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Optimal Incentive Contracts When Workers Envy Their Boss

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Abstract

A worker's utility may increase in his own income, but envy can make his utility decline with his employer's income. Such behavior may call for high-powered incentives, so that increased effort by the worker little increases the income of his employer. This paper uses a principal-agent model to study optimal incentive contracts for envious workers under various assumptions about the object and generality of envy. Envy amplifies the effect of incentives on effort and, therefore, increases optimal incentive pay. Moreover, envy can make profit-sharing optimal, even when the worker's effort is fully contractible. We discuss several applications of our theoretical work. For example, envy can explain why lower-level workers are awarded stock options, why incentive pay is usually lower in non-profit organizations, and higher in larger firms. Envy may also make governmental production of a good more efficient than private production.

Keywords: Principal-agent, Envy, Moral hazard, Compensation, Incentives, Contracts, Profit-sharing, Stock options, Public vs. private production.

JEL-codes: D23, J31, J33, M52.

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1 Introduction

Envy appears in all ethnographically or historically recorded human societies (Brown (1991, 1999)). Experimental evidence for envious feelings is provided by Camerer (2003a): subjects whose brains were imaged while presented with an unfair offer showed greater activity in the bilateral anterior insula of the brain, revealing that such an offer created negative emotions. Experimental studies by economists also suggest that fairness considerations are important determinants of human behavior (see the survey by Fehr and Schmidt (2003)). Even monkeys appear to react with anger to unequal reward distributions (Brosnan and de Waal (2003)).

This paper considers the implications of envy for optimal incentive contracts. We shall consider a worker who envies his employer's or boss's wealth, and who recognizes that increased effort may enrich his employer or boss. Such feelings explain the rage of workers at American Airlines and at Delta Air Lines in 2003 who learned of bonuses for senior executives at the same time that workers were asked to accept wage cuts. Greenberg (1990) finds empirical evidence that employee theft increases when workers consider their pay to be inequitable. Survey evidence also shows that workers care about how their wage compares to the firm's profits, and that managers fear quits and reduced effort when the wage paid is 'unfair' (Agell and Lundborg (1995), Bewley (1999)).

One might think that envy is irrelevant to effort, since the worker will be paid just enough to yield his reservation utility, with envy merely increasing his pay. But that need not hold. For after an envious person accepts a job, he may be unwilling to work hard even if the reward for his effort exceeds the cost of effort. If a worker is paid the value of his marginal product, then an increase in his effort enriches only himself. But if the worker is paid less, then his increased effort would increase the firm's profits, and so possibly increase the wealth of the boss or of the owner. That in turn means that the more high-powered the incentives offered a worker, the less the worker's incentive to limit effort because of envy.

A worker may be paid less than his marginal product for several reasons. One is that high marginal compensation can cause a moral hazard problem (a person paid handsomely to fight fires may commit arson). Another reason may be that if a producer incurs fixed costs, and the worker cannot pay a large lump-sum to the employer, then a wage equal to marginal product would generate losses to the producer. Lastly, as in the standard principal-

agent model that we adopt in this paper, a risk-averse worker may prefer his compensation to vary little with his output.

We study profit-maximizing incentive contracts for envious workers under various assumptions about the object and the generality of envy. The worker may envy the employer's profits. This envy of profits may also be seen as describing a spiteful worker rather than an envious one. Alternatively, envy may depend on relative income. Further, we distinguish between specific envy and general envy. Specific envy arises when the worker personally contributes to his employer's wealth (this represents a 'warm glow,' or, perhaps more appropriately, a 'cold shiver'). Alternatively, the worker may envy an employer regardless of whether he works for him; we call this general envy.

We shall see that envy amplifies the effect of incentive pay on effort, so that optimal incentive pay is higher when workers are envious. Furthermore, even when effort is fully contractible, the optimal contract may call for incentive pay. Though such profit-sharing increases the risk borne by the worker, it may reduce the expected utility loss from envy, making the job more attractive to the worker, and so reduce the wage paid.

Our theoretical work contributes to a better understanding of several stylized facts. First, envy may explain why lower-level workers are awarded stock options even though any one individual worker's effort hardly affects the stock price. Second, we argue that envy can cause for-profit firms to provide stronger monetary incentives to workers than do non-profit firms. Third, envy can explain why wages increase with the size of the employer. Fourth, envy can make public production of a good more efficient than private production.

2 Literature

Our discussion of envy relates to concern about relative status, as well studied by Frank (1984, 1985). He argues that a worker may prefer a job at firm A which pays less than a job at firm B, if the wage firm A offers is high compared to what it pays others. Workers' concerns about their relative standing in the firm may therefore imply that a highly productive worker at a firm with many low-productivity workers may be paid less than his marginal product. Likewise, a worker with low productivity must be paid a compensating wage differential for enduring a low-status position amongst his co-workers. Fershtman, Hvide, and Weiss (2003) examine how such concern

about relative status affects workers' effort and affects the pay package a firm should offer. Status concerns increase effort and may result in a 'rat race' among workers.¹

Other papers assume that people dislike inequity or inequality (Fehr and Schmidt (1999), Bolton and Ockenfels (2000)). That is, instead of agents valuing a high-status position, they feel compassion for lower ranked agents, and feel envy towards higher ranked agents. Several recent papers explore optimal incentive contracts when workers feel envy and compassion towards co-workers. (See Bartling and Von Siemens (2003), Biel (2002), Demougin and Fluet (2003), Grund and Sliwka (2003), Itoh (2004), and Neilson and Stowe (2003)).

For our purpose, it is immaterial whether people value high status (as in Frank (1985)) or suffer from it (as in Fehr and Schmidt (1999) and related work). In contrast to these papers, we ignore envy towards co-workers and, instead, focus on envy of the boss. As workers rarely earn more than their boss (professional sports may be an exception), our analysis ignores this possibility and, consequently, need not consider how agents feel when they are relatively better off.²

A few papers examine optimal contracts when workers envy their employer. Fehr and Schmidt (2000) and Fehr, Klein, and Schmidt (2001) study the employer's choice of contractual incompleteness in a model where both the worker and the employer may care about fairness. The presence of fair-minded employers can make an incomplete bonus contract optimal, as fair-minded employers reward hard work with a bonus. Selfish employers mimic the contract offered by fair employers, but pay no bonus. In such a setting fair-minded workers (who face an additional utility loss, increased inequality, when the employer appears to be of the selfish type and does not pay the bonus) may exert less effort than selfish workers.

More closely related to our analysis is Englmaier and Wambach (2002). They study optimal incentive contracts when workers dislike inequality and employers are selfish. The authors concentrate on determining whether the

¹A similar effect appears when people want to 'keep up with the Joneses;' see Dupor and Liu (2003).

²We also abstract from positive feelings or from feelings of obligation toward the employer, which are prominent in Akerlof's (1982) model of the gift-exchange, and in Rabin's (1993) model of reciprocity; see Rotemberg (2002) for a survey. Further, we do not consider workers' promotions to a managing position. When a worker's chance of promotion increases in his effort, envy may increase effort; see Grund and Sliwka (2003).

incentive contract is linear in output, finding conditions under which it is. Since we assume two possible outcomes (output is either High or Low), that is not our focus. Instead, we shall focus on the implications of envy for the power of the incentive scheme, for total wage compensation, and for worker's effort.

We differ from their work and other work (e.g. Itoh (2004)) in three ways. First, we focus on workers who are never richer than their bosses. We show that because envy amplifies the effect of incentives on effort, optimal incentive pay is higher when envy is present.

Second, we explicitly consider whether a person envies a boss only when he works under him, or whether he envies the boss's wealth even if someone else works under that boss. These two different types of envy have different implications for a worker's participation constraint, and therefore different implications for the wage contract a firm will offer.

Third, we apply the idea to new issues, including why lower-level workers are awarded stock options, and why government generally offers lower-powered incentives than do for-profit firms.

3 Assumptions

Consider the following principal-agent model. A risk-neutral employer hires a risk-averse worker. The employer aims to maximize profits, Π . Profits equal the worker's output minus the wage paid (the price of output is normalized to one). The worker chooses effort e . The worker's effort yields output H with probability $\phi(e)$ and yields output L with probability $[1 - \phi(e)]$, with $\phi'(e) > 0$ and $\phi''(e) \leq 0$. The cost of effort to the worker is $c(e)$, with $c'(e) > 0$ and $c''(e) > 0$. We examine optimal contract design when effort is contractible and when it is not. Output is always contractible; the worker is paid w_i when output is i . Thus, w_L is the base salary and $w_H - w_L$ is the bonus or incentive pay.

The worker's income, cost of effort, and envy are separable in the utility function:

$$U = u(w) - c(e) - \gamma v(x), \tag{1}$$

with $u'(w) > 0$ and $u''(w) \leq 0$. The function $v(x)$ represents envious feelings, with γ the weight on envy in the worker's utility function, $v'(x) > 0$, and $v''(x) \geq 0$.

The simplest assumption about the object of envy is that the worker's utility declines with his employer's profits ($x = \Pi$). This envy of profits may also be seen as describing a spiteful worker rather than an envious one.³

Alternatively, in Section 5 we model envy as increasing with the difference in income between the employer and the worker ($x = \Pi - w$).⁴

3.1 Specific envy

We analyze the consequences of two different assumptions about how envy affects the worker's participation constraint. One assumption is that a worker envies an employer only if the worker personally contributes to his employer's wealth. This is the 'cold shiver' assumption; it resembles the 'warm glow' assumption used in some analyses of the private provision of a public good, where a person cares about both aggregate provision and his own contribution.⁵ We shall be succinct by calling this specific envy. Under this assumption, a person who is self-employed or unemployed suffers no envy. Let the worker's income be \bar{w} , and let his effort be \bar{e} when choosing the outside option. Then the envy-free utility when choosing the outside option is

$$\bar{U} = u(\bar{w}) - c(\bar{e}).$$

The participation constraint is

$$E[u(w) - c(e) - \gamma v(x)] \geq \bar{U}.$$

where E is the expectation operator.⁶ We shall see that such specific envy always makes behavior differ from what it would be in the absence of envy.

³Note, however, that if $v(\cdot)$ is linear, $x = \Pi$ is behaviorally equivalent to $x = \Pi - U$ and to $x = \Pi - u(w) - c(e)$. That is, when $v(\cdot)$ is linear, assuming that the worker's utility decreases in profits is equivalent to assuming that the worker's envy increases in the difference between the employer's profits and the worker's utility. When $v(\cdot)$ is convex, and $x = \Pi - U$, we cannot solve the model analytically.

Varian (1974) defines an allocation as envy-free when no agent prefers any other agent's consumption-leisure bundle to his own. Hence, the more time executives spend at work, the less workers will envy them for a given difference in consumption bundles. We abstract from employer's effort. Our qualitative results continue to hold, however, if the worker envies his boss, even if the worker takes into account the boss's effort.

⁴Experimental evidence indicates that people care about absolute differences rather than about relative shares, see Camerer (2003b, p. 110-111).

⁵Important papers on the 'warm glow' in provision of a public good include Arrow 1972; Andreoni 1989, 1990; Cornes and Sandler 1984; Kingma 1989; Roberts 1987.

⁶We assume that income and effort are certain when choosing the outside option. As seen in Section 5, this does not affect our results, except when envy is general and depends

3.2 General envy

The alternate assumption is that a worker envies the employer in question regardless of whether he works for him.⁷ We call this general envy. Let a worker's expected disutility from envy when outside the firm be $Ev(x_e)$. The participation constraint is then

$$E[u(w) - c(e) - \gamma v(x)] \geq \bar{U} - \gamma Ev(x_e).$$

Under many plausible conditions, general envy will have the same effects as specific envy. The reason is that, when the firm makes an offer to a worker, the worker's expectations are given, and so $Ev(x_e)$ is fixed.⁸ This implies that the firm's optimization problem becomes, with one difference, the same as with specific envy. The difference is that the reservation utility under specific envy can differ from that under general envy. That, however, will not change the type of incentive contract the principal offers; it will only affect the base salary.

General envy may lead to different results from specific envy if the firm commits to the wages it will offer, to the current and any alternative prospective hires, with the same wage package offered to any potential hire. Thus, when workers are homogeneous, each realizes that, in equilibrium, the employer's profits are independent of who he hires. Hence, when envy depends only on profits ($x = \Pi$), the value of $Ev(x)$ equals the value of $Ev(x_e)$. This makes the participation constraint $E[u(w) - c(e)] \geq \bar{U}$, which is independent of envy. When, however, envy increases with the difference in income ($x = \Pi - w$), and the wage at the firm can differ from income under the outside option (\bar{w}), the expected disutility from envy may differ inside and outside the firm. General envy then directly affects the decision to take the job, as in the case of specific envy. In the following, when we refer to general envy we assume that the employer does so commit to the wage package.

on relative income.

⁷It is straightforward to extend the utility function to allow for envious feelings towards more than one employer. This does not affect our results when envy increases only with profits. When envy increases with relative income, a worker who tries to reduce his envy of other employers, for which he does not work, will increase his effort. In other words, allowing for more employers in the model would introduce a 'keeping up with the employers'-effect.

⁸This would, of course, be different when workers have a lack of information about the profitability of the firm. Then, the firm's offer could serve as a signal to the worker. We abstract from this.

For future reference, let $\beta = 0$ for general envy (that is, when envy arises even when another worker takes the job) and $\beta = 1$ for specific envy. Write the worker's participation constraint as

$$E[u(w) - c(e) - \gamma v(x)] \geq \bar{U} - (1 - \beta)\gamma Ev(x_e). \quad (2)$$

We study the polar cases of specific envy and general envy, by letting β equal 1 or 0; a more general analysis would let it take intermediate values. Thus, a computer programmer working for Sun or for Oracle may envy the wealth of Bill Gates; but perhaps someone at Microsoft envies him even more. The balance between specific and general envy may also depend on where a person lives. A worker in New York City may notice so many wealthy employers that he little envies any one employer unless he works for him. But a worker in a small city can be highly aware of a boss's wealth even when not working for him. So specific envy may be more common in large cities and large countries, and general envy more common in smaller cities and smaller countries.

In the following we shall consider the solutions that arise under different assumptions: a worker's envy can be specific or general; his envy may depend either on the employer's profits or else on the difference between the employer's profits and the worker's income; the pay can be contingent on both effort and output (effort is contractible) or else (because effort is not contractible) only on output. This gives eight different possibilities to consider. But since in many of the cases general envy either has no effect, or effects qualitatively similar to specific envy, we shall often omit discussion of general envy, but note when it does lead to different conclusions.

4 Envy increases with employer's profits

4.1 Contractible effort

We start by allowing pay to increase with both the worker's effort and his output. When effort is thus contractible, the principal-agent problem is simple. In the standard model with risk-averse but non-envious workers, the profit-maximizing contract pays the worker a fixed wage (so that the firm bears all the risk) and demands an effort level such that the worker's marginal cost of effort equals the firm's expected marginal revenue from that

effort. As we will see, when a worker envies his boss, the optimal contract may impose some of the risk on the worker.

The employer's optimization problem is

$$\max_{e, w_H, w_L} \phi(e)(H - w_H) + [1 - \phi(e)](L - w_L) \text{ subject to (2).}$$

The first-order conditions are:

$$\begin{aligned} \phi'(e) [H - L - w_H + w_L] + \lambda \{ \phi'(e) [u(w_H) - u(w_L)] - c'(e) \} \\ - \lambda \beta \gamma \phi'(e) [v(H - w_H) - v(L - w_L)] = 0 \end{aligned} \quad (3)$$

$$-\phi(e) + \lambda [\phi(e)u'(w_H) + \beta \gamma \phi(e)v'(H - w_H)] = 0 \quad (4)$$

$$- [1 - \phi(e)] + \lambda \{ [1 - \phi(e)]u'(w_L) + \beta \gamma [1 - \phi(e)]v'(L - w_L) \} = 0 \quad (5)$$

$$\begin{aligned} \phi(e)u(w_H) + [1 - \phi(e)]u(w_L) - c(e) \\ - \beta \gamma \{ \phi(e)v(H - w_H) + [1 - \phi(e)]v(L - w_L) \} = \bar{U}, \end{aligned} \quad (6)$$

where λ is the Lagrange multiplier.

In these equations, β and γ always appear as $\beta\gamma$. Therefore under general envy ($\beta = 0$) the weight of envy in utility (γ) is irrelevant, and so envy here has no effect. The neutrality arises because the contractibility of effort effectively makes the worker's only decision whether to participate. In equilibrium, the worker realizes that the employer's profits are independent of who is hired. As he will envy the employer anyway, envy is irrelevant for the worker's participation decision. In contrast, with specific envy ($\beta = 1$), the worker can avoid feelings of envy by choosing the envy-free outside option. Then, as is clear from the participation constraint, (6), for a given level of effort, the worker must be compensated for the utility loss of envy, and so envy increases the worker's pay.⁹

Combining (4) and (5) characterizes the optimal pay schedule:

$$u'(w_L) - u'(w_H) = \beta \gamma [v'(H - w_H) - v'(L - w_L)]. \quad (7)$$

The result follows intuition: when workers are risk-averse and lack envy ($\gamma = 0$), or when workers are risk-averse and suffer from general envy ($\beta = 0$),

⁹Clearly, with specific envy and high γ , the expected wage may exceed expected revenues, and so the firm may hire no worker. Envy may thus obstruct an otherwise mutually beneficial relation. Throughout the paper, we focus on interior solutions.

a fixed wage ($w_H = w_L$) is optimal. A fixed wage places all the risk on the employer; because the employer is risk neutral, this is optimal. With specific envy, however, if the marginal utility loss from envy increases with profits ($v'' > 0$), a profit-maximizing firm will share profits (and thus risk) with the worker. The intuition lies with the observation that when the marginal disutility from envy increases with profits, the worker suffers much more when profits are high than when profits are low. With a fixed wage, profits are high when output is high and low when output is low. The employer can increase the worker's expected utility, and so reduce the worker's expected total compensation, by paying more when output and profits are high, and paying less when output and profits are low. Such profit-sharing increases the employer's expected profits.¹⁰ The cost of profit-sharing is the increased risk borne by the worker. The optimal contract trades off this cost and the benefit of reduced envy. In the extreme case of a risk neutral worker, (7) implies that the optimal bonus equals the full marginal product of the worker ($w_H - w_L = H - L$).

Combining these results with the first-order condition for effort (3) shows that specific envy affects effort, whereas general envy does not. Note that if expected profits increase with effort, specific envy makes it more costly to induce a worker to exert effort (see the last term in (3)). This, however, has no implications for the optimal level of effort specified in the contract: envy is like a tax on profits, the higher are the profits the more must the firm pay the worker. But just as a tax on profits does not change the profit-maximizing level of output, it does not change the profit-maximizing level of effort.

The presence of envy can, however, indirectly affect the effort the firm wants to induce. First, the presence of specific envy causes the firm to compensate the worker with higher pay. When the worker's utility is concave in income, the increase in pay reduces the worker's marginal utility from income, and so increases the marginal cost to the firm of increasing the worker's effort. Optimal effort is therefore less than in the absence of envy.

Second, envy can make profit-sharing optimal. The worker then faces risk, the marginal benefit of effort to the worker changes, and the employer adjusts the induced effort to reduce the risk borne by the worker. Note that,

¹⁰Notice that when $v(\Pi)$ is linear, the expected utility loss from envy always increases with expected profits. Hence, the only way to reduce the worker's expected disutility from envy, and thereby relax his participation constraint, is to reduce expected profits; this clearly hurts the employer. The convexity of $v(\cdot)$ implies that profit-sharing can reduce the expected utility loss from envy even though expected profits for the employer increase.

for a given incentive wage, risk is highest when $\phi(e) = 1/2$. Whether effort is higher or lower therefore depends on the equilibrium level of $\phi(e)$ in the absence of envy. When $\phi(e) < 1/2$, profit-sharing involves a reduction in effort so as to reduce risk; the reverse holds when $\phi(e) > 1/2$.¹¹

To summarize, when effort is contractible, only specific envy affects the optimal contract: the employer compensates the worker for his envy by increasing pay. Moreover, if utility is convex in envy, the optimal contract calls for profit-sharing. So, though incentives are unnecessary to induce effort, and are costly because of the worker's risk-aversion, a pay schedule that resembles performance pay is optimal. Envy may affect the effort requirement in the contract, as a result of an income effect and of the employer's benefit from weakening the consequences of profit-sharing on the worker's risk. Lastly, specific envy necessarily reduces profits, even when the worker's effort may increase. The reason is that the firm must compensate the worker fully, both for the disutility from envy and for the disutility from effort.

4.2 Noncontractible effort

Suppose now that effort is not contractible. Workers make two decisions: whether to participate and, if so, how hard to work. We solve the model by backward induction.

When choosing effort, the worker's expected utility is:

$$U = \phi(e)u(w_H) + [1 - \phi(e)]u(w_L) - c(e) - \gamma \{ \phi(e)v(H - w_H) - [1 - \phi(e)]v(L - w_L) \}. \quad (8)$$

Note that, by the definition of general and specific envy, it does not matter whether envy is general or specific at the moment the worker chooses effort. The worker's first-order condition for optimal effort is:

$$\phi'(e)[u(w_H) - u(w_L)] - c'(e) - \gamma\phi'(e)[v(H - w_H) - v(L - w_L)] = 0. \quad (9)$$

Clearly, when incentive pay is less than the worker's marginal product (that is, $w_H - w_L < H - L$), envy reduces the worker's effort. The reason is that the worker's effort increases his employer's profit, making the worker more

¹¹This effect relies heavily on the assumed production technology. For instance, it would not appear if uncertainty in pay stems from additive noise in production, or from additive noise in the performance measure.

envious. Though envy reduces the worker's effort given the power of the incentive schedule, envy amplifies the effects of incentives:

$$\begin{aligned}\frac{de}{dw_H} &= \phi'(e)[u'(w_H) + \gamma v'(H - w_H)]s^{-1} \\ \frac{de}{dw_L} &= -\phi'(e)[u'(w_L) + \gamma v'(L - w_L)]s^{-1},\end{aligned}$$

where $-s$ is the second-order condition:

$$s = -\frac{\partial^2 U}{\partial e^2} = c''(e) - \phi''(e) \{u(w_H) - u(w_L) - \gamma [v(H - w_H) - v(L - w_L)]\} > 0.$$

Besides the usual effect, stronger incentives imply that the employer gains less from marginal effort. This gives envious workers an additional incentive to work harder when incentive pay increases.¹²

The employer maximizes profits subject to the worker's participation constraint, so that the employer's objective is to

$$\max_{w_H, w_L} \phi(e)(H - w_H) + [1 - \phi(e)](L - w_L) \text{ subject to (2),}$$

with e implicitly described by (9). The first-order conditions for a profit-maximizing contract are:

$$\begin{aligned}& -\phi(e) + \frac{de}{dw_H} \phi'(e)[H - w_H - L + w_L] \\ & + \lambda \{ \phi(e)u'(w_H) + \beta\gamma\phi(e)v'(H - w_H) \} \\ & + \lambda \left\{ \frac{de}{dw_H} (1 - \beta)\gamma\phi'(e)[v(H - w_H) - v(L - w_L)] \right\} = 0\end{aligned}\quad (10)$$

$$\begin{aligned}& -[1 - \phi(e)] + \frac{de}{dw_L} \phi'(e)[H - w_H - L + w_L] \\ & + \lambda \{ [1 - \phi(e)]u'(w_L) + \beta\gamma[1 - \phi(e)]v'(L - w_L) \} \\ & + \lambda \left\{ \frac{de}{dw_L} (1 - \beta)\gamma\phi'(e)[v(H - w_H) - v(L - w_L)] \right\} = 0\end{aligned}\quad (11)$$

¹²In addition to this first-order effect, envy further magnifies the effect of incentive pay on effort if there are decreasing returns to effort, $\phi''(e) < 0$; see the second-order condition.

$$\begin{aligned} & \phi(e)u(w_H) + [1 - \phi(e)]u(w_L) - c(e) \\ & -\beta\gamma \{ \phi(e)v(H - w_H) + [1 - \phi(e)]v(L - w_L) \} = \bar{U}, \end{aligned} \quad (12)$$

where λ is the Lagrange multiplier and the terms in large brackets have been simplified using the first-order condition for effort (9).

When $v(\cdot)$ is linear, the optimization problem has a simple solution. Combining (10) and (11) and letting $v(\cdot)$ be linear shows that the optimal contract has

$$w_H - w_L = H - L - \frac{\phi(e)[1 - \phi(e)][u'(w_L) - u'(w_H)]s}{[\phi'(e)]^2[u'(w_H) + \gamma][u'(w_L) + \gamma]}. \quad (13)$$

Clearly, when workers are risk neutral [$u'(w_L) = u'(w_H)$], for all values of γ profit maximization requires full incentives (that is, $w_H - w_L = H - L$). When workers are risk averse [$u'(w_L) > u'(w_H)$], the employer always sets partial incentives (that is, $w_H - w_L < H - L$). Optimal incentives decline with the degree of risk aversion and with the uncertainty about the equilibrium level of output, measured by $\phi(e)[1 - \phi(e)]$. Optimal incentives increase with the effect of effort on expected output [$\phi'(e)$]. Lastly, and most importantly, the marginal incentive an employer offers increases with the importance of envy (as captured by γ) to the worker. The reason is that incentives induce more effort when workers are envious, making it more costly to weaken incentives for risk-sharing reasons.¹³Note that when $v(\cdot)$ is linear, optimal incentive pay is independent of whether envy is specific or general. As in the previous section, the kind of envy does matter for total compensation. As is clear from the participation constraint (12), the worker earns more when envy is specific (when $\beta = 1$) than when envy is general (when $\beta = 0$).

When $v(\cdot)$ is convex and envy is specific ($\beta = 1$), optimal incentive pay

¹³Envy has two additional, indirect, effects on optimal incentive pay. First, if $\phi''(e) < 0$, the absolute value of the second-order condition (s) decreases in γ . Following (13), this further increases optimal incentive pay. The reason is that incentive pay more strongly affects effort when s is small. Second, there is an indirect effect through $\phi(e)$. By the first-order condition (9), envy directly reduces effort e . Hence, $\phi(e)$ falls, and, if $\phi''(e) < 0$, the value of $\phi'(e)$ increases. Following (13), the increase in $\phi'(e)$ implies a further increase in optimal incentive pay. The decrease in $\phi(e)$ has an ambiguous effect, depending on whether $\phi(e) \geq 1/2$, that is, depending on whether risk increases or decreases in effort.

is:

$$w_H - w_L = H - L - \frac{\phi(e)[1 - \phi(e)]\{u'(w_L) - u'(w_H) - \gamma[v'(H - w_H) - v'(L - w_L)]\}s}{[\phi'(e)]^2[u'(w_H) + \gamma v'(H - w_H)][u'(w_L) + \gamma v'(L - w_L)]}. \quad (14)$$

Note, as apparent from the last term in brackets in the numerator, the convexity of $v(\cdot)$ enhances the effect of envy on incentive pay. This is the effect that also appeared for contractible effort: if envy is specific ($\beta = 1$) profit-sharing reduces the expected wage cost as the worker suffers more from envy when profits are high than when profits are low.

When $v(\cdot)$ is convex and envy is general ($\beta = 0$), optimal incentive pay is:

$$w_H - w_L = H - L - \frac{\phi(e)[1 - \phi(e)][u'(w_L) - u'(w_H)]s}{[\phi'(e)]^2[u'(w_H)u'(w_L) + \gamma[1 - \phi(e)]v'(H - w_H)u'(w_L) + \gamma\phi(e)v'(L - w_L)u'(w_H)] + (\gamma[v(H - w_H) - v(L - w_L)])} \left(\frac{[1 - \phi(e)][u'(w_H) + \gamma v'(H - w_H)] + \phi(e)[u'(w_L) + \gamma v'(L - w_L)]}{u'(w_H)u'(w_L) + \gamma[1 - \phi(e)]v'(H - w_H)u'(w_L) + \gamma\phi(e)v'(L - w_L)u'(w_H)} \right). \quad (15)$$

Note that here again the convexity of $v(\cdot)$ amplifies the effect of envy on optimal incentive pay. The intuition is clear from the first-order conditions (10) and (11). Recall that when $\beta = 0$, the worker envies the employer even when another worker takes the job. Envy therefore does not directly affect the worker's decision to take the job. But once on the job, the worker's envy induces him to work less than he otherwise would; effort declines the most when incentive pay is low (see (9)). The reduced effort reduces the worker's utility for a given level of envy. Since, in equilibrium, envy *is* given (that is, independent of the worker's participation), the worker must be compensated for this by a higher base salary. In other words, when $\beta = 0$ and effort is non-contractible, the worker anticipates that when he is hired, his envy will induce him to exert little effort, and so envy indirectly affects the worker's willingness to participate. Higher incentive pay reduces the effect of envy on effort, relaxing the worker's participation constraint. As before, when $v(\cdot)$ is convex, the employer can reduce the expected wage he will pay and thereby

increase expected profits, by giving stronger incentives. The only difference from the result with specific envy is that under general envy the effect is indirect through the worker's choice of effort.

The total effect of envy on worker's effort is indeterminate. On the one hand, envy directly reduces effort, as shown by the first-order condition (9). On the other hand, the firm sets higher incentive pay, inducing higher effort. The total effect depends on the degree of risk aversion and on the shape of the function describing the disutility from envy.

In short, when effort is not contractible, envy reduces worker's effort for given level of incentives, but amplifies the effect of incentives on effort. Consequently, the employer offers stronger incentives. Moreover, when utility is convex in envy, optimal incentive pay increases with envy so as to reduce the worker's expected disutility from envy and, hence, reduce wage compensation. Effort may either increase or decrease in envy. Profits are, however, always lower when workers are envious, even when envy results in higher effort. The reason is that the firm must fully compensate the worker for his higher effort. This also holds when envy is general and, hence, cannot be escaped. If the firm incompletely compensates for the cost of effort, any one person then prefers that some other person take the job. When envy is specific, the firm must also compensate the worker for the disutility from envy.

5 Envy depends on relative income

Suppose now that the worker's envy increases with the difference in income between the employer and the worker. Again, we first consider contractible effort and then consider noncontractible effort. To avoid repetition of arguments, we focus our discussion on the implications of letting envy depend on relative income rather than only on profits.

5.1 Contractible effort

The first-order conditions for the profit-maximizing pay schedule are:

$$\begin{aligned} & \phi'(e) [H - L - w_H + w_L] + \lambda \{ \phi'(e) [u(w_H) - u(w_L)] - c'(e) \} \\ & \quad - \lambda \gamma \phi'(e) \{ v(H - 2w_H) - v(L - 2w_L) \} \\ & + \lambda \gamma \phi'(e) \{ (1 - \beta)v(H - w_H - \bar{w}) - (1 - \beta)v(L - w_L - \bar{w}) \} = 0 \end{aligned} \quad (16)$$

$$\begin{aligned}
& -\phi(e) + \lambda\phi(e)u'(w_H) \\
& + \lambda [2\gamma\phi(e)v'(H - 2w_H) - (1 - \beta)\gamma\phi(e)v'(H - w_H - \bar{w})] = 0 \quad (17)
\end{aligned}$$

$$\begin{aligned}
& -[1 - \phi(e)] + \lambda[1 - \phi(e)]u'(w_L) \\
& + \lambda \{2\gamma[1 - \phi(e)]v'(L - 2w_L) - (1 - \beta)\gamma[1 - \phi(e)]v'(L - w_L - \bar{w})\} = 0 \quad (18)
\end{aligned}$$

$$\begin{aligned}
& \phi(e)u(w_H) + [1 - \phi(e)]u(w_L) - c(e) \\
& - \gamma \{ \phi(e)v(H - 2w_H) + [1 - \phi(e)]v(L - 2w_L) \} \\
& + \gamma(1 - \beta) \{ \phi(e)v(H - w_H - \bar{w}) + [1 - \phi(e)]v(L - w_L - \bar{w}) \} = \bar{U}. \quad (19)
\end{aligned}$$

Though these conditions closely resemble the conditions we described above when envy depends on profits, there are two differences. First, both specific and general envy directly affect the worker's willingness to participate. The reason is that, when envy depends on the difference in income between the employer and the worker, and when wages differ inside and outside the firm, envious feelings may differ inside and outside. Second, under specific envy ($\beta = 1$), the effect of an increase in pay (either w_H or w_L) on the disutility from envy is twice as large. The reason is that, all else equal, an increase in w_i both reduces the employer's profits and increases the worker's income, thus reducing the difference in income by twice as much as the increase in compensation.

Combining (17) and (18) yields:

$$u'(w_L) - u'(w_H) = 2\gamma[v'(H - 2w_H) - v'(L - 2w_L)]. \quad (20)$$

As in the previous section, when utility is convex in envy a trade-off appears between the risk borne by the worker and the expected disutility from envy, implying that some profit-sharing is optimal. In contrast to the previous section, profit-sharing is optimal even when envy is general. The reason is that when envy depends on the difference in income, the expected disutility from envy is no longer a constant. Making pay increase with output reduces the expected disutility from envy more when the person works inside the

firm than when he is outside it. Hence, working for the firm becomes more attractive compared to the outside option, allowing the firm to reduce the base salary.

A second important difference with the results in the previous section is that the expected disutility from envy is minimized when $w_H - w_L = (H - L)/2$. That is, the employer should pay *half* of the marginal product instead of the full marginal product.¹⁴ The intuition is that when the worker is paid a lump-sum plus half his marginal product, the difference in income between the employer and the worker can be made invariant with output.¹⁵ When $v(\cdot)$ is convex, and given the expected value of the income differential, the worker prefers a stable to an uncertain income differential. Since the compensation schedule has no incentive effects, and since the risk-neutral employer only cares about expected profits, not about the distribution of profits over states, the employer chooses the distribution of pay that maximizes the worker's utility, thus enabling the employer to reduce expected wage costs. Comparing (20) to (7), it follows that envy which varies with relative income may induce less profit-sharing than does envy which varies with profits. We should be careful, however, in comparing the two cases because the functions $v(\cdot)$ in the two cases can differ. We are sure, however, that if envy depends on the difference in incomes, then when the importance of envy to the worker rises (when γ increases), or when risk-aversion falls, the optimal level of $w_H - w_L$ converges to half of the marginal product. If instead envy depends on profits, optimal pay converges to the full marginal product.

5.2 Noncontractible effort

Consider next noncontractible effort. The worker chooses that level of effort which satisfies the first-order condition

$$\phi'(e)[u(w_H) - u(w_L)] - c'(e) - \gamma\phi'(e)[v(H - 2w_H) - v(L - 2w_L)] = 0.$$

Note that envy may now increase or reduce effort. When $w_H - w_L < (H - L)/2$, envy reduces effort, as before. But when $w_H - w_L > (H - L)/2$, envy

¹⁴Some data support this prediction. Young and Burke (2001) show that in their sample of Illinois farms, almost all contracts have the same tenant share for all types of crops, and this share is one-half for 80% of the contracts.

¹⁵Note that given that the employer always ends up richer than the worker, a pay system with full incentives results in high income inequality when output is low, whereas the absence of incentive pay results in high income inequality when output is high.

motivates effort, even though effort enriches the employer. The reason is that when incentive pay exceeds half the marginal product, effort reduces the expected difference in income between the employer and the worker, motivating higher effort. Envy amplifies the effects of incentives:

$$\begin{aligned}\frac{de}{dw_H} &= \phi'(e)[u'(w_H) + 2\gamma v'(H - 2w_H)]s^{-1} \\ \frac{de}{dw_L} &= -\phi'(e)[u'(w_L) + 2\gamma v'(L - 2w_L)]s^{-1},\end{aligned}$$

where $-s$ is the second-order condition:

$$s = -\frac{\partial^2 U}{\partial e^2} = c''(e) - \phi''(e) \{u(w_H) - u(w_L) - \gamma [v(H - 2w_H) - v(L - 2w_L)]\} > 0.$$

Stronger incentives make that effort becomes more rewarding in terms of income, but also that the difference in income between the employer and the worker increases less (or decreases more) with effort. Hence, an increase in incentive pay further motivates effort by an envious worker.

The first-order conditions for a profit-maximizing pay schedule are:

$$\begin{aligned}& -\phi(e) + \frac{de}{dw_H} \phi'(e)[H - w_H - L + w_L] \\ & + \lambda \{ \phi(e)u'(w_H) + 2\gamma\phi(e)v'(H - 2w_H) - (1 - \beta)\gamma\phi(e)v'(H - w_H - \bar{w}) \} \\ & + \lambda \left(\frac{de}{dw_H} (1 - \beta)\gamma\phi'(e)[v(H - w_H - \bar{w}) - v(L - w_L - \bar{w})] \right) = 0 \quad (21)\end{aligned}$$

$$\begin{aligned}& -[1 - \phi(e)] + \frac{de}{dw_L} \phi'(e)[H - w_H - L + w_L] \\ & + \lambda \{ [1 - \phi(e)]u'(w_L) + 2\gamma[1 - \phi(e)]v'(L - 2w_L) - (1 - \beta)\gamma[1 - \phi(e)]v'(L - w_L - \bar{w}) \} \\ & + \lambda \left(\frac{de}{dw_L} (1 - \beta)\gamma\phi'(e)[v(H - w_H - \bar{w}) - v(L - w_L - \bar{w})] \right) = 0 \quad (22)\end{aligned}$$

$$\begin{aligned}& \phi(e)u(w_H) + [1 - \phi(e)]u(w_L) - c(e) \\ & - \gamma \{ \phi(e)v(H - 2w_H) + [1 - \phi(e)]v(L - 2w_L) \} \\ & + (1 - \beta)\gamma \{ \phi(e)v(H - w_H - \bar{w}) + [1 - \phi(e)]v(L - w_L - \bar{w}) \} = \bar{U}. \quad (23)\end{aligned}$$

We first solve for the profit-maximizing pay schedule when $v(\cdot)$ is linear. Combining (22) and (23) yields

$$w_H - w_L = H - L - \frac{\phi(e)[1 - \phi(e)][u'(w_L) - u'(w_H)]s}{[\phi'(e)]^2[u'(w_H) + 2\gamma][u'(w_L) + 2\gamma]}. \quad (24)$$

The result much resembles that of the previous section; compare (13). Optimal incentive pay is higher when workers are envious because incentives have a larger effect on effort.

When $v(\cdot)$ is convex, and envy is specific ($\beta = 1$), optimal incentive pay is

$$w_H - w_L = H - L - \frac{\phi(e)[1 - \phi(e)][u'(w_L) - u'(w_H) - 2\gamma[v'(H - 2w_H) - v'(L - 2w_L)]]s}{[\phi'(e)]^2[u'(w_H) + 2\gamma v'(H - 2w_H)][u'(w_L) + 2\gamma v'(L - 2w_L)]} \quad (25)$$

As before, the convexity of $v(\cdot)$ makes some profit-sharing, which reduces the expected disutility from envy, optimal. This effect is captured by the last term in the numerator. Note that the effect of envy on optimal incentive pay becomes ambiguous. Though envy amplifies the effect of incentives on effort and, therefore, increases optimal incentive pay (see the terms in the denominator), profit-sharing may call for lower incentives. This occurs when, apart from profit-sharing reasons, optimal incentive pay is higher than half the marginal product. Then lowering incentive pay reduces uncertainty about the difference in income and thus, as $v(\cdot)$ is convex, reduces the expected disutility from envy. When, apart from profit-sharing reasons, optimal incentive pay is less than half of the marginal product (for instance, when the worker is sufficiently risk averse), envy unambiguously increases optimal incentive pay.

Lastly, let $v(\cdot)$ be convex and let envy be general ($\beta = 0$). Define

$$\begin{aligned} D \equiv & u'(w_H)u'(w_L) + \gamma[2v'(H - 2w_H) - \phi(e)v'(H - w_H - \bar{w})][u'(w_L) + 2\gamma v'(L - 2w_L)] \\ & + \gamma\{2v'(L - 2w_L) - [1 - \phi(e)]v'(L - w_L - \bar{w})\}[u'(w_H) + 2\gamma v'(H - 2w_H)] \\ & - 4\gamma^2 v'(H - 2w_H)v'(L - 2w_L) \end{aligned}$$

Optimal incentive pay is:

$$\begin{aligned}
w_H - w_L = H - L - & \\
& \left\{ \frac{\phi(e)[1 - \phi(e)]s}{[\phi'(e)]^2 D} \right\} \\
\{u'(w_L) - u'(w_H) - \gamma[2v'(H - 2w_H) - v'(H - w_H - \bar{w}) - 2v'(L - 2w_L) + v'(L - w_L - \bar{w})] & \\
+ \gamma[v(H - w_H - \bar{w}) - v(L - w_L - \bar{w})] & \\
\left\{ \frac{[1 - \phi(e)][u'(w_H) + 2\gamma v'(H - w_H)] + \phi(e)[u'(w_L) + 2\gamma v'(L - w_L)]}{D} \right\} & \quad (26)
\end{aligned}$$

To understand the differences between (25) and (26), consider the first-order conditions (21) and (22). These show two additional effects under general envy, described by the last two terms in brackets.

First, because the firm's pay schedule now also affects the worker's envy when another worker takes the job, the pay schedule has a smaller effect on the participation constraint when envy is general. Comparing the numerators in the first fractions in (25) and (26, (third line)) shows that this reduces optimal incentive pay. The reason is as follows. For a given level of effort, weaker incentives imply higher profits. Since wages elsewhere are unaffected by the firm's wage offer, higher profits increase the envy suffered by a person working outside the firm, allowing the firm to reduce the base salary.

Second, working in the opposite direction, is an indirect effect through effort, described by the last terms in brackets in the first-order conditions (21) and (22). The intuition is the following. Higher incentive pay increases effort. This increases the probability of high output. When the firm pays less than the full marginal product, profits will be higher when output is H than when output is L . As the wage elsewhere is fixed, this implies that the worker expects to suffer more from envy when he chooses the outside option. Higher incentive pay therefore makes the outside option less attractive, allowing the firm to reduce the base salary (see the last term in (26)). As the two additional effects have opposite signs, it is unclear whether incentive pay will be higher or lower when envy is specific compared to when it is general.

6 Applications

6.1 Stock options to lower-level workers

Whereas awarding stock options can align the interests of CEOs and shareholders, it is harder to see why lower-level workers should be granted stock options, as each individual worker's effort hardly affects the stock price. Yet, many firms offer stock options to non-executive workers (Hall and Murphy (2003) and Oyer and Schaefer (2004)). Workers' envy of the manager's wealth may be an explanation. As we saw, when utility is convex in envy, the profit-maximizing compensation schedule is not a flat wage, even when effort is fully contractible. Instead it pays a high wage when output (and hence profit) is high and a low wage when output (and hence profit) is low. The employer balances the cost of risk to the worker with the worker's expected disutility from envy. These effects can make a profit-maximizing firm award stock options to workers even if any one individual worker's effort hardly affects the stock price. When, for incentive reasons, the CEO is awarded stock options, workers should be also, so as to reduce the expected disutility from envy.

Workers' envy may also affect the optimal compensation of the CEO. When workers' envy is limited to the CEO's wealth, and utility is convex in envy, a grant of stock options to the CEO increases the disutility of workers from envy, and so requires an increase in workers' wages. Similarly, when workers also envy the stockholders' wealth, but CEOs are wealthier than the average stockholder, stock options to the CEO may increase wage compensation to workers. Hence, workers' envy may weaken the stockholders' incentive to motivate the CEO by awarding stock options.

6.2 Wages are higher at larger establishments

Other things equal, in a large firm or a large plant, the income of the boss will be higher. We can think of multiple workers under each boss or owner. The higher income creates higher envy, and so induces higher wages and higher-powered incentives. Agell (2003), using a representative survey of compensation managers, finds that small establishments rely less on pecuniary incentives and report less often that their employees care about relative pay.

Empirical studies find that large employers pay higher wages than smaller ones, and that this wage premium remains even after controlling for observ-

able characteristics of workers and of firms. The size effect is large; Brown, Hamilton and Medoff (1990) show that employees in U.S. companies with more than 500 employees earn 35 percent more than those in companies with less than 500 employees. Brown and Medoff (1989), Groshen (1991), Oi and Idson (1999), and Troske (1999) report and summarize similar results for the United States. The increase of wages with employer size is also found in other countries. Arai (2003) reports results for Sweden. Albaek et al. (1998) present results for the Nordic countries, and provide references to studies for other non US-countries. Abowd et al. (1999) find a positive firm-size wage-relation for France, of which 75% is explained by variation in average employee heterogeneity across firms of different sizes.

6.3 Profit vs. non-profit organizations

In a privately-held firm the firm's owner is the residual claimant of net profit. In contrast, in a governmental or non-profit organization the residual claimants are a large fraction of the public, with incomes typically lower than those of owners of firms. It is therefore reasonable to suppose that envy plays a less important role for workers outside for-profit firms.¹⁶

The lack of envy means that a worker will be willing to work for a lower wage at a governmental job. It also means that, when envy depends on profits or when envy depends on relative income and incentive pay is less than half of the marginal product, a government worker faced with low-powered incentives will work harder than he would given the same incentives at a for-profit firm. Lastly, non-profit organizations will optimally set weaker incentives than comparable for-profit organizations.

Empirical evidence indeed suggests that government workers face lower-powered incentives than do workers in the private sector. Burgess and Metcalfe (1999) find that British firms in the private sector use incentive wages more extensively than do firms in the public sector, even after controlling for occupation, union density, and work force composition. They conclude that incentives in the public sector are suboptimally weak. Our analysis shows

¹⁶For the same reason, corporate taxes and progressive taxation may reduce workers' envious feelings in for-profit firms, as the worker's marginal product contributes less to the firm's profits. Hence, corporate taxes and progressive taxes may increase the output of lower-level workers. See also Agell and Lundborg (1992)'s study on the effects of tax policies on output and unemployment in a general equilibrium model where workers care about the functional distribution of income.

that the lack of envy in the public sector may be an explanation. Kikeri and Nellis (2002) discuss several studies which find an increase in performance-based incentives for workers in privatized firms. Martin and Parker (1997) report similar evidence for several British firms. Other evidence shows that governmental workers are paid less. Borjas (2003) shows that public sector workers in the United States earn about 5 to 10 percent less than comparable workers in the private sector. Moreover, several studies find that wages at firms increased after privatization in the United Kingdom. (See Bishop and Kay (1988), Haskel and Szymanski (1993), and Parker and Martin (1996)). La Porta and Lopez-de-Silanes (1999) find the same for Mexico, and Brainerd (2002) for Russia.¹⁷

7 Conclusion

We examined the behavior of a worker who envies his employer, and characterized the employment contracts that may result. Our analysis implies that the employer's profits are lower the more the workers envy the owner or manager. One way of reducing envy is to hide the total amount of executive compensation (Bebchuk and Fried, 2003). Another way to reduce envy is to make other attributes of the manager's job appear unattractive to his subordinates. Requirements for credentials (such as an MBA degree) by managers, can make executive positions appear less attractive to some workers, and thus reduce their envy. The nasty and brutal campaigns that candidates for political office endure, and the continued scrutiny by the press, can make citizens little envy a governor or senator, and therefore more willing to work on his behalf. The difficulty of Officer Candidate School in the military can similarly make enlisted soldiers more willing to obey their officers. In short, many phenomena which appear to fit a signaling story which sorts different types of people into different positions, may instead or in addition reduce envy of superiors.

¹⁷The literature offers some other explanations for low-powered incentives in government: the absence of market discipline (Niskanen (1971), Hanushek (1996), Acemoglu, Kremer, and Mian (2003)), optimal design of governmental agencies to limit collusion and corruption (Crozier (1967), Tirole (1986), and Banerjee (1997)), problems arising from the multi-task, multi-principal nature of many government jobs (Dixit (2002)), and selection and motivation of workers with a public service motivation (Francois (2000), Delfgaauw and Dur (2002), Besley and Ghatak (2004)).

Our reasoning can be applied not only to production, but also to consumption. (See Rotemberg (2003) for a related argument based on reciprocal behavior). Suppose that a consumer envies the wealth of the sellers of goods. As Kahneman, Knetsch, and Thaler (1986), for example, document, consumers may refuse to buy from firms that are seen to profiteer from natural disasters. Similarly, Olmstead and Rhode (1985) tell the fascinating story of California oil companies in the 1920s. Standard Oil of California, the dominant firm and price-setter, refused to raise gasoline prices when the real price of light crude doubled. Similarly, during the 1979 gasoline crisis large oil companies such as Exxon and Mobil posted lower prices for gasoline and heating oil than did small companies (Erfle, Pound, and Kalt 1981; Erfle and McMillan 1990). In our terms, we can think of a consumer's utility as increasing with his consumer surplus, and decreasing with the seller's profits. If price equals marginal cost, the quantity a consumer buys does not affect the firm's profits. But the more price exceeds marginal cost, the higher the profits to the seller on each additional unit sold. Envy will then reduce demand. Or stated differently, envy makes demand more elastic, inducing the seller to charge a lower price than he would in the absence of envy. And, in analogy with our analysis of production, an increase in the tax rate on profits will increase consumer demand.

8 Notation

$c(e)$ Cost of effort

e Effort

\bar{e} Outside option effort

H Firm's revenue when production is high

L Firm's revenue when production is low

$u(w_i)$ Worker's utility from income

$v(x)$ Worker's disutility from envy

U Worker's utility

\bar{U} Worker's envy-free outside option utility

w_i Wage when productivity is i

\bar{w} Worker's outside option wage

$\phi(e)$ Probability that production is high

γ Weight on envy in the worker's utility function

Π Profits

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