The art of envy manipulation

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Abstract

We present a principal-agent model with an employer and two types of employees/workers, low and high skilled. Low-skilled workers are envious of their high-skilled peers, and incur a disutility cost, whenever the latter receive a positive surplus from their labor contract. We show that: *i*) even if high-skilled workers do not directly benefit from being envied, they can obtain a payoff higher than that they would get when low-skilled workers are not envious; *ii*) if the envy cost can be manipulated (increased or reduced), high-skilled workers can take actions of envy-reduction or envy-provocation to further increase their expected payoff.

Keywords: envy, principal-agent model, other-regarding preferences.

JEL classifications: D82, J33, M52.

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"*To feel envy is human, to savour schadenfreude is devilish.*"
Schopenhauer

1 Introduction

The literature on the principal-agent theory has extensively focused on problems of asymmetric information and incentive design in workplace settings. The aim of the present paper is to contribute to that literature by exploring how the presence of agents with other-regarding preferences can affect the structure of optimal contracts. Specifically, we develop a simple model with an employer and two types of employees/workers, low skilled and high skilled. We assume that low-skilled workers are envious of their more productive peers, and incur a disutility cost, whenever the latter receive a positive rent from their labor contract. We will show that this disutility cost will ultimately be borne by the principal. Thus, in the design of incentive contracts, the principal must trade off the benefits of hiring low-skilled individuals against the cost of their envy in the workplace. In the article, we derive two main results. The first is that the presence of envious individuals may increase the well-being of high-skilled workers, even though they do not directly benefit from being envied. Then, in the core part of the paper, we assume that the envy cost of low-skilled employees can be manipulated (increased or reduced) by their high-skilled coworkers through actions of envy-reduction or envy-provocation. The manipulation process can be interpreted as a production function, the output of which is the new envy level of low-skilled employees, and the inputs are all those actions that are carried out by high-skilled individuals, at a cost, to elicit more or less envy. The second result of the paper is that, through these actions of envy manipulation, high-skilled individuals can further increase their equilibrium payoff.

On the first result, we follow the standard approach of the literature on other-regarding preferences, which assumes that individuals care about their relative position in a group or society, and tend to display fairness or other forms of inequity concerns (see Fehr and Schmidt, 1999). On this topic, Itoh (2004) develops a principal-agent model in which players dislike team contracts with "unfair" performance-based payments. He shows that equitable contracts ease the incentive constraints and increase the principal's expected profit. Goel and Thakor (2006) argue that envy among agents has two opposing effects which can make the principal either better or worse off in equilibrium. Envy can provide additional incentives to agents to exert effort, but forces the principal to pay higher wages to mitigate their utility loss[1]. Desiraju and Sappington (2007) show that, if agents are ex-ante identical, the principal will offer fair contracts that avoid ex-post inequality and thus make envy irrelevant. Bartling and von Siemens (2010) analyze a framework with multiple agents and stochastic performance, in which agents are envious whenever others receive higher wages. They show that, if agents are risk-averse and not protected by limited liability, the principal will pay flat-wages to elicit the cost-minimizing effort levels. Our model is also close to the works of Dur and Glazer (2007) and Manna (2016). Dur and Glazer (2007) assume that workers are envious of their employers, and show that profit sharing would be an optimal solution, as it lowers the expected cost of envy. Manna (2016) studies the effect of envy towards the boss and colleagues in the workplace. She shows that envy leads to a distortion in the effort exerted by low productivity employees, and that such a distortion can be offset by the envy felt towards the boss. In contrast, we focus on the impact of envy among employees, but we assume that the envied does not directly benefit from the negative emotional state of their peers (that is, there are no additional elements related to envy in their utility function). Nonetheless, we show that envy can increase the equilibrium payoff of the envied. The reason is that, under asymmetric information, the interaction between the agents' participation and incentive compatibility constraints forces the principal to transfer part of the information rent from low- to high-skilled workers.

As for the second result of the paper, we refer to both the literature on social psychology and organizational behavior. This literature reports that equity concerns are rather common in the workplace, and that they generally have harmful consequences on the effort and performance of employees. Some studies suggest that competitive contexts that foster upward social comparisons can trigger feelings of envy and increase hostility (Vecchio, 2005), or even lead to actions of sabotage (Ambrose et al., 2002). Both the envious and the envied may be worse off in the workplace, contributing to a general loss of efficiency. But, envy and resentment can also have positive incentive effects, which might stem from higher motivation to work hard or from feelings of self-enhancement and self-worth for envied individuals (Smith et al., 2016). In general, Wobker (2015) points out how envy should be included in an optimization problem in order to obtain the highest difference between the beneficial motivating effects and the costly negative behavior arising from it. In the model we

[1] Goel and Thakor (2006) also point out that the introduction of fairness concerns in the design of compensation schemes may lead to a violation of the informativeness principle as formulated by Holmstrom (1979). The reason is that other-regarding preferences can distort the performance indicators about the actions chosen by agents. This implies that the payments received by agents cannot be related solely to the information contained in the outcomes generated by their actions.

develop in this paper, envious workers are not motivated by envy to improve their job performance, but suffer due to the higher status of their peers[2]. We assume that envious individuals do not engage in interactive or communicative responses to envy, such as, talking to the boss or coworkers, sabotaging the other's work and reputation, or harassing and gossiping the rivals. The only response of envious workers will be an increase or a decrease in the effort exerted in the workplace, according to the contract designed by the principal for them. As argued by Sussangkarn and Goldman (1983), when envy is included explicitly into the individual's utility function, there is no reason to expect the outcome to be Pareto efficient. In our agency model, the envious will always obtain their reservation payoff in equilibrium, while the envied may end up being better off. This implies that the envied may have the incentive to provoke or reduce the envy felt by their peers to further increase their payoff. That is, the envied may want to take advantage of their superior position in the workplace and of the disutility cost that this imposes to the envious. And indeed, a quite extensive literature focuses on the behavior of people who take actions to manipulate the envy of others. Elster (1991) argues that people who are better off may be expected to follow strategies designed to provoke or maintain the envy of the worse off or, in some cases, even actions of envy reduction[3]. In this article, we want to provide a theoretical justification for these manipulation behaviors and show that they are perfectly consistent with the paradigm of rational choice. In particular, we show that with actions of: *i*) envy-provocation, high-skilled agents can be better off, while the principal is always worse off in equilibrium; *ii*) envy-reduction, it is pos-

[2] We follow the definition of malicious envy which, as opposed to benign envy, is characterized by displeasure and negative or even hostile feelings toward envied individuals and their status or possessions (see Bedeian, 1995).

[3] Elster (1991) reports a series of concrete cases in which people's actions may be ascribed to an attempt to manipulate (increase or reduce) the envy of others. Envy provocation is done, essentially, by making more visible the envied's superiority, such as positional spending and status-seeking behavior. The envied can deliberately trigger feelings of inferiority on others (see Dupor and Liu, 2003, and Huang and Shi, 2015, which also discuss about conspicuous leisure). For example, conspicuous consumption or costly entertaiments choices. The envied may also try to make the worse off remain badly off. The choice of some husbands who prevent their wives from going to work may be partly motivated by the enjoyment of their "job envy". Sometimes, the envied may elicit more envy by making the envious better off, as for example by excessive show of hospitality. Actions of envy-reduction are also rather common. Exline and Lobel (1999) report that high-skilled workers may perform below their capabilities so as to maintain good relations with their envious peers. Or, workers who share their meal bonuses with their colleagues to reduce their feeling of jealousy. In general, all social norms that prevent rate-busting can have the effect to reduce the envy within a group of individuals. Another example is that reported by Foster (1972), cited in Mui (1995), in which the villagers of Tzintzuntzan kept pregnancies a secret to avoid that other women in the community could suffer from envy.

sible to achieve a Pareto improvement in which both the principal and high-skilled workers are better off in equilibrium.

The rest of the paper is as follows. Section 2 outlines the model. Section 3 characterizes the equilibrium. Section 4 shows what happens when high-skilled workers can manipulate (increase or reduce) the envy felt by their low-skilled peers. Section 5 concludes.

2 The setup

Consider a simple risk-neutral workplace setting with a principal (employer) and many agents (employees/workers) of two types, low skilled (L) and high skilled (H). Initially, all workers are employed in entry-level job positions, which do not require any skill or effort. There, workers are paid their (common) reservation wage, which we normalize to 0. Entry-level workers have the opportunity to be promoted to upper-level positions, which pay a higher wage and require positive effort. In the model, we analyze the structure of the contracts offered by the principal for such upper-level positions. Labor contracts are combinations of the wage, w_i, with $i \in \{L, H\}$, and the effort exerted, e_i, which is observable and contractible. The effort costs of L and H workers are affected by their skill levels. To simplify the analysis, effort costs are quadratic and indicated, respectively, by $\overline{\theta} e_L^2/2$ and $\underline{\theta} e_H^2/2$, with $\overline{\theta} > \underline{\theta} > 0$. We will also assume that the effort cost of L types is not too large compared to that of H types, and specifically such that

$$\overline{\theta} < 2\underline{\theta}. \tag{1}$$

There is asymmetric information: employees know their and each other's skill level, so they know the ability of L and H workers to perform in upper-level jobs; the principal only knows the proportions, λ and $1 - \lambda$, of H and L workers.

We assume that low-skilled workers are envious of their high-skilled peers whenever the latter are expected to obtain a positive surplus from their contracts in upper-level positions. Envy stems from a feeling of unfairness, that is from the fact that individuals can be paid more than their true ability. Hence, the *direct* source of envy is that high-skilled can receive better contract offers, while the *indirect* source is that that workers have different inherent abilities. With this interpretation, if information were symmetric, low-skilled types would not be envious of their high-performance peers: the latter would get a higher wage, but would also work more (exert higher effort) and get no surplus from the labor contract. This would be considered fair by low-skilled individuals[4]. Envy entails a disutility loss for L workers,

[4] If low-skilled individuals were also envious of the higher ability of their peers, the results with

which is proportional to an (envy cost) parameter, $c \in [0,1]$, and to the expected surplus of H workers. We assume that H individuals do not inherently benefit from the envy of their coworkers (there is no envy-enjoyment). As is standard in this type of literature, the envy cost, c, is perfectly observable by the principal and agents[5].

The timing of the game for the upper-level contracts is:

1) nature determines $\overline{\theta}$, $\underline{\theta}$, λ, and c;
2) the principal offers incentive-compatible contracts of the type (w_i, e_i);
3) employees decide whether to accept or not the contracts;
4) if contracts are accepted, production takes place and wages are paid
(If workers do not accept, they keep their entry-level jobs).

We solve the game by backward induction.

In Section 4, we will assume that H individuals can take actions to manipulate (increase or decrease) the envy cost, c, incurred by L individuals. In line with the literature, we will refer to the notions of envy-provocation and envy-reduction. The activity of envy manipulation is observable by all workers, but not by the principal. The principal is able to observe the (manipulated) envy cost level before proposing the new contracts. With actions of envy-provocation and envy-reduction, the game timeline is amended so that, before stage 2, there is the envy manipulation stage.

2.1 Symmetric information and no envy

As a benchmark, in this sub-section, we will briefly discuss the equilibrium outcome when there is perfect information about the employees' skills and when there is no envy. In this standard case, the principal can offer the "right" combinations of wage and effort to each type of agent for the upper-level positions. The contracts are denoted by (w_L, e_L) and (w_H, e_H). The payoffs that L and H workers will obtain under such contracts are indicated by:

$$U_L(w_L, e_L) = w_L - \frac{\overline{\theta}}{2} e_L^2; \tag{2}$$

$$U_H(w_H, e_H) = w_H - \frac{\underline{\theta}}{2} e_H^2. \tag{3}$$

asymmetric information would be strengthened.

[5] Although envy cannot be measured directly, some proxies can be used to estimate the magnitude of its effects. For instance, Vidaillet (2008) argues that, in a workplace, envy may discourage stable and cohesive working teams, make collaboration difficult, generate tensions, or rise the turnover rates. The empirical and experimental literature provides many approaches to (indirectly) measure envy. See, for example, Smith et al. (1999).

The principal will maximize the expected profit on the average worker,

$$E[\pi] = \lambda\left(e_H - w_H\right) + (1-\lambda)\left(e_L - w_L\right), \tag{4}$$

where we assume that the expected return corresponds to the expected effort of L and H workers.

When $U_L(w_L, e_L) = 0$ and $U_H(w_H, e_H) = 0$, that is when the surplus obtained by workers is 0, we can substitute the expressions for the wages, $w_L = \overline{\theta} e_L^2/2$ and $w_H = \underline{\theta} e_H^2/2$, into (4). Then, from the first-order conditions for e_H and e_L, we derive the full-information or first-best (FB) effort levels of L and H employees,

$$e_L = \frac{1}{\overline{\theta}} \equiv e_L^{FB}, \text{ and } e_H = \frac{1}{\underline{\theta}} \equiv e_H^{FB}. \tag{5}$$

The principal's profit, by substituting the efforts in (4), is equal to the first-best level,

$$E[\pi] = \frac{\lambda\left(\overline{\theta} - \underline{\theta}\right) + \underline{\theta}}{2\underline{\theta}\overline{\theta}} \equiv E[\pi]^{FB}. \tag{6}$$

The equilibrium wages are

$$w_L = \frac{1}{2\overline{\theta}} \equiv w_L^{FB}, \text{ and } w_H = \frac{1}{2\underline{\theta}} \equiv w_H^{FB}, \tag{7}$$

where $w_L^{FB} < w_H^{FB}$.

The equilibrium payoffs of L and H workers under the contracts (w_L^{FB}, e_L^{FB}) and (w_H^{FB}, e_H^{FB}) are

$$U_L(w_L^{FB}, e_L^{FB}) = 0, \text{ and } U_H(w_H^{FB}, e_H^{FB}) = 0. \tag{8}$$

Under symmetric information, we derive the standard result that agents obtain their reservation utilities. Note that H workers receive a higher wage than L workers, but exert more effort. Both types obtain no rent from their labor contracts and this implies that, if L workers were envious but information still symmetric, the equilibrium configuration would not change.

2.2 Asymmetric information and no envy

If there is asymmetric information on the skills and no envy, the principal can offer one of three main contract menus: *i*) a couple of incentive-compatible contracts; *ii*) a flat-wage (pooling) contract; *iii*) a couple of separating contracts in which L types are screened out of the new positions and keep their entry-level jobs. We first analyze the incentive-compatible contracts. In remarks 1 and 2 below, we discuss the other two types of offers.

The contracts must satisfy the participation (individual rationality) and incentive compatibility constraints for each type of workers. With no envy (NE), we denote the payoffs of L and H workers, under the contracts (w_L, e_L) and (w_H, e_H), by $U_L^{NE}(w_L, e_L)$ and $U_H^{NE}(w_H, e_H)$. The participation constraints of L and H individuals are:

$$U_L^{NE}(w_L, e_L) = w_L - \frac{\overline{\theta}}{2} e_L^2 \geq 0; \qquad (PC_L)$$

$$U_H^{NE}(w_H, e_H) = w_H - \frac{\underline{\theta}}{2} e_H^2 \geq 0. \qquad (PC_H)$$

The incentive compatibility constraints are:

$$U_L^{NE}(w_L, e_L) \geq U_L^{NE}(w_H, e_H); \qquad (IC_L)$$

$$U_H^{NE}(w_H, e_H) \geq U_H^{NE}(w_L, e_L). \qquad (IC_H)$$

As is standard in this class of problems, the principal will choose the contracts such that (PC_L) and (IC_H) are binding[6]. So, in equilibrium,

$$w_L = \frac{\overline{\theta}}{2} e_L^2, \text{ and } w_H = \frac{\underline{\theta}}{2} e_H^2 + \frac{\overline{\theta} - \underline{\theta}}{2} e_L^2.$$

If we substitute the above wages in the principal's profit function, $E[\pi] = \lambda (e_H - w_H) + (1 - \lambda)(e_L - w_L)$, and take the first-order conditions, we obtain

$$e_L = \frac{1 - \lambda}{\overline{\theta} - \lambda \underline{\theta}} \equiv e_L^{NE}, \text{ and } e_H = \frac{1}{\underline{\theta}} = e_H^{FB}.$$

The effort of H workers is not distorted by the presence of asymmetric information, whereas the effort of L workers is lower than the first-best level in (5). Using the above effort levels, the equilibrium wages are

$$w_L = \frac{(1-\lambda)^2 \overline{\theta}}{2(\overline{\theta} - \lambda \underline{\theta})^2} \equiv w_L^{NE}, \text{ and } w_H = \frac{1}{2\underline{\theta}} + \frac{(1-\lambda)^2 (\overline{\theta} - \underline{\theta})}{2(\overline{\theta} - \lambda \underline{\theta})^2} \equiv w_H^{NE}. \qquad (9)$$

The equilibrium payoffs of L and H individuals are:

$$U_L^{NE}(w_L^{NE}, e_L^{NE}) = 0;$$

$$U_H^{NE}(w_H^{NE}, e_H^{FB}) = \frac{(1-\lambda)^2 (\overline{\theta} - \underline{\theta})}{2(\overline{\theta} - \lambda \underline{\theta})^2} \equiv U_H^{NE}. \qquad (10)$$

[6] It can be easily shown that the other two constraints are satisfied in equilibrium.

The expression in (10) is positive, so H workers receive a payoff above their reservation level. The rent that H workers can obtain thanks to asymmetrci information will be the main source of envy of L individuals in the analysis of the following section.

The principal's equilibrium profit is

$$E[\pi] = \frac{\lambda\overline{\theta} + (1-2\lambda)\underline{\theta}}{2(\underline{\theta}\overline{\theta} - \lambda\underline{\theta}^2)} \equiv E[\pi]^{NE}. \tag{11}$$

From (6) and (11), $E[\pi]^{NE} - E[\pi]^{FB} = -\lambda(1-\lambda)(\overline{\theta} - \underline{\theta})/2\overline{\theta}(\overline{\theta} - \lambda\underline{\theta}) < 0$ so, under asymmetric information, the principal is no longer able to obtain the first-best profits.

The difference between (average) welfare under symmetric information, which corresponds to the principal's expected profit, $E[\pi]^{FB}$, and welfare under asymmetric information, $E[\pi]^{NE} + \lambda U_H^{NE}$, is $(1-\lambda)\lambda^2(\overline{\theta}-\underline{\theta})^2/2\overline{\theta}(\overline{\theta}-\lambda\underline{\theta})^2 > 0$. So, as is customary, asymmetric information results in an overall loss of efficiency.

Remark 1. Screening out L workers
Since (PC_L) and (IC_H) are binding at equilibrium, the principal can modify the contract terms so that the incentives are strict and only H individuals apply for the new contracts[7]. In this kind of separating contract, H types obtain a surplus of 0, so $w_H = \underline{\theta}e_H^2/2$. From the maximization of the principal's payoff, $\pi = \lambda\,(e_H - w_H) = \lambda\,(e_H - \underline{\theta}e_H^2/2)$, the effort level is $e_H = 1/\underline{\theta} = e_H^{FB}$, and the wage is $w_H = 1/2\underline{\theta}$. The principal's equilibrium profit is $\pi = \lambda/2\underline{\theta} \equiv \pi^S$. By using (11), $E[\pi]^{NE} - \pi^S = (1-\lambda)^2/2(\overline{\theta} - \lambda\underline{\theta}) > 0$. This means that the principal has no incentive to offer a separating contract in which L workers are excluded from the new job positions.

Remark 2. Flat (pooling) wages
If a pooling contract, (w, e), were to be offered, from the binding participation constraint of L workers, the wage would be equal to $w = \overline{\theta}e^2/2$ and, from the profit maximization of the principal, the effort would be $e = 1/\overline{\theta}$. The principal's equilibrium profit would be $\pi^F = 1/2\overline{\theta}$ and, using (11), $E[\pi]^{NE} - \pi^F = \lambda(\overline{\theta}-\underline{\theta})^2/2\underline{\theta}\overline{\theta}(\overline{\theta}-\lambda\underline{\theta}) > 0$. Thus, the principal would never offer flat wages for the new job positions.

3 Asymmetric information with envy

In this section, we assume that low-skilled employees are envious of their high-skilled peers whenever they expect the latter to obtain a positive surplus from the contracts for the upper-level jobs (that is, when the contract of H workers is such that

[7] On this specific point, see Minelli and Modica (2009).

$w - \underline{\theta}e^2/2 > 0$). For L individuals, envy has a utility-decreasing effect, which is proportional to the cost parameter $c \in [0,1]$, and to the expected surplus of H employees, if positive. With envy (E), the payoffs of L and H workers, under the contract (w,e), are indicated by $U_L^E(w,e)$ and $U_H^E(w,e)$. In particular, the payoff of L workers can be written as

$$U_L^E(w,e) = w - \frac{\overline{\theta}}{2}e^2 - c \cdot \max\{0, U_H^E(w,e)\}. \tag{12}$$

We first analyze incentive-compatible contracts, and then show that it is not profitable for the principal to offer flat wages or to screen out L types of the new jobs. Note that, as is standard in this type of literature, the principal can observe the level of envy (the parameter c) in the workplace before offering the contracts.

The participation constraints, under the incentive contracts (w_L, e_L) and (w_H, e_H), are:

$$\begin{aligned} U_L^E(w_L,e_L) &= w_L - \frac{\overline{\theta}}{2}e_L^2 - c \cdot \max\{0, U_H^E(w_H,e_H)\} \geq 0; && (PC_L^E) \\ U_H^E(w_H,e_H) &= w_H - \frac{\underline{\theta}}{2}e_H^2 \geq 0. && (PC_H^E) \end{aligned}$$

In (PC_L^E), we take account of the fact that L types know that the principal will offer incentive-compatible contracts, so they will be envious of the surplus that H types can receive from the contract (w_H, e_H). In (PC_L^E), we use the assumption that H individuals do not directly benefit from the envy of their low-skilled coworkers[8].

The incentive compatibility constraints are:

$$\begin{aligned} U_L^E(w_L,e_L) &= w_L - \frac{\overline{\theta}}{2}e_L^2 \geq w_H - \frac{\overline{\theta}}{2}e_H^2 = U_L^E(w_H,e_H); && (IC_L^E) \\ U_H^E(w_H,e_H) &= w_H - \frac{\underline{\theta}}{2}e_H^2 \geq w_L - \frac{\underline{\theta}}{2}e_L^2 = U_H^E(w_L,e_L). && (IC_H^E) \end{aligned}$$

In (IC_L^E), we consider that L workers would be envious if they were to accept the contract (w_H, e_H), and would still incur the envy cost, $c \cdot \max\{0, U_H^E(w_H,e_H)\}$, in case H workers obtain a positive rent. Note that the structure of the participation constraint of L workers provides a justification of why the envy parameter, c, must lie between 0 and 1: if c were equal or larger than 1, L workers should obtain a contractual surplus, $w_L - \overline{\theta}e_L^2/2$, equal or larger than that of H workers, so the latter

[8]If H workers were to benefit from the envy of their coworkers, the conclusions of the paper would be less interesting.

would always prefer to mimic low-skilled types and accept the contract designed for them (that is, the high-skilled type's incentive constraint could never be satisfied).

In equilibrium, (PC_L^E) and (IC_H^E) are binding, so

$$w_L = \frac{\overline{\theta}e_L^2 - c\underline{\theta}e_H^2}{2} + cw_H, \text{ and } w_H = \frac{(1-c)\underline{\theta}e_H^2 + (\overline{\theta}-\underline{\theta})e_L^2}{2(1-c)}.$$

From the maximization of the principal's profit function, the equilibrium effort levels are

$$e_L = \frac{(1-\lambda)(1-c)}{\overline{\theta} - [\lambda + (1-\lambda)c]\underline{\theta}} \equiv e_L^E, \text{ and } e_H = \frac{1}{\underline{\theta}} = e_H^{FB}.$$

Hence, envy has no effect on the effort of H workers, but has a negative effect on the effort of L workers, as $de_L^E/dc = -(1-\lambda)(\overline{\theta}-\underline{\theta})/[\overline{\theta} - [\lambda+(1-\lambda)c]\underline{\theta}]^2 < 0$, and $e_L^E = 0$ when $c = 1$.

The equilibrium wages are

$$w_L = \tfrac{(1-\lambda)^2(1-c)(\overline{\theta}-c\underline{\theta})}{2[\overline{\theta}-(\mu+(1-\lambda)c)\underline{\theta}]^2} \equiv w_L^E, \text{ and } w_H = \tfrac{1}{2\underline{\theta}} + \tfrac{(1-\lambda)^2(1-c)(\overline{\theta}-c\underline{\theta})}{2\{\overline{\theta}-[\lambda+(1-\lambda)c]\underline{\theta}\}^2} \equiv w_H^E.$$

The equilibrium payoffs of L and H workers are:

$$\begin{aligned} U_L^E(w_L^E, e_L^E) &= 0; \\ U_H^E(w_H^E, e_H^{FB}) &= \frac{(1-\lambda)^2(1-c)(\overline{\theta}-\underline{\theta})}{2\{\overline{\theta}-[\lambda+(1-\lambda)c]\underline{\theta}\}^2} \equiv U_H^E. \end{aligned} \tag{13}$$

The payoff of H workers in (13) is positive for each $\lambda \in (0,1)$ and each $c \in (0,1)$, and eaches a maximum for

$$c = \frac{(2-\lambda)\underline{\theta} - \overline{\theta}}{(1-\lambda)\underline{\theta}} \equiv c^*. \tag{14}$$

The critical value c^* corresponds to a maximum as the second-order condition, evaluated at c^*, is $d^2U_H^E/dc^2 = -(1-\lambda)^3\underline{\theta}/16(\overline{\theta}-\underline{\theta})^2 < 0$; in addition, c^* is always below 1 and above 0 if $\lambda \leq 2 - \overline{\theta}/\underline{\theta}$, where the right-hand side of this inequality is positive under the assumption in (1). The sign of dU_H^E/dc is ambiguous. In particular, U_H^E is increasing for $c < c^*$, decreasing for $c > c^*$, and has an inflection point at $c = [(3-\lambda)\underline{\theta} - 2\overline{\theta}]/(1-\lambda)\underline{\theta} \equiv \widetilde{c}$, where it can be shown that $\widetilde{c} \in (0, c^*)$. In figure 1, we present a numerical example of the function U_H^E: for each $c \in (0, c^*]$, $U_H^E > U_H^{NE}$, so the H type's payoff is larger than that obtained when L types are not envious (U_H^{NE} corresponds to the payoff obtained when $c = 0$); when L types are too envious, that is when $c \in (c^*, 1]$, the payoff of H types is decreasing in c and

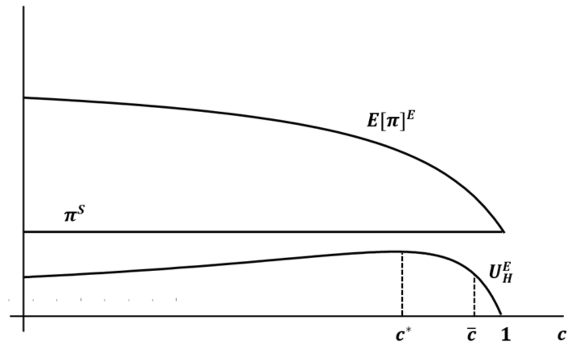

Figure 1.
Principal's profit function and H worker's payoff
(Parameters: $\overline{\theta} = 0.7$, $\underline{\theta} = 0.5$, $\lambda = 0.4$, $\delta = 1$)

ends up being lower than that without envy. The presence of the inflection point at $\widetilde{c}$ is clearer in figure 3. From (10) and (13), $U_H^E \geq U_H^{NE}$ when $c \in (0, \overline{c}]$, where $\overline{c} = [(2-\lambda)\underline{\theta} - \overline{\theta}](\overline{\theta} - \lambda\underline{\theta})/(1-\lambda)^2\underline{\theta}^2$ is always larger than c^*, lower than 1, and decreasing in λ, as $d\overline{c}/d\lambda = 2(\overline{\theta} - \underline{\theta})^2/(\lambda - 1)^3\underline{\theta}^2 < 0$.

The principal's equilibrium profit is

$$E[\pi] = \frac{\lambda[\overline{\theta} - (2-c)\underline{\theta}] + (1-c)\underline{\theta}}{2\underline{\theta}\{\overline{\theta} - [\lambda + (1-\lambda)c]\underline{\theta}\}} \equiv E[\pi]^E, \tag{15}$$

The profit in (15) is positive for each $\lambda \in (0,1)$ and $c \in (0,1)$, and is always decreasing in c, as $dE[\pi]^E/dc = -(1-\lambda)^2(\overline{\theta} - \underline{\theta})/2\{\overline{\theta} - [\lambda + (1-\lambda)c]\underline{\theta}\}^2 < 0$. An example of the function $E[\pi]^E$ is reported in figure 1. From (11) and (15), the difference between the principal's profit with and without envy is $E[\pi]^E - E[\pi]^{NE} = -c(1-\lambda)^2(\overline{\theta} - \underline{\theta})/2[\overline{\theta} - \lambda\underline{\theta} - c(1-\lambda)\underline{\theta}](\overline{\theta} - \lambda\underline{\theta}) < 0$. This means that envy has always a negative effect on the expected profit of the principal. For all $c \in [0,1]$, we obtain that $E[\pi]^E - \pi^F = \lambda/2\underline{\theta}$, so the principal's equilibrium profit is always larger than that obtained with flat wages. Besides, the difference between the profit with envy and the profit obtained when L types are screened out is $E[\pi]^E - \pi^S = (1-c)(1-\lambda)^2/2\{\overline{\theta} - [\lambda + (1-\lambda)c]\underline{\theta}\} > 0$, so the principal will never choose to exclude L workers from the new job positions[9]

The discussion above leads to the following result.

Proposition 1. *If* $c \in (0, \overline{c}]$ $(c \in (\overline{c}, 1])$*, the presence of envious low-skilled workers*

[9] With envy, the procedure to derive the screening profit, π^S, is equivalent to that described in Remark 1.

lowers the principal's expected profit and increases (decreases) the well-being of high-skilled workers.

The intuition behind Proposition 1 is that the interaction between the participation and incentive constraints forces the principal to forgo part of the rent on the contract designed for L agents, and transfer it to H agents. Specifically, envy decreases the effort exerted by L workers compared to the full-information case and this means that, since H types can always mimic the behavior of L types, they must receive a higher rent from their contracts. In other words, low-skilled agents need to be compensated for the envy cost that they incur as their participation constraint becomes more binding and, in turn, this implies that high-skilled agents must obtain a higher contractual rent to satisfy their incentive constraint. But, while the principal is unambiguously worse off in equilibrium, whether the high-skilled agents benefit from a higher envy cost, c, is less clear-cut, as there are two opposing effects: 1) if we write the H type's payoff as $U_H^E(w_H, e_H) = (\overline{\theta} - \underline{\theta})e_L^2/2(1-c)$ (that is, before substituting the equilibrium e_L), it is clear that, for a given e_L, $U_H^E(w_H, e_H)$ is increasing in c; 2) as $dE[\pi]^E/dc < 0$, an increase in c raises the marginal effect on the aggregate rent that the principal must forgo on the two contracts. This last effect implies that the principal will choose a lower equilibrium e_L, which is indeed decreasing in c. In turn, this effect drags $U_H^E(w_H, e_H)$ down, as it is increasing in e_L. This happens when the envy cost is very high, that is $c > \overline{c}$, as the rent the principal can extract from L workers is too low[10].

Remark 3. Envy and symmetric information
If we had symmetric information, all types of workers would get no rent from their labor contracts. In this case, the term $\max\{0, U_H^E(w_H, e_H)\}$ in the L types' participation constraint would be 0 and envy would play no role in the structure of contracts. Low-skilled workers would not be envious, as they would consider fair the situation in which their high-skilled peers obtain a higher wage simply because they exert more effort.

Remark 4. Envious high-skilled workers
If we were to consider that any worker (high skilled or low skilled) are envious when the other types earns more than they "deserve", we would obtain the following

[10] In the model, the utility loss due to envy does not depend on the proportion (number) of high-skilled co-workers. It might seem more natural to think that, if there are few high-skilled agents, the extent of envious feeling should be weaker. However, envy can also be triggered by the feeling of inferiority and comparison with a single or a few high-achiever persons. For instance, in many related papers, workers are primarily envious towards their boss and superiors (see Dur and Glazer, 2007).

expression for the H worker's expected payoff:

$$U_H^E(w,e) = w - \frac{\theta}{2}e^2 - c \cdot \max\{0, U_L^E(w,e)\}.$$

The theoretical conclusions would still hold as long as the principal offers incentive-compatible contracts such that the participation constraint of L types is binding, so that the term $\max\{0, U_L^E(w,e)\}$ in the above expression would be 0.

4 Envy manipulation

From the analysis of Section 3, if by chance $c = c^*$, H individuals obtain the highest possible payoff, $U_H^E = (1-\lambda)/8\underline{\theta} \equiv U_H^*$, which is always larger than the payoff with no envy, U_H^{NE}, in (10). This means that, if $c \neq c^*$, H individuals would benefit from an increase or a decrease in the envy cost of L workers. In this section, we assume that H individuals can manipulate (increase or decrease) the envy cost, c, of their L coworkers before the contract offers for the upper-level positions.

We assume that H individuals coordinate their actions as a group, and that they collectively choose the envy manipulation activity. In the literature, it is well established that different job positions may be characterized by the presence of distinct groups of workers with strong social ties and who identify themselves with the interests of the group. Envy-related behavior are affected by socialization and are embodied in cultural norms and practices. As argued by Van Vugt and Hart (2004), whenever people choose to identify themselves with their group, the welfare of each individual becomes intertwined with the welfare of the group. People can engage in group or team activities even though this may lead to personal sacrifice. Thus, although we follow the standard approach of methodological individualism, we can think of the envy game as something that is related to the social dimension of intergroup relations, or as Foster (1972) puts it: "individuals envy individuals and groups envy groups"[11].

To get around the potential problem of free riding, we also assume that the group of H workers can impose social sanctions on defaulters who choose not to take actions of envy manipulation, and that the sanction cost is larger than the manipulation cost. A strong group loyalty can discourage the free-riding tendency, especially for small groups, such as those in workplace contexts (Albanese and van

[11] The endogeneous effect of envy can also be related to the popular notion of "keeping up with the Joneses" (introduced in Duesenberry, 1952), whereby individuals derive utility from the comparison between their own status and that of a reference group.

Fleet, 1985). Levine and Moreland (2002) stress how group loyalty is a key element of collectivistic behavior, and argue that this is stronger for high-status people, since they may be more rewarded in their decision to remain in the group and may have more to lose whenever they leave it. Of course, group loyalty can be justified on simple cost-benefit grounds, as individuals make their decisions based on personal rewards and costs (punishments) associated with group membership[12].

Since we assume that the manipulation activity is carried out when workers hold their entry-level jobs, the new timing of the game for the upper-level contracts is:

1) nature determines $\overline{\theta}$, $\underline{\theta}$, λ, and c;
2) H workers manipulate the envy cost, c, of L workers;
3) the principal observes the new (manipulated) envy cost and offers the contracts;
4) workers decide whether to accept or not the contracts;
5) if contracts are accepted, production takes place and wages are paid
(If workers do not accept, they keep their entry-level jobs).

Envy manipulation actions are observable by all types of workers, but not by the principal, who can only observe the new level of envy cost, c, incurred by L workers before the contract offers[13]. We will distinguish between two cases: 1) $c < c^*$, so H individuals take actions of envy-provocation, so as to increase the envy cost to $c(1+\mu)$, with $\mu > 0$; 2) $c > c^*$, so H individuals take actions of envy-reduction, so as to decrease the envy cost to $c(1+\mu)^{-1}$. This implies that the manipulation cost of H types is larger the higher the distance between c and c^* (that is, it is more costly to manipulate L workers with a very low or very high initial level of envy). If the intial envy cost is c^*, or as we will show close to it, the envied will simply abtain from actions of provocation or reduction, so envy-avoidance will become the prevalent social norm. The manipulation cost of each high-skilled individual is $\delta\mu$, with $\delta \in (0,1)$, which thus can take into account that every H worker only bears a fraction of the cost of the whole group. The group of H workers choose μ such that the payoff of each member is maximized.

[12] On this topic, Luttmer (2001) shows that individuals are more willing to support welfare spending when the proportion of recipients from the same racial group rises. Chen and Li (2009) present an experiment that tests the effect of group identity on social preferences. They report that participants exhibit more charity (envy) when their match obtain a lower (higher) payoff and, in particular, their charity (envy) toward ingroup members is significantly larger (lower) than that toward outgroup individuals.

[13] In the model, we do not consider a monitoring activity of the principal. The reason is that this would partially or fully solve the asymmetric information problem.

4.1 Envy-provocation

If $c < c^*$, H individuals will take actions of envy-provocation (EP). We denote the payoffs of L and H workers as $U_L^{EP}(w,e)$ and $U_H^{EP}(w,e)$. Consider first the incentive compatibility contracts, (w_L, e_L) and (w_H, e_H). Then, we will discuss what would happen with flat wages and when low-skilled infividuals are screened-out from the upper-level positions.

The participation constraints can be rewritten as:

$$\begin{aligned} U_L^{EP}(w_L,e_L) &= w_L - \frac{\overline{\theta}}{2}e_L^2 - c(1+\mu)\max\{0, U_H^{EP}(w_H,e_H)\} \geq 0; & (PC_L^{EP}) \\ U_H^{EP}(w_H,e_H) &= w_H - \frac{\underline{\theta}}{2}e_H^2 - \delta\mu \geq 0. & (PC_H^{EP}) \end{aligned}$$

The incentive constraints are:

$$\begin{aligned} U_L^{EP}(w_L,e_L) &= w_L - \frac{\overline{\theta}}{2}e_L^2 \geq w_H - \frac{\overline{\theta}}{2}e_H^2 = U_L^{EP}(w_H,e_H); & (IC_L^{EP}) \\ U_H^{EP}(w_H,e_H) &= w_H - \frac{\underline{\theta}}{2}e_H^2 \geq w_L - \frac{\underline{\theta}}{2}e_L^2 = U_H^{EP}(w_L,e_L). & (IC_H^{EP}) \end{aligned}$$

In the design of the incentive scheme, we consider that L types would be envious even if they were to choose the contract, (w_H, e_H), offered to H workers, provided the latter obtain a positive surplus. Conversely, we assume that, if H types were to accept the contract, (w_L, e_L), offered to L types, they would bear the manipulation cost, $\delta\mu$ (because the manipulation activity is performed before the contract-offer stage). However, in this case, they would not have to pay the free-riding sanction cost, as they would not eventually be members of the H-type group of workers in upper-level jobs.

If we substitute the wages, w_L and w_H, deriving from the binding (PC_L^{EP}) and (IC_H^{EP}) into the H-type payoff expression and simplify, and then maximize the principal's profit, we obtain

$$e_L = \tfrac{(1-\lambda)[1-c(1+\mu)]}{\overline{\theta}-[\lambda+(1-\lambda)c(1+\mu)]\underline{\theta}} \equiv e_L^{EP}, \text{ and } e_H = \frac{1}{\underline{\theta}} = e_H^{FB}.$$

Again, the effort of H workers is not distorted, even after envy manipulation. The effort of L workers is, instead, decreasing in the manipulation activity, as

$$\frac{de_L^{EP}}{d\mu} = -\tfrac{(1-\lambda)c(\overline{\theta}-\underline{\theta})}{\{\overline{\theta}-[\lambda+(1-\lambda)c(1+\mu)]\underline{\theta}\}^2} < 0,$$

By substituting the above effort levels into the utility functions of L and H workers, we obtain:

$$
\begin{aligned}
U_L^{EP}(w_L^{EP}, e_L^{EP}) &= 0; \\
U_H^{EP}(w_H^{EP}, e_H^{FB}) &= \tfrac{(1-\lambda)^2[1-c(1+\mu)](\overline{\theta}-\underline{\theta})}{2\{\overline{\theta}-[\lambda+(1-\lambda)c(1+\mu)]\underline{\theta}\}^2} - \tfrac{\delta\mu}{1-c(1+\mu)}.
\end{aligned} \tag{16}
$$

In equilibrium, H workers choose μ so as to maximize (16), which gives

$$
\mu = \frac{[2-\lambda-(1-\lambda)c]\underline{\theta}-\overline{\theta}}{(1-\lambda)c\underline{\theta}} \equiv \mu^{EP}. \tag{17}
$$

The critical value μ^{EP} is positive for each $c < c^*$, and equal to 0 if $c = c^*$ (when $c = c^*$, there is of course no need to manipulate envy). In equilibrium, the product $c(1+\mu^{EP})$ is exactly equal to c^*. Hence, c^* will be the new envy cost observed by the principal in stage 3 of the game.

By substituting $\mu = \mu^{EP}$ into (16), the equilibrium payoff of H workers is

$$
U_H^{EP}(w_H^{EP}, e_H^{FB}) = \tfrac{(1-\lambda)c[(8\delta\underline{\theta}-1)\underline{\theta}+\overline{\theta}]-8\delta[(2-\lambda)\underline{\theta}-\overline{\theta}]\underline{\theta}}{8c(\overline{\theta}-\underline{\theta})\underline{\theta}} \equiv U_H^{EP}. \tag{18}
$$

Four relevant features of the H type's payoff function, U_H^{EP}, are: 1) it is increasing in c, as $dU_H^{EP}/dc = \delta[(2-\lambda)\underline{\theta}-\overline{\theta}]/c^2(\overline{\theta}-\underline{\theta}) > 0$ (the term $(2-\lambda)\underline{\theta}-\overline{\theta}$ is positive when c^* is positive); 2) it tends to $-\infty$ when $c \to 0$; 3) it is less than proportionally increasing in the initial level of envy cost, c, as $d^2U_H^{EP}/dc^2 = -2\delta[(2-\lambda)\underline{\theta}-\overline{\theta}]/c^3(\overline{\theta}-\underline{\theta}) < 0$; 4) it is equal to the maximum of the payoff function with no-manipulation, U_H^E, derived in Section 3, when $c = c^*$. That is, if $c = c^*$, then $U_H^{EP} = U_H^E = U_H^* = (1-\lambda)/4\underline{\theta}$, which corresponds to the highest possible payoff that H workers can achieve in this model setup. These properties, coupled with the fact that the no-manipulation payoff, U_H^E, has an inflection point at $c = \widetilde{c} \in (0, c^*)$, imply that it is possible to find two cost levels, denoted by[14] c_{MIN}^{EP} and c_{MAX}^{EP}, such that $U_H^{EP} \geq U_H^E$ for all $c \in [c_{MIN}^{EP}, c_{MAX}^{EP}]$, that is such that the H type's payoff with manipulation is higher than that without it. In figure 2, we plot the functions U_H^E and U_H^{EP} against the initial (before manipulation) level of c. For the function U_H^E, figure 2 uses the same parameters as in figure 1, but with a different scale for the vertical axis. The set

[14] The following analytical expressions are obtained by using the software Mathematica-Wolfram Research:

$$c_{MIN}^{EP} = \tfrac{(16\delta\underline{\theta}-\lambda+3)\underline{\theta}-[\lambda(16\delta\underline{\theta}-1)+2]\underline{\theta}-\overline{\theta}^2-(\overline{\theta}-\underline{\theta})\sqrt{\overline{\theta}^2-2(32\delta\underline{\theta}-\lambda+2)\overline{\theta}\underline{\theta}+[(2-\lambda)^2+64\lambda\delta\underline{\theta}]\underline{\theta}^2}}{2(1-\lambda)[\overline{\theta}+(8\delta\underline{\theta}-1)\underline{\theta}]\underline{\theta}};$$

$$c_{MAX}^{EP} = \tfrac{(16\delta\underline{\theta}-\lambda+3)\underline{\theta}-[\lambda(16\delta\underline{\theta}-1)+2]\underline{\theta}-\overline{\theta}^2+(\overline{\theta}-\underline{\theta})\sqrt{\overline{\theta}^2-2(32\delta\underline{\theta}-\lambda+2)\overline{\theta}\underline{\theta}+[(2-\lambda)^2+64\lambda\delta\underline{\theta}]\underline{\theta}^2}}{2(1-\lambda)[\overline{\theta}+(8\delta\underline{\theta}-1)\underline{\theta}]\underline{\theta}}.$$

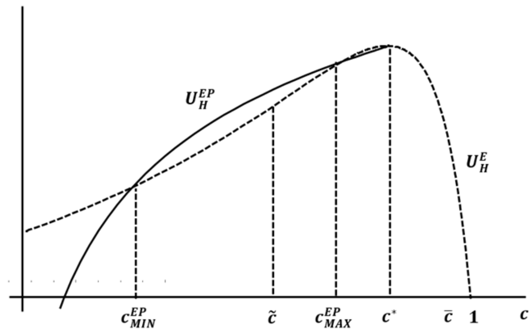

Figure 2.
H worker's payoffs with and without manipulation
(Parameters: $\overline{\theta} = 0.7$, $\underline{\theta} = 0.5$, $\lambda = 0.4$)

$(c_{MIN}^{EP}, c_{MAX}^{EP})$ is decreasing in the manipulation cost, δ, borne by each H worker, and disappears if

$$\delta > \frac{(1-\lambda)c\{[2-\lambda-(1-\lambda)c]\underline{\theta}-\overline{\theta}\}(\overline{\theta}-\underline{\theta})}{8\{\overline{\theta}-[\lambda+(1-\lambda)c]\underline{\theta}\}^2\underline{\theta}} \equiv \delta_{MAX}^{EP}. \tag{19}$$

Thus, if $\delta > \delta_{MAX}$, then $U_H^{EP} < U_H^E$ for each $c \in [0, c^*)$. Note that, when c approaches c^*, envy manipulation is not profitable for H individuals, as

$$\left.\frac{dU_H^{EP}}{dc}\right|_{c=c^*} = \frac{\delta(1-\lambda)^2\underline{\theta}^2}{[(2-\lambda)\underline{\theta}-\overline{\theta}](\overline{\theta}-\underline{\theta})} > 0 = \left.\frac{dU_H^E}{dc}\right|_{c=c^*},$$

which means that the marginal utility of manipulation is relatively low compared to the marginal cost[15]. Conversely, when c tends to 0, manipulation is not profitable, the reason being that it is too costly to alter the behavior of people with a very low initial level of envy.

The principal's profit, evaluated at the equilibrium level of manipulation activity, μ^{EP}, chosen by H types, and at the maximizing effort levels, e_L^{EP} and e_H^{EP}, is

$$E[\pi] = \frac{4\delta[(2-\lambda)\underline{\theta}-\overline{\theta}]^2+(1-\lambda)c\{(4\delta\underline{\theta}+\lambda+1)\overline{\theta}-[4(2-\lambda)\delta\underline{\theta}+\lambda+1]\underline{\theta}\}}{4(1-\lambda)c(\overline{\theta}-\underline{\theta})\underline{\theta}} \equiv E[\pi]^{EP}. \tag{20}$$

In figure 3, we plot the principal's equilibrium expected profit, $E[\pi]^{EP}$, against the initial envy cost, c. The profit is always decreasing in c, as $dE[\pi]^{EP}/dc = -\delta[(2-\lambda)\underline{\theta}-\overline{\theta}]^2/(1-\lambda)c^2(\overline{\theta}-\underline{\theta})\underline{\theta} < 0$ (where, again, $(2-\lambda)\underline{\theta}-\overline{\theta} > 0$ for c^* to be positive). If we compare $E[\pi]^{EP}$ in (20) with the profit obtained with envy but no manipulation in (15), $E[\pi]^E$, we obtain that $E[\pi]^{EP} < E[\pi]^E$ for each $c \in (\widehat{c}, c^*)$, where it can be

[15] If $\delta = 0$, the H type's payoff is equal to $U_H^{EP} = U_H^* = (1-\lambda)/4\underline{\theta}$ for each $c \in (0, c^*]$.

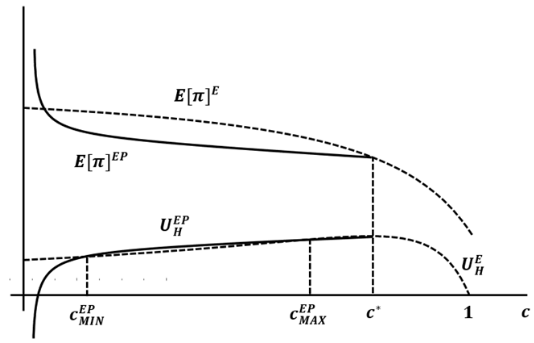

Figure 3.
Envy manipulation (envy-provocation)
(Parameters: $\overline{\theta} = 0.7$, $\underline{\theta} = 0.5$, $\lambda = 0.4$)

shown that[16] $\widehat{c}$ is above 0 and below c_{MIN}^{EP}. Thus, if H workers choose to provoke envy, the principal will earn a profit lower than that without manipulation. If $c = c^*$, then $E[\pi]^{EP} = E[\pi]^E = (1+\lambda)/4\underline{\theta}$, which is the lowest possible profit that the principal can earn in this setup[17].

We now show that $E[\pi]^{EP}$ is always larger than the profit obtained when L types are screened out from the new job positions. We still denote this profit by π^S. Following the procedure of Remark 2, but taking into account the equilibrium manipulation cost, $\delta\mu^{EP}$, of each H individual, the screening profit can be written as

$$\pi^S = \frac{\lambda}{\underline{\theta}} \left\{ \frac{1}{2} - \frac{(1-\delta)[(2-\lambda)\underline{\theta} - \overline{\theta}]}{(1-\lambda)c} \right\}. \tag{21}$$

When $c < c^*$, the profit in (21) is always increasing in c, as $d\pi^S/dc = \lambda\delta[(2-\lambda)\underline{\theta} - \overline{\theta}]/(1-\lambda)c^2\underline{\theta} > 0$, and is equal to $(1-\lambda)/4\underline{\theta} < (1+\lambda)/4\underline{\theta} = E[\pi]^{EP}$ for $c = c^*$. This means that $E[\pi]^{EP} > \pi^S$ for each $c \in (0, c^*)$, so the principal will not exclude L workers from the new contracts.

Proposition 2. *If $c \in (c_{MIN}^{EP}, c_{MAX}^{EP})$ and $\delta < \delta_{MAX}^{EP}$, H workers take actions of envy-provocation. In equilibrium, they are better off and the principal worse off compared to the case in which envy cannot be manipulated.*

---

[16] $\widehat{c} = \frac{4\delta[(2-\lambda)\underline{\theta}-\overline{\theta}](\overline{\theta}-\lambda\underline{\theta})}{4(2-\lambda)\delta\underline{\theta}+\lambda-1)\underline{\theta}-(4\delta\underline{\theta}+\lambda-1)\overline{\theta}}$.

[17] If $c \to 0$, the manipulation cost would be prohibitively high and the H type's payoff would tend to $-\infty$. If hyphotetically, H workers were to manipulate envy, the principal's profit would tend to $+\infty$.

For Proposition 2, when $c < c^*$, envy manipulation will occur for intermediate values of the initial envy cost, c, of L workers. If the initial c is very low, in particular below c^{EP}_{MIN}, it is too costly to manipulate envy. Similarly, if c is close to c^*, in particular above c^{EP}_{MAX}, the marginal benefit of envy provocation is larger than the marginal cost. The key mechanism behind this result is that the principal must pay part of the envy manipulation cost, $\delta\mu^{EP}$, of H workers in order to induce them to accept the new contracts. Giving the timing of the game, when $c < c^{EP}_{MIN}$, $c > c^{EP}_{MAX}$ or $\delta > \delta^{EP}_{MAX}$, then $U^E_H > U^{EP}_H$, so H workers would never manipulate envy. In this case, the principal would offer the pair of separating contracts of Section 3.

An implication of Propositions 1 and 2 is that, to prevent social comparison, the principal could try to make the attributes and rewards of high-skilled agents less visible, or even maintain secrecy about the contracts for the upper-level positions. As argued by Bebchuk and Fried (2003) and Cohen-Charash and Mueller (2007), secrecy would reduce the possibility of envy, unfairness and harmful behavior. However, such a strategy may be not applicable in most situations and, in some cases, even undesirable (see the equilibrium outcome under envy-reduction).

It can be shown that aggregate welfare under envy provocation, that is $E[\pi]^{EP} + \lambda U^{EP}_H$, is always lower than that achieved with envy but no manipulation, $E[\pi]^E + \lambda U^E_H$. The reason is that the equilibrium effort level of L workers, evaluated at μ^{EP}, is equal to $e^{EP}_L = 1/2\underline{\theta}$, which, when $c < c^*$, is lower than the effort without envy manipulation, e^E_L, of Section 3. Thus, envy-provocation leads to an overall efficiency loss.

Remark 5. Envy manipulation by the principal

The principal could, in theory, decide to take actions of manipulation to offset the envy-provocation activity of H workers. This type of preventing strategies are known in the literature as envy manipulation by a third party. For example, schoolteachers that require pupils to wear school uniforms and not to bring special treats from home to reduce possible jealousy among them. Or governments, motivated by envy and fairness concerns, that choose to set high tax rates even if they can have the negative effect of decreasing public revenues. However, it can be shown that, in the game analyzed in this model, the principal would never find it profitable to manipulate the envy of L individuals. The reason is that, since the group of H workers would take their actions before the contract offers, the principal would still have to pay for part of the manipulation cost of H workers (detailed results are available from the authors upon request).

4.2 Envy-reduction

If $c > c^*$, H individuals will take actions of envy-reduction (ER). In this case, the participation constraint of L workers can be written as

$$U_L^{ER}(w_L, e_L) = w_L - \frac{\overline{\theta}}{2}e_L^2 - \frac{c}{1+\mu}\max\{0, U_H^{ER}(w_H, e_H)\} \geq 0, \qquad (PC_L^{ER})$$

whilst all other constraints remain unchanged with respect to those in subsection 4.1. Following the procedure of the previous case, we derive

$$e_L = \frac{(1-\lambda)(1-c+\mu)}{(1+\mu)\overline{\theta}-[(1-\lambda)c+\lambda(1+\mu)]\underline{\theta}} \equiv e_L^{ER}, \text{ and } e_H = \frac{1}{\underline{\theta}} = e_H^{FB}.$$

This time, the effort of L workers is increasing in the manipulation activity of H individuals, as

$$\frac{de_L^{ER}}{d\mu} = \frac{(1-\lambda)c(\overline{\theta}-\underline{\theta})}{\{(1+\mu)\overline{\theta}-[(1-\lambda)c+\lambda(1+\mu)]\underline{\theta}\}^2} > 0.$$

By maximizing the principal's profit function, we obtain:

$$\begin{aligned} U_L^{ER}(w_L^{ER}, e_L^{ER}) &= 0; \\ U_H^{ER}(w_H^{ER}, e_H^{FB}) &= \frac{(1-\lambda)^2(1+\mu)(1-c+\mu)(\overline{\theta}-\underline{\theta})}{2\{(1+\mu)\overline{\theta}-[(1-\lambda)c+\lambda(1+\mu)]\underline{\theta}\}^2} - \frac{\delta\mu(1+\mu)}{1-c+\mu}. \end{aligned} \qquad (22)$$

The optimal manipulation activity, μ, for H workers is

$$\mu = \frac{\overline{\theta} - [2-\lambda-(1-\lambda)c]\underline{\theta}}{(2-\lambda)\underline{\theta}-\overline{\theta}} \equiv \mu^{ER}, \qquad (23)$$

which is positive for each $c > c^*$, and equal to 0 if $c = c^*$. In equilibrium, the fraction $c/(1+\mu^{EP})$ is equal to c^*, and this will be the new envy cost that the principal will observe before offering the new contracts. By substituting $\mu = \mu^{ER}$ into (22), the equilibrium payoff of H workers is

$$U_H^{ER}(w_H^{EP}, e_H^{FB}) = \frac{(1-\lambda)\{8\delta[2-(1-\lambda)c-\lambda]\underline{\theta}+\lambda-2]\underline{\theta}^2\}-(1-\lambda)[(8\delta\underline{\theta}+\lambda-3)\overline{\theta}\underline{\theta}+\overline{\theta}^2]}{8[(2-\lambda)\underline{\theta}-\overline{\theta}](\overline{\theta}-\underline{\theta})\underline{\theta}} \equiv U_H^{ER}. \qquad (24)$$

The payoff in (24) is: linear; decreasing in c, as $dU_H^{ER}/dc = -\delta(1-\lambda)^2\underline{\theta}^2/[(2-\lambda)\underline{\theta} - \overline{\theta}](\overline{\theta}-\underline{\theta}) < 0$; equal to $U_H^* = (1-\lambda)/4\underline{\theta}$, the highest possible payoff, when $c = c^*$. An example is depicted in figure 4. From (10) and (24), $U_H^{ER} \geq U_H^E$ when the initial envy cost is equal or above a threshold denoted by[18] c_{MAX}^{ER}. Hence, the H type's

[18] $c_{MAX}^{ER} = \frac{(1-\lambda)\{(16\delta\underline{\theta}-\lambda+3)\overline{\theta}\underline{\theta}-[\lambda(16\delta\underline{\theta}-1)+2]\underline{\theta}^2-\overline{\theta}^2\}-\sqrt{(1-\lambda)^2[(2-\lambda)\underline{\theta}-\overline{\theta}]-[(64\delta\underline{\theta}-\lambda+2)\underline{\theta}-\overline{\theta}](\overline{\theta}-\underline{\theta})^2\underline{\theta}^2}}{16(1-\lambda)^2\delta\underline{\theta}^4}$.

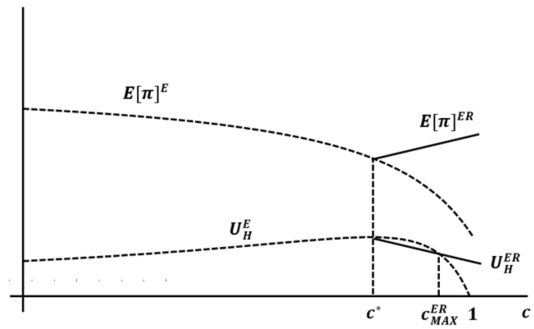

Figure 4.
Envy manipulation (envy-reduction)
(Parameters: $\overline{\theta} = 0.7$, $\underline{\theta} = 0.5$, $\lambda = 0.4$)

payoff with envy reduction is larger than that obtained with no manipulation when $c \in (c_{MAX}^{ER}, 1]$. The threshold c_{MAX}^{ER} is increasing in the manipulation cost, δ, and is equal to 1 when

$$\delta = \frac{(2-\lambda)\underline{\theta}-\overline{\theta}}{8\underline{\theta}^2} \equiv \delta_{MAX}^{ER}. \tag{25}$$

Thus, when $\delta > \delta_{MAX}^{ER}$, then $U_H^{ER} < U_H^E$, so envy manipulation is not profitable.

The principal's equilibrium expected profit, evaluated at $\mu = \mu^{ER}$, is

$$E[\pi] = \frac{(4\delta\underline{\theta}+\lambda+1)\overline{\theta}-\{4[2-\lambda-(1-\lambda)c\ ]\delta\underline{\theta}+\lambda+1\}\underline{\theta}}{4(\overline{\theta}-\underline{\theta})\underline{\theta}} \equiv E[\pi]^{ER}. \tag{26}$$

The profit in (26) is increasing in c, as $dE[\pi]^{ER}/dc = (1-\lambda)\delta\underline{\theta}/(\overline{\theta}-\underline{\theta}) > 0$ and, in the relevant range, $c \in (c_{MAX}^{ER}, 1]$, reaches a minimum, $E[\pi]^{ER} = (1+\lambda)/4\underline{\theta} = E[\pi]^{EP}$, when $c = c^*$, as shown in figure 4. For all $c > c^*$, we obtain that $E[\pi]^{ER} > E[\pi]^E$, so the equilibrium profit is larger than that with no manipulation. The reason why the principal obtains a higher profit is that, thanks to the activity of envy-reduction of H individuals, L workers will increase their equilibrium effort up to $e_L^{ER} = 1/2\underline{\theta}$ which, although it is equal to the equilibrium effort under envy-provocation, e_L^{EP}, obtained in sub-section 4.1, when $c > c^*$, it is higher than that without manipulation, that is e_L^E.

In contrast to subsection 4.1, it can be shown that aggregate welfare under envy reduction, $E[\pi]^{ER}+\lambda U_H^{ER}$, is larger than that with envy but no manipulation, $E[\pi]^E+\lambda U_H^E$. This means that the envy-reduction equilibrium is Pareto efficient.

Proposition 3. *If $c \in (c_{MAX}^{ER}, 1]$ and $\delta < \delta_{MAX}^{ER}$, H workers take actions of envy-reduction. In equilibrium, both H* workers *and the principal are better off compared to the case in which envy cannot be manipulated.*

For Proposition 3, it is relatively easy to manipulate the behavior of individuals with very high levels of envy. When, instead, $c \in (c^*, c^{ER}_{MAX})$ or $\delta > \delta^{ER}_{MAX}$, then $U^{ER}_H < U^E_H$, so the H type's payoff under envy-reduction is always lower than the payoff under envy but no manipulation. In this case, H workers would not manipulate envy, and the principal would offer the separating contracts of Section 3.

Remark 6. Costless manipulation
If $\delta = 0$, H individuals would not incur any cost of envy manipulation. Of course, in this case, the group of H workers would still take actions of envy provocation or envy reduction and the qualitative results of the paper would remain unchanged. The assumption of zero manipulation cost would not be unreasonable in this context. Indeed, it is well know in the literature that envy-provocation could occur without any direct interaction with envied people and through the simple comparisons of material possessions or visible consumption, which springs from status and prestige-seeking behaviour towards the reference group (Elster, 1990). So, in our model, the higher status of high-skilled workers, resulting from the surplus derived in upper-level jobs, could naturally provoke envy. On the opposite, emotional responses related to altruism, empathy or moral commitment could reduce envy even without any direct and costly actions.

5 Conclusion

In this article, we analyze a principal-agent setting with a principal (employer) and two types of agents (employees/workers), low and high skilled. Low-skilled workers are envious of the surplus that their high-skilled peers can obtain from their labor contract. Envy has a utility-decreasing effect on low-skilled workers, but not a utility-increasing effect on high-skilled workers. In Section 3 of the paper, we show that the presence of envious workers can increase the well-being of the envied and decrease the profits of the principal. The payoff of high-skilled individuals is first increasing in the envy cost of low-skilled workers, and then decreasing if the cost is too high. This implies that there is an envy cost level such that the high-skilled type's payoff is maximized. Hence, if the initial envy cost is different from the critical point, high-skilled individuals would benefit from a shift (increase or decrease) in the envy cost incurred by low-skilled workers. Following this argument, in Section 4, we assume that envied workers can manipulate the envy cost of their coworkers, with actions of envy-provocation or envy-reduction. We show that, under certain circumstances, high-skilled workers can further increase their payoff compared to the case in which envy cannot be manipulated.

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