Making a Difference

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Despite the potential for free-riding, workers motivated by 'making a difference' to the mission or output of an establishment may donate labor to it. When the establishment uses performance related compensation (PRC), these labor donations closely resemble a standard private provision of public goods problem, and are not rational in large labor pools. Without PRC, however, the problem differs significantly from a standard private provision of public goods situation. Specifically, in equilibrium: there need not be free-riding, decisions are non-monotonic in valuations, and contribution incentives are significant even in large populations. When PRC is not used, the establishment tends to favor setting low wages which help to select a labor force driven by concern for the firm's output. Expected output can actually fall with the wage in this situation. When wages are optimally set, the introduction of PRC, even if perfect and costless, may lower expected output and firm profits in comparison to the non-PRC outcome.

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1 Introduction

Many organizations are involved in the provision of services or activities that are of wide public concern and draw on donations from employees who share those concerns. Such donations may take a monetary form, and also come in the form of donated labor from volunteers. Paid employees who are willing to work for less than their outside options are also donating labor. Such labor donations have been argued to arise in the provision of education, health care, child-care, charities and social work. Workers often couch their motivation to work in firms providing these services as a desire to "Make a Difference", i.e., to positively change (at least a small part of) the world through their job.[1] But such outcome oriented donating can be subject to free-riding, which is the focus of the present paper. A potential employee may share a concern for the quality of service provided by an organization but conjecture that were they not to take a low paid opening with it, someone else with a similar motivation would. In that case, donating their labor does not "make a difference" because the required tasks would be performed nonetheless.[2]

It is demonstrated here that, in some situations, such outcome oriented giving shares many features of standard private provision of public goods problems. Specifically: 1) there is free-riding in equilibrium - each individual donates less (often) than they would if there were no others; 2) individuals with high valuations donate more (often) than the low; 3) the extent of free-riding is increasing in population size. Though sharing these similarities in some situations, the structure of the labor donations problem also generates insights that are not standard, and which may explain the widespread lack of perfomance related pay and high powered incentives in public good providing organizations.[3] Labor donations are fundamentally differ-

[1] A recent Brookings Institution survey of over 1200 nonprofit workers found that nearly half of all paid charity workers believe they could make more money elsewhere but take the work because they are driven by mission not money. 97% feel they accomplish something worthwhile with their job, and are happy to take the lower pay in order to have a chance to "help people and make a difference", see Light (2003). The US Quality of Employment Survey analyzed by Mirvis and Hackett (1983), finds nonprofit workers reporting higher levels of intrinsic motivation, feelings of accomplishment, and importance of work relative to money in their occupations. The proportion of the labor force in such sectors is not small: 9.5% of the paid workforce is employed in the non-profit and charity sectors in the US. There is also a widespread perception that the non-profit sector requires workers to take pay cuts for the privilege of meaningful work. For example, a prominent Bay Area non-profit placement agency, "BANJO", states that "As a general rule of thumb, total nonprofit compensation tends to be 25% to 50% lower than similar positions in the private sector". Benefits, and especially bonuses, represent a large share of this difference, (see http://www.ynpn.org/banjo/ol_book/app2.htm).

[2] The free-riding problem does not occur if workers receive utility only when they themselves are employed in the firm about whose mission they care. Mission motivation in this sense, as modeled for example by Besley and Ghatak (2005), is not outcome oriented, per se, but is more closely related to a compensating differential.

[3] A sample of empirical studies documenting the use of low-powered incentives in such organi-

ent from standard donations in that they may be subject to moral hazard. When labor effort is not readily supervised or directly contracted, the act of claiming to donate labor - that is, filling the job - is separate from actually doing so, and taking such a position precludes donations from somebody else. Adding this component to the standard private provision of public goods problem changes results markedly, specifically it is shown that: 4) there need not be free-riding, even in large labor pools; 5) job applications are non-monotonic in individual valuations; 6) asking for larger donations (i.e. paying lower wages) may increase expected output; and 7) output contingent rewards may yield lower expected output than flat rates of pay.

A simple example, familiar to most academics, makes clear the forces at work. In most departments, few individuals actively seek the position of department head but instead perform it (often reluctantly) out of a concern for departmental welfare. Though many are capable and concerned, most would prefer someone else do it so they can free-ride and concentrate on research. However, this changes dramatically when it seems possible that individuals motivated by personal concerns (and not those of the department) may fill the head's position. In that case, those reluctant to fill administrative positions may be induced to volunteer by their concern for the department's well-being. This motivation is absent if the contract between the department and its head is complete. An output contingent contract that correctly aligns the department and head's interests, or a technology that allows full supervision of the head, ensures correct tasks are undertaken irrespective of the head. A potential volunteer then rightly conjectures that his filling the job makes no difference and has incentive to free-ride. However, if the department head's contract and the supervision technology are not perfect, then the "right" actions cannot be ensured. In that case, those ordinarily reluctant to personally bear the costs of the position may do so. They are "making a difference" by doing the job better than another likely candidate would. Labor donations motivated by this concern make sense even in arbitrarily large groups, so that the usual finding of group size exacerbating free-riding need not apply.

The paper demonstrates the potentially perverse effect of wages in such situations. Most departments register only nominal salary increments for department heads, despite the reluctance to fill such positions. According to the present paper, significant salary increments are avoided because these induce not only individuals with departmental motivations, but also those who are pecuniarily motivated to apply. Given the impossibility of specifying the head's tasks through contract, this can actually worsen the pool of potential applicants, lead to a higher probability of the "wrong" candidate getting the job, and lower departmental output.

Low wages may thus be preferred when contracts cannot be specified. However, more surprisingly, even when contracts can be costlessly and perfectly enforced, it

zations are discussed after the main results.

is shown that firms may prefer to leave labor uncontracted and unsupervised. By leaving worker tasks uncontracted, the incentives created for good workers to participate can actually be strong enough to offset the potential damage that arises from hiring a shirker. The use of performance related compensation (PRC) which fully solves labor's moral hazard problem, can lower expected output relative to when labor is free to simply choose its own level of effort. The model can thus explain why public good producing establishments may eschew the use of performance related compensation even where it can be implemented perfectly and costlessly. The threat of morally hazardous behavior serves the role of inducing sincerely concerned individuals to donate labor and "make a difference". Formally, this is an application of the theory of the second best. In the presence of two distortions – a public goods problem and moral hazard – addressing any one – namely, using incentive payments – may worsen performance.

The paper proceeds as follows. The next section briefly relates strands of the literature relevant for the current research. Section 2 sets up the model and solves for equilibria in the labor donations game both with PRC (Section 2.1) and without it (Section 2.2). Section 3 considers an example which compares optimal wages, output and profits both with and without PRC for a tractable, uniform distribution, case. Section 4 concludes. All proofs are in the appendix.

Previous literature

Besley and Ghatak (2005) also explore the implications of an employee's concern for outcomes on organizational design. In their framework, this "mission motivation" takes the form of impure altruism, not the pure altruism assumed here.[4] The individual thus only obtains the benefit when working in provision of the good. Treating the motivation in this way removes the free-riding problem so that it plays no role in their analysis. This is also true of any warm-glow treatment of such donations, for instance that used by Cornes and Sandler (1986) and Andreoni (1990), or for personal investment reasons as in Menchik and Weisbrod (1987). The implications for such intrinsic motivation on the form of optimal contracts are studied in Murdock (2002). Here, however, the free-riding induced by outcome oriented motivation is a central concern. In reality, worker non-pecuniary motivations are likely to combine both pure and impurely altruistic components. The present paper's exclusive focus on the pure altruism thus complements the previous exclusively impure altruism focus.

The paper closest to the present one is Engers and Gans (1998) who also examine incentives to provide effort when concern for the output produced is a primary

[4] Rose-Ackerman (1996) defines pure altruism as altruistic concern which is independent of the provider's identity. An impurely altruistic individual, in contrast, only benefits from the consequences of her own efforts.

motivation. That paper provides an efficiency rationale for why referees may not be paid. Specifically, upon receipt of a paper to referee, if the accompanying payment for the task is large enough, the referee correctly anticipates that, were he to decline the refereeing assignment, the next person asked would be likely to accept it. If the accompanying payment is low, however, then chances are high that the next referee would not accept the task. In that case, the referee motivated by professional concern accepts the assignment. The main contrast with the present paper is that the free-riding which is central to the private provision of public goods problem is circumvented by the direct targetting that occurs through the editorial process. The participation problem of a referee differs from that of a worker ordinarily deciding on a labor donation because the editor of a journal is able to directly solicit the efforts of the referee, and this is done sequentially. To see this, note that, in Engers and Gans (1998) the arrival of a paper to referee from a non- (or low) paying journal, strictly lowers the referee's utility. A referee would never volunteer to be put into the position of having to decide on whether to accept an assignment or not. Thus, part of the free-riding problem inherent to the situation is solved by the editor's direct soliciation. This suggests their structure may be of limited applicability to the problem of labor donations in general. Firms are rarely able to directly solicit potential workers, instead, as modeled here, a notice of vacancy is placed, applicants forward their services, and the firm chooses amongst applicants for the job.

Francois (2000) also investigates the implications of a type of labor donation by workers who are concerned with the output of an organization. However, in that framework, the free-riding problem which is at the heart of the present analysis, does not arise. This is because the moral hazard problem in production is solved by an efficiency wage there. Since the efficiency wage needs to be above opportunity cost in order to induce incentive compatible effort provision, workers end up being more than compensated for the disutility of effort. Also, since workers are homogeneous there, the worker's participation constraint – which is key to the free-riding problem at the centre of the present analysis – never plays a role. In that model, wages are adjusted to simply ensure incentive compatibility, and the focus is on when an organization with a residual claimant must pay higher wages than one without. Because the present paper is concerned with the free-riding that might occur in organizations that are providing public goods (or services that many potential employees may care about), the participation decision is of central concern, not the incentive problem. The model is thus structured here so that both with and without PRC, wages have no effect on incentives. The focus is instead on how wages affect participation when there is PRC and when there is not, and why this may lead to low wages being chosen in the non-PRC case, and why PRC may sometimes be avoided altogether.

Duncan (1999) is also concerned with donations of worker effort, and specifically on whether such donations will be perfectly crowded out by government provision.

However, the model there effectively assumes the use of perfect performance related compensation, as there is no moral hazard in labor supply, and then demonstrates that donations of effort are conceptually similar to monetary donations.[5] Here, in contrast, the important results arise when PRC is not used. As will be seen, because this significantly alters the private provision of public goods problem, insights gained from the standard problem do not apply.

2 The model

There is a single firm. The firm provides a public good, the amount of which is denoted g. The population comprises $N+1$ heterogeneous individuals varying by their valuations of the good, which are non-observable. Individual $i's$ strength of valuation is denoted by the parameter $\gamma_i \geq 0$, which is private information. For N of these individuals, the parameter γ is independently drawn from a common continuously differentiable distribution, $F(\gamma)$, with support $[0, \infty)$. Individuals with high γ_i value the public good relatively more, and those with $\gamma_i = 0$ do not value it at all.[6] The $N+1th$ individual is assumed to have a value of $\gamma_i = 0$. Thus, for any population, there exists at least one individual with zero valuation of the public good, the reason for this assumption will become clear subsequently. The distribution, $F(\cdot)$ is common knowledge and it is continuous. An individual of type $i's$ utility is given by:

$$u_i = \mu(w_i) - c(e_i) + \gamma_i v(g), \tag{1}$$

where w_i denotes $i's$ consumption of a numeraire good and e_i denotes $i's$ effort expended at work, and the functions μ, c and v are strictly increasing and weakly concave and $\mu(0) = c(0) = v(0) = 0$.[7]

We analyze a situation in which the firm requires a worker to participate in its production, and we assume that this worker is to be drawn from the pool of

[5] That literature is also related to the issue of monetary donations for non-profit firms as explored, for example, by Bilodeau and Slivinski (1998). The role of firm commitment in helping illicit donations is also a central concern in Glazer (2004) and in other papers which have emphasized that organizations without residual claimants are more likely to receive them; Hansmann (1980), Rose-Ackerman (1996), Francois (2003), and Grout and Yong (2003).

[6] We shall not dwell on the reasons for variation in γ, which seem to be an indisputable feature of reality. These could arise directly from preferences; some individuals may care more for features like environmental quality, public health care, quality of public schooling, etc. Or they may arise from differences in wealth that are orthogoanl to the concerns here; demand for such public goods may have positive income elasticity.

[7] The separability between the sub-components of utility greatly simplifies the analysis but is not strictly necessary. It is possible to obtain qualitatively similar results for more general specifications of preferences. As is standard where wages must serve to elicit effort, restrictions will need to ensure that complementarities between effort and income are not too large. The addition of public goods here simply requires a similar restriction to the complementarity between public goods and the other elements of the utility function.

$N+1$ potential applicants whose preferences are characterized by (1). The firm's production function is:[8]

$$g = g(e), \tag{2}$$

where e is the amount of effort exerted by the worker in question. For simplicity, we shall assume this production function takes a binary form – though qualitative results generalize to a more standard smooth production function, and to multiple employees. The production function is:

$$g(e) = \begin{cases} 0 \text{ for } e < \overline{e} \\ 1 \text{ for } e \geq \overline{e}. \end{cases}$$

The sequencing of events is as follows. The firm enters the labor market and advertises the position; i.e., wages and conditions (effort requirements). One of three possible outcomes ensues: (1) the firm is unsuccessful in attracting any applicants for the position, in that case, the firm's output is given by $\overline{g}$; (2) the firm fills the position, but the worker turns out to be a shirker who contributes $e < \overline{e}$, and output is thus 0; (3) the firm fills the position with a worker who contributes the correct level of effort, $e \geq \overline{e}$, and output equals 1. We will assume throughout that failing to fill a position is less detrimental to output than filling a position with a worker who shirks, and naturally that filling a position with a non-shirker is better than not filling it at all. This requires that: $0 < \overline{g} < 1$.

All workers not working at the firm producing the commonly valued output receive a wage that just compensates for the disutitily of work, which is normalized to zero, i.e., for all other workers, $w_i - e_i = 0$. We shall also assume that there is a minimum wage that the firm can set, denoted $\underline{w} \ll \overline{e}$. We impose such a minimum because we are interested in labor donations of paid employees, in contrast with pure volunteers, as for example studied by Menchik and Weisbrod (1987). It also does not make sense to analyze performance related compensation (which amounts to promising payment upon performance) with promised payments that are zero, although nothing in the analysis logically excludes applying the results to a case of $\underline{w} \to 0$.

We proceed by analyzing two distinct cases. In the first, the firm is able to perfectly condition wages on effort supplied. This may be because the worker can be easily monitored, or because it is possible to organize effort contingent compensation through some other means. We shall call this the case of performance related

[8] The nature of the firm, i.e., it's government, non-profit, or for-profit status, is not considered here. When the firm is unable to commit to output, for example if the firm controlled other inputs that could be adjusted in light of donated labor, an individual's desire to donate labor could be affected by its for-profit status. This has been a factor used previously to argue for the existence of non-profit firms, as in Francois (2003), but will not be exploited here, as it is assumed that firms do not have a commitment problem.

compensation (PRC). The second is a situation where labor cannot be directly compensated for effort, so that a moral hazard problem arises; the non-PRC case. In this case, a non-performing worker can reap a pecuniary gain by taking the job.

Performance related compensation

Under PRC, the sequencing of moves is as follows: The firm calls a wage/effort pair denoted (w, e), where w is the total payment received in return for e units of effort. The wage effort pair is enforceable. All $N+1$ individuals then simultaneously choose whether to apply for the job or not. If none apply then $g = \overline{g}$. If at least one applies, the firm simply chooses amongst them randomly, selecting one with equal probability from the pool of applicants. All the others remain in the alternative occupation, receiving $w_i - e_i = 0$. Since PRC is used, the successful applicant must contribute effort $\overline{e}$ and output equals 1.

Clearly, any contracted payment, $w : \mu(w) \geq c(\overline{e})$ would induce participation and ensure $g = 1$. With such payments, there is no free-riding problem, but there are also no labor donations, since workers receive more than necessary to compensate for the disutility of effort. Labor donations can only arise if the firm calls a contracted pair with $\mu(w) < c(\overline{e})$. Would anyone participate at such wages? The problem now has a private provision of public goods structure. Individuals with high valuations; $\gamma_i [v(1) - v(\overline{g})] > c(\overline{e}) - \mu(w)$, would strictly prefer to take such a position if they were the only ones able to fill the position, but with others who also value it, individuals can have incentives to free-ride.

These considerations lead to a symmetric Nash equilibrium which closely resembles a standard private provision of public goods problem:[9]

Proposition 1: With PRC, for any payment/effort pair $(w, \overline{e})$, with $\mu(w) < c(\overline{e})$, there exists a symmetric Nash equilibrium of the labor donations game which is unique. Equilibrium is characterized by a cut-off, γ^*, solving:

$$[1 + (N-1)(1 - F(\gamma^*))] F(\gamma^*)^{N-1} \gamma^* [v(1) - v(\overline{g})] = c(\overline{e}) - \mu(w). \tag{3}$$

All individuals for whom $\gamma_i \geq \gamma^*$ apply for the job, all individuals for whom $\gamma_i < \gamma^*$ do not.

The donating individual equates her personal cost to providing the effort - the right hand side of (3) $c(\overline{e}) - \mu(w)$, and her personal benefit to providing it, which is that the public good is produced for certain instead of with probability $1 - F(\gamma^*)^{N-1}$ (which occurs when at least one other population member exceeds the cut off). Note

[9] We focus throughout exclusively on symmetric equilibria.

that, here, what induces an individual with γ above γ^* to apply is the probability that none of the $N-1$ other individuals will be a type γ above γ^*.

There is free-riding in equilibrium if $\gamma^* > \frac{c(\overline{e})-\mu(w)}{v(1)-v(\overline{g})}$. Individuals, i, for whom $\gamma^* > \gamma_i > \frac{c(\overline{e})-\mu(w)}{v(1)-v(\overline{g})}$, do not apply because they conjecture that there is a good enough chance of someone with higher valuation, i.e. $\gamma > \gamma^*$ working instead. Even though these individuals would apply if on their own, they optimally choose to risk provision of the good in a population with $N \geq 2$. In expectation, the probability of any one individual being a free-rider, and thus the expected proportion of free-riders, is given by $F(\gamma^*) - F\left(\frac{c(\overline{e})-\mu(w)}{v(1)-v(\overline{g})}\right)$. As in standard private provision of public goods problems, as N increases, the amount of free-riding increases:

Corrollary 1: (i) For $N=1$, $\gamma^* = \frac{c(\overline{e})-\mu(w)}{v(1)-v(\overline{g})}$. (ii) The amount of free-riding is strictly increasing in N.

The labor donations problem with contractible labor thus closely resembles a standard private provision of public goods problem: there is free-riding in equilibrium and the extent of free-riding increases with N. Moreover, vacancies are endemic, at least probabilistically, as these provide incentives for labor to donate.

The firm's choice variable, w, simply adjusts the threshold for participation. Increasing w monotonically increases the equilibrium level of provision upto $\overline{e}$. By choosing a high enough w, (limiting at $w : \mu(w) \geq c(\overline{e})$) participation is ensured, and output is produced with probability 1. Lower values of w save on labor costs, but leave open the possibility of non-provision, as the expected number of applicants must be strictly less than one in equilibrium to induce participation.[10]

Non-performance related compensation

Firms do not always use performance related compensation. One reason is simply technological. Contracting for labor effort requires some means of supervising and

[10] Our sequencing of the labor market operation assumes the posting of a wage and effort requirement by the firm, with the subsequent participation of workers in response to this. Such a mechanism mirrors the actual functioning of labor markets but is not efficient (i.e. there is always an equilibrium probability of non-provision) and is generally dominated by alternative more complicated mechanisms which can ensure efficiency by eliciting signals from employees. One such mechanism is a type of second price auction where the firm asks potential employees to state the lowest wage at which they would be willing to work, and then commits to hiring the lowest wage worker at a wage equal to that stated by the second lowest. It will be seen that such a mechanism would not solve the problems created when moral hazard also accompanies the position (the next section), and also does not accurately describe job allocation mechanisms that we observe in reality. We thus use the benchmark described in Proposition 1 to compare with the moral hazard case to follow.

verifying effort contributions. Contracting on output, as in a piece-rate, is more likely to be feasible. But to do this, one needs the output to be relatively homogeneous and, in order to administer individual piece-rates, individual contributions should be readily discerned. Even where such contracting and/or supervision is technologically feasible, there are often significant costs to doing so.

In standard models, where there is no public good element to the good being produced, or no direct utility gain from provision of effort, workers are motivated to contribute effort only when firms create a pecuniary incentive to doing so; through PRC or some other means. Here we will see that this need not be the case. The set up we use here is similar to that developed by Macleod and Malcomson (1989), elaborated in Malcomson (1999). In this formulation, there is no observable signal of effort that is readily available (at feasible cost) on which the establishment can condition remuneration.[11] Specifically, a hired worker is paid an agreed upon wage independent of the firm's performance, and without any possibility of the firm observing the worker's performance. Once employed, the worker simply chooses the effort level she contributes, and this choice has no pecuniary impact. Thus, once the individual has been hired, output either equals 0 or 1 depending on whether $e > \overline{e}$. In the framework developed by Macleod and Malcomson the possibility of repeated interaction serves to maintain incentive compatibility. Here we shut down this possibility by analyzing a once off interaction so that, by construction, workers without sufficiently high valuation of the public good will not contribute the required effort.

The equilibrium of the labor donations game will be similar to that of the PRC version already analyzed except that an employed worker receives the wage independently of whether the correct effort is provided. Thus, two types of workers potentially fill a position: (i) motivated applicants, for whom $\gamma_i \left[v\left(1\right) - v\left(0\right)\right] \geq c(\overline{e})$, these individuals will provide the correct effort level; (ii) shirkers, for whom $\gamma_i \left[v\left(1\right) - v\left(0\right)\right] < c(\overline{e})$, these individuals will not find it worthwhile to provide the correct effort. They apply not because of the possibility of making a difference, but because the lack of performance related compensation allows them to receive w without effort.

[11] Of course, the present formulation of the problem does have a direct measure of output that could, in principle, be contractible - the level of service, g. But even when this is contractible, there are more fundamental reasons why such output contingent remuneration of labor may not be feasible. Firstly, the firm will usually control other inputs, so that the worker's effort is not as deterministic of service quality as modeled here, secondly, most goods require the contribution of more than one worker, which raises the problem of rewarding individual contributions, thirdly, the writing of such contracts may be extremely costly, or may induce sub-optimal effort allocations (due to multi-tasking concerns). The addition of any of these features would provide a more fundamental reason for worker effort to be non-contractible. For simplicity, none of these are directly modeled here. We take the non-contractibility as given since results would be unchanged no matter what the underlying source.

Let $n(w, N)$ denote the number of applicants that the single firm receives when offering payment of w, in a population of size N, who are independently drawn from the identical distribution $F(\gamma)$. The variable n is endogenous and will be determined subsequently. Recall that the total number of potential applicants includes N individuals whose γs are independently drawn from $F(\gamma)$ and the $\gamma = 0$ type. It is immediately clear that, in the absence of PRC, the individual for whom $\gamma = 0$ will apply at any positive wage, and since we restrict analysis to positive wages only, all N individuals know that the applicant pool will always be non-empty.

Consider first the application decision for motivated individuals who have a high valuation of the good, i.e., a $\gamma_i \geq \frac{c(\overline{e})}{[v(1)-v(0)]}$. If obtaining the job, such an individual would contribute effort to good provision, since the benefit exceeds the cost. This individual applies if they affect the probability of provision sufficiently much to warrant the effort that they would expend in the position. If applying, since jobs are allocated randomly, the probability of obtaining the position is $\frac{1}{2+n(w,N-1)}$. That is, the applicant pool includes the $n(w, N-1)$ other applicants, the individual applicant himself, and the individual with $\gamma = 0$. If not applying, the probability of the good being produced is denoted $\sigma(w, N-1)$, which is also endogenous and determined subsequently.

The following expression compares, at wage w, the expected net benefit to applying (the left hand side) with the expected net benefit to not applying (the right hand side):

$$\frac{1}{2+n(w,N-1)}\left(\mu(w) - c(\overline{e}) + \gamma_i v(1)\right) + \left(1 - \frac{1}{2+n(w,N-1)}\right)\begin{bmatrix} \sigma(w,N-1)\gamma_i v(1) \\ +(1-\sigma(w,N-1))\gamma_i v(0) \end{bmatrix}$$
$$\gtreqless \sigma(w,N-1)\gamma_i v(1) + (1-\sigma(w,N-1))\gamma_i v(0).$$

Re-arranging this expression yields the high values of γ corresponding to individuals who both apply and donate effort to the firm:

$$\gamma_i \geq \frac{c(\overline{e}) - \mu(w)}{(1-\sigma(w,N-1))[v(1)-v(0)]}. \tag{4}$$

The intuition for this condition is similar to that for condition (3). Individuals with high valuations are not willing to risk the good not being provided, and are thus willing to volunteer labor effort to ensure it is undertaken.

Now consider the low valuation types; $\gamma_i < \frac{c(\overline{e})}{[v(1)-v(0)]}$. If employed at the firm, such individuals would not contribute effort. Moreover, if their decision to apply were to have no impact on expected output, they would always strictly prefer to take the job at any $w > 0$. The reason they do not all apply is that the level of output provision is affected by their taking the job. Their relative benefit to doing so is given by the two sides of the following expression:

$$\frac{1}{2+n\left(w,N-1\right)}\left(\mu\left(w\right)+\gamma_i v\left(0\right)\right)+\left(1-\frac{1}{2+n\left(w,N-1\right)}\right)\left[\begin{array}{c}\sigma\left(w,N-1\right)\gamma_i v\left(1\right)\\ +\left(1-\sigma\left(w,N-1\right)\gamma_i v\left(0\right)\right)\end{array}\right]$$
$$\gtreqless \sigma\left(w,N-1\right)\gamma_i v\left(1\right)+\left(1-\sigma\left(w,N-1\right)\gamma_i v\left(0\right)\right)$$

Individuals for whom the left hand side of the expression above is larger than the right, strictly prefer to apply for the job. Rearranging this yields:

$$\gamma_i \leq \frac{\mu\left(w\right)}{\sigma\left(w,N-1\right)\left[v\left(1\right)-v\left(0\right)\right]}. \tag{5}$$

Individuals with valuations of γ above the right hand side of (5) but below $\frac{c(\overline{e})}{[v(1)-v(0)]}$ do not apply for positions even though they would benefit by shirking.[12] Their valuations, though not high enough to overcome the moral hazard problem, are high enough for them to be better off if the good is provided by someone else. If σ is high enough and w is small enough, then by taking the job and shirking this individual is (with high probability) displacing a worker who would have provided effort and produced the good. Consequently, expected output falls, and this decline is more costly to them than the benefit obtained by receiving the payment; $\mu\left(w\right)$.

We thus obtain two cutoffs for the application decision. From (4), one for individuals who apply for the position with the intention of truly volunteering the requisite effort; $\gamma_i \geq \frac{c(\overline{e})-\mu(w)}{(1-\sigma(w,N-1))[v(1)-v(0)]}$, and from (5) those lower valuation individuals attracted by the possibility of being paid for doing nothing; $\gamma_i \leq \frac{\mu(w)}{\sigma(w,N-1)[v(1)-v(0)]}$. Define such cutoffs respectively by values of γ such that these hold with equality:

$$\gamma^H \equiv \frac{c\left(\overline{e}\right)-\mu\left(w\right)}{\left(1-\sigma\left(w,N-1\right)\right)\left[v\left(1\right)-v\left(0\right)\right]} \tag{6}$$

$$\gamma^L \equiv \frac{\mu\left(w\right)}{\sigma\left(w,N-1\right)\left[v\left(1\right)-v\left(0\right)\right]}. \tag{7}$$

Using these yields an implicit expression for σ as follows:

$$\sigma\left(w,N-1\right)=\frac{\left(N-1\right)\int_{\gamma^H}^{\infty}f\left(\gamma\right)d\gamma}{1+\left(N-1\right)\left(\int_{\gamma^H}^{\infty}f\left(\gamma\right)d\gamma+\int_0^{\gamma^L}f\left(\gamma\right)d\gamma\right)} \tag{8}$$

$$\text{or equivalently}=\frac{\left(N-1\right)\left(1-F\left(\gamma^H\right)\right)}{1+\left(N-1\right)\left(1-F\left(\gamma^H\right)+F\left(\gamma^L\right)\right)}. \tag{9}$$

[12]Such cases will not exist in all equilibria, but provided that equilibrium $\sigma\left(w,N-1\right)c\left(\overline{e}\right)\geq\mu\left(w\right)$, they do.

Intuitively, the probability of the good being produced, for given cutoffs γ^H and γ^L depends on the probability that a randomly chosen member of the applicant pool is a non-shirker, the first term.[13] Substituting for $\sigma(w, N-1)$ into (6) and (7), yields two expressions that implicitly define the equilibrium cutoffs, γ^H and γ^L :

$$\gamma^H = \frac{(c(\overline{e}) - \mu(w))\left(\frac{1}{(N-1)} + 1 - F\left(\gamma^H\right) + F\left(\gamma^L\right)\right)}{\left[\frac{1}{(N-1)} + F\left(\gamma^L\right)\right][v(1) - v(0)]}, \tag{10}$$

$$\gamma^L = \frac{\mu(w)\left(\frac{1}{(N-1)} + 1 - F\left(\gamma^H\right) + F\left(\gamma^L\right)\right)}{\left[1 - F\left(\gamma^H\right)\right][v(1) - v(0)]}. \tag{11}$$

Uniqueness of these two cutoffs is not generally guaranteed. This is because of a complementarity between the actions of those who do not value the good highly enough to provide effort, i.e. the $\gamma_i < \frac{c(\overline{e})}{[v(1)-v(0)]}$, as follows. If most other applicants are true volunteers, that is, individuals who would provide the required effort if employed, then, by taking the job and shirking, an individual with low γ significantly lowers expected output. Were he not to obtain the job, one of the committed others would likely have and g would equal 1. But suppose there is a large increase in the number of other low γ individuals ($\gamma < \frac{c(\overline{e})}{[v(1)-v(0)]}$) applying, so that these individuals constitute the bulk of the applicant pool. A given low γ individual now does not greatly effect expected output by shirking – g would likely have equalled zero anyway because this worker is simply displacing another shirker from the position. The strategic complementarity between application decisions of low valuation types means equilibrium is not as straightforward as in the PRC case, but as shown below the equilibrium is still well behaved.

Proposition 2: For given $w : \mu(\underline{w}) \leq \mu(w) < c(\overline{e})$, there exists: (i) a symmetric Nash equilibrium to the labor donations game, without PRC, which is characterized by a (or perhaps multiple) pairs of cut-offs $\gamma^H(w), \gamma^L(w)$, with $\gamma^H(w) \geq \frac{c(\overline{e})}{[v(1)-v(0)]} \geq \gamma^L(w)$. In any such equilibrium all $\gamma_i \geq \gamma^H(w)$ apply at wage w and contribute $\overline{e}$ if receiving the job. All $\gamma_i \leq \gamma^L(w)$ apply at wage w and contribute zero effort if receiving the job. All $\gamma_i : \gamma^L(w) < \gamma_i < \gamma^H(w)$ do not apply.
(ii) If $\gamma f(\gamma) < F(\gamma)$ for all γ, then there is a unique equilibrium pair of cut-offs satisfying the conditions above.

[13] It is here that the assumption of there being at least one individual with $\gamma = 0$ plays a crucial simplifying role. Dropping this assumption would mean that there would always exist a positive probability of an empty applicant pool, were an individual not to apply. In that case, the existing term for $\sigma(w, N-1)$ would need to be multiplied by the additional term $\left[1 - \left(F\left(\gamma^H\right) - F\left(\gamma^L\right)\right)^{N-1}\right]$, which is the conditional probability of the applicant pool being non-empty. Though conceptually nothing would seem to change, this treatment greatly increases the problem's complexity.

The equilibrium conditions can be more easily understood using the distribution functions rather than the densities:

$$\frac{\frac{1}{(N-1)} + F\left(\gamma^L\right)}{\frac{1}{(N-1)} + 1 - F\left(\gamma^H\right) + F\left(\gamma^L\right)} \gamma^H \left[v(1) - v(0)\right] = c(\overline{e}) - \mu(w) \tag{12}$$

$$\frac{1 - F\left(\gamma^H\right)}{\frac{1}{(N-1)} + 1 - F\left(\gamma^H\right) + F\left(\gamma^L\right)} \gamma^L \left[v(1) - v(0)\right] = \mu(w). \tag{13}$$

Equation (12) is derived from the marginal non-shirker. The right hand side can be interpreted as the cost to obtaining the job, which is the disutility of effort net of its monetary compensation, $c(\overline{e}) - \mu(w)$. This is equated to the left hand side which is the expected cost of not taking the position; i.e., with probability $\frac{\frac{1}{(N-1)} + F\left(\gamma^L\right)}{\frac{1}{(N-1)} + 1 - F\left(\gamma^H\right) + F\left(\gamma^L\right)}$ the good is not produced, and the lost output is valued at $\gamma^H \left[v(1) - v(0)\right]$. Similarly, condition (13) is derived from the marginal shirker. A shirker obtains $\mu(w)$ when taking a position, since no effort is expended and no output is produced; this is the right hand side. This is equated to the benefit of not taking the position, which is that, with probability $\frac{1 - F\left(\gamma^H\right)}{\frac{1}{(N-1)} + 1 - F\left(\gamma^H\right) + F\left(\gamma^L\right)}$ output is produced and valued at $\gamma^L \left[v(1) - v(0)\right]$; this is the left hand side of (13).

Though the decision to shirk is monotonic, the decision to apply for work is not. Individuals with high valuations apply and donate labor if employed, individuals with low valuations apply and shirk if hired. Individuals that are in between do not apply. At all $w : \mu(w) < \frac{c(\overline{e})}{v(1) - v(0)}$ there are some labor donations, but there may also be free-riding, i.e., not all $\gamma \geq \frac{c(\overline{e})}{v(1) - v(0)}$ apply. For high enough values of the wage it is possible that though there remain labor donations there is no free-riding in equilibrium. Specifically:

Proposition 3: If w satisfies:

$$\frac{c(\overline{e})}{\left[v(1) - v(0)\right]} > \mu(w) > \left(1 - F\left(\frac{c(\overline{e})}{\left[v(1) - v(0)\right]}\right)\right) \frac{c(\overline{e})}{\left[v(1) - v(0)\right]}, \tag{14}$$

then, in equilibrium, labor is donated, but there is no free-riding.

Thus, another unusual feature of this equilibrium is that, for sufficiently high values of the wage, even though all individuals would be strictly better off if someone else were to provide effort to the firm, nobody chooses to free ride. Free-riding disappears because the participation of individuals with low valuations, who will shirk, provides incentives for the higher valuation non-shirkers to apply.

Recall that free-riding had to occur under PRC because it was the possibility of free-riding by others (and the probability that the good would not be produced) that induced an individual with high enough valuation to apply. This probability approaches zero as N gets large, so that the extent of free-riding also gets worse, i.e. the cut off γ rises. Here, however, inducement to apply comes from the individuals who will take the job and shirk, i.e. it arises directly from the lack of PRC, so that free-riding need not occur in equilibrium. Moreover, as N gets large, the probability that a shirker will be hired into the position (and thus the incentive to apply) does not converge to zero. Consequently, free-riding is not exacerbated by increased population size. Labor donations make sense even in arbitrarily large labor pools.

Both Andreoni (1990) and Vicary (2000) have developed models where individuals' contributions to a public good need not go to zero as the population becomes large, but for entirely different reasons. In Andreoni (1990) the reason is that the good is not a pure public good. Individuals receive personal benefit from the act of participating. This persists, and motivates contribution, even in large economies. Vicary's finding depends critically on public good levels being directly affected by consumption as well as individual donations - an example is driving a car (worsening the environment) while simultaneously contributing to Greenpeace. Here, in contrast, worker concern is of the pure public good form, without consumption complementarities or benefits to participation.

3 Optimal wage determination

Upto now, wages in both the PRC and non-PRC cases have been taken as given. Optimal wage setting under each type of compensation scheme does not allow a general characterization of the solution as it depends critically on the form of the distribution of valuations and the firm's valuation of output relative to the wage. However, the form of this dependence is illustrated by a simple example which we now consider.

Piece-wise uniform examples

For the piece-wise uniform distribution case it is possible to solve the model analytically. Taking a linear version of all sub-components of the utility function yields:

$$u_i = w_i - e_i + \gamma_i g.$$

Suppose that the γs are distributed over the $[0, 1]$ support, with the distribution, $F(\gamma)$ being uniform over two parts which may vary in their densities. Specifically, the distribution is uniform upto $\overline{e} < 1$ with the mass of the distribution below $\overline{e}$ denoted by α, the remaining mass is uniformly distributed with a potentially different density from $\overline{e}$.to 1. Under this linear utility example, $\overline{e}$ divides the distribution of γ between those who would shirk if occupying a position without PRC ($\gamma < \overline{e}$) and those who would work ($\gamma \geq \overline{e}$). The corresponding distribution function is:

$$F(\gamma) = \begin{cases} \alpha \frac{\gamma}{\overline{e}} \text{ for } \gamma < \overline{e} \\ \alpha + (1-\alpha)\left[\frac{\gamma - \overline{e}}{1-\overline{e}}\right] \text{ for } \gamma \geq \overline{e}. \end{cases}$$

If $\alpha = \overline{e}$, this yields the standard uniform distribution, $F(\gamma) = \gamma$ for all γ. We thus define a variable $x \equiv \overline{e}/\alpha$ which summarizes the relative density of the two components of the distribution. For $x < 1$ the denisty below $\overline{e}$ is greater than that above, so that any potential equilibrium cut-off for γ^L occurs at a point in the distribution where there is a higher density than any potential cut-off for γ^H. The two cases are depicted in Figure 1.

Substituting this distribution and utility function into the equilibrium conditions (12) and (13) yields a pair of cutoffs. Note that uniqueness is not guaranteed here since the sufficient condition in Proposition 2 does not hold when $x > 1$, but in this case the solutions turn out to be unique in any case. This equilibrium values of γ^L and γ^H must solve:

$$\frac{\frac{1}{(N-1)} + \frac{\gamma^L}{x}}{\frac{1}{(N-1)} + 1 - \left(\alpha + (1-\alpha)\left[\frac{\gamma^H - x/\alpha}{1-x/\alpha}\right]\right) + \frac{\gamma^L}{x}} \gamma^H = x/\alpha - w \tag{15}$$

$$\frac{1 - \left(\alpha + (1-\alpha)\left[\frac{\gamma^H - x/\alpha}{1-x/\alpha}\right]\right)}{\frac{1}{(N-1)} + 1 - \left(\alpha + (1-\alpha)\left[\frac{\gamma^H - x/\alpha}{1-x/\alpha}\right]\right) + \frac{\gamma^L}{x}} \gamma^L = w \tag{16}$$

These can be explicitly solved for equilibrium γ^L, and γ^H, which when substituted into the term for expected output, $E(g) = \frac{1 - \left(\alpha + (1-\alpha)\left[\frac{\gamma^H - x/\alpha}{1-x/\alpha}\right]\right)}{\frac{1}{(N-1)} + 1 - \left(\alpha + (1-\alpha)\left[\frac{\gamma^H - x/\alpha}{1-x/\alpha}\right]\right) + \frac{\gamma^L}{x}}$, yield a relatively simple solution:

$$E(g) = \frac{x(1-\alpha)(1-\alpha x) - w(1-x)}{x(1-\alpha)}.$$

Differentiating with respect to the wage yields:

$$\frac{dE(g)}{dw} = -\frac{1-x}{x(1-\alpha)}.$$

Expected output is increasing in wages if and only if $x > 1$. So, if and only if the density below the cut off is smaller than the density above does increasing wages raise output.

The higher density of non-shirkers when $x > 1$ ensures that a marginal increase in the wage induces a larger influx of non-shirkers than shirkers. The consequent improvement in the quality of the labor pool increases expected output. When $x < 1$, wage increases strictly worsen the labor pool and expected output falls. This piece-wise uniform example thus illustrates the critical role played by the density of the distribution in the neighbourhood of the cut-offs, and why it is not possible to obtain general results regarding the impact of wages on output. In general, however, the fact that higher compensation draws in both shirkers and non-shirkers explains the low (and sometimes negative) elasticity of expected output with respect to the wage when PRC is not used.[14] We now turn to examining the effect on organizational performance of introducing performance related output.

Optimal wages and the use of PRC

Though there are no general results on optimal wages, a worked example where optimal wages are chosen for both PRC and non-PRC cases can serve to illustrate the conditions under which firms will choose to use PRC. We shall assume that there are no costs to implementing PRC, and ask simply whether introducing it will serve to raise expected output and/or profit for the firm — assuming that optimal wages are set under each scheme. Once again, the piece-wise uniform example illustrates simply the forces at work. Consider the following representation of preferences similar to the above but where we now allow for some risk aversion over the firm's output, g. Specifically: $\mu(w) = w, c(e) = e$ and $v(g) = \frac{g^{1-\sigma}}{\theta}$:

$$u_i = w_i - e_i + \gamma_i \frac{g^{1-\sigma}}{\theta}.$$

Increasing the parameter σ increases individual's aversion to risk regarding the level of the firm's output, and θ is a parameter to vary the weighting of the firm's output.[15]

We set $x = \frac{1}{1.1}$, so that the density below the cut-off is always 10% larger than that above. Consequently, without PRC, raising wages lowers expected output. In that case, the profit maximizing firm will always choose to set wages equal to their lower bound. We choose a lower bound of 0.1 here. As before, we have $g(\overline{e}) = 1$ for the correct effort, $g(0) = 0$ with a shirker and we set $\overline{g} = .5$ when the position is left vacant. We take a $\sigma = 0.93$, and $\theta = 0.1$ for the worked example. This

[14] The determination of wages is a central concern in the works of Delfgaauw and Dur (2002) and Canton (2005). In their frameworks, as here, workers differ in the extent of their intrinsic motivation which is private information. But the nature of intrinsic motivation is different. The intrinsic motivation in their framework is of the impurely altruistic type (i.e., it effects the cost of worker effort). Here, in contrast, effort costs are uniform, but workers differ in their concern for output and thus differ in their degree of pure altruism. This is why the free-riding which is central to the problem of "making a difference" in large labor markets plays a critical role in the present paper, and not in theirs.

[15] Allowing for risk aversion over income has no qualitative effect on the results that will be shown here so that we persist with the linear version on this sub-component for simplicity.

yields, $v(1) = 10$, $v(0) = 0$ and $v(\overline{g}) = 9.53$. For a worker pool size of $N = 20$ the equilibrium outcome with PRC is determined by the solution to (3) and yields a positive relationship between the value of expected output and the wage as depicted by the concave upward sloping line in the panels of Figure 2. This example takes $\overline{e} = 0.5$ so that for labor donations to be possible it must be the case that $w < 0.5$, so that the disutility of effort is not fully compensated by the wage.

The three panels of Figure 2 graphically depict the optimal level of wages for the PRC case by the dashed vertical line — i.e., the wage maximizing the distance between expected revenue (the concave upward sloping line) and costs (the upward sloping line sourced at the origin). Optimal wages and the value of expected output are depicted for three different output prices: price of 1 in Figure 2A, price of 2 in Figure 2B, and price of 4 in Figure 2C. As already noted, without PRC expected output is falling in the wage (the downward sloping line in each figure), so that it is always optimal for a firm not using PRC to set wages at the lower bound, $\underline{w} = 0.1$.

In Figure 2A, the optimal wage in the PRC firm of approximately 0.18 generates expected revenue of 0.84. Since – when using PRC – wages need only be paid when output is produced, the expected wage bill is $(.18)(.84) = 0.15$ so that expected profit is 0.69. Without PRC expected output at the minimal wage of 0.1 is 0.88, yielding.expected profit for the firm of 0.78. At a price of one, both expected output and expected profits are thus higher when the firm does not use PRC, so that PRC will not be chosen. Figure 2B depicts optimal wages and expected output when the firm faces an output price of two. Without PRC, $w = 0.1$ again, expected output = 0.88 generating expected revenue of 1.76 and profits are 1.66. With PRC, the higher value of output leads to a higher optimal wage; $w = 0.315$. This yields expected output of 0.93, which is greater than in the non-PRC firm, and revenue of 1.86. But since overall profits are lower than without PRC: 1.86-(0.93)(0.315)=1.57, PRC is again not chosen. Figure 2C depicts analogous schedules when output is priced at four. Here, both expected revenue and expected profits are higher when PRC is used. Without PRC, wages of 0.1 yield expected revenue of 3.55 for expected profit of 3.45. With PRC, the higher value of output makes it optimal for the firm to set a wage close to that required to fully compensate for the disutility of effort, 0.49. The firm thus asks for only a small labor donation, and the position is almost certainly filled. This leads to expected output of 0.99 and expected revenue of 3.96. Net profit is thus 3.47.

Figures 2A and 2B illustrate a result which is somewhat at odds with usual intuition. In the case of PRC, all elements relating to the difficulty of contracting over worker effort provision are assumed away – workers are forced to provide effort precisely as contracted. Without PRC, in contrast, the firm has no instruments with which to elicit effort and the worker is free to choose effort in accordance with preferences. Moreover, the firm can never know the workers' preferences. The surprising result is that, since participation is not ensured, at least for a low output price, a firm will not use PRC. This is not always the case, however, as it clearly depends upon the properties of the distribution chosen for the illustration. Moreover, even within this example, higher output prices will generally tilt the balance in favor of PRC. This is becacuse high enough wages can always ensure participation and provision of correct effort under PRC, and if output is priced highly enough, both expected output and profits are higher using it.

Even though only shown through example, this is to our knowledge the first time that the use of PRC that is perfectly and costlessly installed and applies to all activities required of workers, is shown to actually lower expected output and profit compared with the non-PRC case. Previous explanations have generally emphasized the difficulties that arise in implementing PRC. Difficulties arising from: multiple principals, as developed by Bernheim and Winston (1986); or measurement and monitoring when output is multifaceted, not traded or not easily observable; as in Holmstrom and Milgrom (1991), Corneo and Rob (2003), Prendergast (2003) and Canton (2005). Besley and Ghatak (2005), similarly find that organizations producing output that is also valued by their workers will have lower powered incentives. In their framework, successful organizations achieve an alignment between the motivations of workers and principals, but the conditioning of payment directly upon effort would not lead to reduced performance in their setting. Here, in contrast, since the free-riding plays a critical role, by not conditioning payment on effort, the firm solves the free-riding problem. Although this comes at the cost of allowing moral hazard for some employees, as demonstrated above, it may be profitable to do so.[16]

The model predicts less use of performance related pay in the public sector or in non-profit firms, since these sectors are most heavily engaged in production of public goods. Although a comparative reluctance to use PRC in public good producing firms seems anecdotally supported, formal comparisons of the public sectors' propensity to use performance related pay, relative to the private sector, for similar occupations, are sparse. Burgess and Metcalfe (1999) using cross-sectional establishment data from 1990 find that establishments in the public sector are less likely

[16] The issue of performance related compensation does not arise in the set up used by Engers and Gans (1998), but they similarly find that firms (editors) may optimally choose to pay low wages (honorariums), though for different reasons. Specifically, by directly being able to solicit the referee, an editor partly mitigates the participation problem, and the moral hazard problem does not arise. The referee knows that if not accepting the assignment there will be a delay and direct impact on journal quality. The length of delay is lower if the honorarium is higher, (since the next solicited referee is more likely to accept) so higher wages may lower incentives for referees to accept assignments. The sequencing that is central to their set-up is not common to standard labor markets, suggesting their result is tied strongly to the editor/referee context in which their model is set.

to operate an incentive scheme than comparable ones in the private sector, and that this difference arises only amongst non-manual workers, which are the workers more likely to be involved in discretionary practices.[17] Roomkin and Weisbrod (1999) report finding greater use of performance related compensation in for-profit than nonprofit hospitals amongst top managerial positions, even though overall earnings were similar. DeVaro and Samuelson (2003) analyze differences in the use of promotion as an incentive device in non- and for-profit firms. They find a much lower propensity to use promotion in non-profit firms, that promotions are less likely to be based on merit and job performance, and that nonprofits are less likely to use incentive contracting. But these studies do not provide guidance on whether this is due to the reasons forwarded in the present paper, or due to one of the many other possible explanations.

The model implies that public good producing, or mission oriented, firms in which PRC is difficult to introduce will tend to favor the use of relatively low wages, and low powered incentives. Consequently, average earnings in these types of firms should tend to be low. However, since these firms will also select some workers who are not attracted by the mission, but by the opportunity to receive pay for little effort, hourly earnings, or earnings measures that appropriately control for effort contributed at work, may be similar or even higher. Consequently the model makes no clear predictions about the average cost/quality ratio in such organizations relative to standard private firms. However, a testable implication of the present work is that a type of bi-modal distribution of worker effort should be found in such organizations. Some workers – those driven by concern – will excel in performance despite the low pay, but these will co-exist with others who have little concern but work in the sector as it provides an opportunity to be slack. The model thus predicts a higher per worker variation in this ratio for public good providing organizations than in standard firms, or in firms that do not draw on labor donations.

4 Conclusions

Firms that are involved in the production of services that have a social value may obtain donations of labor from their workforce. These workers want to make a difference in their working life by positively affecting society, and do so by working at wages below that required to compensate them for their efforts. The ability to make a difference, however, depends critically on the structure of incentives that operate within the organization. Firms that make heavy use of performance related compensation provide little chance for employees to affect outcomes, because there is little discretion in their behavior. One's motivation to donate labor then arises

[17] See also Brugess and Ratto (2003) for an upto date survey of theory and evidence on incentive provision and its relation to the public sector, and Proper and Wilson (2003) for discussion of the effectiveness of mandated PRC schemes introduced in both the US and UK.

only when one expects that positions could remain unfilled, and a type of free-riding – which is common to all private provision of public goods problems – arises. In contrast, when firms do not (or are unable to) use performance related compensation, or some other form of direct supervision, increased worker discretion allows for the possibility that poorly motivated workers will shirk and adversely affect outcomes. The possibility of shirking thus provides incentives for genuinely motivated workers to donate labor effort; by working, they are making a difference by performing their job better than they expect a replacement employee generally would. This is an application of the theory of the second best. In the presence of two distortions – a public goods problem and moral hazard – addressing any one – namely, using incentive payments – may worsen performance.

When such motivations are at play, this paper has shown that firms may actually wish to 'engineer' the moral hazard problem by purposely eschewing the use of performance related compensation - even when it is both feasible and costless. Though this is a unique result, it is probably too strong a conclusion to draw in reality. It is likely that many organizations do not use performance related compensation because it is costly, difficult to implement and perhaps even infeasible. The conclusion to be drawn from the present work then is that, ceteris parabus, organizations producing socially valued services (particularly services for which they are not highly paid) are more likely to economize on the costs of performance related compensation and rely instead on workers' own outcome oriented motivations. It has also been shown that when PRC is not used, firms will tend to pay lower wages. Increasing wages draws in both highly motivated, and unmotivated (shirking) workers, causing the output elasticity of wages to be low and possibly negative.

5 Appendix

Proof of Proposition 1: Consider the utility of an individual i applying for a job, given a cut-off rule, $\widehat{\gamma}$. Quasi-linearity of the preferences implies that expected values can be considered. The individual applies, if and only if:

$$\begin{aligned}
&\frac{1}{1+(N-1)F\left(\widehat{\gamma}\right)}\left(\mu\left(w\right)-c\left(\overline{e}\right)+\gamma_i v\left(1\right)\right)+\left(1-\frac{1}{1+(N-1)F\left(\widehat{\gamma}\right)}\right)\gamma_i v\left(1\right)\\
&\geq\left(1-F\left(\widehat{\gamma}\right)^{N-1}\right)\gamma_i v\left(1\right)+F\left(\widehat{\gamma}\right)^{N-1}\gamma_i v\left(\overline{g}\right)\\
&\Rightarrow\left(1+(N-1)F\left(\widehat{\gamma}\right)\right)F\left(\widehat{\gamma}\right)^{N-1}\gamma_i\left[v\left(1\right)-v\left(\overline{g}\right)\right]\geq c\left(\overline{e}\right)-\mu\left(w\right).
\end{aligned}\tag{17}$$

With N being the total number of individuals drawn from the distribution $F(\cdot)$, from the perspective of a single individual there are $N-1$ other potential applicants. The left hand side of the first expression above is the expected utility of an applicant. The first term is the expected utility if employed weighted by the probability of receiving the position. The second is the utility if not employed (which is $\gamma_i v(1)$, since if not employed it implies someone else filled the position) weighted by its probability. A symmetric equilibrium is a common cut off value of γ^* such that the induced optimal decision under (17) yields only individuals with $\gamma_i \geq \gamma^*$ applying for the job. That is, an equilibrium is a fixed point solving:

$$\left(1+(N-1)\left(1-F\left(\gamma^*\right)\right)\right)F\left(\gamma^*\right)^{N-1}\gamma^*\left[v\left(1\right)-v\left(\overline{g}\right)\right]=c\left(\overline{e}\right)-\mu\left(w\right),\tag{18}$$

which is equation (3) in the text. Differentiating the left hand side of (18) with respect to γ^* yields:

$$\begin{aligned}
&\left[1+(N-1)\left(1-F\left(\gamma^*\right)\right)\right]F\left(\gamma^*\right)^{N-1}\left[v\left(1\right)-v\left(\overline{g}\right)\right]-(N-1)F\left(\gamma^*\right)^{N-1}\gamma^* f\left(\gamma^*\right)\left[v\left(1\right)-v\left(\overline{g}\right)\right]\\
&+f\left(\gamma^*\right)(N-1)F\left(\gamma^*\right)^{N-2}\gamma^*\left[1+(N-1)\left(1-F\left(\gamma^*\right)\right)\right]\left[v\left(1\right)-v\left(\overline{g}\right)\right].
\end{aligned}$$

Since $F(\gamma^*) < 1$, the first term is positive and the absolute value of the second term is strictly smaller than the third, so that this expression is positive. Thus the left hand side of (18) is monotonically increasing in γ^* and, given continuity of F, is continuous in γ^*. Also, using L'hopital's rule, it can be shown that $\lim_{\gamma\to\infty} LHS$ (18) $\to \infty > c(\overline{e}) - \mu(w)$, and $\lim_{\gamma\to 0} LHS$ (18) $\to 0 < c(\overline{e}) - \mu(w)$ for any, $N > 1$, $w \geq 0$. Thus a point solving (18) exists. The monotonicity of the left hand side implies that such a fixed point is unique. Note finally that, given an equilibrium cut off rule, γ^*, each individual's best response is uniquely determined by their own γ_i according to (17). *Q.E.D.*

Proof of Corrollary 1: Part (i) immediate by setting $N = 1$ in (18).
Part (ii) Consider the impact of an increase in N while holding fixed γ^* on the left

hand side of (18). For given γ^*, and $F(\gamma^*)$ denoted by F below, the relevant part of the derivative is:

$$\begin{aligned}
&\frac{d}{dN}\left(\left(1+(N-1)(1-F)\right)F^{N-1}\right)\\
&=(\ln F)\,F^{N-1}(F+N-FN)+F^{N-1}(1-F)\\
&=F^{N-1}\left[(\ln F)(F+N(1-F))+(1-F)\right].
\end{aligned}$$

Since $F<1$ then $\ln F<0$, and the term in square brackets is decreasing in N. Consider then, the case of $N=1$, in which the term in square brackets becomes: $(\ln F)+(1-F)<0$. Consequently the left hand side of (18) is decreasing in N, and clearly the right hand side is unchanged. Since, in the proof of Proposition 1, it was already demonstrated that the left hand side of (18) is increasing in γ^*, for equilibrium to be restored following an increase in N, necessarily γ^* increases. Thus, the amount of free-riding $\gamma^*-c(\overline{e})+\mu(w)$ also increases.*Q.E.D.*

Proof of Proposition 2: The first part of the proof demonstrates existence and uniqueness under the sufficient condition stated in the proposition. The second part shows existence of an equilibrium in general.

Part (i). Existence Proof for a general distribution function $F(\gamma)$.

Conditions (10) and (11) can be expressed as:

$$\frac{\frac{1}{(N-1)}+F\left(\gamma^L\right)}{\frac{1}{(N-1)}+1-F\left(\gamma^H\right)+F\left(\gamma^L\right)}\gamma^H=\frac{c(\overline{e})-\mu(w)}{[v(1)-v(0)]} \tag{19}$$

$$\frac{1-F\left(\gamma^H\right)}{\frac{1}{(N-1)}+1-F\left(\gamma^H\right)+F\left(\gamma^L\right)}\gamma^L=\frac{\mu(w)}{[v(1)-v(0)]}. \tag{20}$$

The right hand side of both expressions is constant, given w. For given γ^L, the left hand side of (19) is monotonically increasing and continuous in γ^H. For given γ^L, the left hand side of (19) is monotonic in γ^H. For γ^H at its lower bound, $\gamma^H=\frac{c(\overline{e})}{[v(1)-v(0)]}$, either (i) LHS $<$ RHS of (19) or (ii) LHS $\geq$ RHS of (19). Case (i): If LHS $<$ RHS of (19), then by the continuity and monotonicity of LHS (22) $\exists$ $\gamma^H>\frac{c(\overline{e})}{[v(1)-v(0)]}$ which solves (22) with equality, and monotonicity implies this value is unique. Case (ii) If LHS $\geq$ RHS at $\gamma^H=\frac{c(\overline{e})}{[v(1)-v(0)]}$, then for the given value of γ^L there does not exist a value of γ^H solving (19) with equality. Note that, since the LHS is strictly increasing in γ^L there exists a unique lowest value of γ^L , denote it $\underline{\gamma}^L$, such that if and only if $\gamma^L\geq\underline{\gamma}^L$ then the LHS$\geq$RHS for any $\gamma\geq\frac{c(\overline{e})}{[v(1)-v(0)]}$. At such values of γ^L any $\gamma\geq\frac{c(\overline{e})}{[v(1)-v(0)]}$ would strictly prefer to participate. Now define a function $\gamma^H\left(\gamma^L\right)$ as the value of γ^H which solves (19) for given γ^L when

$\gamma^L < \underline{\gamma}^L$, and as equal to $\frac{c(\overline{e})}{[v(1)-v(0)]}$ when $\gamma^L \geq \underline{\gamma}^L$. Note that, since the LHS of (19) is monotonically increasing in γ^L, for $\gamma^L \leq \underline{\gamma}^L$ necessarily $\frac{\partial \gamma^H(\gamma^L)}{\partial \gamma^L} < 0$. The function is also continuous. Substitute this function for γ^H in equation (20) yielding a LHS to this expression of

$$\frac{\int_{\gamma^H(\gamma^L)}^{\infty} f(\gamma)\, d\gamma}{\frac{1}{(N-1)} + \int_{\gamma^H(\gamma^L)}^{\infty} f(\gamma)\, d\gamma + \int_0^{\gamma^L} f(\gamma)\, d\gamma} \gamma^L. \tag{21}$$

Note that the continuity of the function $\gamma^H\left(\gamma^L\right)$ implies that expression (21) is also continuous in γ^L. Clearly for $\gamma^L = 0$ this expression equals 0 and then necessarily LHS<RHS of (20). Now consider the set of all values of γ^L which maximize this expression. Denote this set $\langle \gamma^{L\max} \rangle$. For any $\gamma^L \in \langle \gamma^{L\max} \rangle$, there are two possible cases for equation (20) evaluated at these γ^L, either: (1) RHS≤LHS of (20), or (2) RHS >LHS of (20). First consider case (1). In this case it follows from the continuity of (21) that there exists at least one value of γ^L that solves (20) with equality. Denote the set of such values by $\langle \gamma^L \rangle$. Clearly for any element of this set $\gamma^{L'}$ there exists a corresponding $\gamma^{H'} = \gamma^{H'}\left(\gamma^{L'}\right)$ which either solves (19) with equality (i.e. when the $\gamma^{L'} < \underline{\gamma}^L$) or is such that the LHS≥RHS of (19) for all feasible γ^H. By construction of the function $\gamma^H\left(\gamma^L\right)$ any such pairs $\gamma^{L'}, \gamma^{H'}$ constitute an equilibrium to this system. If $\gamma^{L'} < \underline{\gamma}^L$ then the solution is interior in γ^H, i.e., $\gamma^{H'}\left(\gamma^{L'}\right)$ solves (19) with equality. If $\gamma^{L'} \geq \underline{\gamma}^L$ then $\gamma^{H'} = \frac{c(\overline{e})}{[v(1)-v(0)]}$ and the equilibrium involves full participation of the high types. Now consider case (2). In this case, there does not exist a value of γ^L solving (20) with equality. Thus all $\gamma^L \leq \frac{c(\overline{e})}{[v(1)-v(0)]}$ strictly prefer to participate. In this case, it is still possible to solve for a corresponding γ^H using the $\gamma^H(\cdot)$ function defined above, this is $\gamma^H\left(\frac{c(\overline{e})}{[v(1)-v(0)]}\right)$. The pair, $\left(\gamma^L = \frac{c(\overline{e})}{[v(1)-v(0)]}, \gamma^H\left(\frac{c(\overline{e})}{[v(1)-v(0)]}\right)\right)$ then constitute an equilibrium. If $\gamma^H\left(\frac{c(\overline{e})}{[v(1)-v(0)]}\right) = \frac{c(\overline{e})}{[v(1)-v(0)]}$, then this equilibrium involves full participation – all γ will apply for the job. If $\gamma^H\left(\frac{c(\overline{e})}{[v(1)-v(0)]}\right) > \frac{c(\overline{e})}{[v(1)-v(0)]}$ then equilibrium involes full participation by the potential shirkers and non participation only by the low valued non-shirkers $\gamma^H \in [\frac{c(\overline{e})}{[v(1)-v(0)]}, \gamma^H\left(\frac{c(\overline{e})}{[v(1)-v(0)]}\right))$.

Part (ii). If $\gamma f(\gamma) \leq F(\gamma)\ \forall \gamma$, then there exists a symmetric equilibrium to the labor donations game that is unique.

Assume $\gamma f(\gamma) \leq F(\gamma)$ for all γ. The same two equilibrium conditions (19) and (20) apply. Once again, the right hand side of both expressions is constant, given w. For given γ^L, the left hand side of (19) is monotonically increasing and continuous in γ^H. For any γ^L the LHS is monotonically increasing with γ^H, and unbounded.

For given γ^H, the left hand side of (20) is not necessarily monotonic in γ^L, but if

$$\frac{1}{N-1}+1-F\left(\gamma^H\right)+F\left(\gamma^L\right)-\gamma^L f\left(\gamma^L\right)>0,$$

then the left hand side of (20) is monotonically increasing in γ^L. A sufficient condition for this is the condition stated in the proposition. Consequently, the LHS of (20) is monotonic under this condition which is assumed to hold. Thus since the Left Hand Side is increasing in γ^L, define $\gamma^L\left(\gamma^H\right)$ as the value of γ^L that solves (20) given γ^H and w. Note that $\frac{\partial\gamma^L\left(\gamma^H\right)}{\partial\gamma^H}>0$. Substitute the function $\gamma^L\left(\gamma^H\right)$ for γ^L into the left hand side of (19) to obtain the expression $\frac{\frac{1}{(N-1)}+\int_0^{\gamma^L\left(\gamma^H\right)} f(\gamma)d\gamma}{\frac{1}{(N-1)}+\int_{\gamma^H}^{\infty} f(\gamma)d\gamma+\int_0^{\gamma^L\left(\gamma^H\right)} f(\gamma)d\gamma}\gamma^H$. Now use this to evaluate the expression (19):

$$\frac{\frac{1}{(N-1)}+\int_0^{\gamma^L\left(\gamma^H\right)} f\left(\gamma\right)d\gamma}{\frac{1}{(N-1)}+\int_{\gamma^H}^{\infty} f\left(\gamma\right)d\gamma+\int_0^{\gamma^L\left(\gamma^H\right)} f\left(\gamma\right)d\gamma}\gamma^H \gtreqqless \frac{c\left(\overline{e}\right)-\mu\left(w\right)}{\left[v\left(1\right)-v\left(0\right)\right]}. \tag{22}$$

Note that the derivative of the LHS of this function in γ^H is positive, i.e.

$$\begin{aligned}
&\left(\frac{1}{(N-1)}+\int_{\gamma^H}^{\infty} f\left(\gamma\right)d\gamma+\int_0^{\gamma^L\left(\gamma^H\right)} f\left(\gamma\right)d\gamma\right)\left(\frac{1}{(N-1)}+\int_0^{\gamma^L\left(\gamma^H\right)} f\left(\gamma\right)d\gamma+\gamma^H\frac{\partial\gamma^L\left(\gamma^H\right)}{\partial\gamma^H}f\left(\gamma^L\right)\right)-\\
&\left(\frac{1}{(N-1)}+\int_0^{\gamma^L\left(\gamma^H\right)} f\left(\gamma\right)d\gamma\right)\gamma^H\left(-f\left(\gamma^H\right)+\frac{\partial\gamma^L\left(\gamma^H\right)}{\partial\gamma^H}f\left(\gamma^L\right)\right)\\
\equiv&\left(\frac{1}{(N-1)}+\int_{\gamma^H}^{\infty} f\left(\gamma\right)d\gamma+\int_0^{\gamma^L\left(\gamma^H\right)} f\left(\gamma\right)d\gamma\right)\left(\frac{1}{(N-1)}+\int_0^{\gamma^L\left(\gamma^H\right)} f\left(\gamma\right)d\gamma\right)\\
&+\int_{\gamma^H}^{\infty} f\left(\gamma\right)d\gamma\gamma^H\frac{\partial\gamma^L\left(\gamma^H\right)}{\partial\gamma^H}f\left(\gamma^L\right)+\left(\frac{1}{(N-1)}+\int_0^{\gamma^L\left(\gamma^H\right)} f\left(\gamma\right)d\gamma\right)\gamma^H f\left(\gamma^H\right)\\
>&\,0
\end{aligned}$$

Thus the value of γ^H solving (22), if it exists, is unique, and therefore also is γ^L. We have already shown in part 1 of this proof that such values generally exist and therefore under the stated sufficient condition, they are unique.$Q.E.D.$

Proof of Proposition 3: We demonstrate that when the wage satisfies the second inequality in (14), all apply for the job, thus there is no free-riding. A sufficient condition for all $\gamma\geq\frac{c(\overline{e})}{[v(1)-v(0)]}$ to apply, given that all $\gamma<\frac{c(\overline{e})}{[v(1)-v(0)]}$ are applying, is that the left hand side of condition (22) strictly exceeds the right hand side at $\gamma^H = \gamma^L = \frac{c(\overline{e})}{[v(1)-v(0)]}$. That is:

$$\frac{\frac{1}{(N-1)} + \int_0^{\frac{c(\overline{e})}{[v(1)-v(0)]}} f(\gamma)\, d\gamma}{\frac{1}{(N-1)} + \int_{\frac{c(\overline{e})}{[v(1)-v(0)]}}^{\infty} f(\gamma)\, d\gamma + \int_0^{\frac{c(\overline{e})}{[v(1)-v(0)]}} f(\gamma)\, d\gamma} c(\overline{e}) > c(\overline{e}) - \mu(w)$$

$$\Leftrightarrow \left[\frac{1}{(N-1)} + \int_0^{\frac{c(\overline{e})}{[v(1)-v(0)]}} f(\gamma)\, d\gamma\right] c(\overline{e}) > \left(\frac{1}{(N-1)} + 1\right)(c(\overline{e}) - \mu(w)) \quad (23)$$

$$\Leftrightarrow \left(\frac{1}{(N-1)} + 1\right)\mu(w) > c(\overline{e})\left[1 - \int_0^{\frac{c(\overline{e})}{[v(1)-v(0)]}} f(\gamma)\, d\gamma\right] \quad (24)$$

A sufficient condition for all $\gamma < \frac{c(\overline{e})}{[v(1)-v(0)]}$ to apply given that all $\gamma \geq \frac{c(\overline{e})}{[v(1)-v(0)]}$ are applying is that the left hand side of (20) is strictly less than its right hand side under $\gamma^H = \gamma^L = \frac{c(\overline{e})}{[v(1)-v(0)]}$. That is:

$$\frac{\int_{\frac{c(\overline{e})}{[v(1)-v(0)]}}^{\infty} f(\gamma)\, d\gamma}{\frac{1}{(N-1)} + \int_{\frac{c(\overline{e})}{[v(1)-v(0)]}}^{\infty} f(\gamma)\, d\gamma + \int_0^{\frac{c(\overline{e})}{[v(1)-v(0)]}} f(\gamma)\, d\gamma} \frac{c(\overline{e})}{[v(1)-v(0)]} < \frac{\mu(w)}{[v(1)-v(0)]}$$

$$\Longleftrightarrow \left(\int_{\frac{c(\overline{e})}{[v(1)-v(0)]}}^{\infty} f(\gamma)\, d\gamma\right) c(\overline{e}) < \left(\frac{1}{(N-1)} + 1\right)\mu(w)$$

$$\Longleftrightarrow \left(1 - \int_0^{\frac{c(\overline{e})}{[v(1)-v(0)]}} f(\gamma)\, d\gamma\right) c(\overline{e}) < \left(\frac{1}{(N-1)} + 1\right)\mu(w)$$

which is identical to (24) and identical to the second inequality in (14) . Thus, under this condition, all apply. The first inequality in (14) is necessary and sufficient to ensure that labor is being donated, as workers are not fully compensated for the disutility of effort.$Q.E.D.$

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7 Figures

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RJE
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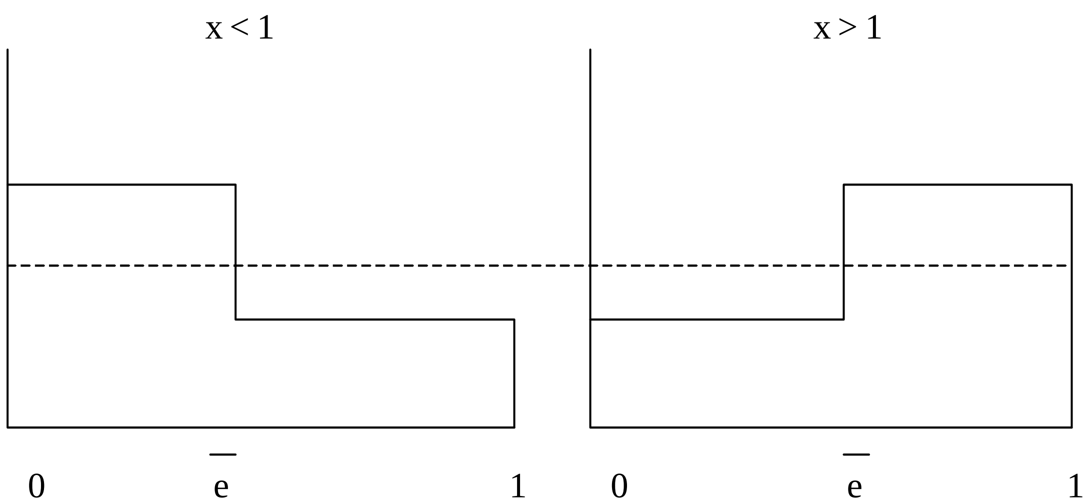

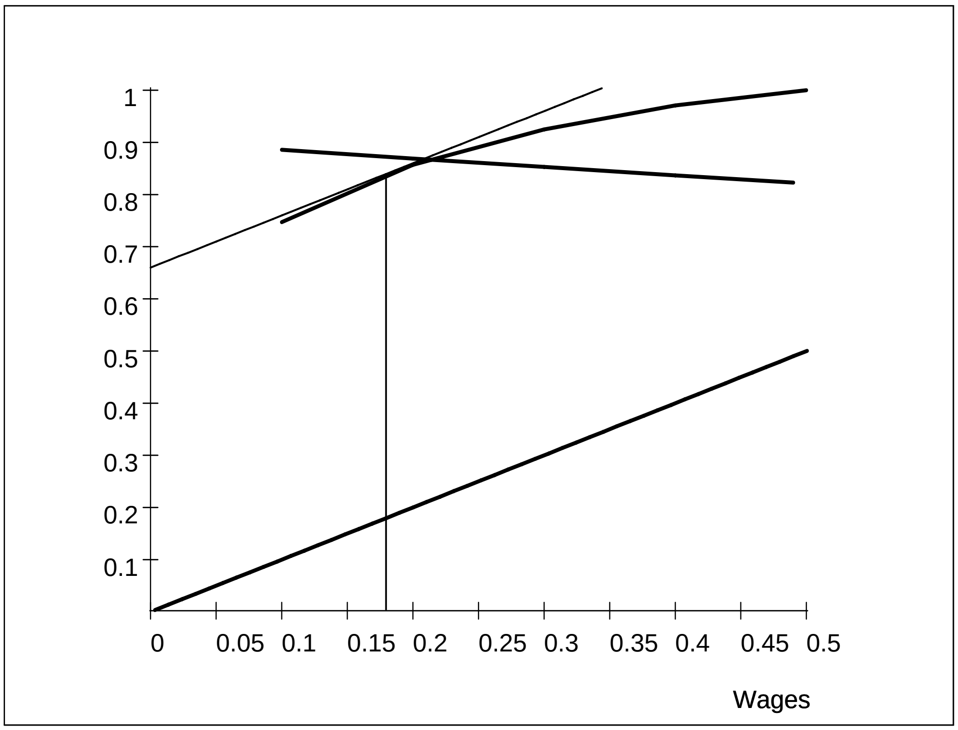

Figure 2A. Price of output = 1

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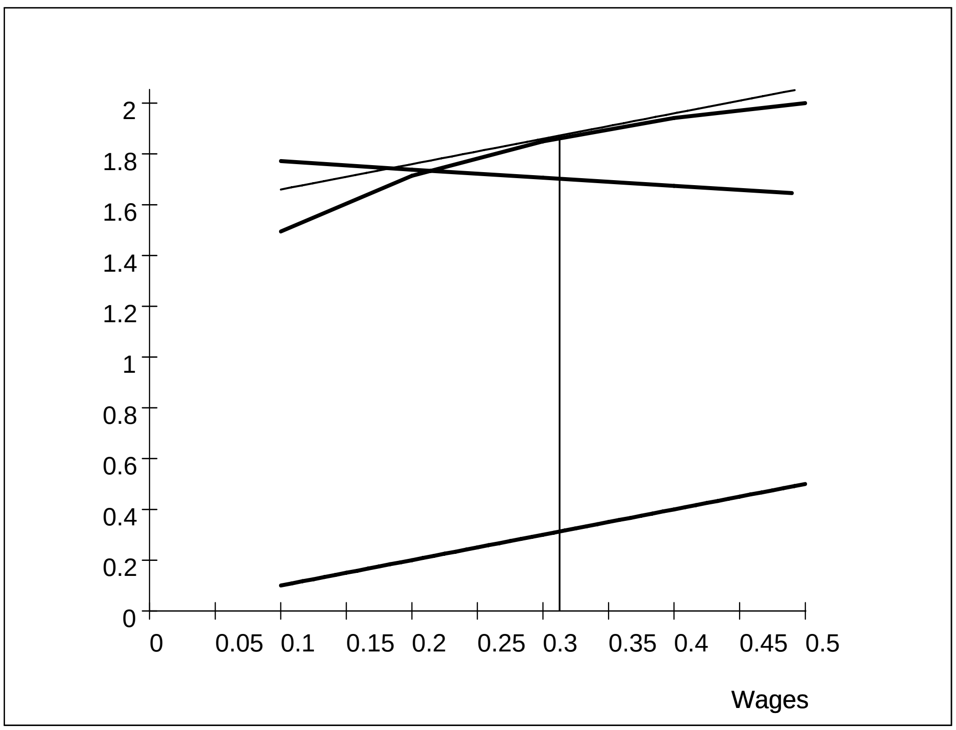

Figure 2B. Price of output = 2

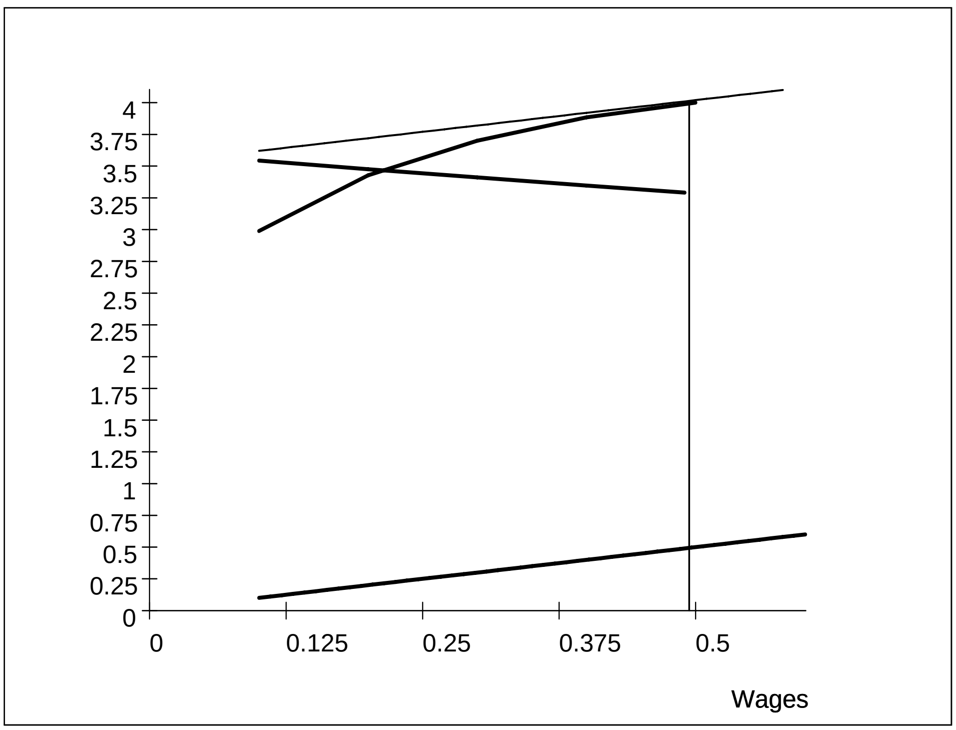

Figure 2C. Price of output = 4