Incentives and Peer Effects in the Workplace:
On the Impact of Envy and Wage Transparency on
Organizational Design[*]

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Abstract

The article is concerned with understanding the impact of social preferences and wage transparency on the optimal organizational design of firms. We consider a moral-hazard environment with envious workers. The integration of workers in one organizational unit yields productive complementarities but also triggers income comparisons and envy. Separating workers rules out social comparison but also precludes productive synergies. Instead, the firm may impose a wage-secrecy policy to keep the latter while avoiding the former. We show that productive synergies and envy are strategic substitutes under unlimited liability when wages are transparent while they become strategic complements when workers earn rents. As a result, firms are much more likely to integrate workers when the latter are protected by limited liability. Furthermore, even when firms can impose wage secrecy, they prefer *not to* as long as workers are not too envious. In both cases, firms exploit the incentive effect of pay inequality to raise productive efforts and profits. For the same reason, firms may deliberately establish pay inequality by opting for individual performance pay rather than for group bonuses. In this sense, transparency and "sunshine laws" may not be in the self-interest of employees, even more so under a positive minimum wage.

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1   Introduction

"Envy is the great leveler: if it cannot level things up, it will level them down."

Dorothy Sayers (1949: 771)

It is well-established that people compare themselves to others. How such comparisons affect economic outcomes has been examined theoretically, experimentally and empirically, at both the macro- and the microeconomic levels. In the current paper, we study how the presence of social preferences affects firms' optimal organizational structures and furthermore, their attitude towards wage transparency. Using an agency model and focusing on *envy* as one of the most relevant manifestations of such preferences within firms (see Fehr and Schmidt (1999)), we specifically consider whether organizations prefer to integrate workers into teams or rather separate them into different units instead. It is in the context of the former case where the question of whether to make wages transparent also becomes relevant. Our results demonstrate that the two issues are interrelated and that the optimal choices concerning these organizational aspects depend specifically on whether or not firms can exploit envy to increase workers' effort and generate higher profits. We show that, when firms can extract workers' surplus, they may prefer social distancing even in the presence of productive synergies. In stark contrast, when workers earn informational rents, firms are likely to integrate them into teams and make wages deliberately transparent, thereby generating profitable peer effects arising from envy.

Our paper is motivated by three common characteristics of many workplace environments: the presence of social comparisons and envy, the prevalence of wage secrecy rules, and the existence of peer effects.[1] That social and income comparisons are ubiquitous in the organizational context is evidenced for example by Card et al. (2012), Cohn et al. (2014), Cullen and Perez-Truglia (2022), and Dube et al. (2019). Within this context, it is *envy* that has been found to be of particular importance (see, e.g. Vecchio (2000, 2005), Duffy et al. (2008), Sterling and Labianca (2015), and Duffy et al. (2021)). In this respect, the management literature lists both positive and negative consequences of envy for employees and organizations and suggests various organizational responses, affecting in particular the social and physical proximity of workers.[2] Addressing the negative consequences of envy, Obloj and Zenger (2017) note the importance of peer-proximity for the formation of reference groups. Invoking the idea of "out of sight, out of mind", they imply that spatial separation is likely to rule out social comparisons (p. 16). These authors observe that some big pharma firms choose to outsource research projects rather than integrate them in order to avoid demotivational internal comparisons to high-powered incentives that are common in small R&D startups (p. 16). As another method to manage envy in the workplace, Sterling and Labianca (2015) suggest, to "mix things up" (p. 303) by occasionally changing office space and team assignments in an attempt to avoid social comparisons and their manifestations. That envy plays a role also in the academic context is well known (Romero (2022)). Sometimes this becomes visible even in terms of organizational consequences. For example, in 1998, Stanford University decided to split its anthropology department into two units

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[1] We present a comprehensive overview of the related literature in Section 2.

[2] The two possible behavioral responses to envy are discussed, among others, by van de Ven et al. (2009) and Tai et al. (2012).

as a consequence of long-lasting internal strife. Clearly, the reason for the strife was multifaceted, yet as indicated by the Stanford Magazine, it had "much to do with personality conflicts, [..] and festering disappointments," which we take the liberty to interpret as one manifestation of social preferences and perhaps envy.[3]

The second relevant workplace feature, wage secrecy norms, has recently been the subject of extensive research and public debate. The *Glassdoor (2017)* Global Salary Transparency Survey, conducted in several advanced OECD countries, documents the prevalence of secrecy rules within companies. According to that survey, only about one third of employees say their company discloses salaries internally. Further evidence on the prominence of wage secrecy around the world is presented by Cullen and Perez-Truglia (2022). In fact, employment contracts frequently stipulate clauses on salary-related confidentiality. In the United States, "between 2017-2018, nearly half of full-time workers reported they were either discouraged or prohibited from discussing wages and salaries" (Sun et al. (2021)).[4] In the recent past, however, there is indication that some companies actively promote wage transparency out of their own volition.[5] The University of California too has made the compensation of all its employees public as of 2011.[6] Another example is the Whole Foods Market, Inc., which has implemented a complete transparency policy.[7] At the public level, public sector workers in many European countries and federal employees in the United States are paid according to publicly available salary schemes. Moreover, many countries have recently undertaken efforts to implement pay-equality and antidiscrimination laws, thereby indirectly enhancing transparency. Typically, firms are required to report data aggregated along gender and ethnic dimensions. In the United States, so-called "sunshine laws" explicitly prohibit pay-secrecy clauses, albeit only in less than half of the states. A further example is Germany which passed the Remuneration Transparency Act (2017), entitling employees to inquire about their peers' *average* pay. Sweden has a long tradition of maximum transparency, whereby *individual* tax records have been publicly accessible since 1766. Much more recently, Norway has implemented similar legislation in 2001.[8]

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[3]See the Stanford Magazine: *Divided They Stand* at `https://stanfordmag.org/contents/divided-they-stand` (January/February 2000). One of the co-authors of the current paper can attest to at least three similar incidents he has witnessed where departmental reorganization was clearly driven by interpersonal and envy-driven motives.

[4]Interestingly, the Glassdoor survey finds that, compared to men, women are more likely to work under a pay secrecy policy *and* to violate that policy. In addition, French or English workers tend to chat more easily about their salary than Germans.

[5]See e.g. `https://hbr.org/2016/03/why-keeping-salaries-a-secret-may-hurt-your-company`. Promoting wage transparency may either take the form of establishing the "right of workers to talk" or actively publishing salary information. In this respect, an interesting recent study finds that the former approach may not be successful since workers are still hesitant to discuss wages due to traditional norms stipulating a "salary taboo" (Cullen and Perez-Truglia (2018)).

[6]For the UC website listing workers' pay, see `https://transparentcalifornia.com/salaries/university-of-california`. Card et al. (2012) have exploited the introduction of wage transparency in the UC system in their analysis of worker satisfaction.

[7]The CEO of Whole Foods Market, Inc. is cited as saying: "I'm challenged [on salaries] all the time. How come you are paying this regional president this much, and I'm making this much?' I have to say, 'Because that person is more valuable. If you accomplish what this person has accomplished, I'll pay you that too.'" See `https://hbr.org/2016/03/why-keeping-salaries-a-secret-may-hurt-your-company`.

[8]For the European countries, see `https://kompetenz-online.at/2018/05/15/lohntransparenz-im-internationalen-vergleich/`. To identify the U.S. states, see the map on `https://www.dol.gov/agencies/wb/equal-pay-protections`. Further details may be found in Cullen and Pakzad-Hurson (2023), Footnote 12. See Perez-Truglia (2020) for a short discussion of transparency rules in

Finally, peer effects, constituting the third relevant workplace feature, arise when the presence of peers has an impact on worker behavior and productivity. A multitude of field experiments investigates the manifestation of peer effects in various productive environments such as supermarkets, agricultural firms, online labor markets, and the like. They indicate that peer effects tend to increase worker efforts and productivity. Related to the foregoing transparency discussion, these studies also indicate that the emergence of such peer effects depends on the informational environment, specifically the *observability* of peers' actions and wages. Accordingly, peer effects may even provide a kind of a "free lunch" for firms, enabling them to exploit the associated *social* incentives as an alternative to monetary rewards.

We suggest a model that incorporates all three workplace features within a unified analytical framework. The underlying force in our environment is *envy*. In particular, it is this social preference that drives the emergence of peer effects, the integration or separation decision, and the wage-transparency or -secrecy policy. Formally, we consider a stylized moral-hazard environment with two envious workers. Output is generated by the workers' non-contractible effort. When workers work jointly in an integrated unit, output is further enhanced through productive synergies. The employer chooses whether to integrate or separate workers, and in the former case, whether to impose a wage-secrecy rule or, on the contrary, make payments public. Workers are motivated by optimally designed individual bonus contracts. In determining the optimal organizational setup, wage-transparency policy, and contract design, we separately consider two scenarios in which ex-post wages are either constrained by a lower bound or not. The latter case constitutes unlimited worker liability, whereby the employer can extract all informational rents from workers by adjusting the fixed wage accordingly. In the more realistic scenario where workers are protected by limited liability (perhaps arising from wealth constraints, standard wages, minimum wages, etc.), the employer is forced to leave informational rents to the workers.

We find that, under unlimited liability where the employer can extract rents from workers, the presence of envy increases employment costs, thereby making productive synergies and envy *strategic substitutes*. Intuitively, ex ante workers form expectations about the *ex-post* occurrence of payoff inequity. To induce participation, the employer needs to compensate them by an *inequity (envy) premium* for the associated disutility stemming from the other-regarding nature of their preferences. In this sense, the workers' social preferences imply a negative peer effect that counteracts the productive synergies. As a result, if wages are transparent, integrated production will be chosen only if workers are not too envious and productive synergies are sufficiently pronounced. Imposing wage secrecy instead removes the cost associated with social comparisons, making worker integration the optimal choice. In stark contrast, under limited liability, productive synergies and envy become *strategic complements* as long as workers earn rents. Specifically, when working jointly under wage transparency, workers increase effort to reduce the likelihood of falling behind their co-worker's wage ex post, a consequence known as the *incentive effect of envy*. This increased effort is manifested as positive peer effects, providing the employer a "free lunch" in terms of higher productive output and reduced informational rents. However, when envy is intense, workers' envy premia become so large that rents vanish. It then becomes optimal to impose wage secrecy, if possible, or to separate the workers, if not,

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the Scandinavian countries and Iceland.

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also under limited liability. This also explains why employers may deliberately establish pay inequality by opting for individual performance pay rather than group bonuses.

On the normative side, we conclude that popular pressures for transparency and "sunshine laws" do not necessarily raise workers' welfare. In the absence of rents, enforcing transparency may induce firms to separate workers, thereby forgoing gains from positive production externalities and bearing efficiency losses. Alternatively, in the presence of rents, sunshine laws benefit those employers who failed to recognize the profitable incentive effect of wage transparency at the expense of workers. The latter then find themselves placed in settings which trigger social comparisons and envy.

By the foregoing findings, our paper contributes to the various strands of literature dealing with the different manifestations of the aforementioned workplace characteristics. First, we provide a unified formal theory that highlights how the presence of envy accounts for the emergence of peer effects. Second, the model features envy as a possible key consideration affecting firms' decisions on whether to integrate workers or separate them instead. Third, our model shows when and why firms tend to foster wage secrecy or encourage wage transparency. Fourth, our study emphasizes the interdependence of the foregoing organizational dimensions. Finally, beyond the observational ramifications, our theory exposes that the optimal organizational design and firms' attitude towards wage transparency may crucially depend on whether their contract design is constrained by a lower wage bound.

The remainder of the paper is structured as follows. In the following section, we present literature concerning the various aspects of the workplace environment and the model. Section 3 presents the theoretical environment. In Section 4, we consider, as a benchmark, the moral-hazard problem under unlimited liability. Specifically, we first analyze the workers' optimization problem and then derive the optimal incentive contracts under worker integration and separation. Thereafter, we characterize the optimal organizational architecture under wage transparency and thereafter analyze whether the latter feature is optimal. Section 5 turns to the more realistic moral-hazard problem when workers are protected by limited liability. In particular, we reconsider the optimal organizational architecture and discuss the striking differences compared to the unlimited-liability case. In Section 6, we present three extensions considering the effects of a positive minimum wage, imperfect wage secrecy, and the inclusion of joint performance pay. Then, in Section 7, we discuss some of the simplifying features of our model and consider broader manifestations of other-regarding preferences and how they feature envy. Finally, the last section concludes and presents some general, societal, and managerial implications.

2 Literature

2.1 Peer Effects in the Workplace

While peer effects span various behavioral aspects (see, e.g., Welteke (2015)), we focus here on field experiments related to productivity, which is the measure relevant to our study. In this context, a variety of different empirical studies are consistent with our model's theoretical predictions. For example, Mas and Moretti (2009) used productivity data on supermarket cashiers

at a supermarket chain. Their findings indicate the presence of positive peer effects, the extent of which depends on the frequency of interaction in the workplace and, in line with our approach, on *observability*, in their case of actions. Bandiera et al. (2010) identify workers' friends within a U.K. agricultural firm and combine this information with each worker's productivity. In line with our results, they conclude from the data that even in the absence of productivity externalities "firms can exploit social incentives as an alternative to monetary incentives" (p. 417). In the same vein, using German social-security data, Cornelissen et al. (2017) identified peer groups by workers' occupation and their employer. Distinguishing between jobs in which *mutual observation* and judgments are easy and those where such comparisons are more difficult, they found large peer effects on effort, particularly among workers in the former type of occupations. Cornelissen et al. (2017, p. 454) emphasize that it is peer pressure, rather than knowledge spillover, that provides an incentive for workers to increase their efforts. Horton and Zeckhauser (2018) conduct field experiments on Amazon's online labor market, Mechanical Turk (MTurk). By controlling the informational environment of workers, they could identify peer effects even among workers who did not physically interact. Most relevant for our theoretical environment is their finding that exposing workers to the output of their peers increases their own efforts. This finding led Horton and Zeckhauser (2018, pp. 25, 27) to conclude that "(i)n settings where effort and productivity are tightly coupled and workers can easily monitor each other, peer pressure would seem to provide a kind of free lunch for the firm."

2.2 Wage Transparency

Many studies investigate the impact of the informational environment, in particular income transparency, on workers' wellbeing and behavior (see, e.g., Perez-Truglia (2020)). While much of this literature is motivated by "fairness" concerns and the role of wage transparency in alleviating them (see, e.g., the discussion in Charness and Kuhn (2007)), many studies report that wage transparency has significant behavioral impact on affected individuals. In fact, there is increasing evidence that making workers aware of the wages of their peers has positive effects on effort. Bamberger and Belogolovsky (2010) found this effect in an experimental setting, using a computer matching game with bonuses paid for success. In that setting, pay secrecy was associated with decreased performance. Huet-Vaughn (2015) designed an experiment on MTurk to show that exposing workers to information about the earnings of others, who perform a similar task at the same piece rate, increased output of the informed group by about 10 percent. Gao et al. (2021) exploit the natural experiment provided by changes in legislation of several U.S. states, passing explicit laws prohibiting wage secrecy clauses (so-called pay-secrecy laws). Using a difference-in-difference approach on a large sample of firm-year observations, they were able to show that (p. 2) "(o)n average, firms headquartered in states that have adopted pay secrecy laws increase their number of patents by 17.7% and increase their number of patent citations by 17.5%, relative to firms headquartered in other states."[9] Focusing on settings with incentive pay, these findings are in line with the positive peer effects identified in our model.

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[9] Gao et al. (2021) ascribe the productivity effect of increased transparency to the removal of discriminatory behaviours towards women and ethnic minorities, helping raise the moral and motivation of scientists belonging to these population groups.

In a different setting where wages are fixed and independent of output, Cohn et al. (2014) find that peers exposed to disadvantageous income inequality tend to react by reducing effort. Cullen and Perez-Truglia (2022) also detect effort reductions resulting from horizontal disadvantageous pay differences. A similar effect is found in a field experiment by Breza et al. (2017) and also implicitly by Bennedsen et al. (2020) who exploit a natural experiment. Despite this seeming contradiction to our finding, whereby wage comparisons have positive effort effects, this behavior is nevertheless consistent with our preference specification albeit not with our agency model. Specifically, the foregoing studies investigate the effort effects of given fixed-wage discrepancies. In contrast to our model, they do *not* however consider incentive contracts, where worker effort affects final wage payments. The distinct behavioral outcomes are due to this basic difference. Whereas the only way to compensate for disadvantageous fixed-wage inequality is to reduce effort, in our scenario, workers can and will undertake effort to reduce the likelihood of envy to arise.

In a very different context, Cullen and Pakzad-Hurson (2023) analyze the effects of wage transparency in a dynamic general-equilibrium bargaining setting. In their empirical application, they find that disadvantageous income inequality eventually leads to increased employment cost (see also Cullen (2023)). At the partial-equilibrium level, our agency model also predicts increased employment cost, provided workers receive no rents.

2.3   Social Preferences in Agency Models

Our theoretical framework is embedded in the principal-agent literature investigating other-regarding preferences in the firm. Many of these papers study the effects of social preferences on the efficiency of different incentive schemes. Our study extends the scope of the analysis to the optimal organizational design and the firms' attitude towards wage transparency.

In line with our work, the agency literature frequently identifies an incentive-strengthening effect of envy, which reflects the workers' desire to lower the chances of earning less than their peers (see, e.g., Bartling (2011), Bartling and von Siemens (2010a), Demougin et al. (2006), Englmaier and Wambach (2010), Grund and Sliwka (2005), or Neilson and Stowe (2010)). Nevertheless, most of these papers highlight overall adverse effects of wage comparisons on total agency cost, thereby providing good reasons for existing sharing rules and secrecy norms.[10]

The foregoing literature typically disregards financial constraints, whereas we explicitly analyze the impact of liability limits. A few studies have already included such constraints in related settings. Closely related to our work, Demougin and Fluet (2003, unpublished) in a tournament setting and Demougin and Fluet (2006) have already recognized the profitable impact of envy in the presence of informational rents. The latter paper concludes that it is precisely this effect that makes joint performance pay often undesirable from the firm's point of view. In the current study, we consider this exact incentive effect of envy and show explicitly how firms can *actively* exploit it by means of organizational tools. In a somewhat different setting, Kräkel (2016) identifies a similar incentive effect when workers are concerned with relative performance rather than income. In his model, social preferences manifest themselves by direct positive or negative

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[10]In a perfect-information environment, Stark and Hyll (2011) identify a positive effect of envy for low-productivity workers.

performance-related externalities on utility, referred to as peer effects. He too finds that the presence of social preferences unambiguously benefits the principal if agents earn positive rents.

Some papers discuss the effects of envy on organizational and incentive design with risk averse workers. For example, Bartling (2012) assumes that social comparisons arise only under relative performance pay (interpreted as 'organizational integration') but not when contracts are independent (interpreted as 'organizational separation'). The optimal contract (interpreted as optimal organizational design) eventually hinges on the risk-reduction effects relative to the costly social comparison induced under relative performance pay.

Analyzing the boundaries of the firm, Bartling and von Siemens (2010b) investigate the countervailing effects of envy on the prevalence of incentive pay in an environment with risk-averse workers and (un)limited liability. Their findings are driven by the key conjecture that social comparisons are more relevant within the firm than in market transactions. Similarly, Nickerson and Zenger (2008) find that envy and social comparisons raise organizational cost, thereby motivating firms to move activities outside their boundaries.

Goel and Thakor (2005) analyze the effects of envy in the context of resource allocations within firms. In their setting, the cost arising due to envy between the division managers may prompt the firm to spin-off divisions. This finding is analogous to our result where worker separation becomes optimal when envy is sufficiently large and no rents are paid.

Another strand of agency literature finds positive effects of envy in dynamic (repeated) settings. For example, Kragl and Schmid (2009) and Kragl (2015, 2016) study the optimality of different incentive regimes in relational contracts and show that the incentive effect of envy may facilitate the employer's commitment ability (credibility) and thus raise profits in the long term. In a recent paper, Fahn and Zanarone (2022) study the benefits and costs of organizational transparency regarding pay and performance evaluations in relational contracts. Similar to Kragl and Schmid (2009), they emphasize the positive effect of transparency on accountability and credibility, yet they also identify the 'endogenous transparency cost' arising from (vertical) income comparisons. The latter may induce employers to leave rents to their employees or contractors, even in the absence of liability constraints.

3   The Model

Consider a single-period agency model with one employer and two identical workers, labeled $i = 1, 2$. All parties are risk-neutral. The production technology is given by

$$Y = e_1 + e_2 + \delta_I \cdot \gamma e_1 e_2, \tag{1}$$

where $e_i \in [0, \infty)$ represents the effort of worker i. As one aspect of the firm's *organizational design,* the parameter δ_I captures the firm's *organizational architecture.* Specifically, when the *setup indicator* $\delta_I = 1$ the employer assigns its workers jointly to a single productive unit. In this case, the *synergy factor* $\gamma \geq 0$ represents potential productive complementarities between workers. We refer to this case as *integration.* Alternatively, when $\delta_I = 0$, the employer assigns the workers to separate units of the firm, and no productive externalities arise (*separation*).

The workers' effort cost is given by an increasing and strictly convex function, $c(e_i)$, with

$c(0) = 0$, $c'(e_i) > 0$, and $c''(e_i) > 0$. Effort and total productive output Y are not verifiable. Nevertheless, the employer observes a verifiable effort-related signal $s_i \in \{0, 1\}$ for each worker. The probability of obtaining a "favorable" outcome $s_i = 1$ is given by

$$\Pr[s_i = 1 | e_i] = p(e_i), \tag{2}$$

where $p(e_i) \in [0, 1)$ with $p(0) = 0$, $p'(e_i) > 0$, $p''(e_i) \leq 0$, and $\lim_{e_i \to \infty} p(e_i) = 1$.

Worker i's utility may be affected by interpersonal income comparisons, whereby the realizations of the latter are affected by the employer's organizational design. In line with the evidence presented in the introduction (Obloj and Zenger (2017)), we assume that under separation ($\delta_I = 0$) workers are not aware of each other's compensation. Moreover, under integration ($\delta_I = 1$) the employer may tailor the informational environment with respect to wage comparisons. Specifically, we assume that the employer may choose to implement an organizational policy that imposes a *secrecy clause* or, on the contrary, make payments public. In particular, when such a clause is implemented the *policy indicator*, δ_S, takes the value of 1, and workers are prohibited from discussing and disclosing their income. For simplicity, we assume that the secrecy clause is fully enforceable at no cost.[11] When $\delta_S = 0$ no such clause is imposed and common knowledge prevails. We refer to the first case as wage *secrecy* and to the latter as wage *transparency*. Altogether, depending on the setup and policy indicators, worker i's utility is given by:

$$U_i(W_i, W_j, e_i | \delta_I, \delta_S) = W_i - c(e_i) - \delta_I \cdot (1 - \delta_S) \cdot \alpha \max\{W_j - W_i, 0\}, \quad i \neq j, \tag{3}$$

where W_i denotes the worker's ex-post wage payment, W_j is the corresponding wage of his/her peer, and $\alpha > 0$ represents the worker's sensitivity to disadvantageous inequality, i.e., their propensity for *envy*. Accordingly, provided that $\delta_I = 1$ and $\delta_S = 0$, the last term of the utility function reflects the disutility associated with the worker's knowledge that his/her wage is lower than that of the co-worker.[12] Clearly, social preferences are thus relevant only under integration and absent a secrecy clause. For simplicity, we set the workers' reservation utility to zero.

The employer's objective is to maximize expected profit. To align incentives the workers are offered incentive contracts, consisting of a fixed payment w and a bonus b paid if the favorable signal is detected, respectively. Altogether, the timeline of the model is as follows. First, the employer determines the two dimensions of the firm's *organizational design;* the employer selects the *organizational architecture* ($\delta_I = 0$ or $\delta_I = 1$) and, conditional on selecting $\delta_I = 1$, the *organizational policy,* $\delta_S = 1$ or $\delta_S = 0$. Next, the employer offers the workers a take-it-or-leave-it employment contract (w, b). Each worker then decides whether to accept the contract. If a worker rejects the contract, s/he receives the reservation utility of zero. If the worker accepts the contract, s/he exerts the effort e_i, thereby generating a non-verifiable output Y. Finally, the signal s_i is realized and the contractual compensations are paid.

In the following sections, we derive the optimal organizational design under two different

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[11] For further discussion, see Section 6.

[12] Notice that income comparisons involve gross-of-effort-cost wages. In our setup with homogenous workers this assumption turns out to be innocuous since we focus on symmetric equilibrium efforts and contracts, rendering gross and net-effort comparisons equivalent.

scenarios. In Section 4, we analyze environments where the employer can exact payments from workers (unlimited liability). Thereafter, we reconsider the optimal organizational design when workers are protected by limited-liability regulations in Section 5. For each setting, we analyze the workers' and the employer's problem, determine the respective profits, and then derive the optimal organizational design. For that purpose, we first assume that wages are common knowledge and determine the optimal organizational architecture. We then investigate if imposing wage secrecy is optimal to derive the optimal organizational policy.

4   The Moral-Hazard Problem

In the following, we first analyze the workers' optimization problem. Next, we derive the optimal incentive contracts under integration and separation. Then, we characterize the optimal organizational design without wage secrecy and finally turn to the case where wage secrecy can be imposed.

4.1   The Workers' Optimization Problem

Based on the specification in (3), (2), and the contract (w, b), worker i maximizes his/her expected utility, taking the effort choice of the other worker as given:

$$\max_{e_i} \ w + p(e_i)b - c(e_i) - \delta_I \cdot (1 - \delta_S) \cdot \alpha(1 - p(e_i))p(e_j)b, \quad i \neq j \tag{4}$$

Notice that under worker separation ($\delta_I = 0$) the problem degenerates to the well-known standard case. By contrast, under integration and absent a secrecy clause ($\delta_I = 1$ and $\delta_S = 0$), the last term in the utility captures the case where worker i does not obtain the bonus while being aware of the fact that co-worker j does obtain it.

The first-order condition becomes

$$p'(e_i)b - c'(e_i) + \delta_I \cdot (1 - \delta_S) \cdot \alpha p'(e_i)p(e_j)b = 0, \quad i \neq j, \tag{5}$$

which implicitly defines worker i's best response, $e_i^*(e_j)$, to worker j's effort choice. For $\delta_I = 1$ and $\delta_S = 0$ the condition shows the well-known *incentive effect of envy*, capturing the notion that the presence of envy increases a worker's effort as compared to that of purely selfish ones (see e.g. Grund and Sliwka (2005), Demougin and Fluet (2006), or Kragl and Schmid (2009)). Intuitively, workers raise effort to reduce the probability of not getting the bonus and thus suffering additional disutility due to disadvantageous pay inequality:

$$\frac{\partial e_i^*}{\partial \alpha} = - \frac{\delta_I \cdot (1 - \delta_S) \cdot p'(e_i^*)p(e_j)b}{p''(e_i^*)b(1 + \delta_I \cdot (1 - \delta_S) \cdot \alpha p(e_j)) - c''(e_i^*)} \quad \begin{matrix} > 0 & \text{if } \delta_I = 1 \text{ and } \delta_S = 0, \\ = 0 & \text{otherwise,} \end{matrix} \quad i \neq j, \tag{6}$$

where the inequality sign follows from the second-order condition in the denominator.

We focus on the symmetric Nash equilibrium in effort, $e(\delta_I, \delta_S)$, characterized by the simultaneous solution to the system of equations implied by (5) for the two workers.[13] To simplify

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[13]A sufficient condition for the existence of a Nash equilibrium is that the curvature of the effort costs is

notation, in the following, we denote the design-dependent Nash effort by e.

4.2 The Employer's Problem

Suppose the *organizational design* (δ_I, δ_S) is given. Accordingly, the employer's objective is

$$\max_{w,b,e} \quad 2e + \delta_I \cdot \gamma\,(e)^2 - 2(w + p(e)b)$$

$$s.t. \quad b = \frac{c'(e)}{p'(e)(1 + \delta_I \cdot (1 - \delta_S) \cdot \alpha p(e))}, \qquad (IC) \qquad \text{(I)}$$

$$\qquad w + p(e)b - c(e) - \delta_I \cdot (1 - \delta_S) \cdot \alpha(1 - p(e))p(e)b \geqslant 0, \quad (PC)$$

where the participation constraint (PC) ensures that workers accept the contract. The incentive-compatibility constraint (IC) guarantees that effort choices by the workers are utility-maximizing for them. We assume that the second-order conditions are satisfied throughout.[14]

Since there is no limit on w, condition (PC) is binding in the optimal contract:

$$w + p(e)b = c(e) + \delta_I \cdot (1 - \delta_S) \cdot \alpha(1 - p(e))p(e)b \qquad \text{(IP)}$$

Accordingly, the employer's expected wage cost per worker consists of the effort costs and of an *envy premium* when $\delta_I = 1$ and $\delta_S = 0$. The latter is necessary to induce participation, compensating the worker for the expected disutility arising from the prospect of pay inequality under integration and wage transparency. Substituting b from (IC) and w from (PC) in the objective function and simplifying yields:

$$\Pi^U (\delta_I, \delta_S; \alpha, \gamma) = \max_e \quad 2\left[e - c\,(e) + \delta_I \cdot \left[\frac{1}{2}\gamma e^2 - (1 - \delta_S) \cdot \frac{\alpha(1 - p(e))p(e)c'(e)}{p'(e)(1 + \alpha p(e))}\right]\right] \qquad \text{(7)}$$

First, observe that the profit is independent of both α and γ when $\delta_I = 0$. However, when $\delta_I = 1$ an increased synergy factor γ unambiguously raises the profit. In contrast, with $\delta_S = 0$ an increase in α has countervailing effects on the envy premium. On the one hand, ceteris paribus, a higher sensitivity to inequality lowers the bonus needed to induce given effort due to the incentive effect of envy (see Eq. (IC)). On the other hand, for a given bonus it raises the envy premium (see Eq. (IP)). As is well known from the related literature, absent productive complementarities, a higher envy reduces the optimal profit (Grund and Sliwka (2005), Demougin and Fluet (2006), Kragl and Schmid (2009), or Bartling and von Siemens (2010a)). This is true also in the presence of $\gamma > 0$. Proposition 1 below reconsiders this finding for our particular setting.

Proposition 1 *Let $\delta_I = 1$ and $\delta_S = 0$. For any $\gamma > 0$, the profit $\Pi^U (1, 0; \alpha, \gamma)$ is decreasing in α and increasing in γ.*

Proof. Both results are immediate implications of the envelope theorem. ∎

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increasing. Otherwise, existence may fail if α becomes too big.

[14]Note that the second-order conditions are satisfied in our parametric specification (see Footnote 16). In general, these conditions involve third-order derivates and are thus cumbersome.

According to the above result, ceteris paribus, employing envious workers under integration creates additional cost for the employer. Specifically, the agency cost associated with the workers' other-regarding preferences is then increasing in their envy. As a result, the profit-maximizing effort induced by the employer is decreasing in α, implying a lower optimal bonus.

4.3   The Optimal Organizational Design

In this section we analyze the firm's organizational design. We first focus on the optimal organizational architecture under wage transparency. Next, we consider the optimal organizational policy, showing that imposing wage secrecy strictly dominates worker separation under unlimited liability, thereby making integration the optimal architecture throughout.

4.3.1   Wage Transparency

In this subsection we determine the optimal organizational architecture when no secrecy clause is imposed ($\delta_S = 0$). For that purpose, we compare the resulting optimal profits $\Pi^U (1, 0; \alpha, \gamma)$ to that of separate production, $\Pi^U (0, \cdot; \cdot, \cdot)$, leading to the following result.

Corollary 1 (Optimal Organizational Setup under Unlimited Liability) *Consider $\delta_S = 0$. Let $\alpha^U (\gamma) : \Pi^U (0, \cdot; \cdot, \cdot) = \Pi^U (1, 0; \alpha^U, \gamma)$ be finite. Then (i) for $0 \leq \alpha < \alpha^U (\gamma)$, setting $\delta_I = 1$ is optimal, for $\alpha > \alpha^U (\gamma)$, $\delta_I = 0$ becomes optimal, while, at $\alpha = \alpha^U (\gamma)$, the employer is indifferent between $\delta_I = 0$ and $\delta_I = 1$. (ii) $\alpha^U (\cdot)$ is increasing in γ with $\alpha^U (0) = 0$. (iii) If no finite $\alpha^U (\gamma)$ exists, then $\delta_I = 1$ is optimal for any α.*

Proof.   The proof follows immediately from Proposition 1 and the fact that $\Pi^U (0, \cdot; \cdot, \cdot)$ is independent of both α and γ. ∎

The foregoing corollary defines the level of envy, $\alpha^U (\gamma)$, for which the profit functions under the two architectural setups intersect.[15] First, consider the case when **productive synergies are absent** ($\gamma = 0$). Then, by Corollary 1(i), $\alpha^U (0) = 0$. Accordingly, when workers are purely selfish, the organizational architecture is inconsequential, whereas worker separation ($\delta_I = 0$) *always* dominates integration for envious workers. In contrast, in the **presence of productive synergies** Corollary 1(i) states that, given γ, the employer chooses integration ($\delta_I = 1$) as long as envy is not too large ($\alpha < \alpha^U (\gamma)$) and separation ($\delta_I = 0$) otherwise. Moreover, by Corollary 1(ii), as γ increases, the integration becomes optimal for a larger set of inferiority-aversion parameters.

The results of Corollary 1 are illustrated in Figure 1.[16] In this and all subsequent figures the dashed (dark blue) lines represent profits under worker separation ($\delta_I = 0$), where income

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[15] Note that, in our numerical example (see Footnote 16), $\alpha^U (\gamma)$ may not be finite. Intuitively, in that case, the productive synergy overwhelms the negative impact of envy even when $\alpha \to \infty$. Specifically, in that example applying L'Hospital's rule to the first-order condition associated with the employer's problem in (7) implies that for the optimal effort $e^* (\alpha, \gamma)$, $\lim_{\alpha \to \infty} e^* (\alpha, \gamma) = \frac{\gamma - 1}{\gamma}$. Using this result, it can be shown that, for sufficiently large values of γ, $\Pi^U (1, 0, \infty, \gamma) > \Pi^U (0, \cdot, \cdot, \cdot)$ so that no intersection exists.

[16] For all illustrations we use the parametric specifications $c(e) = \ln(1 - e) + e$ and $p(e) = e$. The cost function guarantees that $e \in [0, 1)$, i.e. $p(e) \in [0, 1)$.
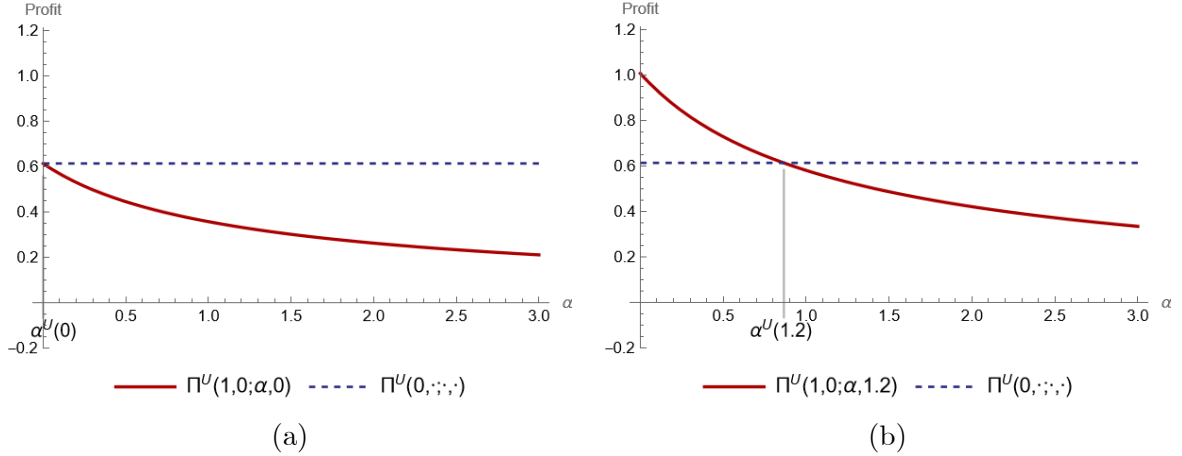
Figure 1: Optimal Organizational Setup under Unlimited Liability (a) without and (b) with Productive Synergies

comparison and productive synergy play no role. The downward-sloping solid (red) curves depict profits under integration ($\delta_I = 1$). Panel (a) shows the case where **productive synergies are not present**. Then, under joint production, with $\delta_S = 0$ the presence of envy motivates the employer to implement lower effort in order to reduce possible wage differentials and the associated envy-related compensation. These adverse consequences can be avoided by means of worker separation. In contrast, **productive complementarities** *per se* motivate the employer to induce higher effort. The combined effects of synergy and increased effort shift profits under integration upwards while profits under worker separation remain unaffected, as shown in panel (b) for $\gamma = 1.2$. Still, envy forces the employer to bear the envy-premium costs. Accordingly, as long as the intensity of envy is not too high, integration becomes superior to worker separation. Beyond that critical point ($\alpha^U(1.2) = 0.87$), separation dominates as the combined effort and synergy effect is no longer sufficient to overcome the agency cost even though the induced effort is still higher than it is under separation. It is in this sense that the synergy factor γ and the workers' propensity for envy α are *strategic substitutes* with regard to the optimal organizational design.

4.3.2 Wage Secrecy

In this subsection we reconsider the optimal organizational architecture when the employer can also choose the organizational policy. The result is formally summarized by the following corollary.

Corollary 2 (Optimal Organizational Policy under Unlimited Liability) *(i) For $\gamma = 0$, setting $\delta_I = 1$ and $\delta_S = 1$ is equivalent to setting $\delta_I = 0$. (ii) For $\gamma > 0$ and $\alpha > 0$, setting $\delta_I = 1$ and $\delta_S = 1$ strictly dominates setting $\delta_I = 1$ and $\delta_S = 0$ as well as setting $\delta_I = 0$. (iii) For $\gamma > 0$ and $\alpha = 0$, setting $\delta_I = 1$ and $\delta_S = 1$ is equivalent to setting $\delta_I = 1$ and $\delta_S = 0$.*

Proof. Given the results of Corollary 1, only $\gamma > 0$ needs to be considered. From equation (7) it is obvious that $\Pi^U(1, 1; \cdot, \gamma) \geq \Pi^U(1, 0; \cdot, \gamma)$, with strict inequality for $\alpha > 0$. ∎
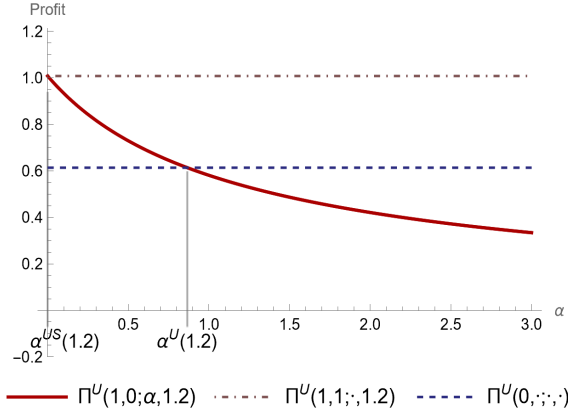
Figure 2: Optimal Organizational Design under Unlimited Liability

The Corollary implies that choosing to integrate workers ($\delta_I = 1$) and imposing a secrecy clause ($\delta_S = 1$) becomes (weakly) dominant for any level of envy. Absent social comparisons, integration dominates because it sustains productive complementarities. In the presence of social comparisons wage secrecy then becomes the optimal organizational policy as it rules out any adverse effect of envy.

The result is illustrated for $\gamma = 1.2$ in Figure 2. The red curve depicting profits under integration and wage transparency, $\Pi^U(1, 0; \alpha, 1.2)$, and the dashed (dark blue) one representing profits under worker separation, $\Pi^U(0, \cdot; \cdot, \cdot)$, are both identical to those shown in panel (b) of Figure 1. With wage secrecy the profit under integration and productive synergy ($\gamma = 1.2$) is depicted by the dot-dashed (grey-brownish) horizontal line. As the secrecy clause neutralizes the effect of envy it originates at $\Pi^U(1, 0; 0, 1.2)$ which is, of course, larger than $\Pi^U(0, \cdot; \cdot, \cdot)$.

Altogether, the above may rationalize empirical observations regarding the tendency of employers to impose wage secrecy despite the questionable legality thereof. In the next section, we reconsider the firm's optimal organizational design under worker limited liability and verify that the dominance of the wage policy is no longer universally true.

5 The Moral-Hazard Problem under Limited Liability

In this section we analyze the employer's optimal organizational architecture under the constraint that workers are protected by limited liability, i.e. there exists a lower bound to ex-post wage payments in any state of the world. For simplicity and in line with most of the agency literature we set this lower bound to zero. As it will turn out, this restriction has far-reaching consequences for the optimal incentive contracts and the resulting organizational design. Specifically, we highlight the essential effects on the (non)optimality of worker separation and wage secrecy.

5.1 The Employer's Problem

The workers' choice of effort for a given contract (w, b) is unaffected by the introduction of limited liability. Accordingly, their optimal effort e is characterized by the same symmetric Nash-equilibrium described in Subsection 4.1.

Analogous to our discussion above we start the analysis of the employer's problem by assuming that the organizational architecture (δ_I, δ_S) is given:

$$\max_{w,b,e} \quad 2e + \delta_I \cdot \gamma(e)^2 - 2(w + p(e)b)$$

$$\text{s.t.} \quad b = \frac{c'(e)}{(1 + \delta_I \cdot (1 - \delta_S) \cdot \alpha p(e))p'(e)}, \qquad (IC)$$

$$\qquad w + p(e)b - c(e) - \delta_I \cdot (1 - \delta_S) \cdot \alpha(1 - p(e))p(e)b \geqslant 0, \qquad (PC)$$

$$\qquad w \geqslant 0, \qquad (NNC_1)$$

$$\qquad w + b \geqslant 0, \qquad (NNC_2)$$

$$(II)$$

where (NNC_1) and (NNC_2) ensure that a worker earns a non-negative wage for all possible realizations of his/her signal. Condition (IC) implies that $b \geq 0$, and hence (NNC_2) can be disregarded.

From (IC), (PC) and (NNC_1) and simplifying, the fixed wage satisfies

$$w = \max\left\{c(e) - \delta_I \cdot (1 - \delta_S) \cdot \alpha(1 - p(e))p(e)\frac{c'(e)}{(1 + \alpha p(e))p'(e)}, 0\right\}. \qquad (8)$$

This implies that either (PC) or (NNC_1) or both must be binding. Note that workers earn a rent when (PC) does not bind. Under separation, (NNC_1) always binds and rents are positive at any effort $e > 0$. Under integration, this also holds for selfish workers but once workers become sufficiently envious, (PC) starts binding. Intuitively, as the workers' propensity for envy increases, at given effort, also the envy premium increases and eventually exhausts the rent.

Substituting w from Eq. (8) into (II), the problem becomes:

$$\Pi^L(\delta_I, \delta_S; \alpha, \gamma) = \max_e \left[2e + \delta_I \cdot \gamma(e)^2 \right.$$
$$\left. -2 \cdot \max\left\{c(e) + \delta_I \cdot (1 - \delta_S) \cdot \frac{\alpha(1 - p(e)))p(e)c'(e)}{(1 + \alpha p(e))p'(e)}, \frac{p(e)c'(e)}{(1 + \delta_I \cdot (1 - \delta_S) \cdot \alpha p(e))p'(e)}\right\}\right] \qquad (9)$$

Remark 1 *Consider $\delta_I = 1$ and $\delta_S = 0$. Let $\alpha_L^c(\gamma)$ denote the level of envy at which (NNC_1) and (PC) are just binding and $\alpha_U^c(\gamma)$ denote the level of envy where $w = 0$ when (NNC_1) is not imposed. Then $\alpha_L^c(\gamma) < \alpha_U^c(\gamma)$ for any $\gamma \geq 0$ and for $\alpha \in [\alpha_L^c(\gamma), \alpha_U^c(\gamma)]$ the optimal bonus, wage and effort are jointly determined by (IC), (NNC_1) and (PC) as binding constraints.*

The existence of this interim region follows from the fact that, as long as $\alpha < \alpha_L^c(\gamma)$, the constraint (NNC_1) binds while (PC) does not bind. In this case the profit-maximizing effort is determined by the respective first-order condition associated with (9), whereby the employer is forced to pay rents and to reduce effort relative to the case without worker protection. Moreover, absent worker protection the fixed wage would be strictly negative in that region. This is still true at $\alpha_L^c(\gamma)$, where (NNC_1) still binds and (PC) just becomes binding. Accordingly, when envy rises further to the point $\alpha_U^c(\gamma)$, (NNC_1) just stops binding and w is optimally set to 0. Inside the interval $[\alpha_L^c(\gamma), \alpha_U^c(\gamma)]$, bonus, wage, and effort are hence determined solely by the constraints (IC), (PC), (NNC_1), and (NNC_2). Beyond $\alpha_U^c(\gamma)$, optimal effort is again derived

from the employer's first-order condition (9), and the associated fixed wage and bonus are derived from (IC) and (PC) of (II), respectively.

Proposition 2 *Let $\delta_I = 1$ and $\delta_S = 0$. (i) For any $0 \leq \gamma$, then, as long as $\alpha < \alpha_L^c(\gamma)$, $\Pi^L(1,0;\alpha,\gamma)$ is increasing in α, and once $\alpha > \alpha_U^c(\gamma)$, $\Pi^L(1,0;\alpha,\gamma)$ is decreasing in α.*

Proof. (i) Consider the following (partial) decomposition of (9):

$$\Pi_L^L(1,0;\alpha,\gamma) = \max_e \ 2e + \gamma(e)^2 - 2\left[\frac{p(e)c'(e)}{(1+\delta \cdot \alpha p(e))p'(e)}\right], \ \alpha < \alpha_L^c(\gamma)$$

$$\Pi_U^L(1,0;\alpha,\gamma) = \max_e \ 2e + \gamma(e)^2 - 2\left[c(e) + \frac{\alpha(1-p(e))p(e)c'(e)}{(1+\alpha p(e))p'(e)}\right], \ \alpha > \alpha_U^c(\gamma)$$

Since (PC) is not binding in the region $\alpha < \alpha_L^c(\gamma)$, the optimal effort is determined by the first-order condition associated with the maximand and the envelope theorem can be applied, yielding the result. In the region $\alpha > \alpha_U^c(\gamma)$ the function $\Pi_U^L(1,0;\alpha,\gamma)$ coincides with $\Pi^U(1,0;\alpha,\gamma)$ in (7) and is decreasing in α. ∎

The above result shows that - in strict contrast to the case of unlimited liability - under wage transparency employing envious workers in a joint-production setting may be advantageous for the employer. More specifically, as long as (NNC_1) is binding and workers earn rents, the employer exploits the above-mentioned incentive effect of envy to elicit higher productive efforts. Intuitively, inducing effort becomes cheaper because, given any bonus, both workers increase effort in an attempt to avoid being inferior to their peer. As long as rents are positive, this does not lead to an adjustment of the fixed wage. Consequently, as α increases the employer finds it optimal to raise the bonus and induce an even higher effort. This implies that - again in strict contrast to the case with unlimited liability - the parameters γ and α become *strategic complements,* as long as workers earn rents. At some point however, when workers become sufficiently envious $(\alpha = \alpha_L^c(\gamma))$, rents vanish due to the large envy premium. With a further increase in envy $(\alpha > \alpha_U^c(\gamma))$ the limited-liability restriction becomes ineffective and the employer's profit coincides with that under unlimited liability, where no constraint on the fixed wage was present in the first place.

5.2 The Optimal Organizational Design

To determine the optimal organizational architecture we proceed analogously to the case of unlimited liability. That is, we first analyze the optimal organizational setup in the common-knowledge case and then determine the optimal organizational policy. As it turns out, unlike in the foregoing section, wage secrecy is no longer a strictly dominant policy if workers are protected by limited liability. Notably, in that case the employer may choose to refrain from imposing a secrecy policy to profitably exploit the peer effect.

5.2.1 Wage Transparency

The next Corollary 3 characterizes the optimal organizational architecture for this case, depending on the workers' propensity for envy and the synergy factor.

Corollary 3 (Optimal Organizational Setup under Limited Liability) *Consider* $\delta_S = 0$. *Let* $\alpha^L(\gamma) : \Pi^L(0, \cdot; \cdot, \cdot) = \Pi^L\left(1, 0; \alpha^U, \gamma\right)$ *be finite. Then (i)* $\alpha_U^c(\gamma) < \alpha^L(\gamma)$. *(ii) For* $\alpha < \alpha^L(\gamma)$, $\delta_I = 1$ *while, for* $\alpha^L(\gamma) < \alpha$, $\delta_I = 0$, *and at* $\alpha = \alpha^L(\gamma)$ *the employer is indifferent between* $\delta_I = 0$ *and* $\delta_I = 1$. *(iii)* $\alpha^U(\gamma) < \alpha^L(\gamma)$. *(iv)* $\alpha^L(\cdot)$ *is increasing in* γ *with* $\alpha^L(0) > 0$. *(v) If* $\alpha^L(\gamma)$ *fails to exist, then* $\delta_I = 1$ *is optimal for any* α.

Proof. (i) is an immediate implication of part (i) of Proposition 2. (ii) is analogous to part (i) of Corollary (1), since for $\alpha > \alpha_U^c(\gamma)$ the function $\Pi_U^L(1, 0; \alpha, \gamma)$ coincides with $\Pi^U(1, 0; \alpha, \gamma)$ in (7). (iii) follows from the fact that $\Pi^L(0, \cdot; \cdot, \cdot) < \Pi^U(0, \cdot; \cdot, \cdot)$. The proofs for (iv)-(v) are analogous to the respective ones in Corollary (1). ∎

By Corollary 3, the profit functions under the two organizational setups intersect at the critical level $\alpha^L(\gamma)$ of envy when workers are protected by limited liability. According to part (i) of the corollary, integration *always* dominates worker separation when workers earn rents but even beyond that point. The main point of Corollary 3(iii) is that, for any synergy factor, the employer chooses integration for a *larger range* of α when workers are protected by limited liability as compared to scenarios with unlimited liability. This implies that the optimal organizational architecture critically depends on whether workers are protected by limited liability or not.

First, consider the case when there are **no productive synergies**. Recall that, by Corollary 1(ii), integration is never optimal under unlimited liability. In fact, by 3(iv), when liability is limited the employer finds it optimal to implement integration also when workers are envious. Intuitively, whereas under unlimited liability social comparison is always harmful, in this case joint allocation of workers becomes beneficial. Effort and profitability are increased through the exploitation of work incentives triggered by the workers' envy. Moreover, in line with the unlimited-liability case, **with productive synergies**, employers find it optimal to induce higher effort and the range of α-values for which integration is chosen is raised even further. Altogether, under limited liability, the employer is likely to deliberately implement integration because this not only allows for productive complementarities but also provokes income comparisons across workers, which in turn strengthen work incentives and raises profit.

Figure 3 illustrates the foregoing results. In both panels the profit under worker separation shown by the dashed (blue) line has shifted downwards by exactly the amount of the workers' rents as compared to the case of unlimited liability shown in Figure 1.[17] In line with Proposition 2 profits under integration, shown in solid (red), have kinks at $\alpha_L^c(\gamma)$ and $\alpha_U^c(\gamma)$ (not marked).[18] Thereafter, the curves coincide exactly with those of Figure 1. Again, panel (a) shows the case where there are **no productive synergies**. Notably, in contrast to Figure 1, profits under integration exceed those under worker separation for sufficiently low intensities of envy ($\alpha < \alpha^L(0) = 2.87$). In fact, for the range $\left(\alpha_U^c(0), \alpha^L(0)\right)$ integration remains optimal under limited liability even though profits already decrease in envy. Here, even without the synergy

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[17]Notice that, for the sake of clarity, we adjusted the scale of the y-axis in the figure.

[18]The interim regions are given by $[\alpha_L^c(0), \alpha_U^c(0)] = [0.71, 0.74]$ and $[\alpha_L^c(1.2), \alpha_U^c(1.2)] = [0.82, 0.91]$, respectively. While effort is increasing in α within the interim regions, profits initially continue to increase before they start to decrese once the envy-related costs become dominant.
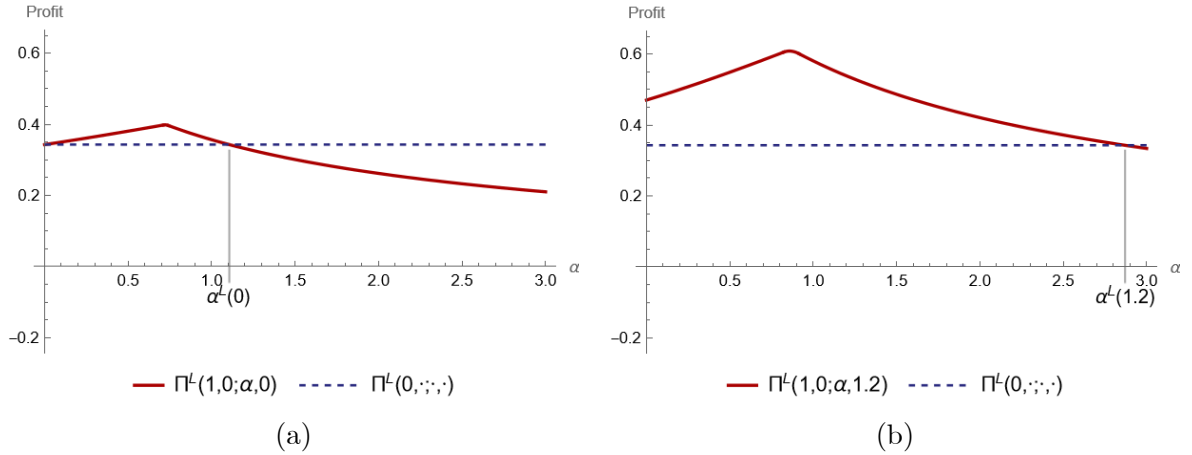
Figure 3: Optimal Organizational Setup under Limited Liability (a) without and (b) with Productive Synergies

effect, at $\alpha^L(0)$ effort under integration is higher than it is under worker separation but profits are eroded by the agency costs. Accordingly, when workers become sufficiently envious $\left(\alpha > \alpha^L(0)\right)$ worker separation dominates also under limited liability. **With productive synergies**, profit under integration shifts upwards due the presence of productive synergy and the higher induced effort (panel (b)). As a result, $\alpha_L^c(\gamma)$, $\alpha_U^c(\gamma)$ and with them the curve's kinks shift to the right. Moreover, the intersection of the profit curves under the alternative organizational setups, $\alpha^L(\gamma)$, shifts to the right as well, so that integration is optimal for higher intensities of envy. A comparison with the case of unlimited liability in Figure 1 shows that the presence of limited liability in fact increases the range of α-values for which the employer chooses integration. In particular, as a consequence of the strictly lower profits under separation, the range of γ-values for which integration is preferred for any degree of envy is larger than that under unlimited liability (and may potentially become even negative).

5.2.2 Wage Secrecy

In this section we again reconsider the optimal organizational architecture under limited liability, and moreover determine the optimal organizational policy. Specifically, we analyze under what circumstances imposing a wage-secrecy clause is optimal. The result is summarized by Corollary 4 as follows:

Corollary 4 (Optimal Organizational Policy under Limited Liability) *Let $\alpha^{LS}(\gamma) \in \left\{\alpha : \Pi^L(1,0;\alpha,\gamma) = \Pi^L(1,1;\cdot,\gamma)\right\} \cap \left\{\alpha \in \mathcal{R}_+\right\}$. Then (i) $\alpha^{LS}(\gamma) < \alpha^L(\gamma)$. (ii) For $\alpha < \alpha^{LS}(\gamma)$, setting $\delta_I = 1$ and $\delta_S = 0$ is optimal, for $\alpha > \alpha^{LS}(\gamma)$, setting $\delta_I = 1$ and $\delta_S = 1$ becomes optimal, and, at $\alpha = \alpha^{LS}(\gamma)$, $\delta_I = 1$ is optimal while the employer is indifferent between $\delta_S = 0$ and $\delta_S = 1$. (iii) $\alpha^{LS}(\gamma)$ is increasing in γ.*

The proof of Corollary 4 is analogous to that of Corollary 3 and is thus omitted.

Absent productive complementarities, the result coincides with panel (a) of Figure 3. It is only once complementarities arise that wage secrecy becomes relevant as it neutralizes the im-
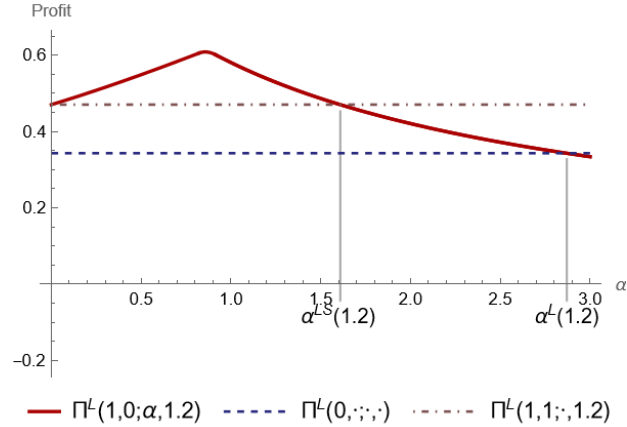
Figure 4: Optimal Organizational Design under Limited Liability

pact of the workers' social preferences under integration. The profit generated by the imposition of secrecy, $\Pi^L(1,1;\cdot,\gamma)$, is represented for $\gamma = 1.2$ by the dot-dashed (grey-brownish) horizontal line in Figure 4. Accordingly, integration dominates worker separation, shown by the dashed (blue) line. However, unlike the case where workers are not protected by liability limits, wage secrecy is *not* always dominant. In particular, as discussed above, with limited liability, envy induces high effort as long as workers receive a rent and even beyond. Clearly, absent envy ($\alpha = 0$), the employer's optimal profit under secrecy, $\Pi^L(1,1;0,\gamma)$, is identical to that under integration without secrecy, $\Pi^L(1,0;0,\gamma)$. Notably, as α increases, wage transparency is more profitable than secrecy. Intuitively, in that case the employer uses transparency to deliberately exploit social comparisons and raise profits. However, once the propensity for envy becomes sufficiently high ($\alpha > \alpha^{LS}(\gamma)$), the envy-premium costs associated with social comparison outweigh the incentive effects on worker motivation, thereby rendering the imposition of wage secrecy the optimal option (in the figure, $\alpha^{LS}(1.2) = 1.61$). Notice that both profits, $\Pi^L(1,0;\alpha,\gamma)$ and $\Pi^L(1,1;\cdot,\gamma)$, shift upwards as γ increases. As a result, in this setting, $\alpha^{LS}(\gamma)$ is always finite so that, even for very high values of γ, at some point wage secrecy becomes the preferred policy.

6 Extensions

In the basic model we assumed that wage secrecy is fully enforceable. Moreover, we focused on individual-bonus schemes. Both of these assumptions may be suspected to be restrictive, yet, as we will show in the following two subsections, the gist of our results continues to hold when extending the model in these two directions. Naturally, the extended versions of the model provide some additional insights.

6.1 Minimum Wage

In our main analysis, for simplicity we assumed that - when existing - the lower bound for the workers' wage is set at 0. In this subsection, we present the effects of a strictly positive lower bound as often prevalent under minimum wages or collectively agreed standard wages. Figure

5(a) replicates Figure 4, where a zero lower bound $\hat{w} = 0$ is imposed. In the figure below, we have adjusted the horizontal scale in order to allow for a comparison to the case with a positive minimum wage $\hat{w} > 0$, shown in Figure 5(b).

The effects are manifold. Firstly, naturally all profit curves shift down because the firm is forced to pay out higher fixed wages under all organizational designs. Secondly, the range of workers' envy for which integration is dominant under wage transparency has increased dramatically. Thirdly, if secrecy cannot be implemented, worker separation becomes optimal for larger values of α. And finally, if secrecy is implementable, the range of propensities for envy for which the employer chooses to impose this policy is smaller than it is in the absence of a positive minimum wage.

The results emerge from the fact that an increased lower bound on the fixed wage creates rents where none existed before. To mitigate the negative impact of these costs on profits, the employer continues to further exploit the forces unleashed by the existence of envy by inducing higher efforts. Technically speaking, the propensity for envy for which the lower-bound constraint becomes slack, $\alpha_L^c(\gamma)$, is increasing under a positive minimum wage. Furthermore, the value of envy at which the wage under unlimited liability starts to exceed the increased lower bound, $\alpha_U^c(\gamma)$, also increases.[19]
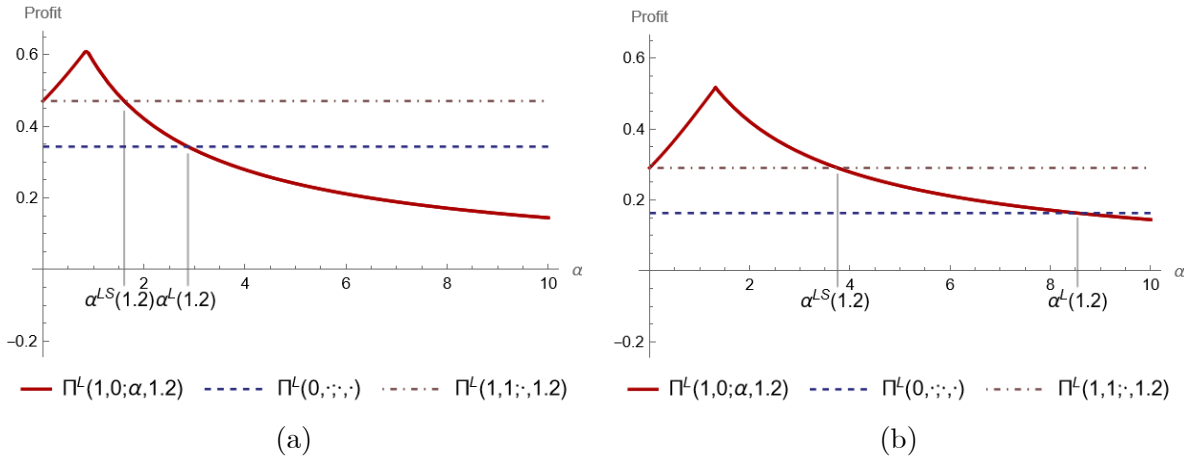

(a)   (b)

Figure 5: Optimal Organizational Design with (a) Non-Negative Wages and (b) a Positive Minimum Wage

Altogether, the introduction of a positive minimum wage is a double-edged sword. On the one hand, it raises worker welfare by transferring part of the surplus from the employer to the workers via the higher fixed wages. On the other hand, the new emergence of rents causes the employer to react by eliciting higher efforts under integration. As discussed above, the employer achieves this by exploiting the incentive effect of envy under wage transparency. Quite obviously, this stands in conflict with the general policy goals related to transparency. Notably, this conflict

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[19]Specifying a 0.09 minimum wage, the interim regions are now given by $[\alpha_L^c(0), \alpha_U^c(0)] = [1.44, 2.40]$ and $[\alpha_L^c(1.2), \alpha_U^c(1.2)] = [1.31, 1.32]$, respectively. For both values of γ, these are strictly larger than those with a zero lower bound (see Footnote 18). In general, once the lower bound on the fixed wage becomes sufficiently large, the unlimited liability case is no longer relevant and the interim region is empty. As long as profits remain positive, for $\alpha > \alpha_L^c(\gamma)$ effort is set at a level that jointly satisfies the lower bound on the fixed wage, the incentive contraint, and the participation contraint.

is even more prominent under a positive minimum wage since the employer can then utilize the effort-enhancing effect of income comparison for an even larger range of workers' envy.

6.2 Imperfect Wage Secrecy

In the above analysis we have assumed that wage secrecy is fully enforceable. However, in practice, this may not be always true. Specifically, workers cannot be hindered from revealing (at least some) information about their wage to (at least some of their) colleagues. Moreover, as stated in the introduction, imposing a wage-secrecy policy may in fact be illegal. To take this into account we below discuss the interim scenario arising under integration when wages are imperfectly transparent or secret.

We allow for wage-secrecy imperfection (under integration) by adjusting the range of the policy indicator, to be $\delta_S \in [0, 1]$, reflecting the *extent to which secrecy is enforceable.* Specifically, a value of δ_S in the interior of the interval indicates that secrecy can be maintained only with probability δ_S. Notice that this is observationally equivalent to assuming that secrecy can be enforced with probability 1, but α has decreased to $\widehat{\alpha} = (1 - \delta_S) \cdot \alpha$. Figure 6 depicts the situation for $\gamma = 1.2$ and $\delta_S = 0.5$. The dash-dotted (purple) curve $\Pi^L(1, 0.5; \alpha, \gamma)$ displays the profit function under a partially implementable secrecy policy. For the sake of clarity, we have also included the critical values, now denoted by $\alpha(\gamma, \delta_S)$, separating the range where it is optimal not to impose (even imperfect) secrecy and the range for which (im)perfect secrecy becomes the optimal option As is obvious from the above-mentioned observational equivalence, for any $\delta_S < 1$, $\alpha^{LS}(\gamma, \delta_S) < \alpha^{LS}(\gamma, 1)$ (for the above parameters, $\alpha^{LS}(1.2, 0.5) = 1.10$ whereas $\alpha^{LS}(1.2, 1) = 1.61$). That is, somewhat surprisingly, as it becomes harder to enforce secrecy, the employer is inclined to impose it for ever lower propensities of envy. Consequently, as secrecy becomes more enforceable, i.e. δ_S rises, the dash-dotted (purple) profit curve is stretched to the right, thereby becoming flatter. In the limit when $\delta_S \to 1$, it converges to the perfect-secrecy case, shown for reference, by the dash-dotted (grey-brownish) horizontal line.

Notice that the above sounds paradoxical at first as it implies that firms may have an interest to *imperfectly* enforce secrecy even when they could perfectly enforce it. Intuitively, analogous to the $\delta_S = 1$-case, the partial success of the secrecy policy allows the employer to benefit from the incentive effect of envy (to a weaker extent) as long as workers are paid rents. Accordingly, for $\delta_S < 1$, profits are rising with α even beyond the point $\alpha^{LS}(\gamma, \delta_S)$. As a matter of fact, the range of α-values for which the employer profits from social comparison is consequently even larger under imperfect wage secrecy as compared to perfect secrecy. More precisely, imposing wage secrecy - if imperfect - becomes optimal already for smaller propensities for envy than it does under perfect secrecy. Eventually, rents are exhausted by the inequality premia also under imperfect secrecy, however at a higher level of envy, and profits start decreasing. This has two obvious consequences. First, when envy becomes very intense profits obtained under partial secrecy fall below those that would have emerged under perfect secrecy. Second and more important, in contrast to the latter case where worker separation was always dominated, separating workers (dashed (blue) line) becomes again the optimal organizational architecture if α is sufficiently high (not shown in the figure).
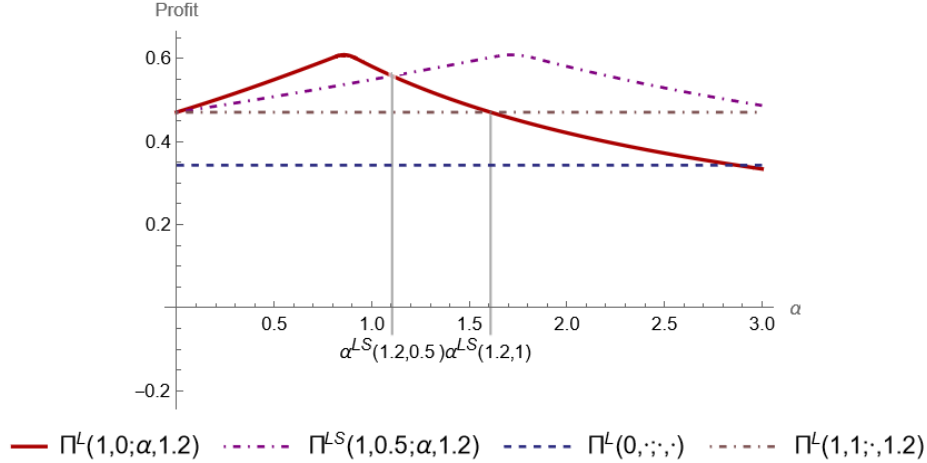
Figure 6: Optimal Organizational Design with Limited Liability and Imperfect Wage Secrecy

6.3 Group-Bonus Scheme

The above analysis ignores the possibility of joint performance pay under integration. As an extreme case thereof, consider a group-bonus scheme whereby the employer pays both workers the same reward provided that a bonus is paid in the first place. In principle, the bonus may be contingent on whether only one of the workers' signals was positive or both signals were positive. Regardless of that contingency, such a group-bonus scheme clearly avoids the issue of envy.

Accordingly, under unlimited liability the employer's problem is equivalent to the individual-bonus case in the presence of wage secrecy (see Section 4.3.2 above). As is briefly shown in the Appendix, in that case the employer induces the first-best effort level and, consequently, the profit is identical to $\Pi^U(1, 1; \cdot, \gamma)$. Hence, when $\gamma > 0$, integration strictly dominates worker separation that would yield $\Pi^U(0, \cdot; \cdot, \cdot)$. Notice that the bonus structure in this case is indeterminate. Altogether, the employer's organizational-design problem is the same as that shown in Figure 2 where the dot-dashed (grey-brownish) horizontal line would, in this case, represent the group-bonus scheme.

Analogously, we show in the Appendix that the result is also equivalent to that obtained with an individual-bonus scheme under a wage-secrecy policy (see Section 5.2.2) when workers are protected by limited liability, so that profits are given by $\Pi^L(1, 1; \cdot, \gamma)$. Somewhat surprisingly, this happens because the optimal group-bonus contract stipulates a bonus to be paid only if *both* workers emit a positive signal. Intuitively, the foregoing contract clearly mitigates the free-riding problem relative to one that stipulates a group bonus even if only one of the workers is successful. However, at the same time the mutual dependency of the workers implies a lower probability of obtaining the group bonus as compared to earning the individual bonus. These proportionate changes lead to the same expected bonus and thus wage costs under both the individual scheme with wage secrecy and the group bonus scheme. As a result, the employer's organizational-design problem under limited liability with a group-bonus scheme under integration is equivalent to that shown in Figure 4 with the dot-dashed (grey-brownish) horizontal line representing the profit under a group scheme. Note that with this extension our study provides an additional rationale for the empirically observed prevalence of team-based production by highlighting the

possible role of social preferences in the firm's organizational-design problem (see Che and Yoo (2001) for the prevalence of team production).

7   Discussion

In this section, we first make a few remarks concerning some of the simplifying features of our model. Thereafter, we consider broader manifestations of other-regarding preferences, specifically discussing whether they embed envy and to what extent they are consistent with the aforementioned evidence on the role of that emotion in the workplace.

7.1   Perceptions of Pay Inequality

In the main body of the paper, we presumed that wage secrecy and organizational separation are informationally equivalent. This equivalence is grounded in the assumption that, under integration and perfect secrecy, workers are *ignorant* of their co-workers' pay while, under separation, workers are *not even aware* of each other. However, one may argue that, under integration, workers might incur disutility due to a *potential* income inequality even when wages are secret. If workers were to correctly anticipate the outcomes then wage transparency and secrecy would be observationally equivalent. Importantly, such equivalence hinges upon the presumption that workers incur disutility from pay inequality regardless of whether they *actually* (ex post) observe the outcome or just *anticipate* it. However, there is abundant evidence regarding the striking utility effects of actually observing peer-related pay information (for example, Card et al. (2012), Perez-Truglia (2020)). Our simplifying assumption that only ex-post *observed* wage differences matter reflects precisely this evidence, thereby allowing us to capture the relevance of the informational environment regarding wage-transparency policies.

Another possibility is that workers do form anticipations about their peers' possible pay but have consistent biases concerning either the probability of a disadvantageous wage differential or its size. The effect of a downward bias in either is similar to that of imperfect secrecy and thereby observationally equivalent to reduced envy. Accordingly, our results in Subsection 6.2, as illustrated in Figure 6, would carry over to such environments, thereby broadening the scope of the positive effects of social preferences on firm profits.

Due to our focus on the firm's architectural and contractual design, we disregard potential social comparisons across firms. However, in some cases wage transparency transcends not only firm boundaries but also national borders. Notice that such published information does not lead to other-regarding effort incentives in the sense of our model. In particular, this informational diffusion is exogenous to organizations and workers other than those belonging to its originator (e.g., the UC system) and bears no resemblance to our setting (see Bental and Kragl (2021) for an analysis of the role of social comparison within a societal framework).

Finally, our paper concerns horizontal income comparisons arising between workers rather than vertical comparisons between workers and their boss. Moreover, we focus solely on ex-ante identical workers who may experience ex-post income differences. Beyond providing analytical clarity, this setting is likely to apply to lateral comparison situations. This is not to say that ex-post income differences resulting from ex-ante distinctions do not affect envious workers.

However, the extent to which such ex-ante differences, e.g., in ability, productivity levels, or life circumstances, affect utility where other-regarding preferences are concerned, goes beyond the scope of this paper (see our companion paper, Bental and Kragl (2023), for an analysis of the role of envy in the face of worker heterogeneity).

7.2 Envy in Other Types of Social Preferences

This paper is motivated by observations attesting to the fact that envy is a key emotion affecting relationships among co-workers. Many experimental settings, though, show that people may behave benevolently towards one another. Prominent examples are ultimatum and dictator games in allocational situations where individuals often tend to display empathy to co-players and preferences towards equality. Significant effort has been devoted to rationalize such behavior patterns by various formal preference specifications. Following the literature review of Cooper and Kagel (2016), we briefly discuss the relevance and possible implications of some of the leading specifications to our environment.

In general, many of the specifications focus on equality concerns and typically assume that people are *inequality averse*, i.e., are both envious as well as empathetic. Accordingly, such individuals suffer whenever allocations deviate from an equitable split in *either direction.* In our setting, it is envy alone that drives the results due to two particular effects it has on the employer's profits. First, when workers earn no rent, envy induces inequality-premium costs. This effect would be enhanced if workers displayed also empathy towards one another. Second, in the presence of rents, envy implies an incentive effect that benefits the employer. Provided empathy is not too pronounced, its presence would diminish the latter effect but not annul it. In fact, the evidence cited in the introduction highlights that envy is the dominant feature in the workplace.

We may also consider broader manifestations of other-regarding preferences. For example, our results would extend to the case of *competitive* workers. Such workers still dislike downward deviations from the equitable payoff distribution, yet derive utility from upward deviations. Provided that also in this case disadvantageous inequality has a greater utility effect, such preferences would still yield positive, though smaller, inequality-premium costs when no rents are paid. Otherwise, these cost would even vanish. On the other hand, the profitable incentive effect is enhanced by competitive preferences, regardless of whether upward or downward deviations matter more to the person.

In light of these observations, in discussing further alternative specifications of other-regarding preferences, our focus is on those specifications that may be relevant to our economic environment and research question. In particular, we discuss whether they admit envy among workers and whether this is a dominant factor. We disregard reciprocity and intentions, which are also considered by many preference specifications, since there is no direct give-and-take relationship between the workers in our setting.

We begin with Rabin (1993) which exemplifies an early attempt to formulate social preferences accounting for *fairness, altruistic behavior, and reciprocity.* In Rabin's formulation (p. 1287) individuals consider the "kindness" of co-players towards them in the context of allocational choices. In particular, an individual's utility depends on the perceived deviation of the

other person's notional allocation from an equal split. Utility is reduced if that person is deemed to be "unkind" (allocating to himself more than the equitable amount). A favorable deviation, on the other hand, is utility-enhancing. The utility's negative reaction to the perception of "unkind" behavior is akin to the presence of envy. The positive impact of "kind" behavior would be similar to the aforementioned competitiveness that we do not explicitly consider in our model.[20]

Levine (1998) rationalizes experimental outcomes of ultimatum and the final round of centipede games. The preference specification (p. 597) allows persons to be *"altruistic"* or *"spiteful"* towards co-players, whereby the utility also depends on whether the other players in turn are altruistic or spiteful towards them. A spiteful (altruistic) person's utility is negatively (positively) affected by the utility of the other parties. Accordingly, we may think of a spiteful person as being envious (at the margin) and of an altruistic person as being empathetic. In this sense, our paper considers only spiteful workers. In line with the reasoning concerning inequality aversion above, were workers to be purely altruistic (empathetic), the inequality premium would still exist but the incentive effect would be reversed.

Bolton and Ockenfels (2000) consider *equity, reciprocity and competition* (*ERC*) in the context of social preferences to rationalize in particular behavior observed in ultimatum and dictator games. In their specification (p. 171), people are sensitive to their share relative to the equal share of the total pecuniary payout, whereby any deviation from that share induces disutility. In their specific example (p. 173), that part of the preference specification is quadratic, implying symmetry between upward and downward deviations of the same absolute magnitude from the equal share. Applying this specification to our environment would imply that envy and empathy are equally weighted, enhancing the inequality premium but annulling the incentive effect. However, as argued above, evidence suggests that in the context of the workplace, where allocational considerations are not present, it is envy that typically dominates.

Charness and Rabin (2002) as well as Engelmann and Strobel (2004) introduce *efficiency concerns* into social preferences. In particular, the formers' social preference specification (p. 852) incorporates a trade-off between the concern for the worst-off member of the relevant group (maximin), and the total payoffs (efficiency) of the group. While the maximin concern is akin to empathy, envy is in fact completely ruled out by that specification. The efficiency consideration would translate in our setup into a concern for the workers' total wages. However, as worker i has no direct effect on worker j's wage, adding this element to the social preferences would not affect our results. Engelmann and Strobel (2004) test the *ERC*-model by Bolton and Ockenfels (2000) against inequality aversion as suggested by Fehr and Schmidt (1999). While the former find that the Fehr-Schmidt theory performs better in many cases, they ascribe this to the concern for the minimal payoff in the group (i.e., empathy). In what they call "envy games", the efficiency consideration seems to dominate. It is noteworthy, however, that, in their respective responses to Engelmann and Strobel (2004), Bolton and Ockenfels (2006) and Fehr et al. (2006) comment that the willingness to pay for efficiency is substantially lower than it is for equity. Again, in our workplace setting, it is envy that is prominent while efficiency and allocational concerns are not relevant.

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[20]Rabin's model has been extended by Dufwenberg and Kirchsteiger (2004) to a dynamic repeated game setting where it becomes crucial how beliefs on others' future intention-based reciprocity are updated.

Finally, the focus of Andreoni and Miller (2002) is on *altruistic behavior*. The paper shows that axioms of revealed preferences can be applied to rationalize such behavior. In fact, the authors estimate a CES utility function which depends on own payoff and that of the other person. Depending on the elasticity of substitution between the two arguments and the cost associated with transferring resources to the other person, the model is consistent with altruistic sharing but also with perfectly selfish behavior. Notably, Andreoni and Miller (2002) found that a significant minority of subjects behave "jealously", whereby these subjects intentionally erode the value of the transferred resources to reduce disadvantageous inequality.

8 Conclusion

With this study, we contribute to literature concerning the presence of envy, the role of wage transparency, and the importance of peer effects in the workplace. We provide a formal theory that integrates these aspects into a unified analytical framework. Taking envy to be the driving force, we investigate its impact on firms' optimal organizational design and their attitude towards wage transparency within a moral-hazard framework.

Our analysis shows that transparency may prove to be a double-edged sword. In fact, it may eventually turn against the employees and benefit the employer instead, and even more so under a positive minimum wage. Specifically, our results of Section 4.3 may rationalize observations regarding the tendency of employers to impose wage secrecy, despite its questionable legality. This occurs because pay inequality raises agency costs when workers are not protected by limited liability. By contrast, in Section 4.3, we show that the popular pressure for transparency ("sunshine laws") may not be necessarily in the self-interest of employees. In fact, the main concern of sunshine laws is to reduce pay inequality and discrimination as well as enforce government accountability. Yet they also generate social comparisons and thus affect organizational design. In our setting, when workers earn rents, transparency triggers pay comparisons and generates envy, thereby raising workers' intrinsic work incentives and efforts. It is the latter that are manifested as positive peer effects and provide a "free lunch" to firms. On the other hand, when workers do not earn rents, forced transparency and the associated envy-related agency costs generate negative peer effects and may induce employers to separate workers even at the expense of productive synergies.

Regarding the organizational consequences, we find that, under unlimited worker liability, agency costs generated by wage comparisons turn out to be of primary concern. To avoid these costs, firms may choose to forgo productive synergies and separate workers into independent productive units. In contrast, worker integration becomes often optimal when workers are protected by limited liability and may thus earn rents. By deliberately placing workers jointly in one productive unit, firms trigger pay comparisons and provoke envy to raise profits. Notably, with wage transparency, integration remains optimal even when rents are dissipated unless envy becomes sufficiently intense, thereby making the costs resulting from social comparisons dominant.

In extensions, we show that, following the same rationale, firms may opt for individual performance pay rather than group bonuses when workers earn rents. However, as just noted,

when workers are highly sensitive to inequality, firms abandon wage transparency and impose secrecy in integrated settings. Interestingly, when wage secrecy is *not* fully enforceable, firms turn out to be more tolerant regarding worker envy and, accordingly, prefer worker integration over separation for higher intensities of social preferences. We also discuss the impact of a minimum wage, showing that integration becomes then more likely because the limited-liability scenario is more likely to apply. Our results are thus in line with the prominent evidence on the presence of positive peer effects amongst workers at the lower end of the wage scale.

Finally, our model may be used to evaluate popular "new-work" environments and the recently widespread use of remote work. There is evidence that working from home reduces interpersonal contacts among coworkers. In the sense of our discussion, this may or may not lower productive synergies, yet it is likely to reduce the extent of social comparisons. However, it seems that after a drastic increase of firms' use of remote work during the Covid-19 pandemic, employers now strive to get workers physically back to the workplace. This "natural experiment" may provide some insights into the interrelationships of synergies, social comparisons, peer effects, effort, and output.

Appendix

A.1 Group-Bonus Scheme

Consider a bonus scheme whereby both workers obtain a bonus B_1 if one of them emits the signal $s = 1$ and a bonus B_2 if both do. Taking the effort choice of worker j, e_j, as given, worker i's participation constraint becomes:

$$w + [p(e_i)(1 - p(e_j)) + p(e_j)(1 - p(e_i))] B_1 + p(e_i) p(e_j) B_2 - c(e_i) \geq 0 \qquad \text{(A.PC)}$$

The associated incentive constraint is:

$$p'(e_i)(1 - 2p(e_j)) B_1 + p'(e_i)p(e_j) B_2 - c'(e_i) = 0 \qquad \text{(A.IC)}$$

Absent any constraints on the payment scheme, the employer sets $e_1 = e_2$ and solves:

$$\Pi^{UGB} = \max_{e,b,B} \left\{ 2e + \gamma e^2 - 2p(e)(1 - p(e)) B_1 - 2p^2(e)B_2 \right\}$$

$$\text{s.t.}$$

$$\text{(A.PC)} \qquad \qquad \text{(A.I)}$$

$$\text{(A.IC)}$$

With condition (A.PC) binding, the employer chooses to induce the first-best effort level, e^{**}, and any pair of (B_1, B_2) that satisfies (A.IC) at e^{**} is consistent with this choice.

Suppose now that workers are protected by limited liability. Focusing again on the symmetric case, the employer faces the following problem:

$$\Pi^{LGB} = \max_{e,b,B} \left\{ 2e + \gamma e^2 - 2p(e)(1 - p(e)) B_1 - 2p^2(e)B_2 \right\}$$

$$\text{s.t.}$$

$$\text{(A.PC)} \qquad \qquad \text{(A.II)}$$

$$\text{(A.IC)}$$

$$w, B_1, B_2 \geq 0$$

Taking into account that at the optimum under limited liability the employer is forced to set $w^* = 0$ and that condition (A.PC) is not binding, the problem (A.II) turns into:

$$\Pi^{GB} = \max_{e,b,B} \left\{ \begin{array}{l} 2e + \gamma e^2 - 2p(e)(1 - p(e)) B_1 - 2p^2(e)B_2 \\ + \lambda \left[p'(e)(1 - 2p(e)) b + p'(e)p(e) B_2 - c'(e) \right] \\ + \mu_{B_1} B_1 + \mu_{B_2} B_2 \end{array} \right\}, \qquad (10)$$

where λ, μ_{B_1} and μ_{B_2} are non-negative multipliers associated with (A.IC) and the non-negativity constraints on B_1 and B_2. Focusing on the latter, we obtain:

$$-2p(e)(1 - p(e)) + \lambda p'(e)(1 - 2p(e)) + \mu_{B_1} = 0$$

$$\text{(A.mult)}$$

$$-2p^2(e) + \lambda p'(e)p(e) + \mu_{B_2} = 0$$

We will next rule out the case where both B_1 and B_2 are strictly positive as well as the case that $B_1 > 0$ and $B_2 = 0$.

Suppose that both bonus payments are strictly positive. In that case, $\mu_{b_1} = \mu_{B_2} = 0$, by the second row of (A.mult) implying $\lambda = \dfrac{p\left(e\right)}{p'\left(e\right)}$. Substituting this in the first row leads to $-p(e) = 0$, a contradiction for $e > 0$.

Suppose next that $B_1 > 0$ but $B_2 = 0$. In this case, $\mu_{B_1} = 0$, implying $\lambda = 2\dfrac{p(e)\left(1 - p\left(e\right)\right)}{p'(e)\left(1 - 2p(e)\right)}$. From the second row of (A.mult) we then obtain $2\dfrac{p^3(e)}{1 - 2p(e)} + \mu_{B_2} = 0$. Since, for $B_1 > 0$, constraint (A.IC) implies that $1 - 2p(e) > 0$, this contradicts the requirement that $\mu_{B_2} > 0$.

As a result, the only remaining case is $B_1 = 0$ and $B_2 > 0$. From (A.IC) we obtain:

$$B_2 = \frac{c'\left(e\right)}{p\left(e\right)p'\left(e\right)} \tag{A.B}$$

Finally, the problem (A.I) becomes:

$$\Pi^{GB} = \max_{e,B}\left\{2e + \gamma e^2 - 2p(e)\frac{c'\left(e\right)}{p'\left(e\right)}\right\} \tag{A.III}$$

Comparing this problem to problem (II) shows that the employer induces exactly the same effort as under perfect wage secrecy and obtains the same profit. Notice that there the individual bonus is adjusted to accommodate the fact that it is paid less often.

References

Andreoni, J. and J. Miller (2002). Giving according to garp: An experimental test of the consistency of preferences for altruism. *Econometrica 70*(2), 737–753.

Bamberger, P. and E. Belogolovsky (2010). The impact of pay secrecy on individual task performance. *Personnel Psychology 63*(4), 965–996.

Bandiera, O., I. Barankay, and I. Rasul (2010). Social incentives in the workplace. *Review of Economic Studies 77*(2), 417–458.

Bartling, B. (2011). Relative performance or team evaluation? Optimal contracts for other-regarding agents. *Journal of Economic Behavior & Organization 79*(3), 183–193.

Bartling, B. (2012). Endogenous social comparisons and the internal organization of firms. *Managerial and Decision Economics 33*(1), 11–17.

Bartling, B. and F. A. von Siemens (2010a). Equal sharing rules in partnerships. *Journal of Institutional and Theoretical Economics (JITE)/Zeitschrift für die gesamte Staatswissenschaft 166*(2), 299–320.

Bartling, B. and F. A. von Siemens (2010b). The intensity of incentives in firms and markets: Moral hazard with envious agents. *Labour Economics 17*(3), 598–607.

Bennedsen, M., E. Simintzi, M. Tsoutsoura, and D. Wolfenzon (2020). Do firms respond to gender pay gap transparency? NBER Working Paper No. 25435, National Bureau of Economic Research, Inc (NBER).

Bental, B. and J. Kragl (2021). Inequality and incentives with societal other-regarding preferences. *Journal of Economic Behavior & Organization 188*, 1298–1324.

Bental, B. and J. Kragl (2023). Equal-wage policies and incentive contracts in firms: The role of envy in the face of worker heterogeneity. Working paper. Available at SSRN: https://ssrn.com/abstract=4469660.

Bolton, G. E. and A. Ockenfels (2000). ERC: A theory of equity, reciprocity, and competition. *American Economic Review 90*(1), 166–193.

Bolton, G. E. and A. Ockenfels (2006). Inequality aversion, efficiency, and maximin preferences in simple distribution experiments: Comment. *American Economic Review 96*(5), 1906–1911.

Breza, E., S. Kaur, and Y. Shamdasani (2017). The morale effects of pay inequality. *The Quarterly Journal of Economics 133*(2), 611–663.

Card, D., A. Mas, E. Moretti, and E. Saez (2012). Inequality at work: The effect of peer salaries on job satisfaction. *American Economic Review 102*(6), 2981–3003.

Charness, G. and P. J. Kuhn (2007). Does pay inequality affect worker effort? Experimental evidence. *Journal of Labor Economics 25*(4), 693–723.

Charness, G. and M. Rabin (2002). Understanding social preferences with simple tests. *The Quarterly Journal of Economics 117*(3), 817–869.

Che, Y.-K. and S.-W. Yoo (2001). Optimal incentives for teams. *American Economic Review 91*(3), 525–541.

Cohn, A., E. Fehr, B. Herrmann, and F. Schneider (2014). Social comparison in the workplace: Evidence from a field experiment. *Journal of the European Economic Association 12*, 877–898.

Cooper, D. J. and J. H. Kagel (2016). Other-regarding preferences: A selective survey of experimental results. In A. E. Roth and J. H. Kagel (Eds.), *The Handbook of Experimental Economics*, Volume 2, pp. 217–289. Princeton: Princeton University Press.

Cornelissen, T., C. Dustmann, and U. Schönberg (2017). Peer effects in the workplace. *American Economic Review 107*(2), 425–456.

Cullen, Z. (2023). Is pay transparency good? NBER Working Paper No. 31060, National Bureau of Economic Research, Inc (NBER).

Cullen, Z. and B. Pakzad-Hurson (2023). Equilibrium effects of pay transparency. *Econometrica 91*(3), 765–802.

Cullen, Z. and R. Perez-Truglia (2018). The salary taboo: Privacy norms and the diffusion of information. NBER Working Paper No. 25145, National Bureau of Economic Research, Inc (NBER).

Cullen, Z. and R. Perez-Truglia (2022). How much does your boss make? The effects of salary comparisons. *Journal of Political Economy 130*(3), 766–822.

Demougin, D. and C. Fluet (2003). Inequity aversion in tournaments. Working Paper 03-22, CIRPÉE.

Demougin, D. and C. Fluet (2006). Group vs. individual performance pay when workers are envious. In D. Demougin and C. Schade (Eds.), *Contributions to Entrepreneurship and Economics - First Haniel-Kreis Meeting on Entrepreneurial Research*, pp. 39–47. Berlin: Duncker & Humblot.

Demougin, D., C. Fluet, and C. Helm (2006). Output and wages with inequality averse agents. *Canadian Journal of Economics 39*(2), 399–413.

Dube, A., L. Giuliano, and J. Leonard (2019). Fairness and frictions: The impact of unequal raises on quit behavior. *American Economic Review 109*(2), 620–63.

Duffy, M. K., K. Lee, and E. A. Adair (2021). Workplace envy. *Annual Review of Organizational Psychology and Organizational Behavior 8*, 19–44.

Duffy, M. K., J. D. Shaw, and J. M. Schaubroeck (2008). Envy in organizational life. *Envy: Theory and research 2*, 167–189.

Dufwenberg, M. and G. Kirchsteiger (2004). A theory of sequential reciprocity. *Games and Economic Behavior 47*(2), 268–298.

Engelmann, D. and M. Strobel (2004). Inequality aversion, efficiency, and maximin preferences in simple distribution experiments. *American Economic Review 94*(4), 857–869.

Englmaier, F. and A. Wambach (2010). Optimal incentive contracts under inequity aversion. *Games and Economic Behavior 69*(2), 312–328.

Fahn, M. and G. Zanarone (2022). Transparency in relational contracts. *Strategic Management Journal 43*(5), 1046–1071.

Fehr, E., M. Naef, and K. M. Schmidt (2006). Inequality aversion, efficiency, and maximin preferences in simple distribution experiments: Comment. *American Economic Review 96*(5), 1912–1917.

Fehr, E. and K. M. Schmidt (1999). A theory of fairness, competition and cooperation. *Quarterly Journal of Economics 114*(3), 817–868.

Gao, H., P.-H. Hsu, and J. Zhang (2021). Pay secrecy laws, salary discrimination, and innovation productivity. Working Paper.

Glassdoor (2017). Global Salary Transparency Survey: Employee Perceptions of Talking Pay. Survey report, Glassdoor Company. Available at https://media.glassdoor.com/pr/press/pdf/GD_Survey_GlobalSalaryTransparency-FINAL.pdf.

Goel, A. M. and A. V. Thakor (2005). Green with envy: Implications for corporate investment distortions. *The Journal of Business 78*(6), 2255–2288.

Grund, C. and D. Sliwka (2005). Envy and compassion in tournaments. *Journal of Economics & Management Strategy 14*(1), 187–207.

Horton, J. J. and R. J. Zeckhauser (2018). Wielding peer effects in online production: Evidence from a series of field experiments. Working Paper.

Huet-Vaughn, E. (2015). Do social comparisons motivate workers? A field experiment on relative earnings, labor supply and the inhibitory effect of pay inequality. Working Paper.

Kragl, J. (2015). Group versus individual performance pay in relational employment contracts when workers are envious. *Journal of Economics & Management Strategy 24*(1), 131–150.

Kragl, J. (2016). Relational bonus contracts versus rank-order tournaments with envious workers. *Journal of Institutional and Theoretical Economics 172*(3), 417.

Kragl, J. and J. Schmid (2009). The impact of envy on relational employment contracts. *Journal of Economic Behavior & Organization 72*(2), 766–779.

Kräkel, M. (2016). Peer effects and incentives. *Games and Economic Behavior 97*, 120–127.

Levine, D. (1998). Modeling altruism and spitefulness in experiment. *Review of Economic Dynamics 1*(3), 593–622.

Mas, A. and E. Moretti (2009). Peers at work. *American Economic Review 99*(1), 112–45.

Neilson, W. S. and J. Stowe (2010). Piece-rate contracts for other-regarding workers. *Economic Inquiry 48*(3), 575–586.

Nickerson, J. A. and T. R. Zenger (2008). Envy, comparison costs, and the economic theory of the firm. *Strategic Management Journal 29*(13), 1429–1449.

Obloj, T. and T. Zenger (2017). Organization design, proximity, and productivity responses to upward social comparison. *Organization Science 28*(1), 1–18.

Perez-Truglia, R. (2020, April). The effects of income transparency on well-being: Evidence from a natural experiment. *American Economic Review 110*(4), 1019–54.

Rabin, M. (1993). Incorporating fairness into game theory and economics. *American Economic Review 83*(5), 1281–1302.

Romero, F. (2022). On the epistemic effects of envy in academia. In S. Protasi (Ed.), *The Moral Psychology of Envy*, pp. 61–76. Rowman & Littlefield.

Sayers, D. (1949). *The other six deadly sins*. New York: Harcourt, Brace and Company.

Stark, O. and W. Hyll (2011). On the economic architecture of the workplace: Repercussions of social comparisons among heterogeneous workers. *Journal of Labor Economics 29*(2), 349–375.

Sterling, C. M. and G. J. Labianca (2015). Costly comparisons: Managing envy in the workplace. *Organizational Dynamics 44*(4), 296–305.

Sun, S., J. Rosenfeld, and P. Denice (2021). On the books, off the record: Examining the effectiveness of pay secrecy laws in the U.S. Policy Brief IWPR #C494, Institute for Women's Policy Research. Available at http://www.jstor.org/stable/resrep34508.

Tai, K., J. Narayanan, and D. J. McAllister (2012). Envy as pain: Rethinking the nature of envy and its implications for employees and organizations. *Academy of Management Review 37*(1), 107–129.

van de Ven, N., M. Zeelenberg, and R. Pieters (2009). Leveling up and down: The experiences of benign and malicious envy. *Emotion 9*(3), 419.

Vecchio, R. P. (2000). Negative emotion in the workplace: Employee jealousy and envy. *International Journal of Stress Management 7*(3), 161–179.

Vecchio, R. P. (2005). Explorations in employee envy: Feeling envious and feeling envied. *Cognition & Emotion 19*(1), 69–81.

Welteke, C. (2015). Peers at work – A brief overview of the literature on peer effects at the workplace and the policy implications. DIW Roundup: Politik im Fokus, Deutsches Institut für Wirtschaftsforschung DIW.