False crowding out*

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Abstract

The motivation crowding out effect has become the standard explanation for a negative relationship between effort and monetary incentives. By treating non-monetary motivation as a variable rather than as a fixed attribute, theorists have shown that higher monetary reward may crowd out non-monetary motivation to such an extent that effort is reduced. In this paper, we show that imperfect contract enforcement can create what we call a false crowding out effect. If enforcement is not fixed but can vary (due to e.g. variations in legal practice), then contractual monetary incentives and effort may be negatively related. Weaker enforcement may induce lower effort, which the principal can mitigate by offering higher-powered incentives.

1 Introduction

The motivation crowding out effect is one of the most interesting anomalies in economics as it suggests that raising prizes reduces supply. The crowding

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out effect is a particularly hot topic in labor and personnel economics since it implies that higher-powered monetary incentives may lead to lower effort. The empirical evidence is twofold. First, there is a range of lab and field experiments documenting a negative causal relationship between effort and monetary incentives (e.g. Frey and Oberholzer-Gee, 1997; Gneezy and Rustichini, 2000, and Fehr and Gachter, 2002). Second, there is a huge empirical literature on a negative correlation between effort and performance pay, especially from reforms in the public sector (New Public Management - NPM). Many scholars argue that NPM's focus on monetary incentives undermines intrinsic motivation and thus the effort of public servants (see e.g. Osterloh, Frey and Homberg, 2007 and Perry, Engbers and Jun, 2009).

This incentive puzzle has gained inquisitive interest from economic theorists. The common denominator of the different theoretical approaches is that non-monetary motivation is treated as a variable as opposed to a fixed attribute.[1] Standard economic theory acknowledges that agents have non-monetary motivation, but it is treated as a fixed entity. Once non-monetary motivation is allowed to vary, higher monetary reward may reduce non-monetary motivation to such an extent that effort is reduced.

In this paper we show that variations in enforcement probability can have similar effects as variations in intrinsic motivation, and we argue that the former can be an alternative explanation to negative correlations between performance pay and effort. If there is probability that an incentive contract is enforced, and this probability is treated as a variable rather than as a fixed parameter, then higher monetary reward in the incentive contract may be associated with lower probability for enforcement. This may lead to reduced effort.

[1] Recent papers show how the structure of monetary rewards may undermine incentives for social esteem (Benabou and Tirole, 2006, and Ellingsen and Johannesson, 2008), affect agents' internal rewards from norm adherence (Sliwka, 2007), or affect agents' perception of their tasks or own abilities (Benabou and Tirole, 2003). See Frey and Regel (2001) for a review of previous literature on motivation crowding out.

To fix ideas, let the total incentives facing an agent be determined by a bonus b, a non-monetary reward d and the probability that the bonus contract is enforced v. In standard economic theory both d and v are fixed. Higher bonus then leads to higher effort. By allowing for the non-monetary reward to be decreasing in the bonus ($d'(b) < 0$), a higher bonus may lead to lower effort, which is the standard crowding out effect. Now, if $b'(v) < 0$, such that a lower enforcement probability v yields a higher bonus, we may also observe a lower effort after a higher bonus, since the lower v implies a lower probability that the bonus is paid. We call this a false crowing out effect since in our case, the bonus does not crowd out intrinsic motivation.

We present a simple moral hazard model where a principal must provide an agent with incentives to exert effort, and where the incentive contract is enforced with a probability v. Our modelling set-up can account for both legal and non-legal, or informal, enforcement mechanisms. With legal enforcement, v is the probability that the court can verify performance and thus enforce the contract. With informal enforcement, v is the probability that the principal feels morally or socially committed to honor the contract. We focus mainly on legal enforcement, but discuss informal enforcement in a separate section.

It is natural to consider the probability of legal enforcement as a variable rather than as a fixed parameter. Generally, the complexity of the transactions, the strength of the enforcement institutions and the practice of legal courts are factors that affect legal enforcement. For contracting parties these typically constitute exogenous variations. But one can also think of enforcement probability as an endogenous variable since the contracting parties' effort in writing a contract that describes a job's tasks and operational performance metrics may also affect the probability of court enforcement (see Kvaløy and Olsen, 2009). In this paper we treat enforcement probability as an exogenous variable. Exogenous variations occur naturally across countries and industries, but it can also affect a given contractual relationship via legal reforms, changes in legal practice, standardization of industry contracts, changes in (labor) law or other institutional changes.

We first adopt the classical model on risk sharing vs. incentives (e.g. Holmström 1979), and show that when enforcement is probabilistic, then under certain conditions contractual incentive intensity and effort are negatively related. We then show that a similar result can also be obtained under risk neutrality and limited liability. This negative relationship is a false crowding out effect since total monetary incentives, which is the product of the enforcement probability and contractual incentives, is positively related to effort. But since the enforcement probability does not show up in the incentive contract, it *appears* that incentives and effort is negatively related.

To see the intuition, note that if the enforcement probability increases, this has a positive effect on effort, but it also increases expected wage costs per unit of effort since the probability that the principal actually has to pay as promised increases. In order to reduce wage costs, the principal can simply reduce expected contractual wage payments. Hence, effort increases, but the contractual incentives are lower-powered. And the other way around: Weaker enforcement induces lower effort since the probability that the agent actually is paid decreases. In order to mitigate the reduction in effort, the principal can thus provide higher-powered incentives.

This result has an important empirical implication: When observing a negative relationship between incentives and effort, one has to control for the probability that incentive pay is actually enforced. If not, one may wrongfully infer that monetary incentives crowd out non-monetary motivation. Take New Public Management (NPM) as an example. NPM describes reforms in the public sector that are characterized by an emphasis on output control, performance related pay and introduction of market mechanisms. As noted, many scholars argue that NPM undermines intrinsically motivated effort. But if NPM actually undermines effort (which of course is debatable, see Stazyk, 2010), would this necessarily come from crowding out of intrinsic motivation? Important aims of NPM include decentralization of management authority, more discretion and flexibility, less bureaucracy and less rules. These institutional changes may affect both the legal and informal enforcement environment. One could for instance hypothesize that fewer rules imply weaker legal enforcement, which in turn reduces effort even with higher-powered contractual incentives.

The crux is that enforcement probability and incentives may be substitutes. In that sense our paper is related to models showing the substitutability between explicit contracts and informal relational contracts (see Baker, Gibbons and Murphy, 1994, and Schmidt and Schnitzer, 1995). In these models, improved explicit contracts may reduce feasible incentive pay under relational contracting, but effort is still positively related to the sum of contractual incentives. In contrast, we find that effort may be negatively related to contractual incentives.

In spirit, our argument also bears similarities to the type of argument Prendergast (2002) uses in order to explain a positive relationship between uncertainty and incentives. Prendergast shows that such a relationship may be due to a positive relationship between uncertainty and delegation, which in turn generates a need for incentive pay. Similarly, we point out that a negative relationship between contractual incentives and effort may be due to a negative relationship between incentives and contract enforcement, which in turn generates a negative relationship between incentives and effort.

With respect to the modelling, a contribution of the paper is to consider probabilistic enforcement in an otherwise standard moral hazard model with risk aversion or limited liability. In the classic moral hazard models (e.g. Holmström, 1979), perfect enforcement is assumed, while in models of incomplete contracting, it is commonly assumed that contracting is prohibitively costly so that legal enforcement is impossible (starting with Grossman and Hart, 1986).

However, imperfect enforcement is increasingly recognized as an important ingredient in models of contractual relationships. Some papers focus on the relationship between ex post evidence disclosure and enforceability (Ishiguro, 2002; Bull and Joel Watson, 2004), while others focus on the relationship between ex ante contracting and enforceability (Battigalli and Maggi, 2002, Schwartz and Watson, 2004, Shavell 2006). There is also a growing literature on the interaction between legal imperfect enforcement and informal (relational) enforcement, see Sobel (2006), MacLeod (2007), Battigalli and Maggi (2008) and Kvaløy and Olsen (2009)

In Section 2 we present the model, first with risk aversion, then with limited liability. In Section 3 we reinterpret the model and concentrate on imperfect *informal* enforcement. Section 4 concludes.

2 Model

We consider a relationship between a principal and an agent, where the agent produces output x for the principal. Output is a random variable ($x \in X$), and the agent's effort a affects the probability distribution (density) $f(x, a)$. Effort costs are given by $C(a)$, where $C'(a) > 0$, $C''(a) > 0$, $C(0) = 0$. We assume that output is observable to both parties, but that the agent's effort level is unobservable to the principal, so the parties must contract on output: the principal pays a wage $w(x) = s + \beta(x)$ where s is a non-contingent fixed salary and $\beta(x)$ is a contingent bonus. We assume that the principal is risk neutral, but allow the agent to be risk averse, with a utility function $u(w)$.

Following Kvaløy and Olsen (2009) we assume that there is a probability $v \in (0, 1)$ that output can be verified, where v is common knowledge.[2] We follow the standard assumption from incomplete contract theory saying that if the variables in a contract are non-verifiable, then the contract is not en-

[2] By not allowing for $v = 1$, we assume that perfect verifiability is prohibitively costly. This is in line with the standard assumption ($v = 0$) in the relational contract literature.

forceable by a court of law. Hence, the probability of verification, v, can thus be interpreted as the probability of legal enforcement of the bonus contract $\beta(x)$. If the court verifies output, it can verify whether or not the parties have fulfilled their obligations regarding the contracted bonus payments.

We analyze the following game:

1. The principal offers a contract $w(x) = s + \beta(x)$ to the agent. If the agent rejects the offer, the game ends. If he accepts, the game continues to stage 2.

2. The agent takes action a and realizes output x.

3. The parties observe x. The principal is obligated to pay the fixed salary s, and then the parties choose whether or not to honor the contingent bonus contract $\beta(x)$. The decision to honor or deviate (offer $\tilde{\beta}(x) \neq \beta(x)$) belongs to the principal if $\beta(x) > 0$ and to the agent if $\beta(x) < 0$.

4. The parties choose whether or not to go to court. If at least one party goes to court, and the court verifies output x, it rules according to a breach remedy that is ex ante common knowledge. If no party goes to court, or if the court does not verify output, the agent and the principal obtain payoffs $u(s + \tilde{\beta}(x)) - C(a)$ and $x - s - \tilde{\beta}(x)$, respectively.

We will now deduce the optimal contract, which is taken to be a perfect public equilibrium of this stage game. With respect to the breach remedy, we assume that the parties apply expectation damages (ED), which entail that the breacher has to compensate the victim so as to make her equally well off as under contract performance. ED is the most typical remedy, and is also regarded as the most efficient one in the seminal literature on optimal breach remedies (Steven Shavell, 1980; and William P. Rogerson, 1984). Given (UCC §2-718 (1987) and RESTATEMENT (SECOND) OF CONTRACTS

§356, which prevents courts from enforcing terms stipulating damages that exceed the actual harm, no party-designed damage rule can do better than expectation damages in our model.

2.1 Risk aversion

By backwards induction we start with stage 4, where the parties choose whether to accept $\tilde{\beta}(x)$ or to go to court. One sees that the court is avoided in stage 4 if and only if the parties have adhered to the contract. If $\beta > 0$ and the principal has deviated by offering[3] $\tilde{\beta} < \beta$ the agent is worse off accepting than taking the case to court (because the expected utility associated with payments in court is here $vu(s+\beta) + (1-v)u(s+\tilde{\beta}) > u(s+\tilde{\beta})$). Similarly, if $\beta < 0$ and the agent has deviated by offering to pay back less ($\tilde{\beta} > \beta$), the principal will go to court.

Given these responses in stage 4, we see that the party making the decision in stage 3 will optimally deviate from the contract and offer $\tilde{\beta} = 0$: the principal will do so because her expected outlay in court will then be minimal and equal to $v\beta < \beta$ for $\beta > 0$, while the agent will do so because his expected utility from payments in court will be maximal and equal to $vu(s+\beta) + (1-v)u(s) > u(s+\beta)$ if $\beta < 0$.

In stage 2 then the agent chooses effort to maximize his expected utility, given by

$$U(a, w, v, s) = v \int f(x, a)u(w(x))dx + (1-v)u(s) - C(a).$$

(Unless otherwise noted, all integrals are over the support X.) For each outcome x, the agent gets the payment $w(x) = s + \beta(x)$ with probability v, and the payment (fixed salary) s otherwise, and this gives expected utility

[3] The principal will never offer $\tilde{\beta}(x) > \beta(x)$ in this game.

as specified. Optimal effort satisfies

$$U_a(a,w,v,s) = v\int f_a(x,a)u(w(x))dx - C'(a) = 0 \tag{IC}$$

(We will invoke assumptions to make the 'first-order approach' valid.)

In stage 1 the principal chooses wages (and effort a) to maximize her payoff, subject to the agent's choice, represented by IC, and the agent's participation constraint:

$$U(a,w,v,s) \geq U_o \tag{IR}$$

The principal, assumed risk neutral, has payoff

$$V(a,w,v,s) = \int f(x,a)\left[x - vw(x)\right]dx - (1-v)s - C(a)$$

Forming the Lagrangian $L = V + \lambda(U - U_o) + \mu U_a$, with multipliers λ and μ on the IR and IC constraints, respectively, one sees that optimal payments satisfy

$$\frac{1}{u'(w(x))} = \lambda + \mu\frac{f_a(x,a)}{f(x,a)}, \qquad \frac{1}{u'(s)} = \lambda \tag{W}$$

These conditions are standard (Holmström 79), and reflect the trade-off between providing insurance and incentives for the agent. This trade off is relevant for the performance dependent bonuses, but not for the fixed payment s. Hence the condition for optimal s only reflects the risk sharing aspect. Given a monotone likelihood ratio $\frac{f_a(x,a)}{f(x,a)}$ (MLRP), payments $w(x)$ will be increasing in output x.

Payments will be chosen to implement the action that is optimal for the principal, and this entails an action that satisfies $L_a = 0$. The optimal action and the associated payments (and multipliers) will depend on the parameter v, i.e. on the level of verifiability.

We now ask, i) does effort go up when the enforcement probability v increases and ii) do contractual incentives at the same time become weaker?

That is: would the new contractual incentives (corresponding to the higher v) have induced lower effort under the old v?

Consider the agent's (marginal) incentives for effort; they are given by $vm(a, w)$, where

$$m(a, w) \equiv \int f_a(x, a)u(w(x))dx \tag{M}$$

Thus $m(a, w)$ is the marginal incentive for effort generated by the contract $w(x) = s + \beta(x)$. We call m the marginal *contractual* incentives.

Consider now $\tilde{v} > v$, and suppose the associated optimal efforts satisfy $\tilde{a} > a$. A way to interpret question ii) is then to ask whether $m(a, \tilde{w}) < m(a, w)$, i.e. whether the monetary payments $\tilde{w}$ associated with the higher $\tilde{v}$ yield in isolation lower marginal incentives for the agent.

Now, optimal effort and payments are functions of v, say $a(v)$ and (with some abuse of notation) $w(v)$, respectively. We thus ask if $m(a, w(v))$ is decreasing in v, i.e. if

$$\frac{\partial}{\partial v}m(a, w(v)) = \int f_a(x, a)\frac{\partial}{\partial v}u(w(x; v))dx < 0$$

Note that in equilibrium the agent's choice of effort will be $a = a(v)$, and hence we have from incentive compatibility (IC) that $vm(a(v), w(v)) = C'(a(v))$. Differentiating this identity we see that for equilibrium effort $a = a(v)$ we have

$$v\frac{\partial}{\partial v}m(a, w(v)) = \left[C''(a) - v\frac{\partial}{\partial a}m(a, w(v))\right]a'(v) - C'(a)/v \tag{1}$$

From this it follows that if, say $a'(v) > 0$ (so effort increases with v), and the last term dominates the other terms on the RHS (so $\frac{\partial}{\partial v}m < 0$), then it will be the case that effort and marginal contractual incentives for effort move in opposite directions. We will in the following provide a specification of functional forms where this is precisely the case.

Note that signing expressions like (1) requires properties of equilibrium effort variations in a moral hazard model, which are hard to obtain analytically. Hence we consider specific functional forms. Assume the following specifications for the probability distribution and for the agent's utility:

$$F(x,a) = \Pr(\textit{outcome} \leq x|\, a) = 1 - e^{-x/a},\ x \geq 0, \qquad u(w) = \sqrt{w} \tag{2}$$

Here the expected output is $Ex = a$, so higher effort increases expected output and leads to a more favorable distribution in the sense of first order stochastic dominance. The distribution satisfies MLRP. The utility function implies constant relative risk aversion ($-wu''/u' = const$).

It turns out in this case that the marginal contractual incentives for effort are constant and independent of effort, i.e. $\frac{\partial}{\partial a} m(a, w(v)) = 0$. So from (1) we have here (for $a = a(v)$)

$$\frac{v^2}{C'(a)} \frac{\partial}{\partial v} m(a, w(v)) = \frac{vC''(a)}{C'(a)} a'(v) - 1 \tag{3}$$

Hence we see that if the equilibrium marginal cost $C'(a(v))$ is inelastic (as a function of v) then marginal contractual incentives will be reduced as the level of verifiability v increases. If at the same time effort increases with higher v, then clearly effort and contractual incentives will move in opposite directions. It can be shown (see the appendix) that this will indeed be the case if e.g. the cost function exhibits inelastic marginal costs ($aC''(a)/C'(a) \leq 1$) and $C'''(a) \geq 0$. (This holds e.g. for quadratic costs; $C(a) = ca^2$). Thus we provide a set of conditions where *effort increases while the incentives for effort generated by the contract decrease.*

Proposition 1 *There are cases where effort increases while contractual incentives decrease. This occurs for functional forms satisfying (2) when marginal effort costs are inelastic ($aC''(a)/C'(a) \leq 1$) and $C'''(a) \geq 0$.*

The intuition is as follows. A higher verifiability increases the agent's incentives to exert effort (other things equal), but it also increases the principal's wage costs per unit of effort (since the probability that the principal actually has to pay as promised increases). Now, even though the principal finds it optimal to induce higher effort when v increases , she will make a trade-off between the benefits from higher effort and the expected wage costs from higher v. She may thus reduce these wage costs by providing lower-powered incentives. In other words, improved enforcement may crowd out contractual incentives.

2.2 Limited liability

We will now show that similar results can be obtained under risk neutrality and limited liability. We assume that the agent is risk neutral in the sense that $u(w) = w$, but that he is protected by limited liability so that $w(x) \geq 0$. We also assume that the principal has limited means so that $w(x) \leq x$. Hence, it is assumed that the principal cannot commit to pay wages above the agent's value added. This constraint resembles Innes (1990) who in a financial contracting setting assumes that the investor's (principal's) liability is limited to her investment in the agent. Finally, it is convenient here to specify that output has support $X = [\underline{x}, \overline{x}]$

Now, the game proceeds as in the previous section, but under risk neutrality, the agent's expected payoff is simply: $s + \int_{\underline{x}}^{\bar{x}} v\beta(x)f(x,a)dx - C(a)$, yielding a first order condition for effort as follows:

$$\int_{\underline{x}}^{\bar{x}} v\beta(x)f_a(x,a)dx - C'(a) = 0 \tag{IC'}$$

In stage 1, the principal maximizes her payoff, which is

$$\int_{\underline{x}}^{\bar{x}} (x - v\beta(x))f(x,a)dx - s,$$

subject to incentive (IC'), participation (IR) and limited liability constraints:

$$s + \int_{\underline{x}}^{\bar{x}} v\beta(x)f(x,a)dx - C(a) \geq U_o \tag{IR}$$

$$x \geq w(x) = s + \beta(x) \geq 0$$

Mainly to simplify notation, we will assume $\underline{x} = 0$ and hence that the fixed salary must be $s = 0$. By the same argument as in Innes (1990), it then follows that the optimal wage scheme pays the minimal wage for outcomes below some threshold, and the maximal wage for outcomes above that threshold ($\beta(x) = 0$ for $x < x_0'$ and $\beta(x) = x$ for $x > x_0'$). It is well known that the discontinuity of this scheme is problematic, and for that reason one requires continuity. The optimal such scheme also has a threshold and pays $\beta(x) = 0$ for $x \leq x_0$ and $\beta(x) = x - x_0$ for $x > x_0$. In the following we will focus on this kind of (constrained optimal) incentive scheme. Since the expected marginal payoff from exerting extra effort is zero as long as output is below x_0, it is clear that the higher is the threshold x_0, the lower is the incentive intensity of the contract.

Given that the principal cannot extract rent form the agent through the fixed salary component, the IR constraint will not bind unless the agent's reservation utility U_o is 'large'. Mainly to simplify notation we will assume here that $U_o = 0$ and hence that this constraint is not binding.

Given the form of the incentive scheme, the expected payment for the agent is now

$$v\int_{\underline{x}}^{\bar{x}} \beta(x)f(x,a)dx = v\int_{x_0}^{\bar{x}} (x - x_0)f(x,a)dx = v\int_{x_0}^{\bar{x}} G(x,a)dx,$$

where the expression in the last integral follows from integration by parts, and where $G(x,a) = \Pr(\mathit{outcome} > x|\, a) = 1 - F(x,a)$. By a similar calculation the principal's expected payoff can be written as

$$\int_{\underline{x}}^{\bar{x}} xf(x,a)dx - v\int_{\underline{x}}^{\bar{x}} \beta(x)f(x,a)dx = \int_{\underline{x}}^{\bar{x}} G(x,a)dx - v\int_{x_0}^{\bar{x}} G(x,a)dx \quad (4)$$

The principal's problem is now (for a given v) to choose x_0, a to maximize this payoff subject to the agent's incentive constraint.

We will focus on cases where higher enforcement probability v is valuable for the principal.[4] Note that a higher v is beneficial for the principal because it strengthens the agent's incentives, but is on the other hand costly because it increases the total expected payments (and therefore the rent) to the agent. It turns out that a higher v is valuable if $G_a(x,a) > 0$ and the ratio $\frac{G(x,a)}{G_a(x,a)}$ is decreasing in x. In the following we will assume that both these conditions hold. The condition $G_a(x,a) > 0$ means that more effort yields a shift to a distribution that is more favorable in the sense of first order stochastic dominance.

Again, we analyze the following question: what happens to the optimal effort (a) and incentive scheme (represented by x_0) when the level of verifiability (v) varies? Comparative statics yields the following

Lemma 1 *If (in addition to $G_a(x,a) > 0$, $\frac{\partial}{\partial x}\frac{G_a(x,a)}{G(x,a)} > 0$ and MLRP) we have*

$$\frac{\partial}{\partial a}\int_{x_0}^{\bar{x}} \frac{G_a(x,a)}{G_a(x_0,a)}dx > 0 \quad (5)$$

then optimal effort increases with higher verifiability; $a'(v) > 0$.

As noted before, a higher verifiability increases the agent's incentives to exert effort (other things equal), but it also increases the principal's wage costs per unit of effort. The proposition gives conditions under which the first effect dominates in the sense that the principal finds it optimal to induce

[4] If the principal can influence the verification probability v, e.g. by making costly investments (say $K(v)$) in better contract specifications or performance metrics, we will have $\partial L/\partial v = K'(v)$ in optimum and thus $\partial L/\partial v > 0$ for the relevant level v.

higher effort when verifiability increases. But the principal may still want to mitigate the latter effect, that is to reduce wage costs by providing lower-powered incentives. The next result shows that this is indeed what will occur, under some conditions. The following conditions turn out to be sufficient:

$$G_{aa}(x,a) < 0, \quad \frac{\partial}{\partial a}\frac{G_{aa}(x,a)}{G_a(x,a)} \leq 0 \quad \text{and} \quad \frac{\partial}{\partial x}\frac{G_{aa}(x,a)}{G_a(x,a)} > 0 \tag{6}$$

Proposition 2 *Suppose that $C'''(a) \geq 0$ and that $G(x,a)$ in addition to the assumptions in Lemma 1 satisfies (6). Then both effort and the threshold for the incentive scheme increase with higher verifiability ($a'(v) > 0$ and $x_0'(v) > 0$), hence higher effort is then associated with lower-powered contractual incentives.*

An example that satisfies all assumptions is $G(x,a) = \Pr(\textit{outcome} > x) = 1 - x^a$, $0 \leq x \leq 1$, (see the appendix).

The proposition demonstrates that higher effort may be associated with lower-powered contractual incentives (higher x_0), and the other way around, even if there is no *motivation*-crowding-out.

3 Informal enforcement

As noted in the introduction, our modelling set-up can also account for non-legal, or informal, enforcement mechanisms. Informal enforcement is often modelled as a repeated game where contract breach is punished, not by the court, but by the contracting parties themselves who can refuse to cooperate or trade with each other after a deviation. But informal enforcement can also be due to moral or social commitment. Greif (1994) defines moral enforcement as enforcement based on the tendency of humans to derive utility from acting according to their values, while social enforcement is related to social sanctions.

In the previous section, variations in v were interpreted as variations in conditions for formal enforcement. But one can also think of variations in conditions for informal enforcement: Both the environments for repeated game reputational enforcement and the conditions for social and moral commitment may vary. As an example of the latter, it is shown in several experiments that communication facilitates trust and trustworthiness. In particular it is shown that stated promises increases the likelihood of trustworthy behavior (Ellingsen and Johannesson, 2004, Charness and Dufwenberg, 2006). One would thus expect stronger moral enforcement in environments where the principal can easily communicate with the agent.

In this section we let v denote the probability that the principal feels (morally or socially) committed to honor the contract. We will then show that the same conclusions as we draw in the previous section can be drawn from this alternative interpretation. Our goal is not to analyze the interaction between legal and non-legal enforcement devices; rather we will show that the model is also relevant for environments where legal enforcement is not an option. We thus assume in this section that contracts are not enforceable by the court of law (hence v does not denote "verifiability" in this section since there is no probability of verification).

Consider now the following stage game:

1. The principal offers a contract $w(x) = s + \beta(x)$ to the agent. If the agent rejects the offer, the game ends. If he accepts, the game continues to stage 2.

2. The agent takes action a and realizes output x.

3. Nature draws. With probability v the principal finds herself committed to pay the bonus $\beta(x)$.

4. The principal observes x, pays s and chooses bonus payment $\tilde{\beta}(x) = \beta(x)$ if she is committed to honor the contract, and $\tilde{\beta}(x) = 0$ if not.

A crucial assumption here is that the principal learns whether or not she will actually honor the contract *after* the contract is offered. This assumption bears some resemblance to the economics literature on will-power and self-control where people learn about their own type from previous actions (see e.g. Benabou and Tirole, 2003). In our model, the principal learns about her own actual commitment after she has offered the contract.

Now, the stage game is simpler than in the previous section, since there is no court decision in stage 4 and the nature draws in stage 3. The backwards induction can then start in stage 2. As above, the agent will choose effort to maximize his expected payoff: $v \int f(x,a)u(w(x))dx + (1-v)u(s) - C(a)$ yielding an incentive constraint such as IC in the previous section. In stage 1, the principal maximizes her payoff $\int f(x,a)\left[x - vw(x)\right]dx - (1-v)s - C(a)$ subject to incentive an participation constraints. Hence, we get the same maximization problem, and thus the same results, as in the previous section. Higher probability of (informal) enforcement triggers effort, but increases the principal's wage costs. In order to save on wage costs, she may offer lower powered incentives, but not so much that effort in sum is reduced. Hence, higher effort may be associated with lower-powered incentives.

4 Concluding remarks

We offer a simple model where contractual monetary incentives and effort are negatively related even if there is no crowding out of non-monetary motivation. The idea is simple: Improved enforcement induces higher effort, but increases the principal's expected wage costs, which can be mitigated by lower-powered incentives. Or: Weaker enforcement induces lower effort, which can be mitigated by higher-powered incentives.

Section 3 offers a *behavioral* model in the sense that the principal has other-regarding preferences: She may care for the agent (with probability v) even if she has no monetary incentives to do so. In contrast, the model in Section 2 does not rely on other-regarding preferences. One can say that Section 3 demonstrates that a behavioral model does not need to rely on endogenous intrinsic motivation in order to explain a negative relationship between effort and incentives, while Section 2 shows that we do not necessarily need a behavioral model at all in order to explain a negative relationship.

However, our model is not an alternative to the behavioral models, but a complement. In contrast to (parts of) the crowding out literature, we do not offer a negative *causal* relationship between incentives and effort. Instead we identify a spurious relationship where improved contract enforcement increases effort but "crowd out" contractual incentives. Total monetary incentives, which is the product of the enforcement probability and contractual incentives, are positively related to effort, but since the enforcement probability does not show up in the incentive contract, it *appears* that incentives and effort are negatively related. The empirical implication is clear: When observing a negative relationship between incentives and effort, one has to control for the probability that the relevant incentive contracts are actually enforced. If not, one may wrongfully infer that monetary incentives crowd out non-monetary motivation.

Appendix

Proof of Proposition 1.

From the Lagrangian $L = V + \lambda(U - U_o) + \mu U_a$, we obtain the following conditions for optimal bonuses $\beta(x)$, or equivalently payments $w(x) = s + \beta(x)$:

$$0 = -vf(x,a) + \lambda v f(x,a)u'(w(x)) + \mu f_a(x,a)u'(w(x)),$$

and for the optimal fixed payment s:

$$0 = -1 + \lambda\left(v\int f(x,a)u'(w(x))dx + (1-v)u'(s)\right) + \mu v\int f_a(x,a)u'(w(x))dx.$$

The first is equivalent to $\frac{1}{u'} = \lambda + \mu\frac{f_a}{f}$, and substituting from the first into the second we get $\lambda u' = 1$. This proves (W).

For utility $u(w) = \sqrt{w}$ we have $1/u' = 2u$, hence the conditions for optimal payments are

$$2u(w(x)) = \lambda + \mu\frac{f_a(x,a)}{f(x,a)}, \qquad 2u(w(s)) = \lambda \tag{7}$$

From the distribution $F(x,a) = 1 - e^{-x/a}$ we have density $f(x,a) = \frac{1}{a}e^{-x/a}$ and likelihood ratio

$$h(x,a) \equiv \frac{f_a(x,a)}{f(x,a)} = \frac{1}{a}(\frac{x}{a} - 1)$$

Consider now the agent's marginal monetary incentive $m(a,w)$, where payments $w()$ are optimal, and thus given by (7) for the optimal action $a = a^*$, say. We now find

$$m(a,w) = \int f_a(x,a)u(w(x))dx = \int f_a(x,a)\frac{\lambda + \mu h(x,a^*)}{2}dx = \frac{\mu}{2(a^*)^2} \tag{8}$$

where the last equality follows from $\int f_a = 0$ (since $\int f = 1$) and the fact that we here have

$$\int f_a(x,a)h(x,a^*)dx = \int_0^\infty \frac{1}{a^2}e^{-x/a}(\frac{x}{a}-1)\frac{1}{a^*}(\frac{x}{a^*}-1)dx$$
$$= \frac{1}{aa^*}\int_0^\infty e^{-y}(y-1)(y\frac{a}{a^*}-1)dy = \frac{1}{(a^*)^2} \quad (9)$$

This proves that $m(a,w)$ is here constant, independent of effort a.

To characterize the optimal effort for the principal, consider

$$\begin{aligned} L_a &= V_a + \lambda U_a + \mu U_{aa} \\ &= \int f_a(x,a)\left[x - vw(x)\right]dx + 0 + \mu(v\int f_{aa}(x,a)u(w(x))dx - C''(a)) \\ &= 1 - v\int f_a(x,a)w(x)dx + 0 + \mu(0 - C''(a)) \end{aligned} \quad (10)$$

where the last equality follows from $\int xf(x,a) = Ex = a$ (so $\int xf_a = 1$) and from (8), which implies that $\int f_{aa}u = \frac{\partial}{\partial a}m(a,w) = 0$.

Note from IC and (8) that we have (when $a = a^*$):

$$C'(a) = v\int f_a(x,a)u(w(x))dx = v\mu\frac{1}{2a^2} \quad (11)$$

and hence that $\mu = 2a^2C'(a)/v$. Note also from IR (which will be binding) and (7) that we have

$$\begin{aligned} U_o + C(a) &= v\int f(x,a)u(w(x))dx + (1-v)u(s) \\ &= v\int f(x,a)\left[\lambda + \mu h(x,a)\right]/2dx + (1-v)\lambda/2 = \lambda/2 \end{aligned} \quad (12)$$

where the last equality follows from the fact that $\int fh = \int f\frac{f_a}{f} = \int f_a = 0$. Hence we see that $\lambda = 2(U_o + C(a))$.

Now consider the condition (10) for optimal effort. Since $u = \sqrt{w}$ we have $w = u^2$, and substituting from (7) we can write

$$\begin{aligned}
\int f_a(x,a)w(x)dx &= \int f_a(x,a)\left(\left[\lambda + \mu h(x,a)\right]/2\right)^2 dx \\
&= \int f_a(x,a)\left[\lambda^2 + 2\lambda\mu h(x,a) + \mu^2 h^2(x,a)\right] dx/4 \\
&= \lambda\frac{\mu}{2a^2} + \frac{\mu^2}{2a^3} \qquad (13)
\end{aligned}$$

where the last equality follows from $\int f_a = 0$, $\int f_a(x,a)h(x,a)dx = 1/a^2$ (see (9)), and the fact that we here have

$$\int f_a(x,a)h^2(x,a)dx = \int_0^\infty \frac{1}{a^4}e^{-x/a}(\frac{x}{a}-1)^3 dx = \frac{1}{a^3}\int_0^\infty e^{-y}(y-1)^3 dx = \frac{2}{a^3}$$

Substituting from (13),(12) and (11) into (10), we get the following condition for optimal effort

$$\begin{aligned}
1 &= v\int f_a(x,a)w(x)dx + \mu C''(a) \\
&= \lambda v\frac{\mu}{2a^2} + v\frac{\mu^2}{2a^3} + \mu C''(a) \\
&= 2(U_o + C(a))C'(a) + C'(a)\frac{2aC'(a)}{v} + \frac{2a^2C'(a)}{v}C''(a) \\
&= 2(U_o + C(a))C'(a) + 2\frac{a}{v}\psi(a)
\end{aligned}$$

where we have defined $\psi(a) = C'(a)\left(C'(a) + aC''(a)\right)$. This yields comparative statics

$$0 = \left(\frac{d}{da}(U_o + C(a))C'(a) + \frac{1}{v}(\psi(a) + a\psi'(a))\right)a'(v) - \frac{a}{v^2}\psi(a)$$

Since our assumptions (including $C'''(a) \geq 0$) implies $\psi'(a) > 0$, we see that for $U_0 \geq 0$ we have $a'(v) > 0$ and

$$a'(v) < \frac{\frac{a}{v^2}\psi(a)}{\frac{1}{v}(\psi(a) + a\psi'(a))} < \frac{a}{v}$$

From (3) we then obtain

$$\frac{v^2}{C'(a)}\frac{\partial}{\partial v}m(a, w(v)) = \frac{vC''(a)}{C'(a)}a'(v) - 1 < \frac{aC''(a)}{C'(a)} - 1 \leq 0,$$

where the last inequality follows from the assumption of inelastic marginal cost. We have thus shown that these assumptions imply that effort and incentives for effort generated by monetary payments move in opposite directions when the level of verifiability v varies ($a'(v) > 0$ and $\frac{\partial m}{\partial v} < 0$).

Proof of Lemma 1

The principal chooses x_0, a to maximize her payoff (4) subject to the agent's incentive constraint, which here takes the form

$$v\int_{x_0}^{\bar{x}} G_a(x, a)dx - C'(a) = 0 \tag{14}$$

The Lagrangian for this problem is

$$L = \int_{\underline{x}}^{\bar{x}} G(x, a)dx - v\int_{x_0}^{\bar{x}} G(x, a)dx + \mu\left[v\int_{x_0}^{\bar{x}} G_a(x, a)dx - C'(a)\right] \tag{15}$$

As noted we focus on cases where higher v is valuable for the principal, i.e. where $\frac{\partial L}{\partial v} > 0$. Since optimization with respect to the threshold parameter x_0 yields $vG(x_0, a) - v\mu G_a(x_0, a) = 0$ and hence $\mu = \frac{G(x_0,a)}{G_a(x_0,a)}$, we have

$$\frac{\partial L}{\partial v} = -\int_{x_0}^{\bar{x}} G(x, a)dx + \mu\int_{x_0}^{\bar{x}} G_a(x, a)dx = \int_{x_0}^{\bar{x}}\left[\frac{G(x_0, a)}{G_a(x_0, a)} - \frac{G(x, a)}{G_a(x, a)}\right]G_a(x, a)dx \tag{16}$$

We see that we will have $\frac{\partial L}{\partial v} > 0$ if $G_a(x, a) > 0$ and the ratio $\frac{G(x,a)}{G_a(x,a)}$ is decreasing in x.

Consider the Lagrangian (15) and write the constraint (14) as

$$H(x_0, a, v) \equiv v \int_{x_0}^{\bar{x}} G_a(x, a)dx - C'(a) = 0 \tag{17}$$

The FOCs for optimal choices are $L_{x_0} = L_a = H = 0$. (Subscripts denote partials.) Differentiation of these conditions yields

$$\begin{bmatrix} L_{x_0x_0} & L_{x_0a} & H_{x_0} \\ L_{ax_0} & L_{aa} & H_a \\ H_{x_0} & H_a & 0 \end{bmatrix} \begin{bmatrix} x_0'(v) \\ a'(v) \\ \mu'(v) \end{bmatrix} = \begin{bmatrix} -L_{x_0v} \\ -L_{av} \\ -H_v \end{bmatrix}$$

and hence the standard comparative statics formulae

$$x_0'(v) = \frac{1}{D} \begin{vmatrix} -L_{x_0v} & L_{x_0a} & H_{x_0} \\ -L_{av} & L_{aa} & H_a \\ -H_v & H_a & 0 \end{vmatrix} = \frac{1}{D}\left[H_a^2 L_{vx_0} - H_a H_{x_0} L_{av} - H_a H_v L_{ax_0} + H_v H_{x_0} L_{aa}\right]$$

$$a'(v) = \frac{1}{D} \begin{vmatrix} L_{x_0x_0} & -L_{x_0v} & H_{x_0} \\ L_{ax_0} & -L_{av} & H_a \\ H_{x_0} & -H_v & 0 \end{vmatrix} = \frac{1}{D}\left[H_{x_0}^2 L_{av} - H_v H_{x_0} L_{ax_0} - H_a H_{x_0} L_{vx_0} + H_a H_v L_{x_0x_0}\right]$$

where

$$D = \begin{vmatrix} L_{x_0x_0} & L_{x_0a} & H_{x_0} \\ L_{ax_0} & L_{aa} & H_a \\ H_{x_0} & H_a & 0 \end{vmatrix} = -L_{x_0x_0}H_a^2 + 2L_{ax_0}H_aH_{x_0} - L_{aa}H_{x_0}^2 > 0 \tag{SOC}$$

From FOC we have $0 = L_{x_0} = vG(x_0, a) - \mu v G_a(x_0, a)$ and hence

$$L_{vx_0} = G(x_0, a) - \mu G_a(x_0, a) = 0 \tag{18}$$

Hence we can write

$$x_0'(v)D = -H_a H_{x_0} L_{av} - H_a H_v L_{ax_0} + H_v H_{x_0} L_{aa} \tag{19}$$

$$a'(v)D = H_{x_0}^2 L_{av} - H_v H_{x_0} L_{ax_0} + H_a H_v L_{x_0 x_0} \tag{20}$$

Writing $g(x,a) = G_x(x,a)$ and using (18) we have

$$L_{x_0 x_0}/v = g(x_0,a) - \mu g_a(x_0,a) = g(x_0,a) - \frac{G(x_0,a)}{G_a(x_0,a)} g_a(x_0,a) < 0$$

where the inequality holds because we have assumed $G_a > 0$ and $\frac{d}{dx}\frac{G_a}{G} = \frac{1}{G^2}(g_a G - G_a g) > 0$.

From (17), $G_a > 0$ and the SOC for the agent we have

$$H_{x_0} = -vG_a(x_0,a) < 0, \quad H_v = \int_{x_0}^{\bar{x}} G_a(x,a)dx > 0, \quad H_a = v\int_{x_0}^{\bar{x}} G_{aa}(x,a)dx - C''(a) < 0 \tag{21}$$

These inequalities imply $H_a H_v L_{x_0 x_0} > 0$, and we thus have from (20): $a'(v)D > [H_{x_0} L_{av} - H_v L_{ax_0}] H_{x_0}$.

Since $H_{x_0} = -vG_a < 0$ we then have $a'(v) > 0$ if $H_{x_0} L_{av} - H_v L_{ax_0} < 0$. To show that this condition implying $a'(v) > 0$ is satisfied, consider

$$\begin{aligned}
H_{x_0} L_{av} - H_v L_{ax_0} &= -vG_a(x_0,a)\left[-\int_{x_0}^{\bar{x}} G_a(x,a)dx + \mu \int_{x_0}^{\bar{x}} G_{aa}(x,a)dx\right] \\
&\quad - \left(\int_{x_0}^{\bar{x}} G_a(x,a)dx\right)[vG_a(x_0,a) - \mu v G_{aa}(x_0,a)] \\
&= \mu v \left[-G_a(x_0,a)\int_{x_0}^{\bar{x}} G_{aa}(x,a)dx + G_{aa}(x_0,a)\int_{x_0}^{\bar{x}} G_a(x,a)dx\right] \\
&= -\mu v G_a^2(x_0,a)\left[\frac{\partial}{\partial a}\int_{x_0}^{\bar{x}} \frac{G_a(x,a)}{G_a(x_0,a)}dx\right] < 0
\end{aligned}$$

The last inequality follows from the assumption (5) and proves that $a'(v) > 0$.

Proof of Proposition 2

First note that $G_{aa} < 0$ implies $L_{av} = -\int_{x_0}^{\bar{x}} G_a(x,a)dx + \mu \int_{x_0}^{\bar{x}} G_{aa}(x,a)dx < 0$, and hence from (21) that $H_a H_{x_0} L_{av} < 0$. We then have from (19):

$$x_0'(v)D = -H_a H_{x_0} L_{av} - H_a H_v L_{ax_0} + H_v H_{x_0} L_{aa} > \left[-H_a L_{ax_0} + H_{x_0} L_{aa}\right] H_v \tag{22}$$

Consider $[-H_a L_{ax_0} + H_{x_0} L_{aa}]$. Since $H_a < v \int_{x_0}^{\bar{x}} G_{aa}(x,a)dx$ by (21), and since $G_{aa} < 0$ implies $L_{ax_0} = vG_a(x_0,a) - \mu v G_{aa}(x_0,a) > 0$, we have

$$\begin{aligned} -H_a L_{ax_0} + H_{x_0} L_{aa} &> -\left(v \int_{x_0}^{\bar{x}} G_{aa}(x,a)dx\right)\left[G_a(x_0,a) - \mu G_{aa}(x_0,a)\right] v + (-vG_a(x_0,a))L_{aa} \\ &= vG_a(x_0,a)\left(-\int_{x_0}^{\bar{x}} G_{aa}(x,a)dx \left[1 - \mu \frac{G_{aa}(x_0,a)}{G_a(x_0,a)}\right] v - L_{aa}\right) \end{aligned} \tag{23}$$

Consider L_{aa}. Since $G_{aa} < 0$ and $C'''(a) \geq 0$ we have

$$\begin{aligned} L_{aa} &= \int_0^1 G_{aa}(x,a)dx - v\int_{x_0}^1 G_{aa}(x,a)dx + \mu\left[v\int_{x_0}^1 G_{aaa}(x,a)dx - C'''(a)\right] \\ &< \int_{x_0}^1 G_{aa}(x,a)\left[1 - v + \mu v \frac{G_{aaa}(x,a)}{G_{aa}(x,a)}\right] dx \end{aligned}$$

Hence from (23) we now have

$$\frac{-H_a L_{ax_0} + H_{x_0} L_{aa}}{vG_a(x_0,a)} > -\int_{x_0}^{\bar{x}} G_{aa}(x,a)\left[1 + \mu v\left(\frac{G_{aaa}(x,a)}{G_{aa}(x,a)} - \frac{G_{aa}(x_0,a)}{G_a(x_0,a)}\right)\right] dx > 0 \tag{24}$$

where the last inequality will be shown to follow from (6). From (22) and the fact that $H_v > 0$ we then see that $x_0'(v) > 0$.

To show the last inequality in (24), note that the assumptions in (6) imply

$$\frac{\partial}{\partial a}\frac{G_{aa}(x,a)}{G_a(x,a)} = \frac{G_{aa}(x,a)}{G_a(x,a)}\left(\frac{G_{aaa}(x,a)}{G_{aa}(x,a)} - \frac{G_{aa}(x,a)}{G_a(x,a)}\right) \leq 0$$

and $\frac{G_{aa}(x,a)}{G_a(x,a)} > \frac{G_{aa}(x_0,a)}{G_a(x_0,a)}$ when $x > x_0$. These inequalities in turn imply

$$\frac{G_{aaa}(x,a)}{G_{aa}(x,a)} \geq \frac{G_{aa}(x,a)}{G_a(x,a)} > \frac{G_{aa}(x_0,a)}{G_a(x_0,a)} \quad \text{when} \quad x > x_0$$

This implies that the expression in (24) is positive, and hence completes the proof that $x_0'(v) > 0$.

To see that the assumptions stated in Proposition 3 are not void, we finally show that they are all satisfied by $G(x,a) = 1 - x^a$, $0 \leq x \leq 1$. For this distribution we have

$$G_a(x,a) = -x^a \ln x > 0$$
$$G_x(x,a) = -ax^{a-1} = -f(x,a)$$
$$G_{xa}(x,a) = -f_a(x,a) = -x^{a-1}\,(a \ln x + 1)$$

Hence $\frac{f_a(x,a)}{f(x,a)} = \ln x + 1/a$ is increasing in x, so MLRP holds. Moreover:

$$\frac{\partial}{\partial x}\frac{G_a(x,a)}{G(x,a)} = \frac{G_{ax}G - G_a G_x}{G^2} = x^{a-1}\frac{-\,(a \ln x + 1)\,G - x^a a \ln x}{G^2} = \frac{x^{a-1}}{G^2}(x^a - \ln x^a - 1) > 0$$

where the inequality follows from the fact that $h(z) = z - \ln z - 1 > 0$ on $(0,1)$. We also have

$$\frac{\partial}{\partial a}\int_{x_0}^{\bar{x}} \frac{G_a(x,a)}{G_a(x_0,a)}dx = \frac{\partial}{\partial a}\int_{x_0}^{1} \frac{x^a \ln x}{x_0^a \ln x_0}dx = \int_{x_0}^{1} (\frac{x}{x_0})^a \ln(\frac{x}{x_0})\frac{\ln x}{\ln x_0}dx > 0$$

hence all the conditions stated in Lemma 2 hold.

Next note that

$$G_{aa}(x,a) = -\tfrac{d}{da}x^a \ln x = -x^a(\ln x)^2 = G_a(x,a)\ln x < 0$$

and hence that $\frac{G_{aa}(x,a)}{G_a(x,a)} = \ln x$. The additional assumptions (6) in Proposition 3 are therefore also satisfied.

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