and the effect this has on worker utility and firm profits.

2. Literature Review and Model Development

2.1 The Limits of Pay-For-Performance Contracting

As the title of Lambert’s (2001) important survey article, “Contract Theory and Accounting”, makes clear, agency research in management accounting is based on the assumption that the firm’s incentive problems can be resolved through the use of pay-for-performance based contracts. When one starts from this presumption, research can focus on mechanism design – the shape and nature of the contracts used to align the worker’s interests with that of the firm – while taking for granted that the chosen contract will allow the firm to achieve its goals of inducing higher effort by the worker, albeit at a higher cost resulting from the inability of the firm to observe that effort and/or the worker’s pre-decision information.

That fundamental assumption about the power of contracting arises because the firm’s inability to observe one piece of information known only to the worker is compensated for by giving the firm complete knowledge about everything else that is relevant about the worker. Thus, in the case of moral hazard, the firm is presumed to know with certainty both the worker’s utility function and how the worker’s unobserved effort affects the production function. Knowing these two allows the firm to write a contract that always restricts the worker to his minimum reservation utility. A risk premium is the only rent that the firm is forced to pay as a consequence of not observing the worker’s effort, and given that risk premium, the worker remains indifferent as to whether he is in a first or second best world. Contracting effectively internalizes to the firm the entire consequences of moral hazard.

In the adverse selection case, unlike with moral hazard, the worker does earn an informational rent that takes his utility above the reservation level. But here too, several assumptions are made in the accounting literature that shift the balance of power in favor of the firm. First, it is assumed that the worker’s private information only has value to the extent that the firm makes use of it, and is useless to the worker personally otherwise – for example, the information that is most often subject to adverse selection is the worker’s productivity when using the firm’s production function. Second, because of the way in which production-related effort is assumed to impact the worker’s utility function, the firm enjoys the ability to use a carrot and stick approach in its contract with the worker, which leads to lower informational rents and truthful disclosure. For example, the firm can threaten to outsource production (“the stick”) if the worker
attempts to exploit his informational advantage by claiming that labor productivity is excessively low, while the firm can induce only high productivity workers to be hired by rationing the material inputs the worker needs to produce output (“the carrot”). And because the worker’s information is useless outside the firm itself, that threat to outsource has bite.

In both the cases of hidden effort and hidden information, the advantages enjoyed by the firm enable it to act as the equivalent of the Stackelberg leader in a market setting. Lambert’s (2001, p.10) comments in regard to this issue concerning moral hazard models apply equally in spirit to the entire accounting literature on incentives:

“In choosing a compensation function, the principal must ensure that it is attractive enough to offer the agent an acceptable level of expected utility... This minimal level is often interpreted as the expected utility of the agent in his next best employment opportunity, or his reservation level of utility. This interpretation suggests that the principal has all the power in the relationship; he can hold the agent to this minimal acceptable level, while he keeps the excess.”

These assumptions that ensure the primacy of contracting are perfectly acceptable as long as the focus of the research is restricted to mechanism design. Lambert (2001) surveys the large literature on contracting in accounting, examining how contracts change to accommodate multiple signals, multiple types of production-related effort, multiple agents or multiple time periods. There is, however, something lost in this exclusive focus on mechanism design, for only looking at the shape of contracts does not provide a means to model the richness of the relationship between worker and employer or the realities of the modern workplace. In particular, the accounting literature assumes that the firm knows the worker’s utility function perfectly, but perfect common knowledge about preferences and drivers of behavior doesn’t exist between parent and child, or husband and wife, much less between worker and employer. The research on incentives in accounting is inherently unable to examine the consequences of that reality and hence has nothing to say about what limits it imposes on the contracting ability of the firm.

The problem is that the limits of contracting have been comprehensively demonstrated in practice in the very area that is the focus of management accounting research: pay-for-performance compensation contracts. Thus, the growing disillusion with stock option based incentive contracts is due to the realization that those workers (if CEOs can be described in such plebeian terms) simply did not behave in the way the agency models assumed they would. From stock option backdating to stacking boards with compliant directors and hiring compensation consultants to ratchet up rewards, workers have not reacted passively to pay-for-performance contracts but have aggressively acted to take advantage of them. Far from being indifferent to how they are paid – as theory suggests they should be – it is workers and not the firm who have acted as Stackelberg leaders in the way they have responded to contracting.¹

¹ Bebchuk and Fried (2003) provide a counterpoint to the standard agency model, firm-centric perspective on CEO compensation.
Examining the limits of contracting does not require the abandonment of the principal/agent models developed in accounting research, but a shift in focus away from mechanism design towards exploring when the assumptions that guarantee the ability of the firm to achieve its goals through contracting are less likely to hold. By the limits of contracting we don’t, of course, mean that there cannot be a contract, for clearly a contract can be offered in any circumstances. But rather, we explore what happens when the principal does not have all the power in the relationship, to paraphrase Lambert. In this paper we systematically approach the issue by examining the circumstances under which the maintained assumption that the firm has complete knowledge of the worker’s utility function becomes a difficult standard to attain, and explore the consequences of relaxing that assumption on what the firm is able to achieve by writing pay-for-performance based contracts.

In contrast to accounting research, the economics literature has long examined broader questions on the nature of the relationship between principal and agent. While both the economics and accounting literature on incentives build on the seminal work of Holmstrom (1979), they take very different approaches towards extending that model. As we have seen, accounting researchers have examined the way in which contracts change to accommodate different types of information. The economics literature instead relaxes Holmstrom’s underlying assumptions. One of the strongest of those assumptions is that of common knowledge: that the principal knows perfectly what the utility function of the agent looks like and so can focus on the optimal design of the contract while extracting as much of the surplus as possible. Given that this is a difficult standard of knowledge to attain in the real world, the nature of common knowledge and the consequences of it failing to hold have been the subject of active research in economics (Shin and Morris, 1997; Shin, 1993; Fudenberg and Tirole, 1991, chapter 14, survey the literature in this area). Kreps (1990, p.370) adds his own pungent comment on the common knowledge assumption, that it “follows from deeply held ‘religious’ beliefs of game theorists. Of course one hesitates to criticize another individual’s religion, but to my own mind this convention has little basis in philosophy or logic.”

What is striking, however, is that with rare exceptions, common knowledge is the maintained assumption in accounting research, reflecting none of the skepticism in economics as to the assumption’s relevance. Indeed, one of the few mentions of the subject is a paper by Shyam Sunder (2002, p.1), in which he calls for the assumption to no longer be the default option in accounting research:

“The concept of common knowledge concerning higher orders of knowledge has seen exciting new developments in the fields of philosophy, game theory, statistics, economics and cognitive science in the recent decades. [Relaxing] common knowledge... may significantly advance our understanding of financial reporting, analysis, securities valuation, managerial control, auditing and information systems.”

One reason for its continued hold on the accounting literature is the fear that once the assumption of common knowledge is relaxed, “anything becomes possible” and models lose their predictive ability. It is also easy to dismiss lack of common knowledge
as being “outside equilibrium”, but one can question the relevance of a model that assumes an equilibrium that cannot exist in the real world. Our perspective is that it is better to have a “messy” model that fits reality rather than an elegant one that does not. What we do in this paper is to systematically identify one set of the circumstances where the standard assumptions of the principal/agent model cannot hold, with the object of retaining the ability of the model to predict what will happen as a result and why. With an eye on the travails of management accountants with executive compensation, we bring into the accounting models an important aspect of the workplace that has been ignored – in this case, both in accounting and to a large extent in economics – that workers do not passively accept incentive contracts, as the model of the firm as a Stackelberg leader implies, but in fact actively respond to them by shaping the workplace to better suit their purposes. They do so by undertaking what we call non-production-related effort in addition to the production-related effort that is all that is usually modeled in the accounting literature.

2.2 Non-Production-Related Effort and Firm Control

The standard principal/agent model of the accounting literature does not ignore the existence of non-production-related effort. Rather it excludes it from consideration on the implicit assumption that any effect it has on the model’s outcome is “second-order”, affecting only the worker’s private utility and having no impact on variables that concern the firm – i.e., the worker’s choice of production-related effort, and hence, firm profits. We argue that the second-order effect of non-production-related effort has only been presumed rather than analytically demonstrated, and hence it is equally possible that non-production-related effort will instead have a “first-order” effect, changing the standard principal/agent model’s results about optimal incentive schemes.

Hence, in this paper we examine a model that formally incorporates both production-related and non-production-related effort in order to endogenously determine whether non-production-related effort does affect the optimality of pay-for-performance schemes, and if it does, how. If these subjects have not been overly covered in the accounting literature, our work does build on a very large empirical and behavioral literature on the importance of non-production-related effort in the workplace and its impact on incentive schemes.\(^2\) There have also been at least two notable analytic papers that explicitly recognize the potential influence of non-production-related effort, which we discuss below.

We model the worker’s non-production-related effort as being aimed at making the workplace less onerous and production-related effort less of a burden. This approach is based on the behavioral paradigm of workers proactively attempting to achieve a balance between production and non-production-related effort, such as taking care of personal business on company time, networking, spending time on personal growth, or adopting a self-designed flexible work schedule to increase their utility from their jobs. Our framework can be extended to model the kind of reverse Stackelberg behavior that characterizes the Bebchuck and Fried (2003) view of executive compensation, but we

defer that to another paper. Instead, in our first examination of the subject, we make the simpler, but no less profound, assumption that within the constraints placed by the firm’s control systems, such as its rules on hours worked, task selection and empowerment, the worker will exert non-production-related effort in order to reduce his disutility from taking production-related effort.

We combine this model of disutility with the assumption that the fundamental distinction between the two types of effort is the level of knowledge and control that the firm has over each. Production-related effort is an input into the firm’s production function that the firm hires the worker to provide. Thus the firm has the advantage in terms of knowledge as to job definition and the means of control. The job of management is to set the ground rules for how the worker carries out production-related effort and how he will be rewarded as a result. By contrast, non-production-related effort is entirely within the domain of the worker, being a function of the particular and unique circumstances that he finds himself in when he is at the workplace. How would the firm know what this kind of effort entails or how much value the worker would place on it?

Of course, there can be an overlap between the two types of effort, with some types of non-production-related effort being more susceptible to control than others (for example, technology can monitor personal calls on company phones or block external websites). Further, some types of non-production-related effort can have a direct (i.e., first-order) effect on the firm by their very nature, such as when they use up firm resources and incur additional direct costs for the firm (for example, if personal web use clogs up the firm’s servers). Alternatively, non-production-related effort can impact not only the worker’s disutility, but his productivity, as in the adage that “happier workers make better workers”. To be as clear as possible in our results we use a model that makes very sharp distinctions between the two types of effort, both in their impact on the worker and on the firm. Thus, non-production-related effort is restricted to affecting the worker’s disutility alone, with no direct costs to the firm, while the firm is assumed not to know what non-production-related effort the worker will undertake or how it affects the worker. That is not to say that managers don’t know that workers are undertaking non-production-related effort in the workplace, only that they have no actionable knowledge about it – that is, knowledge sufficiently precise that it is able to write a contract controlling non-production-related effort the way that it can with production-related effort.3

The firm’s lack of actionable knowledge about non-production-related effort violates the common knowledge assumption of the standard principal/agent paradigm under which the firm knows the worker’s utility function as well as the worker does. Our argument, however, is that it is hard to support the assumption that the firm has the same level of knowledge over non-production-related effort as over production-related effort. The fundamental difference between the two types of effort is that non-production-related effort is entirely the private concern of the worker, and so there is no

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3 Note that another approach that gives rise to non-controllable effort is the literature on incomplete contracting, in this case, the inability of the firm and the worker to specify in advance each and every instance of non-production-related effort. One can certainly postulate that it is easier to achieve contract completeness, which is a form of common knowledge, with production-related effort than with non-production-related effort (Grossman and Hart, 1986).
commonality of experience or interest that allows the firm to obtain that information in the way in which it can with production-related effort, where the work that the worker is performing has been determined by the firm itself.

Indeed, it has been a consistent finding in labor economics and the sociological and behavioral literature that workers and managers have a hard time achieving consensus even over production-related effort. This makes it all the more unlikely that they can find common ground on non-production-related effort, as the above quote from the New York Times illustrates so articulately. An important contribution of our paper is in arguing for the incentive literature to follow the lead of the economics and behavioral literature and question whether the modeling convenience of complete common knowledge is bought at the cost of models that fail to capture the full richness of the workplace. Certainly our results on the consequences of imposing incentive contracts in the workplace are a closer match to the empirical findings than the conclusions drawn from the standard principal/agent model in accounting: by extending the standard principal/agent model, we show that its results about incentive schemes do not carry through unchanged in the presence of non-production-related effort. In other words, non-production-related effort has a first- rather than second-order effect on the optimality of incentive compensation, and hence, its omission in the standard principal/agent model is not without loss of generality. In particular, we show that when workers face a tradeoff between the two types of effort, they also develop preferences over the way in which they are paid, because under incentive based compensation non-production-related effort has a higher opportunity cost than under flat compensation.

These are effects that have not been examined before in the accounting literature, but they are consistent with the empirical evidence that introducing incentive compensation has more complex consequences than are suggested by the standard principal/agent model (Kerr, 1995; Fessler, 2004; Bonner et al., 2000; Banker et al., 2000). Further, our model lends support to the behavioral argument that relaxing controls on workers so as to facilitate flexibility in their tradeoff between production-related and non-production-related effort can actually increase the level of worker effort as well as firm profits, rather than simply being a “give away” to workers.

Two prior analytic papers, both in economics as opposed to accounting, have examined models with non-production-related effort. In Milgrom (1988) workers undertake “influence activities” whose object is to persuade supervisors to make a change to the workplace that increases the worker’s utility. Holmstrom and Milgrom (1991) examined when firms might want to restrict personal business activities on company time. But while these two papers acknowledge the existence of non-production-related effort, their focus is not on the limits of contracting. Rather, retaining the firm’s point of view, they both examine how the firm should control non-production-related effort, taking it for granted that it is fully aware of the worker’s actions and utility functions.

The influence activities in Milgrom (1988) increase not only the worker’s welfare but also the firm’s profits, and the paper focuses on whether the firm should give management the discretion to change work conditions, and hence, to encourage the worker to take time away from production-related effort to carry out these influencing activities instead. This is a special case that is much narrower in scope than what we
envisage as non-production-related effort, and indeed might be more properly classified as a production-related effort that changes the firm’s production function.

Holmstrom and Milgrom (1991) model non-production-related effort in the same way we do, as affecting only the worker’s disutility of effort and not impacting the firm’s profits. However, non-production-related effort can benefit the firm inasmuch as it can reduce the disutility to the worker from undertaking production-related effort, though it also represents an opportunity cost to the firm. As in Milgrom (1988), once again the firm has the ability to ban non-production-related effort whenever it wants, and so again, not surprisingly, the firm only allows that level of non-production-related effort that improves the firm’s profits and bans the rest. Since the firm can optimally and costlessly balance the disutility-reducing impact of non-production-related effort against its opportunity cost, it must be better off than if the worker only undertook production-related effort: a case of the firm having its cake and eating it too. With the paper focusing entirely on the actions of the firm, there is no consideration given in Holmstrom and Milgrom (1991) as to how the firm knows what non-production-related effort choices are available to the worker and nor does it examine in depth the control implications of non-production-related effort. Indeed, the paper models non-production-related effort, which even the authors refer to as “the agent’s personal business”, as a series of different activities which can be controlled “only by exclusion”.

Controlling by exclusion may work for some trivial, and now largely obsolete, examples of non-production-related effort that is susceptible to an outright ban, such as personal calls during business hours, to use the example cited in Holmstrom and Milgrom (1991). But in a knowledge economy, non-production-related effort is rarely likely to be something that can or should be turned off like a tap, encompassing, as it does, the myriad ways in which professional workers juggle their lives, from developing skills on the job to make themselves more marketable to manipulating schedules to better fit childcare needs. Achieving effective control over these types of non-production-related effort requires the ability to affect their magnitude: to turn a dial, so to speak, rather than flip a switch, as in Holmstrom and Milgrom (1991). That is certainly the case with the examples cited in the New York Times letter, which deals with when workers think about their work, it sometimes being more convenient to do so outside work, while doing personal activities at work.

Both of these papers raise intriguing issues, but given when they were written, it is not surprising that they retain the firm- and control-centric mentality of the principal/agent models that only have production-related effort. What is surprising is that in the decade and a half since, there appears to be no other analytic papers that have revisited the impact of non-production-related effort, let alone done so in the context of exploring the limits of contracting. But given what we have learnt in recent years about the problems that pay-for-performance contracts can induce in practice, be it with CEOs and stock options or auto mechanics at Sears, it is clear that we need to rethink the effectiveness of contracting, especially in circumstances where the knowledge of the firm about worker behavior and its ability to control that behavior are likely to be most stressed.

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3. The Standard Principal/Agent Model

This is a standard principal/agent model (Holmstrom, 1979) and we derive it only to serve as a benchmark. Note that it has a firm-centric perspective inasmuch as the firm is assumed to possess full knowledge of the utility function of the worker and of all possible actions that impact that utility function, which combine to give the firm complete ability to control the worker’s behavior through the use of incentive contracts.\(^5\)

The firm consists of a risk neutral owner/manager and a risk averse worker. Output is a function of the production-related effort, \(a_p\), exerted by the worker. The worker’s production-related effort is translated into output, \(\tilde{y}\), through the production function \(f(a_p)\) and a random component, \(\tilde{\epsilon}\), so that: \(\tilde{y} = f(a_p) + \tilde{\epsilon}\) where \(\tilde{\epsilon} \sim N(0, \sigma^2_{\epsilon})\). We denote the probability density function of \(\tilde{\epsilon}\) by \(g(\epsilon)\). The firm’s profits are given by: \(\Pi = Py - s\) where \(P\) is the product price and \(s\) is the worker’s compensation. Without loss of generality, we set \(P = 1\).

The effort exerted by the worker is unobservable. The worker can be relied upon to provide a base level of effort input, \(\tilde{a}_p\), towards production and related functions, so that \(a_p \geq \tilde{a}_p\). The worker’s utility is given by \(U[s - v(.)]\) where \(v(.)\) is his disutility from taking effort. The worker’s disutility function, as perceived by the firm when determining worker compensation, is a function of \(a_p\) alone, with: \(v = v_p(a_p)\) where \(v'_p(.) > 0\) and \(v''_p(.) \geq 0\) for \(a_p > \tilde{a}_p\). Making the simplifying assumption that the worker has constant absolute risk aversion, so that \(U[s - v(.)] = -exp\{-\rho[s - v(.)]\}\), where \(\rho\) is the coefficient of absolute risk aversion, allows us to derive closed-form solutions. The reservation wage set by the market for this type of work is given by \(\tilde{s}\).

If the firm is not content with the level of profits that is obtained when the worker only exerts the base level of effort \(\tilde{a}_p\), it has to induce the worker to exert greater effort by offering a pay-for-performance incentive contract written on output. We assume, as in Holmstrom and Milgrom (1987), that the contract is linear, with \(s = v_p(\tilde{a}_p) + \tilde{s}\) where \(\tilde{s} = \gamma \tilde{y}(a_p) - \beta\), where \(0 < \gamma < 1\) and \(\beta\) are constant contract parameters. The certainty equivalent of variable compensation \(\tilde{s}\) is denoted by \(s_{CE}\).

The firm’s problem is to maximize net profits given the worker’s disutility for production-related effort, and the unobservability of his effort input. We shall denote the solution to these profit maximization problems by “\(m\)’’ to indicate that it reflects management’s solution to the firm’s control problem. The no-incentive solution is further denoted by “\(NI\)’’ and the one with incentive compensation by “\(I\)’’. The no-incentive solution is given by:

**Lemma 1** When the firm is content to receive the base level of production-related effort \(a_p^{m,NI} = \tilde{a}_p\), the firm’s solution to the firm’s profit maximization problem requires the worker to be paid the flat wage \(s = v_p(\tilde{a}_p) + \tilde{s}\). The profits expected by the firm are \(E\Pi^{m,NI} = f(\tilde{a}_p) - v_p(\tilde{a}_p) - \tilde{s}\). The worker’s expected utility is equal to that which he obtains from the reservation wage, with \(E[U_m] = U[\tilde{s}]\), since \(s_{CE}^{m,NI} = \tilde{s}\).

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\(^5\) Since the model used in this paper is only a slight modification of the standard principal/agent model long studied in the literature, in the interest of space the proofs of all lemmas and theorems are omitted, but are available to the reader on request.
When the firm does want to obtain additional effort, $a_p > \bar{a}_p$, pay has to be linked to performance. Lemma 2 characterizes the solution to the firm’s incentive problem:

**Lemma 2** When the firm seeks to obtain production-related effort $a_p > \bar{a}_p$ by offering an incentive contract, the profit maximizing level of production-related effort $a_p^{m,l}$ and the optimal contract parameters are given by the solution to the following three simultaneous equations:

$$
\gamma \frac{\partial f(a_p)}{\partial a_p} = \frac{\partial v_p(a_p)}{\partial a_p}
$$

$$
\gamma = \left[ \frac{\partial f(a_p)}{\partial a_p} + \rho \sigma^2 \frac{\partial \Sigma}{\partial a_p} \right] \frac{\partial f(a_p)}{\partial a_p}
$$

$$
\beta = \gamma f(a_p) - v_p(a_p) - \frac{1}{2} \rho \sigma^2 \gamma^2 - \bar{s}
$$

where $\Sigma = \frac{\partial v_p(a_p)}{\partial a_p} - \frac{\partial f(a_p)}{\partial a_p}$

The profits expected by the firm are $E\Pi^{m,l} = (1 - \gamma) f(a_p^{m,l}) + \beta$. The worker’s expected utility is equal to that which he obtains from the reservation wage, with $EU^{m,l} = U[s]$, since $s^{m,l}_{CE} = \bar{s}$.

Lemma 1 describes the situation that prevails in a firm that has not yet implemented a pay-for-performance scheme, while Lemma 2 describes the consequences of incentive based compensation. Thus, comparing Lemmas 1 and 2 tells the story, from the perspective of the standard principal/agent model, of what happens when incentive schemes are introduced. The worker is utterly indifferent to how he is paid, since the firm’s chosen compensation contract always satisfies the participation constraint, $(PC)$, which also implies that the firm has no reason to fear any resistance to this change to the imposition of the incentive contract. The firm’s expectations about the beneficial effect of incentives on productivity will be exactly fulfilled.

It is important to note, however, that these results are conditional on the assumptions made by management about the worker’s behavior and utility. Whether the firm’s expectations on profits, productivity and the worker’s reaction to incentive compensation will be fulfilled depends on whether the worker behaves in the way in which the firm assumes that he will – which, of course, is true by construction in the standard principal/agent model. In the next section we analyze whether that implicit assumption is robust to the addition of non-production-related effort into the worker’s utility function.
4. Non-Production-Related Effort and the Firm’s Control Ability

4.1 First- and Second-Order Effects of Non-Production-Related Effort

As discussed in the introduction, our objective in this paper is to investigate whether the gap between the results of the standard principal/agent model – that workers are indifferent to the imposition of incentive based compensation and so the firm is guaranteed of achieving its profits goals – and the findings of the empirical literature – that workers care how they are paid and the implementation of incentive contracts often has unexpected consequences, both good and bad for the firm – are due to the exclusive focus of the former on production-related effort alone. Hence, we introduce non-production-related effort into the standard principal/agent model in order to endogenously determine whether there are limits to what the firm can achieve by contracting. For example, resistance to change when pay-for-performance contracts are imposed by the firm is clearly a case in which contracting does not achieve what theory says it should.

We maintain the assumption of that model of the overall aversion to work by the worker and the resulting conflict of interest with the firm: the non-production-related effort by the worker only results in work becoming less unattractive, not actually desirable. Instead, we allow the worker to take actions that make work less of a burden, without those actions necessarily undermining the interests of the firm.

We assume that within the constraints placed by the firm’s control system, such as its rules on hours worked, task selection and empowerment, the worker will exert non-production-related effort directed towards increasing the utility that he derives from his job. In other words, instead of being the reactive follower as assumed in the standard principal/agent model, the worker will proactively act to maximize his well-being. These actions can include such activities as taking care of personal business on company time and engaging in behavior aimed at improving future employment and earnings prospects. It is not our objective to completely capture the full implications of all these varied types of non-production-related effort and their different motivations. For example, it is widely held that productivity improves when the workers are more satisfied with their work (Baron and Kreps, 1999). Such an effect of $a_{np}$ on productivity is assumed away in our model in order to keep the two types of effort distinct. For the same reason, we also assume away any possible effect of non-production-related effort on the firm’s costs (such as using company resources for personal use). Our more limited objective is to illustrate why it is important to incorporate non-production-related effort into the standard principal/agent model of control in the first place, while maintaining comparability with that model.

We represent the efforts by the worker directed towards non-production-related personal goals in the workplace by $a_{np}$. The assumption is that the worker finds this type of effort attractive and therefore wants to do it. As before, production-related effort $a_p$ over and above the base level of $\bar{a}_p$ is aversive and so increases disutility, whereas the non-production-related effort $a_{np}$ decreases disutility. Thus, $v(.) = v(a_p, a_{np})$ whereas before $\frac{dv}{da_p} > 0$ while $\frac{dv}{da_{np}} < 0$. We shall show through a numerical example, below,
that the magnitude of $\frac{\partial v}{\partial a_{np}}$ is a key driver of the results of our model. Our modeling of non-production-related effort is clearly different from that of Holmstrom and Milgrom (1991), where it consisted of a series of activities and the focus was on the allowable set of non-production-related effort rather than on its magnitude. Thus in the Holmstrom and Milgrom (1991) framework the centrality of the interactive term $\frac{\partial v}{\partial a_{np}}$ could not be identified.

We model the tension between production-related and non-production-related effort by assuming that the worker faces a constraint on the total effort that he is capable of exerting, thus forcing a tradeoff between them. This upper limit is denoted by $\bar{a}$, so that $a_p + a_{np} \leq \bar{a}$. This upper limit can be interpreted not just as a physical time constraint (for example, an eight-hour work day) but as the stocks of mental energy, creativity and stamina that a person has to meet the demands exerting both production and non-production-related effort makes on them. While the worker is free to choose to expend as little or as much effort as feasible, the assumptions of the model imply that this constraint will hold with equality. Note that if we were to substitute $a_{np} = \bar{a} - a_p$ into the disutility function $v(a_p, a_{np}) = v(a_p, \bar{a} - a_p)$ we end up with a function that violates the basic assumption of the standard principal/agent model that disutility is monotonically increasing in production-related effort, $\frac{\partial v}{\partial a_p} > 0$. Thus the standard contracting solution will not hold in this setting.

The question we wish to explore is how allowing for non-production-related effort changes the results of the standard principal/agent model. There are two alternate hypotheses of interest, both against the null of no effect of any kind.

- **First-Order Effect:** Despite being non-production-related, the worker’s efforts on this dimension also impact the variables of direct interest to the firm, such as the worker’s production-related effort, and hence, firm profits and worker output.

- **Second-Order Effect:** The worker’s desire for non-production-related effort only affects variables that concern the worker directly, such as his utility, with no impact on variables that concern the firm.

The interpretation of the disutility function $v(a_p)$ in the principal/agent literature is that it represents the cost-minimizing way for the worker to provide $a_p$ units of production-related effort. But the assumption that the firm can restrict itself to this reduced form disutility function essentially ignores the worker’s non-production-related effort. In other words, the standard principal/agent model implicitly assumes that non-production-related effort has only a second-order effect on the firm, and so managers do not have to explicitly take it into account. In this paper we examine whether that assumption is a valid one.

### 4.2 Firm Knowledge and Control of Non-Production-Related Effort

When introducing non-production-related effort into the standard principal/agent model, a critical modeling issue we have to address is the level of knowledge and
control that the firm has over it. Such questions are easily dealt with in the case of production-related effort since it is the firm that determines the kind of work that it hires the worker to perform. But as Milgrom (1988) points out, it is difficult to extend that argument to non-production-related effort since it is solely in the domain of the worker. Indeed, Milgrom (1988) assumes that even the worker does not know what kinds of non-production-related efforts he will want to pursue until after he begins work (i.e. until after the incentive contract is signed), but Milgrom then goes on to assume that the firm and worker share the same probabilistic knowledge as to the range of non-production-related effort that is likely to be possible. That shared knowledge does not prevent the worker from earning utility in excess of reservation utility, however, and this utility cannot be extracted by the firm through the incentive contract.

But Milgrom’s assumption about shared probabilistic knowledge begs the question about how even that limited degree of common knowledge comes about. Even when the worker needs to commence work before he can be certain as to what actions he wishes to undertake to reduce disutility, non-production-related effort is still entirely personal to the worker. The logical conclusion of Milgrom’s insight as to the fundamental differences between the two types of effort is surely that the worker should possess relatively more knowledge about non-production-related effort, in the same way that the firm has the edge in task definition and control over production-related effort. As we discussed in the introduction, to draw as sharp a modeling distinction as possible between the two types of effort we assume that the firm has no actionable knowledge about the worker’s subsequent non-production-related effort, and so has to base its incentive compensation on production-related effort alone.

We reiterate that we do not need for the firm to have absolutely no knowledge about non-production-related effort, only that the worker has better information. The formulation we adopt in this paper is purely for modeling convenience, to allow us to focus more clearly on the impact of non-production-related effort on incentive compensation. Once we have established whether non-production-related effort has a first- or second-order effect on the firm’s choice of incentive compensation, further research can examine the consequences of relaxing the assumptions on effort domain and control ability.

Another possibility we need to consider at this point is whether the lack of knowledge by the firm about the worker’s non-production-related effort can be dealt with in an adverse selection setting. In other words, can the worker be induced to truthfully reveal the non-production-related effort that he undertakes so that the firm can regain its common knowledge-driven control ability and achieve an outcome close to that in the standard principal/agent model? We argue that this is not possible for the same reason that there is a lack of common knowledge in the first place: that by its very nature, non-production-related effort does not fit the assumptions under which the firm is able to achieve truthful revelation.

A revelation mechanism can be found for production-related effort because the single crossing property is assumed to hold with respect to it, meaning that a contract can be constructed that provides incentives for workers of different types to separate themselves. For example, in the case where it is the worker’s productivity that is not known to the firm, the single crossing property ensures that it is easier for a high
productivity worker to achieve an output target with a given quantity of material input than it is for a worker with low productivity. Hence, the firm can induce revelation of worker productivity by a combination of rationing the amount of material input that it provides (which ensures that only high productivity workers are employed) and threatening to outsource production if the worker claims that his productivity is too low (which ensures that the worker does not excessively exploit his informational advantage at the expense of the firm). In other words, what the single crossing property allows is for the firm to use a combination of carrots and sticks to induce the worker to be truthful, while minimizing the rents that he earns. A key to making a revelation mechanism work is that production-related effort is only valuable to the worker to the extent that the worker is able to work for the firm and use the production inputs it provides to him.

None of these conditions applies to non-production-related effort. The worker is willing to reveal his private information about production-related effort because doing so gives him something of value in return: material input and the opportunity to work for the firm. Indeed, the worker earns rents in excess of reservation wages as a result of his informational edge, despite truthfully revealing that information. By contrast, what could the firm offer the worker in exchange for revealing his private information about non-production-related effort? The sole use that the firm can make of that information is to reduce the utility of the worker and restrict him to his reservation utility. All the benefit of revelation would go to the firm, and there is nothing to gain for the worker because the worker needs nothing from the firm to get the full benefits from his non-production-related effort.

Thus even if our non-production-related effort model could somehow be recast as an adverse selection problem – which is itself a stretch, since this is a model of hidden action, not hidden information – our contention is that it will not be possible to overcome the problem that the firm faces with knowing how the worker values his non-production-related effort or how it interacts with production-related effort. The bottom line is that the kind of common knowledge about the worker’s utility function commonly assumed with production-related effort is far more difficult to sustain in the case of non-production-related effort. And of course, despite the preceding discussion, a larger reality needs to be kept in mind, that, while common knowledge about production-related effort may be the default assumption in accounting research, this is a modeling convention that has yet to be attained at any time in any place in the real world.

In the absence of actionable knowledge and control over non-production-related effort, the firm has to make compensation and effort choice decisions on the basis of a model of worker disutility as a function of $a_p$ alone. Thus, the standard principal/agent model discussed in section 2 is a subset of our expanded model, with $v_p(a_p) = v(a_p, 0)$. Note that the firm’s managers, who no doubt undertake non-production-related effort on their own behalf, don’t have to believe that the worker’s disutility is actually $v_p(a_p)$. But they have no choice but to make contracting decisions on the basis of that assumption because they have no way of knowing what $v(a_p, a_{np})$ is, and knowing that they don’t know it doesn’t change that reality.

In our new model the results given in Lemmas 1 and 2 no longer describe actual outcomes. Instead, they only reflect management’s calculations about what will happen
before and after the imposition of incentive schemes. The worker, however, when deciding on how much effort to exert in response to the compensation contract that he is offered, will choose to allocate effort between production-related and non-production-related goals, subject to the upper bound on total effort. Thus, when presented with compensation of $s$, the worker’s decision problem (his new Incentive Compatibility constraint) is to:

$$\max_{a_p, a_{np}} \mathbb{E} U \left[ \bar{s} - v(a_p, a_{np}) \right] g(e) \, de$$

Subject to:

$$a_p + a_{np} \leq a$$
$$a_p \leq a$$

We denote the worker’s effort choices in the expanded model by “$w$” and contrast it with the outcomes based on management’s calculations (“$m$”), derived in Section 2 using the standard principal/agent model.

5. The Effect of Non-Production-Related Effort on the Worker’s Reaction to the Imposition of Incentive Compensation

When the firm does not wish to motivate production-related effort beyond the base level and so only offers a flat wage, the outcome is:

**Theorem 1** In a setting with non-production-related effort, when the worker is paid the flat wage $s = v_p(\bar{a}_p) + \bar{s}$ as determined in Lemma 1, the worker’s effort choices are $a_p^w, a_{np}^w = \bar{a}_p$ and $a_p^{m,nl} = \bar{a} - \bar{a}_p$. Expected profits of the firm are the same as before, since the worker’s production-related effort is the same:

$$\Pi^{w,nl} = \Pi^{m,nl} = f(\bar{a}_p) - v(\bar{a}_p, 0) - \bar{s}$$

while the worker’s utility is given by:

$$EU^{w,nl} = U \left[ v_p(\bar{a}_p) - v(\bar{a}_p, \bar{a} - \bar{a}_p) + \bar{s} \right] > U[\bar{s}] = EU^{m,nl}$$

Since the worker obtains neither incremental utility nor compensation from production-related effort $a_p > \bar{a}_p$, he will not exert anything other than the base level of effort on that dimension. He will instead exert as much non-production-related effort as feasible in order to reduce his disutility. Because the firm cannot reduce wages to extract the worker’s surplus, he obtains higher utility than the base level that the reservation wage provided by the firm is meant to leave him with, with $s_{ce}^{w,nl} > \bar{s}$, $EU^{w,nl} > U[\bar{s}] = EU^{m,nl}$. With production-related effort unaffected by the worker’s desire for non-production-related effort, there is no impact on the firm’s profits either, and so there is only a second-order effect on the firm’s control problem. But as we shall see, this is no longer the case when the firm moves to implement pay-for-performance compensation.
Lemma 2 described the incentive compensation scheme the firm offers the worker and the level of production-related effort that it expects workers will be motivated to provide in return. In our extended model though, the worker will again choose the optimal allocation of production-related and non-production-related effort that maximizes utility, taking as given the pay-for-performance contract offered by the firm. This solution is given by:

**Theorem 2**  In a setting with non-production-related effort, when the worker is paid according to the incentive contract $\tilde{\gamma} = \gamma \tilde{y} - \beta$ as determined in Lemma 2, the worker’s production-related effort choice, $a_p^{w,1}$, is determined by the solution to the equation:

$$
\gamma \frac{df(a_p)}{da_p} = \frac{\partial v(a_p, \tilde{a} - a_p)}{\partial a_p} - \frac{\partial v(a_p, \tilde{a} - a_p)}{\partial a_{np}}
$$

with $a_{np}^{w,1} = \tilde{a} - a_p^{w,1}$. The firm’s actual expected profits will reflect this new level of production-related effort:

$$
\Pi^{w,1} = (1 - \gamma) f(a_p^{w,1}) + \beta
$$

The worker’s expected utility is given by:

$$
EU^{w,1} = U \left[ \gamma f(a_p^{w,1}) - \beta \nu(a_p^{w,1}, \tilde{a} - a_p^{w,1}) - \frac{1}{2} \rho \sigma_\epsilon^2 \gamma^2 \right] > U[\tilde{\gamma}] = EU^{m,1}
$$

Thus, once the firm introduces incentive compensation, non-production-related effort has a first-order effect on the firm’s control problem. With flat compensation the worker only exerts the minimum required production-related effort and then devotes the rest of his time to decreasing disutility. A first-order effect only arises when the presence of pay-for-performance creates an opportunity cost, as the worker faces a tradeoff between production-related and non-production-related effort.

By comparing Theorems 1 and 2 with their corresponding Lemmas as well as against each other, two forces are seen to drive the results. First, once non-production-related effort is introduced the worker is no longer indifferent to an incentive scheme, as he is in the standard principal/agent model, since it is no longer the case that he only earns the equivalent of the reservation wage in both the first and second best worlds. The firm chose the flat wage and the incentive contract so that $s^{m,NI}_{CE} = s^{m,I}_{CE} = \tilde{s}$, but the ability of the worker to reduce disutility by taking non-production-related effort will lead to an increase in worker utility over the reservation wage level in both the incentive and non-incentive cases, a fact which indicates why it would be hard for the firm to induce the worker to truthfully communicate any private information he has about non-production-related effort. Such communication must inevitably make the worker worse off. The fact that the worker has utility in excess of the reservation level means that the worker now has something to defend against the change in the way he is paid.

The second factor is that given the tradeoff the worker has to make between the two types of effort and the higher opportunity cost from doing non-production-related effort in an environment where production-related effort is linked to compensation, there is no commonality between the effort choices of the worker, as given under the worker’s
perspective in Theorem 2, and as expected under the firm’s perspective in Lemma 2. Hence, in general, $a_w^I \neq a_m^I$. When faced with incentive pay the worker obtains a benefit from exerting more production-related effort. The pay from performance obtained by raising $a_p$ above the base level will be traded off against the resulting decrease in non-production-related effort. The extent of that tradeoff depends on the strength of the incentives and the strength of the impact of non-production-related effort on the worker’s utility, as measured by $\frac{\partial v}{\partial a_{np}}$.

These two forces bring about the critical insight of the model, the fact that $EU_{w, NI} > U[s]$ and $EU_{w, I} > U[s]$ do not imply that the worker’s utility under incentives $EU_{w, I}$ will also necessarily exceed the utility the worker enjoyed in the no-incentive case, $EU_{w, NI}$. If it turns out that $EU_{w, I} < EU_{w, NI}$ the worker will resist the change in job expectations and compensation systems. Similarly, the level of production-related effort may fall relative to the firm’s expectations, with $a_p^w < a_p^m$, if the worker shifts effort towards achieving personal goals, so leading to a shortfall in productivity and profits. On the other hand, since the worker’s non-production-related effort reduces the disutility from working harder, it is also possible that the worker may actually want to exert greater production-related effort under the incentive scheme than what is expected by the firm, resulting in $a_p^w > a_p^m$. The worker’s overall utility may also then increase over the level that was earned when there was no pay-for-performance scheme, with $EU_{w, I} > EU_{w, NI}$.

Thus, while introducing non-production-related effort to the principal/agent model limits the power of contracting – meaning that the firm cannot guarantee that it can achieve its desired production-related effort and profit goal – that is not to say that the firm will always be worse off. Depending on the nature of the interaction between the two kinds of effort and their impact on the worker’s utility, it is also conceivable that both firm and worker become better off than the standard principal/agent model would predict. Retaining the firm-centric perspective of the accounting literature can actually prevent the identification of circumstances that are beneficial to the firm.

In summary, our model shows that non-production-related effort has a first-order effect on the firm, but the direction and magnitude of that effect is situation-specific. We conclude the paper with a numerical example to examine in greater detail the range of possible outcomes of this model.

6. The Tradeoff Between Production-Related and Non-Production-Related Effort

To better compare the results of the theorems we shall use a special case of our model with the following parameters, which meets all the assumptions made above in the general analysis:

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6 However, given the unobservability of effort and the random variation in output, it would not be immediately apparent to the firm that its expectations have not been met. Thus the situation can persist for some time. Of course, by construction, production-related effort cannot fall below the base level of $a_p$. 
The parameter $\alpha \geq 0$ is introduced to capture the importance of non-production-related effort on the worker's utility, since $\alpha = 0 \Rightarrow \frac{\partial v}{\partial a_{np}} = 0$. The larger the value of $\alpha$, the greater the benefit to the worker of taking non-production-related effort, $a_{np}$, and so in this example $\alpha$ serves as a proxy for the more general driver of the results of this paper, $\frac{\partial v}{\partial a_{np}}$. When the worker is offered an incentive scheme, he also faces a benefit, in terms of higher compensation, from taking production-related effort, $a_p$. Thus $\alpha$ determines the degree of tradeoff the worker makes between the two types of effort under the incentive pay scheme, with a high value of $\alpha$ allowing the worker to more easily accomplish his dual goals of reducing disutility by taking non-production-related effort and increasing incentive pay by taking production-related effort.

When $\alpha = 0$, the model collapses to a standard principal/agent model whose solutions are given by Lemmas 1 and 2. In this section we compare these solutions to the results from Theorems 1 and 2 where $\alpha > 0$, as well as comparing the solutions from Theorems 1 and 2 against each other, to determine whether the worker will welcome or resist the change to pay-for-performance compensation.

From Lemma 1 and Theorem 1, the outcome when there is no incentive scheme is given by:

**Lemma 3** When the worker is paid a flat wage, the solution to the firm and worker's problems is given by:
\[
\begin{align*}
a^m_{p,NI} &= 1 \\
a^p_{p,NI} &= 1 \\
a^w_{p,NI} &= 1 \\
s &= 1 \\
U^m_{m,NI} &= 0 \\
U^w_{w,NI} &= U \left[ 1 - \frac{1}{1 + \alpha} \right] \\
\tilde{\Pi}^m_{m,NI} &= 0 \\
\tilde{\Pi}^w_{w,NI} &= 0
\end{align*}
\]

Hence, in the absence of incentives, the worker has no reason to exert more than the base level of production-related effort. The ability to do non-production-related effort results in the worker earning utility in excess of the reservation level, since for \( \alpha > 0 \),

\[
s^w_{CE} = 1 - \frac{1}{1 + \alpha} > \bar{s} = 0 \Rightarrow U^w_{w,NI} > U^m_{m,NI}.
\]

It is clear that non-production-related effort only has a second-order effect in this context.

When the firm desires production-related effort over and above the base level, the incentive contract it offers and the productivity and profits it expects to obtain is derived using Lemma 2:

**Lemma 4**  When the worker is paid using incentives, the solution to the firm’s problem is given by:

\[
\begin{align*}
\bar{s} &= \gamma \bar{y} - \beta \\
\gamma &= \frac{1}{3} \\
\beta &= -\frac{25}{36} \\
a^m_{p} &= \frac{7}{6} \approx 1.1667 \\
EU^m &= 0 \\
E\Pi^m &= \frac{3}{36} \approx 0.0833
\end{align*}
\]

\(^7\) By way of comparison, if the firm could observe the worker’s production-related effort choice, \( a_p \), the first best solution to the firm’s profit maximization problem is:

\[
\begin{align*}
a^f_{p} &= 1.5 \\
s^f &= 1.25 \\
U^f &= 0 \\
\Pi^f &= 0.25
\end{align*}
\]
Our objective in this section is to make comparisons between the production-related effort choices and worker utilities between the incentive and no-incentive cases, and with the firm’s expectations on what pay-for-performance will achieve. The comparison between $a^m.p$ and $a^w.p$ tells us whether pay-for-performance fulfills the firm’s goals of raising productivity, and so whether there is a first- or second-order effect on the firm, while the difference between $s^w.CE$ and $s^w.NI$ is a measure of whether the worker will welcome or oppose this change in compensation arrangements. Note that in the NI case, the only effect of having non-production-related effort is on the worker’s disutility, while $a^w.NI = a^m.NI = \bar{a}_p$, and hence, $E\Pi^w.NI = E\Pi^m.I$ remain the same. When the worker is faced with an incentive contract, however, he has to exert production-related effort beyond the base level of $\bar{a}_p$ to earn adequate compensation. Because he has to work harder, so reducing the time available for non-production-related effort, the effect of non-production-related effort in the I case is not confined to disutility alone, and $a_p$, $s_{CE}$ and $E\Pi$ all change.

The reaction of the worker to the firm’s pay-for-performance contract is obtained from Theorem 2:

**Lemma 5** When the worker is paid using incentives, the solution to the worker’s problem is given by:

$$a^w.p = \max \left\{ 1, \arg \max _{\hat{a}_p} \left\{ \frac{1}{3} \hat{a}_p - \frac{1 + (\hat{a}_p - 1)^2}{1 + \alpha (2 - \hat{a}_p)^2} \right\} \right\}$$

$$s^w.CE = \frac{1}{3} a^w.p + \frac{23}{36} - \frac{1 + (a^w.I - 1)^2}{1 + \alpha (2 - a^w.I)^2}$$

$$E\Pi^w.I = \frac{2}{3} a^w.I - \frac{25}{36}$$

The outcome of the worker’s effort choice is a function of $\alpha$. Clearly for $\alpha = 0$, the firm and worker’s solutions must coincide, with $a^w.I = a^m.I = 1.1667$ as can be readily verified from Lemma 5, since then there is no reason for the worker to exert non-production-related effort. The higher the value of $\alpha$, the higher the utility the worker will gain from exerting non-production-related effort and of course in all instances, $U^w.NI \geq U^m.NI$. 
The production-related effort cannot fall below the base level of $\bar{a}_p = 1$. It can be shown in this special case that for $0.26795 < \alpha < 3.7321$ the worker’s production-related effort choice remains at $a^{w,l}_p = 1$. What happens for lower or higher values of $\alpha$? For example, at $\alpha = 0.25$, we have $a^{w,l}_p = 1.0086$, meaning that the worker is exerting less effort than the firm expected when it introduced the pay-for-performance scheme (recall that the level of production-related effort expected by the firm is $a^{m,l}_p = 1.1667$). The worker’s utility is also less than what he earned in the no-incentive case, with $s^{w,l}_{CE} = 0.172228 < s^{w,NI}_{CE} = 0.2$. The incentive compensation is not sufficient to overcome the increase in disutility that results from the fact that the worker has to reduce non-production-related effort in order to obtain enough pay from the now variable pay-for-performance compensation. Hence, the worker would object to the change to incentive pay because it reduces his utility, while the firm is disappointed with the change since productivity and profits fall below expectations ($E\Pi^{w,l} = -0.02204 < E\Pi^{m,l} = 0.08333$).

As expected then, once incentive compensation is introduced to the problem, non-production-related effort switches from a second- to a first-order effect on the firm. In fact, the firm’s profits fall not just below expectations, but below their level prior to the introduction of incentives ($E\Pi^{w,NI} = 0$), since the firm is paying a risk premium without obtaining sufficiently higher productivity in return.

By contrast, for $\alpha = 20$, the worker has the ability to exert production-related effort and obtain incentive pay without greatly sacrificing non-production-related goals. Indeed, the worker will exert even more production-related effort than the firm expects, with $a^{w,l}_p = 1.3108 > a^{m,l}_p = 1.1667$. As a result, the worker’s utility increases above the no-incentive case ($s^{w,l}_{CE} = 0.97137 > s^{w,NI}_{CE} = 0.95238$), and he would welcome the change to pay-for-performance compensation. The firm is also happy with the change, with higher than expected productivity having a corresponding effect on profits, $E\Pi^{w,l} = 0.1794 > E\Pi^{m,l} = 0.0833$.

From Lemma 5 we can show that at $\alpha = 9.21777$ the worker’s effort choice coincides with the expectations of the firm, so that $a^{w,l}_p = a^{m,l}_p = 1.1667$ (as they do at $\alpha = 0$). However, the worker’s utility under incentives ($s^{w,l}_{CE} = 0.88892$) still falls below that he earned in the no-incentive case ($s^{w,NI}_{CE} = 0.90213$), and so the worker will resist the change to pay-for-performance. Thus $\alpha$ drives the worker’s production-related effort choice and his utility in the same direction, but the two effects do not coincide.

\[ \text{argmax} \left[ \frac{1}{3} \hat{a}_p - \frac{1 + (\hat{a}_p - 1)^2}{1 + (2 - \hat{a}_p)^2} \right] = 0.87369 < \bar{a}_p = 1 \]

At $a_p = 0.87369$, $s_{CE} = 0.48228$ which, of course, exceeds the utility the worker obtains when he is constrained to set $a^{w,l}_p = \bar{a}_p = 1$, $s^{w,l}_{CE} = 0.47222$. Both utilities are below the level prior to incentives, $s^{w,NI}_{CE} = 0.5$, and profits, obviously, also fall below expectations, with $E\Pi^{w,l} = -0.02778 < E\Pi^{m,l} = 0.0833$. 

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8 For example, at $\alpha = 1$ and in the absence of the base effort constraint, the worker would like to reduce production-related effort by even more, to concentrate on non-production-related effort, with:

\[ \frac{1}{3} \hat{a}_p - \frac{1 + (\hat{a}_p - 1)^2}{1 + (2 - \hat{a}_p)^2} = 0.87369 < \bar{a}_p = 1 \]
Figure 1: Worker’s Choice of Production-Related Effort

Figure 2: Worker’s Utility With and Without Incentives
Figures 1, 2 and 3 illustrate the above dynamics. Starting from $\alpha = 0$ and $a_p^{w,I} = a_p^{m,I} = 1.1667$, it can be seen from Figure 1 that as $\alpha$ increases, production-related effort initially falls until it hits the lower bound of $a_p = 1$, since the worker prefers to substitute non-production-related effort for production-related effort. For intermediate values of $\alpha$, the firm will find that introducing incentive payments has no observable effect, with production-related effort seemingly “sticky” at $a_p = 1$. However, as $\alpha$ keeps increasing, it becomes easier for the worker to earn incentive pay through production-related effort without sacrificing the amount of disutility reduction that he gets from non-production-related effort. Beyond $\alpha = 3.7321$, increasing $\alpha$ results in production-related effort also increasing, first above the base level of $a_p$, and eventually above even the level that the firm was trying to motivate, $a_p^{m,I}$ (for $\alpha \geq 9.21777$). Similarly, utility under incentives will first fall and then increase relative to the level without incentives. Figure 2 shows that as $\alpha$ increases, the worker’s utility under incentives starts out below the level he earned under the flat wage, giving him a reason to resist the change to pay-for-performance compensation. However, for large values of $\alpha$ the lower opportunity cost of seeking incentive pay makes up for the resulting reduction in non-production-related effort. Figure 3 shows that firm profits will fall below expectations until $a_p^{w,I} \geq a_p^{m,I}$. Table 1 summarizes the results of this numerical example for various values of $\alpha$:
Table 1
Solution of Numerical Example

<table>
<thead>
<tr>
<th>α</th>
<th>$a_p^{m,1}$</th>
<th>$a_p^{w,1}$</th>
<th>$s_{CE}^{m,2}$</th>
<th>$s_{CE}^{w,2}$</th>
<th>$s_{CE}^{m,3}$</th>
<th>$s_{CE}^{w,3}$</th>
<th>EII$^{m,1}$</th>
<th>EII$^{w,1}$</th>
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<td>1.1667</td>
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The numerical example amplifies the point made by the general results, that recognizing the importance of non-production-related effort to workers provides insights on worker reactions to incentive pay and on the limits of what the firm can achieve with contracting not available from the standard principal/agent model. Using our extended model we have argued that workers attempt to enhance the quality of their workplace experience and to make it better suited to their needs. By taking non-production-related efforts workers may obtain utility from their jobs over the reservation level of utility, even if the firm only pays reservation wages. This additional utility has to be taken into account when examining the worker’s reaction to the imposition of, or changes in, incentive based pay.

References


