

The Intensity of Incentives in Firms and Markets: Moral Hazard with Envious Agents

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Abstract

While most market transactions are subject to strong incentives, transactions within firms are often not explicitly incentivized. We offer an explanation for this observation based on the assumption that agents are envious and suffer utility losses if colleagues receive higher wages. We show that envy creates a tendency towards flat-wages if agents are risk-averse and there is no limited liability. Empirical evidence suggests that social comparisons are more pronounced among employees within firms than among individuals that interact in markets. Flat-wage contracts are thus more likely to be optimal in firms. Further, the paper analyzes in general the impact of envy on optimal incentive contracts for multiple agents and isolates the countervailing effects of envy on the costs of providing incentives.

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1 Introduction

While most market transactions are subject to strong incentives, transactions within firms or organizations are often not explicitly incentivized. For example, freelance writers are commissioned to write articles of precisely specified length, business consultants are paid hourly wages while completing a particular mandate, and the salaries of independent software programmers condition on processing a specific project. In contrast, permanent employees conducting the same tasks largely receive fixed wages.¹ While implicit means like career concerns can also provide strong incentives, it is puzzling why firms often abstain from using monetary incentives as an additional instrument. This paper offers an explanation for different levels of explicit incentives in firms and markets that is based on envy among agents and the observation that such social comparisons are more pronounced within firms than among individuals that interact in markets.

In particular, we consider envious agents in an otherwise standard moral hazard model with multiple agents. An envious agent suffers a utility loss whenever another agent receives a higher wage. Each agent can exert some costly but unobservable effort that increases the principal's expected revenue. To provide incentives the principal must thus condition the agents' wages on stochastic performance measures. Most analyses of the principal-agent problem focus on the resulting trade-off between incentives and risk, but chance variations in wages also create wage inequality. Envious agents must be compensated for their expected utility loss from unfavorable wage inequality. We show that if agents are risk-averse and there is no limited liability, envy renders incentive provision more expensive relative to the case with purely self-interested agents. However, agents can always be induced to choose their cost-minimizing effort levels by paying them equal flat-wages. In this case envy causes no additional costs. Since envy increases the cost of implementing higher effort levels, flat-wages can be optimal in situations in which the principal would otherwise provide incentive contracts. Furthermore, social comparisons like envy appear to be more pronounced among employees within firms than among individuals who only interact via the market. Envy is thus more likely to render flat-wage contracts optimal within firms than in markets – even if the underlying principal-agent problems are otherwise identical.

¹This observation goes back at least to Williamson (1975). In the words of Holmström and Milgrom (1991): “It remains a puzzle for this theory that employment contracts so often specify fixed wages and more generally that incentives within firms appear to be so muted, especially compared to those of the market” (p. 24).

In addition to paving the way for our applied results, our theoretical analysis deepens the understanding of how envy affects the optimal provision of incentives in general. As argued above, envy increases the costs of providing incentives when agents must be compensated for expected wage inequality. However, if by exerting more effort an agent can reduce the probability of receiving a lower wage than his colleague, envy causes a positive incentive effect. The overall effect of envy is then ambiguous. Our contribution is to disentangle the countervailing effects of envy in a moral hazard model with multiple envious agents that (i) allows for both risk-neutral and risk-averse agents and (ii) comprises the cases with and without limited liability.

We derive the following results. By transforming the principal's maximization program we show that envy affects the principal's minimum cost of providing incentives in exactly two ways. First, envy allows the principal to punish an agent by paying the other agent a higher wage. If monetary punishments are restricted by limited liability, envy thus enlarges the principal's feasible set of utility combinations for the agents. Second, envious agents must be compensated for their suffering from expected unfavorable wage inequality. This causes additional costs if the agents are to receive contracts that generate unequal wages with strictly positive probability. Envy can thus both decrease and increase the principal's minimum costs of providing incentives.

For the remainder of the paper we then focus on the canonical case with risk-averse agents and unlimited liability. Since there is no limited liability, the cost-decreasing effect of envy cannot arise. To counteract the cost-increasing effect of envy, the principal can adjust incentive contracts to mitigate or avoid expected wage inequality. However, an optimal incentive contract (for selfish agents) serves the dual role of providing incentives and allocating risk. It is therefore not possible to reduce expected wage inequality without impairing the allocation of risk. A reduction in expected wage inequality reduces the necessary compensation for envious agents, but since the agents are also risk-averse it increases the compensation for their risk exposure. Therefore, with risk-averse agents and unlimited liability envy unambiguously increases the costs of providing incentives relative to the case with purely self-interested agents. Moreover, envy appears to be less important in case the (otherwise identical) principal-agent relationship represents market interactions rather than a firm. Our analysis then implies that there exist situations in which flat-wages are optimal within firms whereas incentive contracts are optimal in the market.

Our assumptions concerning the agents' social preferences and reference groups are based on sound empirical evidence. Survey studies by Blinder and Choi (1990), Campbell and Kamlani (1990), and Agell and Lundborg (2003) show that equity concerns are important within firms where they constitute a reason for downwards wage rigidity. In a related study, Bewley (1999) finds that "the main function of internal pay structure is to ensure internal pay equity, which is crucial for good morale." (p. 82) Moreover, numerous carefully conducted laboratory experiments confirm that fairness and equity concerns are important human motives.²

Concerning the workers' reference groups, Bewley (1999) finds that "Pay levels in different firms are only loosely linked, unlike pay rates within company operating units. Whereas resentment and jealousy compel internal structure, the main ties among pay levels in different firms are the forces of supply and demand" (p. 86). This is in line with Festinger (1954), who develops a theory of social comparisons based on the assumption that equity concerns are more pronounced among individuals who perceive themselves to be equal. Adams (1963) subsequently argues that "co-workers will more neatly fit this criterion than will other persons" (p. 424). Akerlof and Yellen (1988) summarize this line of reasoning: "But, in contrast to the marketplace, where traders have little personal contact, in the workplace, where personal contact is close, other emotions such as 'concern for fairness', pejoratively called 'jealousy', are also important" (p. 45). Case studies analyzing the success of mergers also suggest that the boundary of the firm can define the workers' reference group. A prominent example is Williamson's (1985, p. 158) discussion of the 1980 acquisition of Houston Oil and Minerals Corporation by Tenneco, Inc., the largest conglomerate in the U.S. at that time. Houston's business was to find and develop petroleum and mineral deposits, and it had an unusually large bonus program in place to reward its employees for the successful discovery and development of new reserves. To preserve Houston's entrepreneurial and risk-taking corporate culture, Tenneco planned to maintain this pay structure upon merger, but ultimately failed to do so. The reasons for this failure were apparently equity concerns within the conglomerate. Tenneco's vice president for administration told the *The Wall Street Journal*: "We have to ensure internal equity and apply the same standards of compensation to everyone."³ As a result, Tenneco could not match job offers by outside employers who apparently had fewer constraints on their incentive structure. Within a year a large fraction of Houston's employees had left for better opportunities elsewhere. Ultimately, this exodus caused the failure of the merger.

²Camerer (2003) and Fehr and Schmidt (2006) provide excellent overviews of the experimental literature.

³*The Wall Street Journal*, A-1, February 9, 1982.

Related Literature

In a seminal paper, Holmström and Milgrom (1991) propose multi-tasking as an explanation for the different incentive intensities in firms and markets. Like Williamson, they distinguish employees from contractors by the condition of asset ownership. To keep the balance between asset maintenance and output production, optimal output-based incentives for employees must be low-powered as compared to those for contractors. Addressing the same question, Baker, Gibbons, and Murphy (2002) analyze an infinitely repeated trade situation with incomplete contracts à la Grossman and Hart (1986). Repeated game effects induce an agent to choose a desired action and the principal to pay a promised bonus, while asset ownership influences whether such relational contracts can be self-enforcing. In contrast, our explanation for low-powered incentives in firms is based on the cost-increasing effect of envy. It applies in single-tasking settings as well as in one-shot situations. Asset ownership is not part of our explanation; it thus also applies to the service sector where often only human assets are essential for production.⁴

Our model also relates to a growing number of papers that analyze the impact of social preferences in moral hazard settings with multiple agents.⁵ Meyer and Mookherjee (1987) characterize cost-minimizing contracts when the *principal's* objective function reflects a preference for ex-post equality among agents. Since agents have standard preferences, the incentive and participation constraints are unaffected so that the countervailing effects of envy as characterized in our model do not arise. Seminal contributions analyzing optimal contracts when *agents'* preferences reflect inequity aversion are Itoh (2004) and Demougin and Fluet (2006). Both focus on the optimality of team vs. relative performance evaluation with risk-neutral agents and limited liability. Firms can then avoid any cost-increasing effect of envy by paying (equal) wages only if agents have identical output realizations, while relative performance evaluation allows firms to exploit the positive incentive effect. Contrary to our results, it would follow that incentives in firms should be higher as compared to the market. Demougin, Fluet, and Helm (2006) and Neilson and Stowe (2005) also

⁴Note that it might be very difficult to prevent employees to capitalize on their human capital. For example, lawyers often take important clients with them when leaving a law firm.

⁵Dur and Glaser (2006) and Englmaier and Wambach (2005) introduce social preferences in models of moral hazard with a single agent. Grund and Sliwka (2005) analyze tournaments and show that inequity averse agents exert higher effort than purely self-interested for given prizes but that the optimal tournament implements lower effort levels due to the necessary compensation for suffering from inequity. See also Kräkel (2000). Rey Biel (2005) analyzes the positive incentive effect of envy in a setting with complete information.

assume risk-neutral agents and investigate reasons for wage compression. Both papers find that incentives can be muted, but Demougin et al. eliminate the incentive effect of social preferences by assuming that agents compare expected rents, and Neilson and Stowe restrict the analysis to independent piece-rates. Goel and Thakor (2005) and Bartling (2007) characterize optimal incentive contracts if agents are risk-averse. However, both papers do not consider the case with limited liability. Finally and most importantly, none of the above papers decompose the countervailing effects of envy on the principal's optimization problem and thereby show how these effects interact with assumptions about risk preferences and limited liability.

The rest of the paper is organized as follows. Section 2 introduces the moral hazard problem and discusses the agents' social preferences. Section 3 analyzes the impact of envy on the principal's program in a general set-up that allows for both risk-averse and risk-neutral agents and comprises the cases with and without limited liability. Section 4 focuses on the case with risk-averse agents and unlimited liability. Section 5 discusses some of our assumptions. Section 6 concludes.

2 The Model

We begin with a characterization of the impact of envy in a more general setup that allows us to analyze also risk-neutral agents and limited liability. Consider a principal who employs two agents. If employed, each agent chooses an effort level e from a finite set E . The effort vector $\mathbf{e} \in E^2$ determines the probability $\pi(\mathbf{x} | \mathbf{e})$ of some outcome vector \mathbf{x} drawn from a finite set X . Both the dimensionality of \mathbf{x} and the probability mass function π are not restricted. Our model thus comprises situations with individually attributable outcomes, non-separable outcomes, or both. There is no restriction on the correlation of individually attributable outcomes. An outcome realization \mathbf{x} determines the principal's gross profit via the function $f : X \rightarrow \mathbb{R}$. While effort is taken to be non-contractable, the principal can verify the outcome vector. A contract thus assigns each agent a wage w for every outcome realization \mathbf{x} . We restrict wage payments to lie in a compact interval $[\underline{w}, \bar{w}] \in \mathbb{R}$. We can thus discuss the effect of envy in case of limited liability. Moreover, we thereby render the relevant subset of the contract space - the constraint set - bounded. This simplifies the technical analysis. When talking about the case without limited liability we assume the interval $[\underline{w}, \bar{w}]$ to be sufficiently large as to impose no binding restrictions on the principal's wage choices.

Preferences

Our specification of social preferences is related to the theory of inequity aversion by Fehr and Schmidt (1999) and Bolton and Ockenfels (2000). Whereas inequity averse workers also suffer from being better off, the survey evidence discussed in the introduction stresses the role of jealousy or envy. In our model, we therefore assume that agents only suffer a utility loss if the respective other agent is better off.⁶ Formally, if agent i exerts effort e_i and receives wage w_i , his *overall utility* is defined as

$$U_i(w_i, w_j, e_i) = u(w_i) - \psi(e_i) - \gamma_i(w_i, w_j) S(w_i, w_j) \quad (1)$$

if the other agent j gets wage w_j . It is thus additively separable in the following three components. First, agent i enjoys utility $u(w_i)$ from his wage payment w_i by the principal. The function u is identical for both agents; it is strictly increasing, unbounded, continuous, and weakly concave. For the moment being we thus allow for both risk neutrality and risk aversion. Second, agent i bears the personal cost $\psi(e_i)$ of his effort choice. The function ψ is assumed to be identical for both agents; it is continuous, and strictly increasing.

Finally, an envious agent i suffers a utility loss $\gamma_i(w_i, w_j) S(w_i, w_j)$ which is positive if the other agent j receives a higher wage w_j .⁷ Envy is split into the two components $S(w_i, w_j)$ and $\gamma_i(w_i, w_j)$ to simplify algebraic manipulations and comparative statics. The function $S : \mathbb{R} \rightarrow \mathbb{R}$ measures the perceived wage inequality depending on the absolute wage difference $|w_i - w_j|$. It is zero at $w_i = w_j$, strictly increasing in $|w_i - w_j|$, and thus weakly positive. We assume S to be continuous, but we impose no restrictions concerning the curvature or differentiability. The weight γ_i measures how much agent i suffers from the wage inequality depending on whether he is ahead or behind; it is defined as

$$\gamma_i(w_i, w_j) = \begin{cases} 0 & \text{if } w_i \geq w_j \\ \alpha_i & \text{if } w_i < w_j. \end{cases} \quad (2)$$

The constant $\alpha_i \geq 0$ can thus be interpreted as agent i 's degree of envy. We do not restrict α_i to equal α_j , thus agents might differ in their degree of envy. The vector $\boldsymbol{\alpha} = (\alpha_i, \alpha_j)$ describes the agents' degrees of envy.

⁶In Section 5 we argue that our results are only reinforced if agents also suffer from favorable wage inequality.

⁷In Section 5 we discuss the assumption that agents only compare wages and argue that accounting for effort costs would not change our qualitative results. Note that agents do not perform interpersonal utility comparisons but only wage comparisons.

Both agents maximize their expected overall utility. Their outside options are normalized at zero. The principal is assumed to be risk-neutral and interested only in his expected gross profit minus expected wage payments. We thus assume that he does not compare his profit to the agent's wage levels. This mirrors our assumption that the agents' reference groups are confined to the respective other agent.

3 The General Impact of Envy

The characterization of the optimal incentive contract follows Grossman and Hart (1983) and Mookherjee (1984). In the first step, the principal derives the second-best cost incentive scheme that implements a given effort vector \mathbf{e} as a Nash equilibrium among the agents, subject to the constraints that the agents receive at least their reservation utilities and choose the desired effort level. If a solution to this minimization problem exists, it yields the second-best costs. If no solution exists, these costs are set to plus infinity. Given degrees $\boldsymbol{\alpha}$ of envy, this generates a second-best cost function $C^{SB}(\mathbf{e}, \boldsymbol{\alpha})$ for every effort vector \mathbf{e} . In the second step, maximizing the principal's expected profit minus costs determines the optimal effort vector \mathbf{e} and the associated optimal contracts.

If the principal maximizes over the assigned wages, envy directly enters the participation and incentive constraints via the agents' utility functions. Since envy reduces utility, its effect on the participation constraint is clearly negative. Yet the influence on the incentive constraints is ambiguous: its effect depends on how the agent affects his expected utility loss from envy by choosing the desired effort. It may well be that envy provides an agent with an extra incentive to choose a (desired) high effort to reduce expected unfavorable wage inequality.

To clarify the overall effect of envy we therefore change the principal's control variables. Define agent i 's *utility from money* as the sum of his utility $u(w_i)$ from his wage and the potential utility loss $\gamma_i(w_i, w_j) S(w_i, w_j)$ from envy. An agent's utility from money is thus his overall utility U_i as defined in (1) excluding effort costs. Let the vector (v_i, v_j) denote a combination of utilities from money for agents i and j . Taking utilities from money as control variables, a contract is a function $\mathbf{v} : X \rightarrow \mathbb{R}^2$ that assigns the agents utilities from money $v_i(\mathbf{x})$ and $v_j(\mathbf{x})$ conditional on the realized outcome \mathbf{x} . Let \mathbb{V} be the space of all such functions, and let $V(\boldsymbol{\alpha})$ be the set of all utility from money combinations the principal

can grant the agents by paying them wages in $[\underline{w}, \bar{w}]$. As we will show, there exists exactly one combination of wages (w_i, w_j) that provides agents with a combination of utilities from money (v_i, v_j) given their degrees α of envy. Thus, the principal's minimum costs if agents with degrees $\alpha \in \mathbb{R}^+ \times \mathbb{R}^+$ of envy are to receive combination $(v_i, v_j) \in \mathbb{R}^2$ of utilities from money can be described by a function $h : \mathbb{R}^2 \times \mathbb{R}^+ \times \mathbb{R}^+ \rightarrow \mathbb{R}$. We call h the principal's *indirect cost function*. As indicated by the notation, both V and h depend on the degree α of envy in a way to be made precise below.

Suppose the principal wants to implement an effort vector e at the least cost, facing agents with degrees α of envy. The second-best costs $C^{SB}(e, \alpha)$ are then determined by minimizing his expected wage payments

$$\sum_{\mathbf{x} \in X} \pi(\mathbf{x} | e) h(\mathbf{v}(\mathbf{x}), \alpha) \quad (3)$$

with respect to the contract \mathbf{v} , subject to the constraints

$$\sum_{\mathbf{x} \in X} \pi(\mathbf{x} | e) v_i(\mathbf{x}) - \psi(e_i) \geq 0 \quad (4)$$

$$\sum_{\mathbf{x} \in X} [\pi(\mathbf{x} | e) - \pi(\mathbf{x} | e'_i, e_j)] v_i(\mathbf{x}) - [\psi(e_i) - \psi(e'_i)] \geq 0 \quad (5)$$

$$\mathbf{v}(\mathbf{x}) \in V(\alpha) \text{ for all } \mathbf{x} \in X \quad (6)$$

for $i = 1, 2$ and for all $e'_i \in E$. The participation constraints (4) ensure that both agents accept the contract. The incentive constraints (5) render it optimal for each agent to choose the desired effort level conditional on the other agent doing the same. Finally, the limited liability constraint (6) restricts the principal to assign utilities from money that are attainable by paying wages from the interval $[\underline{w}, \bar{w}]$. A contract is *incentive compatible* if it satisfies the incentive constraints (5). It is *incentive feasible* if in addition it fulfils the participation constraints (4). The contracts satisfying the constraints (4) and (5) form the *feasible set*. Finally, the *constraint set* consists of all incentive feasible contracts that also fulfil the limited liability constraint (6).

Inspection of the principal's program shows that envy enters the program in exactly two ways: First, via the set $V(\alpha)$ of possible utilities from money and, second, via the indirect cost function $h(\mathbf{v}, \alpha)$. In the following we analyze the impact of these two effects on the principal's second-best costs $C^{SB}(e, \alpha)$.

Set of Attainable Utility from Money Combinations

If the agents are to receive utilities from money (v_i, v_j) , their wages (w_i, w_j) must satisfy

$$u(w_i) - \gamma_i(w_i, w_j) S(w_i, w_j) = v_i \quad (7)$$

$$u(w_j) - \gamma_j(w_i, w_j) S(w_i, w_j) = v_j. \quad (8)$$

The following lemma greatly simplifies the ensuing analysis. All proofs are in the appendix.

Lemma 1 (Ranking) *Consider some (v_i, v_j) with $v_i \geq v_j$. Then any solution (w_i, w_j) to (7) and (8) satisfies $w_i \geq w_j$.*

Suppose agent i receives a weakly higher wage than agent j . Since both agents share the same utility from wage function, agent i then receives a weakly higher utility $u(w)$. Agent i does not suffer a utility loss from envy, whereas agent j might suffer from envy if his wage is strictly smaller. Hence, agent i receives a weakly higher utility from money. This yields Lemma 1. If $v_i \geq v_j$, equations (7) and (8) are thus equivalent to

$$w_i = u^{-1}(v_i) \quad (9)$$

$$u(w_j) - \alpha_j S(u^{-1}(v_i), w_j) = v_j. \quad (10)$$

We can now analyze the set of attainable utility from money combinations. Rendering our previous definition more precise, let $V(\alpha)$ be the set of all utility from money combinations $(v_i, v_j) \in \mathbb{R}^2$ for which there exist wages $(w_i, w_j) \in [\underline{w}, \bar{w}]^2$ solving (7) and (8). Then

Proposition 1 (Attainable Utility from Money Combinations) *For given degrees α of envy and interval $[\underline{w}, \bar{w}]$ of possible wage levels,*

$$V(\alpha) = \left\{ (v_1, v_2) \in \mathbb{R}^2 : \text{if } v_i \geq v_j \text{ then } \right. \\ \left. v_i \in [u(\underline{w}), u(\bar{w})] \text{ and } v_j \in [u(\underline{w}) - \alpha_j S(u^{-1}(v_i), \underline{w}), v_i] \right\} \quad (11)$$

characterizes the set of attainable utility from money combinations. Envy thus increases the set of attainable utility from money combinations.

Envy never increases the utility of an agent, hence the maximum attainable utility from money remains at $u(\bar{w})$. However, an envious agent suffers a utility loss when the other agent receives a higher wage. By creating unfavorable wage inequality, the principal can reduce an envious agent's minimum utility from money below the level that a selfish agent derives from the minimum wage. Figure 1 offers an illustration. If both agents receive the minimum wage,

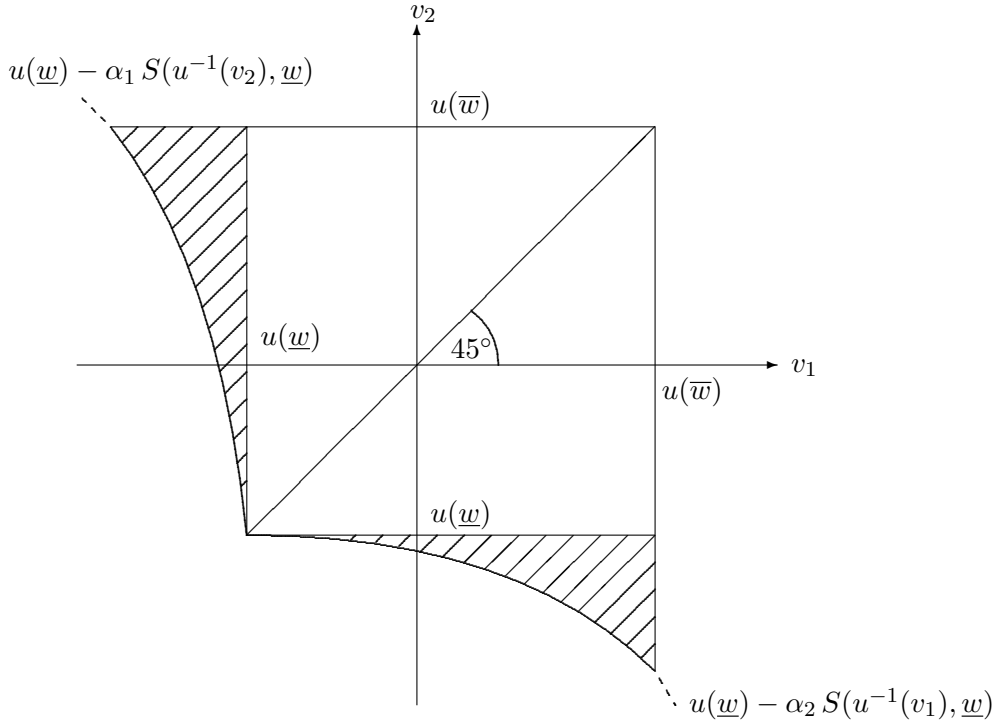


Figure 1: **Set of Attainable Utility from Money Combinations.** The shaded areas indicate the additional utility from money combinations rendered attainable by envy.

there is no wage inequality and they receive the utility from money combination $[u(\underline{w}), u(\underline{w})]$. Suppose the principal now increases the wage of, say, agent 1 but holds the wage of agent 2 fixed. The utility from money of agent 1 then rises as he enjoys the increased wage. Since his wage is higher than agent 2's wage, he does not suffer from envy. Agent 2's utility from money, however, is reduced by envy. He now receives $u(\underline{w}) - \alpha_2 S(u^{-1}(v_1), \underline{w})$. In Figure 1 this corresponds to a movement from the lower left corner of the set along the curve that confines the right shaded area from below. Envy thus enlarges the set of attainable utility from money combinations, that is, envy enlarges the principal's constraint set. A relaxed constraint set to the principal's program might allow the principal to employ a cheaper contract, hence envy can have a decreasing effect on the principal's second-best cost $C^{SB}(e, \alpha)$.

The Principal's Indirect Cost Function

In the previous section we have identified a potential cost-decreasing impact of envy. We now turn to the effect of envy on the principal's indirect cost function $h(v, \alpha)$ and show that envy can also increase the costs of providing incentives. Let

$$h(v_i, v_j, \alpha) = \min \{w_i + w_j : (w_i, w_j) \text{ solves (9) and (10)}\} \quad (12)$$

characterize the principal's minimum costs of providing the agents with the utility from money combination (v_i, v_j) with $v_i \geq v_j$. Strict monotonicity of both the utility function u and the left hand side of (10) imply that (9) and (10) have a unique solution. Analyzing this solution, the effect of envy on the indirect cost function is the following.

Proposition 2 (Indirect Cost Function) *Suppose the principal wants to grant the agents utilities from money $(v_i, v_j) \in \mathbb{R}^2$ with $v_i \geq v_j$. Then his indirect cost function $h(\mathbf{v}, \boldsymbol{\alpha})$ is*

1. *independent of α_i ,*
2. *independent of α_j if $v_i = v_j$, and*
3. *strictly increasing in α_j if $v_i > v_j$.*

Agent j 's envy thus causes strictly positive extra indirect costs if and only if $v_i > v_j$.

Inspection of (9) and (10) shows that the agents must receive different wages if and only if they are to receive different utilities from money. The agent with the lower wage, agent j , then suffers from envy. If he is to receive a particular utility from money, he must be compensated for the utility loss from envy. This entails extra costs for the principal that are increasing in agent j 's utility loss and thus in his degree α_j of envy. Consequently, envy renders a contract more expensive if and only if the agents are given different utilities from money with strictly positive probability in equilibrium. Envy can thus have an increasing effect on the principal's second-best costs $C^{SB}(\mathbf{e}, \boldsymbol{\alpha})$.

General Effect of Envy

The above analysis shows that the general impact of envy on the principal's program is twofold. First, envy might enlarge the set of attainable utility from money combinations if there is limited liability. Second, envy renders the implementation of unequal utility from money combinations more expensive. The first effect relaxes the principal's minimization problem and thus weakly reduces the second-best costs, whereas the second effect on the indirect cost function weakly increases the second-best costs relative to the case with purely self-interested agents. The overall effect of envy on the principals minimum costs of providing incentives thus depends decisively on the underlying principal agent problem.

Our results show how the findings of Itoh (2004) and Demougin and Fluet (2006) depend on their assumptions concerning agents' risk preferences and limited liability. They consider

settings with risk-neutral agents and limited liability and show that envy can only reduce agency costs. Optimal contracts for purely self-interested agents are then not unique and, in particular, include an extreme team contract in which the agents are paid a positive (and equal) wage only if all agents are successful. By choosing such a team contract, all wage inequality and thus the cost-increasing effect of envy can be avoided without causing any further expenses. Yet firms can use individual or relative performance evaluation to exploit the positive incentive effect of envy. In their settings envy can thus only decrease agency costs.

4 Envy, Risk-Aversion, and No Limited Liability

In the following we focus on the canonical case with risk-averse agents and no limited liability. Further, we assume that each agent i manages his own project that generates a stochastic and individually attributable outcome x_i . Project outcomes are taken to be independent, thus the probability $\pi_i(x_i|e_i)$ of outcome x_i exclusively depends on agent i 's effort.⁸ We thus consider a situation with $\mathbf{x} = (x_1, x_2)$ and $\pi(x_1, x_2 | \mathbf{e}) = \pi_1(x_1 | e_1) \pi_2(x_2 | e_2)$. Note that we do not require projects to be symmetric, i.e. without envy it can be optimal to offer both agents different incentive contracts. To avoid situations where there is no trade-off between incentives and insurance, projects have full support and $\pi(x_i|e_i) > 0$ for all efforts and outcomes. Finally, we consider the case in which social or legal constraints - although they might exist - are not binding.⁹ In technical terms, the interval $[\underline{w}, \bar{w}]$ is sufficiently large so that for every effort vector any solution to the principal's minimization program (3) to (5) satisfies the limited liability constraint (6) if agents are not envious.

To formalize the total effect of envy we define the *envy costs* as the cost difference caused by envy if the principal wants to implement some effort vector \mathbf{e} ,

$$EC(\mathbf{e}, \boldsymbol{\alpha}) = C^{SB}(\mathbf{e}, \boldsymbol{\alpha}) - C^{SB}(\mathbf{e}, \mathbf{0}). \quad (13)$$

Let $\underline{\mathbf{e}}$ denote the effort vector that minimizes each agent's effort cost, and call an effort vector *implementable* if the corresponding feasible set is non-empty. We then get the following result.

⁸Our results also hold if outcomes are correlated except for the knife-edge cases in which there never arises wage inequality even with purely self-interested agents.

⁹Binding limited liability implies that agents are sometimes pushed down to the legal minimum wage. In occupations where wages condition on performance, this is rarely observed.

Proposition 3 (Envy Costs, Risk-Aversion, and No Limited Liability) *Suppose the agents are risk-averse, there is no limited liability, project outcomes are independent, and there is full support. Then the envy costs $EC(\mathbf{e}, \boldsymbol{\alpha})$ of any implementable effort vector \mathbf{e} are strictly positive if and only if $\mathbf{e} \neq \underline{\mathbf{e}}$.*

The intuition for Proposition 3 is as follows. First, suppose the principal wants to punish an agent with wage inequality. Since there is no limited liability, he can impose the same punishment by lowering the respective agent's wage. Reducing wages reduces the principal's expected costs. Thus, there is no benefit from punishing agents by creating wage inequality if there is no limited liability while the cost-increasing effect of envy on the principal's indirect cost function remains. Moreover, if the agents are risk-averse but not envious, the optimal contracts that implement a particular effort vector are unique. If at least one of the agents is to choose an effort level that is not cost-minimizing, he cannot receive a flat-wage. Since the outcomes are independent, the principal learns nothing about an agent's effort choice by observing the other agent's output. It then follows from Holmström's (1979) sufficient statistics result that an agent's contract conditions only on his own output. As there is always full support and outcomes are independent, the agents receive different utilities from money with strictly positive probability. It then follows from Proposition 2 that the contracts that are optimal for purely self-interested agents cause strictly higher costs with envious agents. Since envy renders all alternative (and therefore initially strictly more costly) contracts weakly more expensive, the principal's second-best costs must increase.

Flat-Wage Contracts

In our moral hazard model with risk-averse agents and no limited liability, the implementation of all effort levels $\mathbf{e} \neq \underline{\mathbf{e}}$ causes wage inequality and thus strictly positive envy costs. The principal, however, can implement the cost-minimizing effort levels $\underline{\mathbf{e}}$ by paying flat-wages. Since both agents share the same effort cost function, there arises no wage inequality and thus no envy costs. Envy thus generates a tendency towards flat-wage contracts. In fact, if for all higher effort levels $\mathbf{e} \neq \underline{\mathbf{e}}$ the envy costs exceed the benefits from implementation,

$$EC(\mathbf{e}, \boldsymbol{\alpha}) \geq \sum_{\mathbf{x} \in X} [\pi(\mathbf{x} | \mathbf{e}) - \pi(\mathbf{x} | \underline{\mathbf{e}})] f(\mathbf{x}) - [C(\mathbf{e}, \mathbf{0}) - C(\underline{\mathbf{e}}, \mathbf{0})], \quad (14)$$

then envy renders flat-wage contracts optimal. Clearly, there can be situations where the implementation of high effort levels does not increase the principal's profit by much. The right hand side of inequality (14) would then be rather small for most effort levels $\mathbf{e} \neq \underline{\mathbf{e}}$. In

such cases even moderate degrees of envy can have a radical effect on the optimal employment contract: with purely self-interested agents the principal wants to implement high effort levels and thus provide the necessary monetary incentives, whereas flat-wage contracts are optimal if the agents are envious.

Within-Firm vs. Market Interactions

In the introduction we argued that the relevance of social comparisons like envy depends on the institutional context in which workers interact. In particular, co-workers within firms appear to constitute a natural and important reference group, which implies that social comparisons between individuals who interact only via the market are less pronounced. This point is made most clearly by Bewley (1999) who finds that “External pay comparisons do not have the emotional impact that internal ones have” (p. 86).¹⁰

In general, principal-agent models allow for different interpretations of what they represent. In the context of the theory of the firm, this point is made by Hart (1995) who emphasizes that principal-agent theory “does not pin down the *boundaries* of the firm” (p. 20). Our model can thus be interpreted as representing either a firm with two employees where the degrees of envy are likely to be high, or market-mediated contracts between a buyer and two independent suppliers where the degrees of envy are less likely to be high. Condition (14) then directly implies that there exist situations in which flat-wage contracts are optimal within firms, whereas incentive contracts are optimal in market settings, although the underlying principal-agent problems do not differ in any other respect. Our model thus provides a behavioral explanation for the empirical observation that incentives within firms are muted as compared to incentives in markets.

Theory of the Firm

The results of our paper can also contribute to the theory of the firm. On the one hand, the horizontal integration of firms can boost profits by realizing complementarities in production or other synergy effects. On the other hand, Williamson’s (1985) case study of Tenneco’s acquisition of Houston Oil and Minerals Corporation arrestingly demonstrates that changing the boundary of the firm can change the workers’ reference groups. Our analysis then shows

¹⁰In a recent empirical study, Kwon and Meyersson-Milgrom (2007) use M&A as identification strategy and show that firm boundaries influence workers’ reference groups. For evidence from organizational psychology see for example Goodman (1974), Gartrell (1982), and Shah (1998).

that the resulting social comparisons like envy can increase the agency costs of providing incentives by imposing further restrictions on firms' wage schemes.

Kole and Lehn's (2000) case study of the merger of USAir with Piedmont Aviation shows that the costs of equity requirements can be substantial and significantly affect the profitability of mergers and acquisitions. To avoid labor conflicts the management of USAir had conceded its labor force wages that were relatively high as compared to industry standards. At the time of the merger, employees at USAir thus received more generous remuneration schemes as compared to their colleagues at Piedmont Aviation. After the merger, unions resisted plans to integrate Piedmont Aviation as a subsidiary with less generous labor contracts. The management of USAir gave in to this request for equal treatment and decided to adjust wages at Piedmont Aviation upwards, thereby boosting labor costs. As a consequence, net profits fell from a projected gain of 206 to a loss of 63 million USD in the year of the merger.

5 Discussion

Inequity Aversion

Contrary to the theory of inequity aversion, we do not model the possibility that agents also suffer from favorable wage inequality (compassion). However, doing so would only reinforce our results. Suffering from being better off has two effects. First, an agent can get the highest utility from money only if the other agent also receives the highest wage from the set of possible wages. If the other agent is to receive a lower utility from money, he must be given a lower wage. The agent with the higher wage then suffers from compassion. This shrinks the set of attainable utility from money combinations, which can reduce or even offset the potentially cost-reducing effect of envy in case limited liability is restricting the principal's contract choice.¹¹ Second, if agents are to be given unequal utilities from money, now also the agent with the higher wage must be compensated for his utility loss, which requires the principal to strictly increase the corresponding wages. Consequently, considering inequality aversion instead of envy only further increases the costs of providing incentives.

¹¹If both agents receive the maximum wage, there is no inequality and the agents receive the utility from money combination $[u(\bar{w}), u(\bar{w})]$. In Figure 1 this corresponds to the right upper corner of the set of attainable utility from money combinations. If, say, agent 2 receives a lower wage, then compassion also reduces agent 1's utility from money. The right boundary of the set in Figure 1 is thus no longer attainable. The same is true for the upper boundary.

Effort Costs in the Social Comparisons

In our specification of envy, agents only compare wages. It is clearly conceivable that agents also account for effort costs in their comparisons. However, in this case it is not clear how effort costs enter social comparisons. Effort costs and wages accrue in different dimensions such that it is not obvious how they are aggregated. Self-serving biases are also likely to be important: “Yes, the other agent worked very hard. But I also worked hard, thus he does not deserve to earn that much more.” Wages instead are directly comparable and thus constitute the most salient reference point.

Nevertheless, suppose the agents in our model account for effort costs in their social comparisons. An agent might then, *ceteris paribus*, want to lower his effort because the resulting reduction in effort costs can only reduce his utility loss from envy. This effect would lower incentives to exert effort, and thereby increase agency costs. We therefore conjecture that our results would hold or even be reinforced if we included effort costs in the agents’ social comparisons.

Wage Secrecy

Our analysis shows that envy can increase the costs of providing incentives. If firms can prevent such social comparisons by keeping wages secret, the additional agency costs can be avoided. At first sight, our results could thus be regarded as a rationale for the observation that many labor contracts prohibit employees from communicating their salaries to their colleagues. However, it is far from obvious that wage secrecy can prevent social comparisons. In the context of our model, even if the principal follows a policy of wage secrecy, agents are likely to form beliefs about the other agent’s contract, effort choice, and thus wage. Furthermore, to uphold wage secrecy an agent’s wage cannot condition on the other agent’s performance, which can be optimal to reduce the cost of envy. A policy of wage secrecy thus constrains the principal’s contract choice, and if agents suffer from their beliefs about unequal wages as much as they suffer from observed differences, then wage secrecy only further increases agency costs. This conclusion is in line with most textbooks on personal management, e.g. Henderson (2005), that recommend a policy of openness with regard to wages and salaries.

6 Summary

This paper analyzes the effect of envy in a moral hazard problem with multiple agents. In a general set-up, we show that envy affects the principal's minimum cost of providing incentives via two channels. First, the principal can afflict agents with additional punishment by creating wage inequality. If limited liability restricts the principal's use of monetary punishments, envy can therefore have a cost-decreasing effect. Second, envious agents must be compensated for their suffering from expected wage inequality if they are to accept the principal's contracts. Envy thus causes additional costs whenever wage inequality arises with positive probability. Since envy can have a cost-increasing and a cost-decreasing effect, its total impact depends on the underlying principal-agent problem.

For the canonical case of risk-averse agents and unlimited liability we can show that envy never decreases the costs of providing incentives. First, there can be no cost-decreasing effect since there is no limited liability. Second, the principal cannot avoid or reduce expected wage inequality and the associated necessary compensation without deviating from the optimal contract for purely self-interested agents, i.e. without impairing the allocation of risk, which increases the compensation for risk exposure. However, envy causes no additional costs if the principal implements the cost-minimizing effort levels by paying the agents equitable flat-wages. Envy thus generates a tendency towards flat-wage contracts. Since social comparisons like envy appear to matter more within firms than in the marketplace, our paper offers a behavioral explanation for the empirical observation that incentives within firms are muted as compared to incentives in markets – even if the underlying principal-agent problems are otherwise identical.

Appendix

Proof of Lemma 1

Suppose $w_i < w_j$. Then $\gamma_i(w_i, w_j) = \alpha_i$, $\gamma_j(w_i, w_j) = 0$, and $u(w_i) < u(w_j)$. Thus, (w_i, w_j) can solve (7) and (8) only if $v_i < v_j$. Consequently, any (w_i, w_j) that solves (7) and (8) for $v_i \geq v_j$ must satisfy $w_i \geq w_j$. *Q.E.D.*

Proof of Proposition 1

It follows from (9) that $w_i \in [\underline{w}, \bar{w}]$ if and only if $u^{-1}(v_i) \in [\underline{w}, \bar{w}]$. It follows from Lemma 1 that any solution w_j to (10) must lie in the interval $[\underline{w}, u^{-1}(v_i)]$. For all $w_j \in [\underline{w}, u^{-1}(v_i)]$ the left hand side of (10) is strictly increasing and continuous in w_j . It takes on the value v_i for $w_j = u^{-1}(v_i)$. Since we have $v_i \geq v_j$, the mean value theorem and monotonicity imply the existence of a $w_j \in [\underline{w}, u^{-1}(v_i)]$ if and only if $u(\underline{w}) - \alpha_j S(u^{-1}(v_i), \underline{w}) \leq v_j$. *Q.E.D.*

Proof of Proposition 2

For $v_i \geq v_j$ consider (9) and (10). First, $w_i = u^{-1}(v_i)$ is unique by the strict monotonicity of u . Second, w_j is unique as the left hand side of (10) is strictly increasing in w_j for all $w_j \in [\underline{w}, u^{-1}(v_i)]$. Consequently, we get $h(v_i, v_j) = w_i + w_j$ with (w_i, w_j) uniquely defined. The properties of h follow directly from the properties of w_i and w_j as characterized below.

The solution $w_i = u^{-1}(v_i)$ is independent of α_i and α_j . If $v_i = v_j$, then $w_j = u^{-1}(v_i)$ is the unique solution to (10), and it is independent of α_i and α_j . If $v_i > v_j$, Lemma 1 implies that solutions to (10) satisfy $w_j < u^{-1}(v_i)$. $S(u^{-1}(v_i), w_j)$ is then strictly positive. Increasing α_j thus lowers the left hand side of (10) which implies a counterbalancing increase in w_j . *Q.E.D.*

Proof of Proposition 3

Necessity

The principal optimally implements \underline{e} by paying both agents a flat-wage of $w = u^{-1}(\psi(\underline{e}))$. Since wage inequality never arises, the envy costs are zero.

Sufficiency

a) Suppose the principal wants the agents to choose an implementable effort vector $\mathbf{e} \neq \underline{e}$ and agents are not envious. Since then $h(v_i, v_j) = u^{-1}(v_i) + u^{-1}(v_j)$, the principal's objective function (3) is continuous and strictly convex. Ignoring the limited liability constraint (6), the feasible set can be artificially bounded by applying a result of Bertsekas (1974). By the weak inequalities in (4) and (5) the feasible set is closed and thus compact. The considered effort vector is implementable such that the feasible set is non-empty. Since the objective function (3) of the principal's minimization problem is continuous, Weierstrass' theorem implies the existence of a solution \mathbf{v}^* . As it is strictly convex, the solution is unique. We consider the case without limited liability, thus \mathbf{v}^* satisfies (6).

b) Since $e \neq \underline{e}$ there exists an agent i whose effort is not cost-minimizing. This agent cannot be paid a fixed wage, because he would then choose the cost-minimizing effort. Hence, there exist outcomes x_i and x'_i with $v_i^*(x_i) > v_i^*(x'_i)$. We assume independent outcomes, consequently Holmström's (1979) sufficient statistics result implies that each agent's wage conditions only on his own output. There must thus exist an outcome (x_i, x_j) such that $v_i^*(x_i) \neq v_j^*(x_j)$. By assumption there is full support, therefore (x_i, x_j) arises with the strictly positive probability $\pi_i(x_i|e_i) \pi_j(x_j|e_j)$ in equilibrium.

c) Since there is no limited liability, the optimal contract \mathbf{v}^* attains a global minimum. All other incentive feasible contracts cause the principal strictly higher costs. By Proposition 2 envy renders the optimal contract \mathbf{v}^* strictly more expensive as there arises wage inequality in equilibrium. Since all other contracts are rendered weakly more expensive, the envy costs are strictly positive. *Q.E.D.*

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