Social Norms and Economic Incentives in Firms

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Abstract. This paper studies the interplay between economic incentives and social norms in firms. We introduce a general framework to model social norms arguing that norms stem from agents' desire for, or peer pressure towards, social efficiency. In a simple model of team production we examine the interplay of three different types of contracts with social norms. We show that one and the same norm can be output-increasing, neutral, or output-decreasing depending on the incentive scheme. We also show how social norms can induce multiplicity of equilibria and crowding out.

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1. Introduction

In a world without externalities, there would be no need for society or, in fact, anything social. If one agent's actions never harmed or kindled another, there would be no need for rules of conduct, law, or social norms. There would be no relevant *inter*action and, thus, no reason for governing it. But the moment there is interaction, the moment agents can inflict externalities on each other, norms (of any sort) become relevant and, typically, desirable. That is, norms are rooted in the presence of externalities. In this paper, we focus on social norms, i.e., norms that are not formally enforced. We conceptualize such norms as resulting from players having social preferences that discourage actions causing negative and encourage actions causing

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positive externalities. However, in contrast to most recent models of social preferences the strength of social incentives in our framework is endogenous, depending on the actions of others. This reflects the peculiar nature of social norms that, although everyone might assent to their desirability nobody might stick to them.

After laying down our general approach to modeling social norms, we proceed by specifically applying our framework to production in firms. The main conclusion from this analysis is that the impact of one and the same social norm may crucially depend on the *economic* incentives that are in place. In fact, one and the same social norm may be output enhancing, neutral, or output decreasing, depending on the type of contract chosen by the firm's owner. This points to a new and important role of contract design: By choosing appropriate contracts one can "manage" social norms, i.e., determine the way norms impact on behavior. As we prove, this offers a new rationale for team incentives even in the absence of complementaries of efforts. Once we have laid down our analytical framework, the logic of this result is astonishingly simple. Consider a firm where total output is just the sum of all workers' efforts. (This will be the lead example throught our paper.) Under individual piece rates there is no meaningful interaction between workers, in particular, there are no externalities. This is crucially different under team incentices where agents' efforts cause *positive* externalities on each other. The presence of such externalities triggers the social norm which, by definition, encourages actions that induce positive externalities. As a consequence, social norms will (weakly) enhance a firm's productivity under team incentives.

The opposite is true for incentives based on relative performance such as tournament incentives. Holding everything else constant—the firm's technology and workers' preferences—we can show that the introduction of relative pay renders the same social norm that increased output under team pay now becomes detrimental to the firm's performance. Remarkably, this is exactly what is found in a recent field experiment by Bandiera, Barankay, and Rasul (2005). They study fruit pickers working under two different incentive schemes, a piece rate solely based on own productivity and a relative-performance scheme. Consistent with our model, they find that, as long as fruit pickers can observe each other's effort, efforts are much lower under the relative-performance scheme than under piece rates. They attribute this to workers "internaliz[ing] the negative externality they impose on others under the relative incentive scheme".

There are other important consequences of social norms that can be studied for a given type of incentive scheme. Most importantly, we show that social norms can naturally give rise to multiplicity of equilibria. Equilibria with low efforts (where nobody cares much about others because others don't care much) can coexist with high-effort equilibria (where everybody cares a lot about others precisely because everybody else cares a lot). These high-effort equilibria can even induce over-zealous behavior—as apparently common in many firms of the financial sector where employees often report they have to work very long hours (with very little output) simply because everybody else does.

Multiplicity of equilibria makes it harder to determine optimal incentives. Consider a one-parameter model where the firm owner simply varies a bonus rate. (This is the model that we shall consider in our section on team pay.) The highest possible profit may result from a bonus that induces multiple equilibria which may induce an enormous risk. If workers coordinate on the low-effort equilibrium the firm may be better off to choose a "second-best" bonus rate where efforts are unique. A similar analysis also shows that multiplicity may provide a rationale for dynamic wage setting. If a firm is stuck in the low-effort branch of the equilibrium correspondence, it can be optimal to adjust incentives to levels where the low-effort equilibrium ceases to exist. Once on the high-effort branch, incentives can then be slowly adapted towards a new optimal level.

Finally, we show that the presence of social norms may explain one of the bigger puzzles in economics: why steeper incentives can reduce efforts. These so-called "crowding effects" of economic incentives, as discussed, for example, in Frey (1997) or Frey and Jegen (2003)[1] have recently attracted wide attention and, by now, there is a large body of literature documenting such "perverse" incentive effects. In our framework such effects can arise rather naturally. A slow-motion view of the adjustment dynamics show why. Suppose (team) incentives get steeper but agents exert still the same effort. As a consequence everybody is now doing less for the common good relative to what they *could* do. As a consequence this may reduce the pressure from the social norm and agents may, in the new equilibrium, exert less effort.

There are several papers in the economics literature where social norms have been included in microeconomic analyses.[2] However, not many attempts have been made to study how social norms affect the incentive structure within firms.[3] The most

[1]Drawing on the sociology and psychology literature Frey argues that economic incentives can crowd out *intrinsic motivation*. An early example for this effect goes back to Titmuss (1970) who argues that monetary incentives for blood donations undermine people's intrinsic willingness to give blood. In contrast, the argument here is that economic incentives can weaken the effect of a *social norm*. Empirically, the two mechanisms might sometimes be hard to distinguish. However, our simple model offers diverse comparative static predictions that are testable.

[2]See e.g. Akerlof (1980), Moffitt (1983), Besley and Coate (1992), Bernheim (1994), Lindbeck, Nyberg and Weibull (1999, 2002), Hart (2001), Kübler (2001), and Vendrick (2003) and the literature cited in these studies.

[3]For exceptions, see Kandel and Lazear (1992) and Barron and Gjerde (1997). Hart (2001) also focuses on norms and firms, but rather deals with the question whether the degree of trust between agents influences the optimal ownership structure. Also related is recent work by Rey Biel (2002)

prominent paper in this (small) literature is perhaps Kandel and Lazear (1992) who develop a model of norms in teams. The most important difference to our model is that they rule out any form of multiplicity by assuming peer pressure to have certain convexity properties that are not easy to justify. By contrast, we allow for multiplicity of equilibria which helps to explain some of the empirical evidence.

There is actually a growing empirical literature that suggests that group norms in firms may have important effects on behavior. We have already cited Bandiera, Barankey and Rasul (2005) who study a very intruiging field experiment. Encinosa, Gaynor, and Rebitzer (1997) find that group norms matter in medical partnerships. Knez and Simester (2001) provide evidence for the airline industry, and Ichino and Maggi (2000) for the banking industry.[4] The latter is of particular interest. Ichino and Maggi report substantial shirking differentials between branches of a large Italian bank, despite identical monetary incentives governing the employees' efforts in these branches. They identify group-interaction effects as a key explanatory variable that allows for multiple equilibria. This evidence is supplemented by experimental data consistent with multiplicity. In a laboratory study, Falk, Fischbacher, and Gächter (2002) find that the same individual contributes more to a public good in a group with high average contributions than in a group with low contribution levels. Falk and Ichino (2003) report similar evidence on the effects of peer pressure in a recent non-laboratory experiment.

2. Modeling social norms

In this section we develop an approach to modelling social norms that is supposed to be generally applicable, extending beyond the examples of how norms operate in firms on which we will focus from Section 3 onwards. We propose that modelling social norms from first principles should be based on externalities. In particular, social norms will provide incentives for causing positive externalities and disincentives for causing negative externalities on others. In that sense, we use the term "social norms" as determining what individuals in a society "ought" to do. Complementarily, we use the term "social ideal" as the *specific action profile* agents ought to implement in a given context and contractual environment.

Suppose there is a group of n *agents*, where each agent i chooses an "effort" $x_i \geq 0$. An *effort profile* thus is a vector $\vec{x} = (x_1, ..., x_n) \in \mathbb{R}^n_+$. We write (x'_i, x_{-i}) when others act according to the profile $\vec{x}$ but agent i deviates to effort x'_i. Each effort profile results in material and social payoffs to all agents.

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who studies how inequity aversion of agents affects optimal contracts.

[4]While Encinosa *et al.* focus on the interplay of group norms, multitasking and risk aversion, Knez and Simester show that firm-wide performance goals do have an effect on employees if these work in small groups, which allows them to monitor each other's work effort closely.

The *material payoff* to agent i from effort profile $\vec{x}$ is denoted $u_i(\vec{x})$, where $u_i : \mathbb{R}_+^n \to \mathbb{R}$ is twice differentiable. We have in mind the effects on agent i's well-being by way of his or her consumption and leisure. In the subsequent applications these will be functions of all agents' efforts. Let $\hat{X} \subset \mathbb{R}_+^n$ be the set of Pareto efficient effort profiles defined with respect to these material payoffs. A *social ideal* is a specific profile $\hat{x} \in \hat{X}$.

If an agent i deviates from such an ideal $\hat{x}$ by making an effort $x_i \neq \hat{x}_i$ while the others stick to the ideal, she causes the *externality*

$$\psi_i(x_i, \hat{x}_{-i}) = \sum_{j \neq i} [u_j(x_i, \hat{x}_{-i}) - u_j(\hat{x})] \tag{1}$$

upon the collective of other agents in the group. The externality, so defined, may be negative (if agent i shirks from her ideal effort) or positive (if agent i is over-zealous with respect to her ideal). The externality is zero if agent i, too, sticks to the ideal, i.e., $\psi_i(\hat{x}) = 0$.

Conversely, suppose agent i sticks to her ideal effort level while other agents don't stick to theirs. Thus, let $x_i = \hat{x}_i$ and $x_j \neq \hat{x}_j$ for all or some $j \neq i$. The *externality* imposed by others on agent i is

$$\psi_{-i}(\hat{x}_i, x_{-i}) = u_i(\hat{x}_i, x_{-i}) - u_i(\hat{x}). \tag{2}$$

We again note that this externality may be negative (other agents shirk in the aggregate) or positive (they are over-zealous in the aggregate), and that it is zero if the others also stick to the ideal.

Given a social ideal $\hat{x}$, let $v_i(\vec{x})$ denote the *social payoff* to agent i that results from an effort profile $\vec{x}$. We assume that this is a function of the externality that agent i imposes upon the others and the externality that they impose upon her:

$$v_i(\vec{x}) = G_i[\psi_i(x_i, \hat{x}_{-i}), \psi_{-i}(\hat{x}_i, x_{-i})], \tag{3}$$

for some twice differentiable function $G_i : \mathbb{R}^2 \to \mathbb{R}$.

We assume that this function has a non-negative partial derivative with respect to its first argument: $G'_{i1} \geq 0$. Thus, the social payoff to agent i does not decrease with the externality that she imposes on the others. In other words, an agent obtains more social payoff if she works harder. This social utility from working hard may depend on the effort choices of the others, as will be seen in more detail in the examples below.

Note that the social payoff depends on deviations from the ideal by way of their effect on material payoffs. Disutility from shirking results either because the social norm is internalized or because of external "peer pressure" which, of course, requires that team members can observe each other's effort choice.[5]

The *total utility* to an agent from an effort profile is assumed to be the sum of the agent's material and social payoffs:

$$U_i(\vec{x}) = u_i(\vec{x}) + v_i(\vec{x}). \tag{4}$$

The first-order effect of an agent's unilateral change of effort is transparent: given any effort profile $\vec{x} = (x_1, ..., x_n)$, there is a direct effect on his own material payoff and a weighted effect on all other's *virtual* material payoffs — the material payoffs they would have earned had he stuck to the social ideal:

$$\frac{\partial U_i(\vec{x})}{\partial x_i} = \frac{\partial u_i(\vec{x})}{\partial x_i} + G'_{i1}\left[\psi_i\left(x_i, \hat{x}_{-i}\right), \psi_{-i}\left(\hat{x}_i, x_{-i}\right)\right] \sum_{j \neq i} \frac{\partial u_j(x_i, \hat{x}_{-i})}{\partial x_i} = 0 \tag{5}$$

The weight factor depends on how much the agent's social payoff increases from inflicting a smaller negative or greater positive externality on others. Hence, any positive effort satisfying this first-order condition will be such that the first term in (5), her marginal material payoff, will have the opposite sign of the last term, the marginal externality she inflicts on others by increasing her effort. If the latter is positive (as in our first example below), the former will be negative, and vice versa (as in our example in Section 5). Moreover, we see that the externalities that others impose on i enter the first-order effect through the weight factor that i attaches to others' material payoffs. It is natural to assume that this weight factor is larger the closer others adhere to the social ideal: agents care more about others' material well-being if these others contribute more to the common good. We will return to this issue in the subsequent applications.

Suppose that each agent has to choose his or her effort without knowing the others' efforts. This defines a simultaneous-move game where each agent's strategy is a non-negative real number — that agent's effort. Let $\vec{x} = (x_1^*, ..., x_n^*)$ be a Nash equilibrium. Symmetric equilibria — Nash equilibria in which all agents exert equal efforts, $x_i^* = x_j^*$ for all i and j —are of particular interest in symmetric games. In the present context, the game is symmetric when all agents have the same material and social payoff function. We will call x^* the common effort level exerted in such a symmetric equilibrium.

[5]In our model, both interpretations are equivalent as the output from agents' efforts will be deterministic. With stochastic production, the two interpretations give different results.

3. Social norms in a firm

We now apply the above framework to a very simple model of a firm. Consider a firm in a perfectly competitive market for its output, with a profit-maximizing owner (the principal) as residual claimant. Thus, the firm is a price taker in its product market, and we normalize the price of its output to unity. There are $n > 1$ identical workers (the agents) working in the firm. Each worker i exerts some effort $x_i \geq 0$. Effort costs are convex. The production technology is linear: output y equals the sum $x_1 + ... + x_n$ of all workers' efforts.

We shall introduce social norms into this setting by assuming that workers care only about each other (about their peers) and not about the firm owner who is the residual claimant. We shall keep this simple baseline model for all that is to follow but we shall make different assumptions about the type of contract the firm owner can choose. In the first, quite trivial, subsection we look at the case where the firm owner observes individual outputs and can choose piece rates. This, of course, achieves the first best regardless of whether there is a social norm or not. A social norm is neutral as each workers' payoff only depends on his own effort and there are no externalities.

In the second subsection we shall focus on team pay where the owner can set a simple non-negative bonus rate for the entire team (perhaps because only aggregate output is observable). Finally, we shall assume that the firm owner receives a (noisy) signal about each worker's output and employs a relative performance scheme. To keep the exposition as simple as possible, we assume in all these cases that the workers' outside option is not binding. The analysis with a (possibly binding) outside option gets more involved, but the basic results remain the same.

3.1. Piece rates. If the principal observes each worker's output piece rates can induce the first best as their are no complementarities in production. Let b_i denote the piece-rate the firm owener pays to worker i. Then the worker's material payoff is

$$u_i\left(b_i, x_i\right) = b_i x_i - \frac{1}{2} x_i^2 \tag{6}$$

where x_i denotes worker i's effort. It is immediate that each worker chooses $x_i^* = b_i$ as his optimal effort. The principal earns

$$\sum_{i=1}^{n} (1 - b_i) x_i. \tag{7}$$

Hence, the optimal piece rate is $b_i^* = 1/2$. This achieves full efficiency.

Crucially, the analysis does not change in the presence of a social norm. Since there are no externalities between workers the social norm does not change anything. It is completely neutral.

3.2. Team pay. Let us now consider the case where the principal observes the firm's output y but not individual workers' efforts. All workers receive the same wage, and this wage is proportional to output.[6] More precisely, each worker receives the same wage

$$w = by/n, \tag{8}$$

where b is a non-negative *bonus rate* b, chosen by the owner. This structure induces externalities. Each worker will now benefit if one of his colleagues works harder. Efforts cause positive externalities and social norms will affect behavior. Workers' material payoff functions are, as before, linear-quadratic in income and effort. With a slight abuse of notation:

$$u_i\left(b, \vec{x}\right) = \frac{b}{n}\sum_{j=1}^{n} x_j - \frac{1}{2}x_i^2 \tag{9}$$

Since all workers are alike, a natural candidate for the ideal effort profile $\hat{x}$ is the profile that maximizes the sum of all workers' material payoffs. It is easily verified that this profile is $\hat{x} = (b, b, ..., b)$. In other words, each worker should ideally exert the same effort b, for any bonus rate $b \geq 0$ that the owner may choose. This way, the sum of workers' material payoffs is maximized. From (1) and (2) we obtain, again with a slight abuse of notation, that

$$\psi_i\left(b, x_i, \hat{x}_{-i}\right) = \frac{b}{n}(n-1)(x_i - b) \tag{10}$$

and

$$\psi_{-i}\left(b, \hat{x}_i, x_{-i}\right) = \frac{b}{n}\left[\sum_{j \neq i} x_j - (n-1)b\right]. \tag{11}$$

The social payoff to worker i is thus

$$v_i\left(b, \vec{x}\right) = G\left[\frac{b}{n}(n-1)(x_i - b), \frac{b}{n}(n-1)\left(\bar{x}_{-i} - b\right)\right], \tag{12a}$$

where $\bar{x}_{-i} = \sum_{j \neq i} x_j / \left(n-1\right)$ is the average effort of workers other than i; and G is twice differentiable with non-positive first partial derivative G_1'. Note that the social

[6] We do not consider contracts that also contain a fixed payment. The main reason is that linear contracts create free-riding incentives in the most transparent and parsimonious way. Another reason for studying this type of contract is that coalition-proofness requires the fixed term to be zero.

payoff is a function of the bonus rate b, the number of workers n, the worker's own effort x_i, and the average effort of others $\bar{x}_{-i}$. We also note that the social payoff to worker i is non-decreasing in his or her own effort.

By equation (4), we have now defined each worker's total utility:

$$U_i(b, \vec{x}) = b \sum_{j=1}^{n} x_j/n - \frac{1}{2}x_i^2 + G\left[\frac{b}{n}(n-1)(x_i - b), \frac{b}{n}(n-1)\left(\bar{x}_{-i} - b\right)\right] \tag{13}$$

The firm's profit — the residual left to the owner — is simply

$$\pi(b, \vec{x}) = y - nw = (1-b)\sum_{j=1}^{n} x_j. \tag{14}$$

The owner is a risk neutral profit-maximizer. To focus on peer effects among the workers, we assume that the employer receives only material payoffs.

The interaction takes the form of a two-stage game, where the owner first chooses a bonus rate $b \geq 0$, and then all workers observe this rate (the contract offered to them) and simultaneously choose their individual efforts x_i.[7] Hence, a strategy for the owner is a real number $b \in \mathbb{R}_+$, and a strategy for a worker i is a function, or "rule " $\xi_i : \mathbb{R}_+ \to \mathbb{R}_+$ that assigns an effort level $x_i = \xi_i(b)$ to every bonus rate b. We solve this game for symmetric subgame perfect equilibrium, that is, subgame perfect equilibria in which all workers use the same strategy and hence exert identical efforts under any given bonus rate b.

More precisely, for any bonus rate $b \geq 0$, let $X^{NE}(b)$ be the set of effort levels x such that x is the common effort level in some symmetric Nash equilibrium at that bonus rate b. A strategy pair (b^*, ξ^*), where $b^* \in \mathbb{R}_+$ is the owner's strategy and $\xi^* : \mathbb{R}_+ \to \mathbb{R}_+$ the common strategy for the workers, constitutes a symmetric subgame perfect equilibrium (SSPE) if and only if ξ^* selects a common Nash equilibrium effort level for all bonus rates and b^* maximizes the owner's profit, given ξ^*. Formally:

$$\begin{aligned} \text{[SSPE1] } \xi^*(b) &\in X^{NE}(b) \text{ for all } b \geq 0 \\ &\text{and} \\ \text{[SSPE2] } b^* &\in \arg\max_{b \geq 0} (1-b)\,\xi^*(b). \end{aligned}$$

[7]In the section below we will also analyse the case where workers can reject the contract and take an outside option in its stead. For now, we shall assume that workers are stuck with their firm. This can be seen as a short-run analysis (where the labor market is sticky) but it mainly simplifies the exposition of the general mechanics induced by a social norm in a firm.

Without a social norm. As a benchmark, let us first consider the situation when there is no social norm operating. In that case $G \equiv 0$ and workers maximize only their material payoffs. From (9) it is immediate that workers' decisions concerning effort are strategically independent in this case. Hence, regardless of whether workers decide simultaneously (as we have assumed) or sequentially, each worker i solves the same maximization problem

$$\max_{x_i \geq 0} \left(\frac{b}{n} x_i - \frac{1}{2} x_i^2 \right). \tag{15}$$

Consequently, the unique Nash equilibrium effort level, under any bonus rate b, is $x_i^* = b/n$ for all workers i—one nth of the socially ideal effort level. Inserting the equilibrium effort into the expression for the firm's profit, we obtain

$$\pi = (1 - b)b. \tag{16}$$

Hence, the owner's choice of bonus rate is simple: set $b^* = 1/2$.

In sum: in the absence of social payoffs, there exists a unique subgame-perfect equilibrium. In this equilibrium, the owner offers a 50/50 split of the firms' revenue with the team of workers. Workers' common effort level on the unique equilibrium path is $x = 0.5/n$.

Note the free-riding among workers in equilibrium. Under any bonus rate, their common equilibrium effort is only one nth of the socially ideal effort level. Hence, if they could, the workers as a collective would like to commit to the higher effort level $x = b$. We will call this effort level the *social ideal*, and we will denote this $\hat{x}(b) = b$.

With a social norm. Suppose now that the function G is not identically equal to zero. A necessary and sufficient condition for a worker's effort to be optimal is

$$x_i = \frac{b}{n} + (n-1)\frac{b}{n} G_1' \left[\frac{b}{n}(n-1)(x_i - b), \frac{b}{n}(n-1)\left(\bar{x}_{-i} - b\right) \right]. \tag{17}$$

Focusing on interior symmetric equilibria, the set of equilibrium effort levels, $X^{NE}(b)$, is identical to the set of fixed points $x = F(x)$, where $F : \mathbb{R}_+ \to \mathbb{R}$,

$$F(x) = \frac{b}{n} \left(1 + (n-1) G_1' \left[\frac{b}{n}(n-1)(x - b), \frac{b}{n}(n-1)(x - b) \right] \right). \tag{18}$$

It follows immediately that no equilibrium effort with social payoffs is lower than the unique equilibrium effort without social payoffs: if x^* is a fixed point under F, then $x^* \geq b/n$.

What about existence of equilibria? We will show below that a sufficient condition for existence is $G_1'(0,0) \leq 1$. This is a natural condition in many situations. Some technical regularity conditions aside, the condition is met (with a margin) if an agent's social payoff is maximized when he exerts his socially ideal effort, given that all other agents exert their socially ideal efforts.[8] To see this, suppose that all other agents stick to their socially ideal efforts. Then $\psi_{-i}(\hat{x}_i, x_{-i}) = 0$, and hence $v_i(\vec{x}) = G[\psi_i(x_i, \hat{x}_{-i}), 0]$. Suppose, moreover, that the social payoff to agent i, in such a situation, is maximized when she, too, chooses her socially ideal effort level. If this level is positive, as it is in the present application, then we necessarily have $G_1'(0,0) \frac{\partial}{\partial x_i}\psi_i(x_i, \hat{x}_{-i}) = 0$, and hence $G_1'(0,0) = 0$ if $\frac{\partial}{\partial x_i}\psi_i(x_i, \hat{x}_{-i}) \neq 0$. This condition is met in "generic" cases of externalities between agents' actions — for example in the present application (see equation (11)).

Proposition 1. *The common effort level x^* in any symmetric Nash equilibrium satisfies $x^* \geq b/n$. If $G_1'(0,0) \leq 1$, then there exists at least one symmetric Nash equilibrium with common effort level $x^* \leq b$.*

Proof Suppose $b \geq 0$. By definition, $G_1' \geq 0$. Hence, $F(x) \geq b/n$ for all $x \geq 0$, so $x^* \geq b/n$ is necessary for symmetric Nash equilibrium. Moreover, $G_1'(0,0) \leq 1$ implies $F(b) \leq b$. Since F is continuous, $F(x^*) = x^*$ for some $x^* \in [b/n, b]$. □

In general, it is not an easy task to find and characterize the set of SSPE, the main reason being the possibility of multiple Nash equilibrium effort levels for a given bonus rate b. Rather than embarking on a general and abstract analysis of the set of SSPE, we move on to a diagrammatic illustration in a special case. Its purpose is to develop an intuition for what *can* happen within the general framework developed here.

Example. Suppose the social payoff to worker i is affine with respect to the externality he imposes on the others, and logistic in the externality they impose on him. It is thus as if each worker attaches a logistic weight to the material externality he imposes on others, and adds this weighted effect to his own material payoff. Formally, let

$$G(\psi_i, \psi_{-i}) = \frac{\psi_i - \psi_{-i}}{\alpha + \beta \exp(-\lambda \psi_{-i})}$$

for parameters $\alpha, \beta, \lambda > 0$. Clearly, G is twice differentiable, has a positive first partial derivative with respect to its first argument, and $G_1'(0,0) = 1/(\alpha + \beta)$. Moreover,

[8] The condition fails if some individual maximizes his or her social payoff by being "over zealous," that is, by exceeding the socially ideal effort when all others stick to the social ideal. We believe this case to be an exception rather than the rule.

$G(\psi, \psi) = 0$ for all ψ, that is, G vanishes when the externality caused by others equals the externality imposed on them (a normalization that turns out to be convenient in later applications). The function G compares the externality created by agent i with the externality imposed on agent i. The larger the difference, the bigger agent i's social utility. This difference is weighted with a term that is increasing in ψ_{-i}, that is, the more others shirk, the less weight agent i attaches to the externality differential.

From equation (18) we obtain

$$F(x) = \frac{b}{n}\left(1 + \frac{n-1}{\alpha + \beta \exp\left[-\lambda(n-1)(x-b)b/n\right]}\right).$$

Figure **??** displays this fix point problem for for $n = 5$, $b = 0.4$, $\alpha = 0.4$, $\beta = 0.8$ and $\lambda = 10$ (broken line), 20 (normal line) and 30 (dotted line). Note that for $\lambda = 30$ there are three fixed points, and note that two of these exceed the socially ideal effort level, $\hat{x} = 0.4$. In those two equilibria, all workers are "over-zealous." For $\lambda = 20$ there are two fixed points and for $\lambda = 10$ there is only one fixed point.

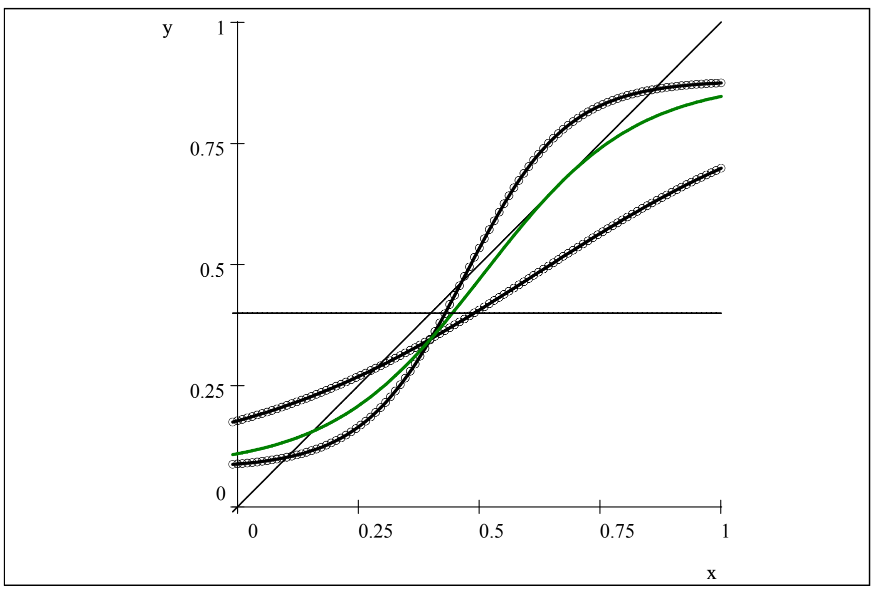

Figure 1: The fix-point equation, for three different parameter values.

The possibility of multiple equilibria immediately raises the question whether there is a reasonable way of selecting among them. In what follows we will make some informal arguments about equilibrium selection. For example, we will discuss what happens when workers coordinate on the payoff-dominant equilibrium. And we will disregard intermediate equilibria as they are unstable under many adaptive expectations.

Figure **??** shows the graph of the Nash equilibrium correspondence that maps each bonus rate b (on the horizontal axis) to the corresponding set of equilibrium effort levels x (on the vertical axis), for $\lambda = 30$. The figure also contains iso-profit curves, and these show that the optimal bonus rate, along the Nash equilibrium manifold, coincides with the optimal bonus rate in the absence of social payoffs, $b = 0.5$. This is one out of infinitely many subgame perfect equilibrium outcomes. In the associated subgame perfect equilibrium, the workers coordinate on the over-zealous equilibrium, exerting effort $x \approx 1.1$. Suppose the owner has chosen the optimal bonus rate, and suppose that the workers, for some reason, instead coordinate on the associated low-effort Nash equilibrium. The fall in profits would be huge and, as the diagram shows, the owner would have been better off by instead choosing a bonus rate around 0.24 where there is a unique subgame equilibrium. Notice also that increasing the bonus rate a little beyond 0.24 causes the unique equilibrium effort to fall. In other words, despite increased economic incentives, the workers work less hard. Economic incentives "crowd out" social incentives. However, a small increase in the bonus rate from about $b \approx 0.31$ can, in theory, bring about a drastic increase in workers' effort by way of a jump to a high-effort equilibrium (non-existent at lower bonus rates), and an accompanying increase in profits.

When looking at the agent's optimal x given a bonus rate b (expression (17)), it becomes clear why individual and total effort can decrease after an increase in the bonus rate. An increase in b has three effects on agent i's effort (holding others' effort constant): It increases i's incentive to work via the direct monetary incentive. It also increases i's social incentive to work as it decreases the (positive) externality i imposes on others. However, an increase in the bonus rate also *reduces* agent i's incentive to work as the (positive) externality others impose on him decreases, which reduces social pressure. If this third effect outweighs the first two effects, agent i starts to reduce his effort which, from a dynamic perspective, will cause a cascade of downward adjustments by the other agents as well.

The diagram also helps us to identify the set of SSPE outcomes. This set consists of two distinct components, one singleton set and a continuum set. The singleton is the profit maxium along the low-effort branch of the Nash equilibrium correspondence, at $b \approx 0.24$ and $x^* \approx 0.18$, resulting in a profit of about $\pi^* \approx .65$. This shows the remarkable effects of a social norm for the firm owner. While in the absence of a social norm the owner makes a maximal profit of 0.25, he gets in this example 160% more—and this with a lower bonus rate than in the absence of the norm. In the presence of the norm the owner can induce considerable effort with much lower bonus rates.

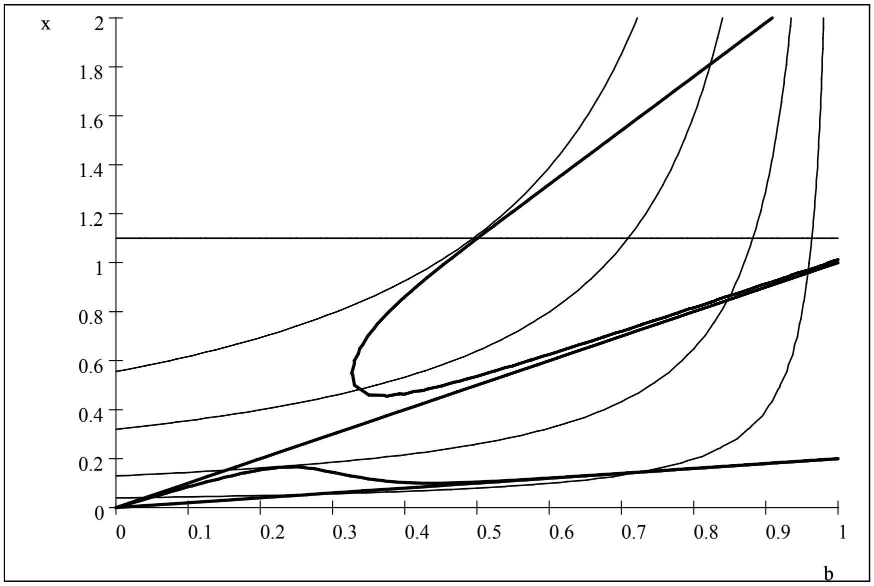

Figure 2: The Nash equilibrium correspondence, mapping bonus rates b to symmetric Nash equilibrium efforts x.

The continuum component of SSPEs consists of those points on the other branch of the Nash equilibrium correspondence where the profit is equal to or higher than in the mentioned singleton equilibrium. To see that this is the case, pick any point on that branch of the Nash equilibrium manifold, (b', x'), with x' being the Nash equilibrium effort at bonus rate b', and let the Nash equilibrium efforts at all other bonus rates be such that the accompanying profit is lower (for example by having all workers play the low-effort Nash equilibrium for all other bonus rates). This provides a SSPE. We also note that *all but one* of the SSPE outcomes in the continuum component rely on *discontinuous beliefs*: at each such equilibrium workers' efforts are expected to jump down by a discrete amount at arbitrarily small changes in the bonus rate. The only SSPE outcome that does not rely on discontinuous beliefs is the above-mentioned optimal bonus rate, $b = 0.5$, combined with the "over-zealous" effort. Hence, if we require continuous beliefs, then there remain only two SSPE: the optimal one and the singleton element. Both make game-theretic sense and rely on continuous beliefs. In this example, our model, augmented with the requirement of continuous beliefs, thus does not produce a a unique prediction: any one of these two SSPE meet the imposed requirements.

Figure **??** shows how the equilibrium correspondence looks when the parameter β has been reduced by 50%. This parameter change reflects that the social payoff to a worker is less sensitive to other workers' efforts. As a consequence, optimal wage setting is markedly different. With high bonus rates there is again multiplicity of Nash equilibria, while there is uniqueness with low bonus rates. However, this time the unique equilibrium with the low bonus rate is the high-effort and not the low-effort Nash equilibrium. This gives rise to the possibility of optimal dynamic wage setting. Suppose the bonus rate is 0.5 (which would be optimal without social norms) and the workers coordinate on the low-effort equilibrium. Then the owner could lower the bonus rate below 0.38, where the low-effort equilibrium ceases to exist, which would cause workers' efforts to jump up to the high-effort branch of the Nash equilibrium correspondence. If there is inertia in worker's effort adaptation to slightly changed bonus rates, so that the common effort stays on the same equilibrium branch, then the bonus rate could be slowly increased to move worker's effort into the first-best outcome at a bonus rate close to 0.5.

In this example, there is a unique SSPE outcome component: that part of the high-effort branch of the Nash equilibrium correspondence where the profit is at least as large as in the high-effort equilibrium when the bonus rate is such that there are exactly two Nash equilibria ($b \approx 0.38$). To see this, first note that lower bonus rates than $b \approx 0.38$ are incompatible with SSPE since a slightly higher bonus rate still has a unique Nash equilibrium in efforts, and results in a higher profit. For the same reasons, too high bonus rates are incompatible too. To see that the remaining continuum is a SSPE component, pick any point on that part of the high-effort branch. The corresponding bonus rate is optimal for the owner if he or she believes that workers will coordinate on a less profitable effort level at all other bonus rates (such equilibria always exist). Again only one of the SSPE outcomes has continuous beliefs: the above-mentioned one in which the owner sets the optimal bonus rate $b \approx 0.5$ and workers are "over-zealous", exerting effort $x \approx 1.1$. Hence, in this example, despite the multiplicity of Nash equilibria for high bonus rates, there exists a unique SSPE with continuous beliefs.

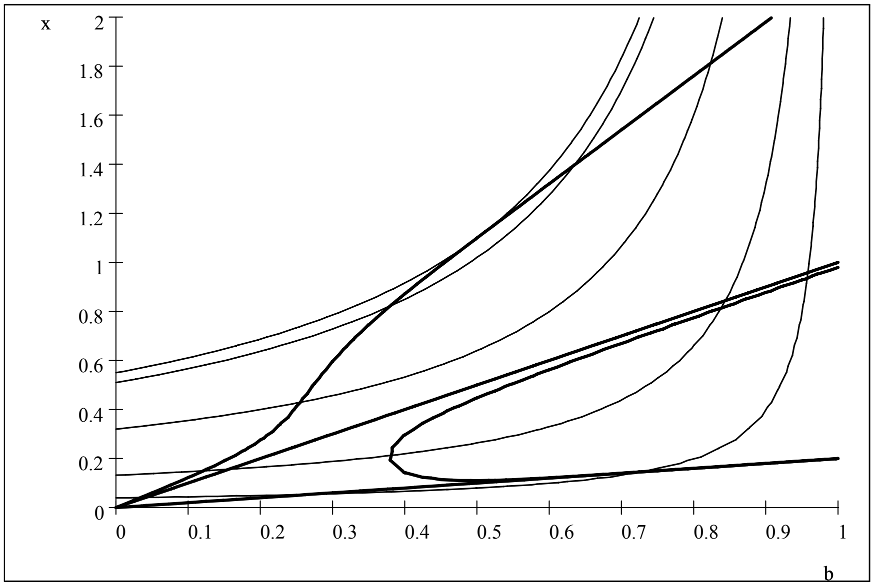

Figure 3: The Nash equilibrium correspondence when workers' social payoffs are less sensitive to others' behavior ($\beta = 0.4$ instead of $\beta = 0.8$).

Before we move on, let us briefly summarize the key effects of social norms that we have seen here:

- Social norms always increase efforts in the simple team-pay framework and, consequently, a firm owner will be better off when he hires workers who are prone to norms.
- Social norms can induce over-zealousness. In equilibrium, workers might work much harder than what would be socially ideal for them.
- The presence of social norms can cause crowding-out effects. Higher monetary incentives can actually *reduce* equilibrium efforts.
- With social norms there might be scope for optimal dynamic wage setting where bonus rates are either reduced or increased for a while only to destroy an unwanted low-effort equilibrium.

3.3. Relative-performance pay. In the model versions considered so far, a worker's effort causes a positive externality for others—an increase in i's effort increases j's income and hence material payoff, *ceteris paribus*. We saw that a social norm based on externalities then works in favor of the firm owner. In other environments, such as when there is an element of competition between the workers, one worker's effort may cause a negative externality on other workers—an increase in i's effort may decrease j's income. Can a social norm then work against the owner's interest? If social payoffs (induced, perhaps, through peer pressure) make workers compete less hard with each other, then social payoffs may restrain their efforts and cause profits to be lower than if workers had only material payoffs.

In order to analyze this in the simplest possible setting, suppose now that the owner observes each worker's effort with some noise and pays each worker i a wage w_i proportional to the worker's *relative* performance. More specifically, let the wage of worker i be

$$w_i = \begin{cases} b\frac{x_i}{\sum_{j=1}^n x_j} \text{ if } \sum_{j=1}^n x_j \geq m \\ 0 \text{ if } \sum_{j=1}^n x_j < m \end{cases} \tag{19}$$

where $m > 0$ denotes a minimum output the firm owner demands. Worker i's material payoff is now given by

$$u_i(b, \vec{x}) = \begin{cases} b\frac{x_i}{\sum_{j=1}^n x_j} - \frac{1}{2}x_i^2 \text{ if } \sum_{j=1}^n x_j > m \\ -\frac{1}{2}x_i^2 \text{ if } \sum_{j=1}^n x_j < m \end{cases}. \tag{20}$$

As before, the firm owner collects the residual

$$\pi = y - b = \sum_j x_j - b.$$

It is straightforward to compute the social ideal. For sufficiently small m, it is given as

$$\hat{x}_i = \frac{m}{n}$$

for all i and yielding payoffs of $\frac{2nb-m^2}{2n^2}$. On the other hand, the Nash equilibrium efforts in the absence of a social norm are given by

$$x_i^* = \frac{1}{n}\sqrt{(n-1)\,b}.$$

Thus, the optimal bonus is $b = \frac{n-1}{4}$ inducing profits of $\frac{n-1}{4}$.

Let us now introduce social norms in the same manner as before. A worker's total utility in the presence of a norm is given as

$$\begin{aligned} U_i(b, \vec{x}) &= u_i(b, \vec{x}) + v_i(b, \vec{x}) \\ &= b\frac{x_i}{\sum_{j=1}^n x_j} - \frac{1}{2}x_i^2 && (21) \\ &\quad +G_i\left[\psi_i(x_i, \hat{x}_{-i}), \psi_{-i}(\hat{x}_i, x_{-i})\right], && (22) \end{aligned}$$

where, as before,

$$\begin{aligned}\psi_i\left(x_i, \hat{x}_{-i}\right) &= \sum_{j \neq i} \left[u_j(x_i, \hat{x}_{-i}) - u_j(\hat{x})\right] \\ &= (n-1)\left(\frac{bn}{n(n-1)+mx_i} - \frac{b}{n}\right) \qquad (23)\end{aligned}$$

and

$$\begin{aligned}\psi_{-i}\left(\hat{x}_i, x_{-i}\right) &= u_i\left(\hat{x}_i, x_{-i}\right) - u_i(\hat{x}) \\ &= \frac{bn}{n+m(n-1)\bar{x}_{-i}} - \frac{b}{n}\end{aligned}$$

The fixed-point problem becomes

$$x = b\frac{(n-1)}{n^2 x} + G'_{i1} * \frac{-bn(n-1)m}{(n(n-1)+mx)^2}$$

Since $G'_{i1} > 0$ it is clear that equilibrium efforts will be lower in the presence of social preferences. If the incentive scheme is such that one workers' effort causes negative externalities for others, a social norm is detrimental for the firm. Let us illustrate this also with an example, using the same G-function as above,

$$G(\psi_i, \psi_{-i}) = \frac{\psi_i - \psi_{-i}}{\alpha + \beta \exp\left(-\lambda \psi_{-i}\right)},$$

and parameters $n = 5, m = 0.01, \alpha = 10^{-4}, \beta = 8 \times 10^{-3}, \lambda = 5$.

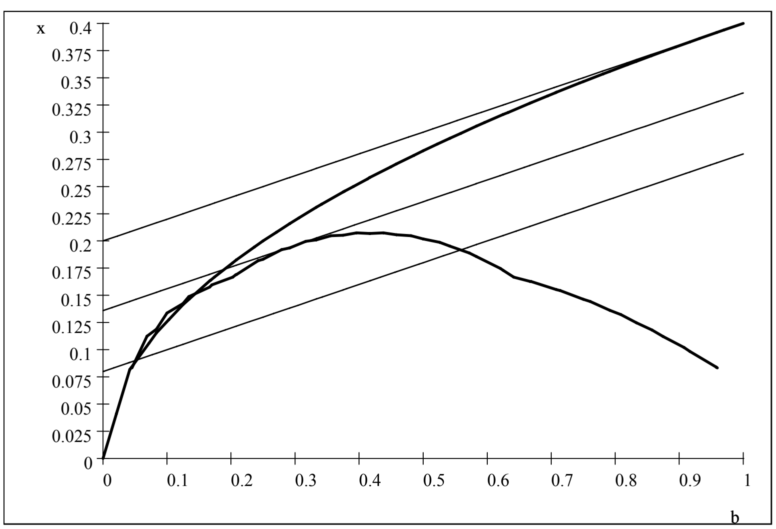

Figure 4: The equilibrium correspondence for relative-performance pay with (bottom) and without (top) a social norm.

Figure **??** shows two equilbium correpondences, one for the case without a social norm (the top curve) and one for the case with a norm with this set of parameters (the bottom curve). The straight lines are isoprofit curves with increasing profits towards the northwest. There are three important observations to make. First, as derived for the general case, norms harm the firm's performance. Second, the optimal bonus rate in the presence of the norm is far smaller than the optimal bonus rate in the benchmark case without a norm. Third, we find again that steeper incentives can actually reduce efforts. Crowding-out can, thus, occur regardless of whether a norm encourages good or discourages bad behavior.

4. Discussion

Social norms root in externalities. They encourage actions that induce positive and discourage actions that induce negative externalities. The strength of the social norm may depend on how well others adhere to it. These are the basic premises for our paper that, following these premises, develops a general framework for studying social norms in economic contexts. This framework is fully flexible and can be applied to any economic context where externalities are important.

Our application is that of a very simple firm with a linear production technology. The fundamental observation we make is that in such a firm economic incentives can determine the *sign* of the effect that social norms have on actions. One and the same social norm can be efficency-enhancing, neutral, or efficiency-decreasing depending on the type of contract used. More specifically, we show that individual piece rates render social norms irrelevant, team pay utilizes them to enhance efficiency while tournament incentives render norms detrimental. This suggests the importance of "norm management" when a principal designs a contract.[9] In particular, team pay emerges as an incentive scheme that can generate effort-enhancing social presssure.[10]

We also illustrate that social norms make the optimal design of economic incentives tricky as there can be multiplicity of equilibria, jumps, and crowding out — all of which can give rise to optimal dynamic wage setting.

The paper raises many new questions. First of all, one can explore the robustness of our results in a variety of settings and in an older version we examined, among other cases, sequential production, franchises, binding outside options, etc. But there also other types of questions. One that is immediate concerns the issue of

[9]See Kübler (2001) on the similar notion of "norm regulation".

[10]A related argument in favor of team work is provided by Che and Yoo (2001). They show that team pay can be optimal in a dynamic setting even if individual contributions are verifiable. Implicit contracts, i.e. sanctions against free riders by other team members, increase effort levels beyond those achieved by contracts based on individual performance.

equilibrium selection on which we have only touched above. One possible avenue for future research is to apply tools from evolutionary game theory to investigate this in more detail. Another question where tools from evolutionary models could be useful concerns the endogeneity of the social norm. In our model we have assumed that workers have social preferences and we have not studied where these preferences originate from. Intuitively, one might suspect that agents who have such preferences have an evolutionary disadvantage since others (with standard preferences) can always free ride on them. However, a key observation for understanding the *evolution* of work norms is that the matching between workers and firms is typically not random (as normally assumed in evolutionary models and implicit in the above argument for why free-riders should survive). Rather workers apply to selected firms and firms select applicants after careful interviewing. Firms care a lot about dimensions that can be summarized under "personality".[11] A version of our team production model can explain why this is the case. As the equilibria in the effort game are Pareto-ranked, our firm would try to select workers who are sensitive to peer pressure. Firms that don't care for the "personality" of their workers would consistently earn less than others, and might therefore ultimately disappear. For workers, similar dynamics may apply. Those who are insensitive to peer pressure would only be selected by firms with a lower "work morale," that is, by firms that in equilibrium pay less and that face a bigger risk of being shut down. This implies a double disadvantage for workers who are insensitive to social norms and would free-ride. They earn lower wages and they are more likely to lose their jobs. Hence, there may be evolutionary selection in favor of workers who are sensitive to peer pressure in such settings. Interestingly, the opposite holds true for tournaments. A firm using relative performance schemes would like to select workers who are insensitive to social pressure. Thus, different incentive schemes can lead to sorting of worker types, a phenomenon which may be related to certain personality differences observed between the private and the public sector.[12]

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[11] See, for example, the recent article by Highhouse (2002) who discusses the advantages of the "holistic approach" to personnel selection over standardized tests.

[12] See, for example, Francois (2000), who deals with public sector motivation from the vantage point of economics, or the recent survey on public sector motivation in the literature on public administration by Wright (2001).

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