Incentives and Peer Effects in the Workplace: On the Impact of Inferiority Aversion on Organizational Design*

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Abstract

The article is concerned with understanding the impact of social preferences on the optimal organizational design of firms. We consider a moral-hazard environment with inferiority averse workers. The integration of workers in one organizational unit yields productive complementarities but also triggers income comparisons and pay inequality. 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, when wages are common knowledge, productive synergies and inferiority aversion are strategic substitutes under unlimited liability 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. What is more, even when firms can impose wage secrecy, they prefer *not to* as long as workers are not too inferiority averse. 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 group bonuses. Accordingly, popular pressures for transparency and "sunshine laws" may not be in the self-interest of employees.

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"*A natural question for managers is whether they should encourage peers to influence each other [...]. In 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.*"

Horton and Zeckhauser (2018)

1 Introduction

That people compare themselves to others is a well established fact. How such comparisons affect economic outcomes has been examined theoretically, experimentally and empirically, both at the macro- and microeconomic levels.[1] In the current paper we focus on the latter and examine how the presence of mutual income comparisons may affect the choice of organizational architecture. Focusing on *inferiority aversion* as the manifestation of other-regarding preferences,[2] we consider whether workers should be separated or integrated and, in the latter case, whether wages should rather be transparent or secret. Using an agency model, we show that, when firms can extract workers' surplus, they may prefer social distancing even in the presence of productive interactions. In stark contrast, when workers are protected by limited liability clauses, firms are likely to exploit the peer effects created by inferiority aversion. Specifically, they find it optimal to integrate workers and moreover promote wage transparency in order to increase workers' effort and generate higher profits.

In fact, we find that organizations differ along the aforementioned dimensions of organizational design. With respect to their architecture, some organizations implement rather integrated structures while others prefer more separated settings. For example, in the Stanford Graduate School of Business all faculty members are organized within a single unit while the Wharton School's professors are assigned to ten disciplinary departments (Aithal and Aithal (2018)). Similar differences are found in the business context. ABB Asea Brown Boveri Ltd. adopted a very complex organizational form with 1,300 operating companies and some 5,000 profit centers (Roberts (2007)) whereas Nokia is highly integrated.[3] Similarly, Facebook and Google are characterized by flat, cross-functional and rather team-based organizational (matrix) structures. In stark contrast, at Apple, multiple research units, assigned to the same area, work independently. In line with these organizational features, some companies like Google and Facebook encourage communication among employees, foster direct social links within the firm, and motivate researchers to share their research and exchange ideas. Specifically, Google has become known for its large open-space working environment and ambitious "new-work" projects. Apple, on the other hand, deliberately creates communication barriers so that researchers are not aware who

[1] See the literature discussion below.

[2] We prefer to use inferiority (superiority) aversion rather than the emotion-related concepts of envy (compassion) that are typically used in the literature in the context of other-regarding preferences. As there is widespread evidence that envy is of major relevance in the workplace (see, e.g., Vecchio (2000) and the references therein) and in line with Fehr and Schmidt (1999) who find envy to be stronger than compassion in the context of inequality aversion, we focus here on inferiority aversion. We argue however in Section 6 that our results extend to broader specifications of other-regarding preferences.

[3] See, e.g., `https://ivypanda.com/essays/nokia-organizational-structure`.

they are competing with and what others are working on. Apple seems to believe that secrecy drives internal competition among employees and enhances innovation efficiency.[4]

The rationale for the foregoing strategies stems from various underlying factors such as measurability and monitoring problems, collaboration and synergies issues, and the like. Notice, however, that choosing to separate workers and hinder communication as Apple entails also the hindrance of income comparisons and the emergence of peer effects whereas integrated structures such as Google's enhance the same. In fact, companies widely differ with respect to that second dimension of organizational design, whereby some companies directly encourage wage comparisons while others implement wage-secrecy rules. The prevalence of secrecy rules is evidenced by the *Glassdoor* Global Salary Transparency Survey (Glassdoor (2017)) conducted in the United States, Canada, United Kingdom, France, Germany, the Netherlands, and Switzerland. According to that survey "[o]nly about one-third (36 percent) of employees say their company discloses salaries internally among all employees." (p. 7) On the contrary, employment contracts seem to 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)).[5] Facing this situation, the legal system found it necessary to intervene, mainly for fairness and anti-discrimination considerations.[6] For example, Sweden has a long tradition of maximum transparency, whereby, since 1766, all tax records are publicly accessible. Much more recently, Norway has implemented similar legislation in 2001.[7] By contrast, in the United States no comprehensive transparency legislation exists, and moreover, only less than half of the states have implemented "sunshine laws", explicitly prohibiting pay-secrecy clauses.[8] Germany has passed the Remuneration Transparency Act (2017), entitling employees to inquire about their peers' average pay. In contrast, in the recent past, there is indication that some companies actively promote wage transparency out of their own volition (see, e.g., `https://hbr.org/2016/03/why-keeping-salaries-a-secret-may-hurt-your-company`).[9]

We theoretically analyze the two aforementioned aspects of firms' *organizational design*. In this respect, we distinguish between the *organizational setup* which captures the firm's structure regarding worker integration on the one hand and the *organizational policy* concerning wage secrecy on the other. For this purpose, we consider a stylized moral-hazard environment with

[4] For the Google projects, see, e.g., `https://www.cbsnews.com/news/inside-google-workplaces-from-perks-to-nap-pods/`. For communication policies at Apple, Google, and Facebook, see Shan (2017).

[5] 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.

[6] Note that many countries have implemented pay-equality and antidiscrimination laws, thereby indirectly enhancing transparency. However, in most cases, the required data concerns aggregate information along gender and ethnic dimensions.

[7] See Perez-Truglia (2020) for a short discussion of transparency rules in the Scandinavian countries and Iceland.

[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 (2018), Footnote 12.

[9] 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 hesistant to discuss wages, due to traditional norms stipulating a"salary taboo" (Cullen and Perez-Truglia (2018)).

two workers. Being inferiority averse, each worker's utility increases with their own income but decreases with their co-worker's wage, provided the latter is known and higher. Output is generated by the workers' effort, which is not contractible. When workers work jointly under an integrated organizational setup, output is further enhanced through positive externalities, representing productive synergies. In this environment, the employer determines the optimal organizational setup and, under integration, sets the optimal organizational policy. That is, the employer decides, *ex ante*, whether to impose a wage-secrecy rule or, on the contrary, make payments public. Depending on the optimal organizational design, the employer sets bonus contracts to align incentives accordingly.

We find that the optimal organizational design depends on whether the employer faces a limited-liability constraint on the workers' side that forces wages to be non-negative in all states. Absent such a constraint, the presence of inferiority aversion is increasing employment costs, thereby making productive synergies and inferiority aversion *strategic substitutes*. Intuitively, ex ante workers form expectations about the ex-post occurence of payoff inequity. To induce participation, firms need to compensate them by a so-called *inequality premium* for the associated disutility stemming from the other-regarding nature of their preferences. As a result, if payments are common knowledge, integrated production will be chosen only if workers are not too inferiority averse and the production externality is sufficiently high. Imposing wage secrecy removes the cost associated *ex-post* with social comparisons, making worker integration the optimal choice. In stark contrast, in the presence of limited liability, productive synergies and inferiority aversion become *strategic complements* as long as workers earn rents. When working jointly and wages are transparent, workers increase effort to reduce the likelihood of falling behind their co-worker's wage ex post. This comes at the expense of the rents, thereby providing a "free lunch" to the employer. Accordingly, beyond the productive externality, under wage transparency, integration enables the employer to exploit the incentive effect of pay inequality and raise productive efforts and profits. However, when inferiority aversion is sufficiently high, workers' inequality premia become so large that rents vanish. Then it becomes optimal to impose wage secrecy, if possible, or separate the workers if not. In the same vein, 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" may not be in the best interest of employees.

While, theoretically, it is straightforward to represent social preferences through an other-regarding utility specification, empirically, the presence of such preferences can be gauged only in an indirect manner. In particular, we believe that *peer effects* are one useful channel for detecting interdependent social preferences. While peer effects span various behavioural 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 supports our aforementioned 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 the *observability* of actions. Bandiera et al. (2010) identify workers' friends within a U.K. agricultural firm and combine this information with the worker's

productivity. In support of 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. Closest to our setting are the field experiments conducted by Horton and Zeckhauser (2018) 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."

Other studies investigate the impact of the informational environment regarding wages on workers' wellbeing and behavior. In many different societal, workplace, and lab environments, researchers detect the presence of other-regarding preferences, in particular inferiority aversion (Card et al. (2012), Cohn et al. (2014), Cullen and Perez-Truglia (2022), or Perez-Truglia (2020)). Some of these studies moreover report significant behavioral effects on the concerned individuals. Specifically, in a 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. Despite this seemingly conflicting finding, this behavior is constistent with our preference specification. Intuitively, given a reduction of the fixed wage relative to the peer, the affected individuals seek to reestablish equality by reducing effort, thereby lowering their private cost and raising net payoff. In a similar vein, Cullen and Perez-Truglia (2022) demonstrate that horizontal disadvantegeous pay differences lead to lower effort. 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.[10] Notably, the foregoing studies investigate the effects of *ex-post* discoveries of wage discrepancies. Unlike them, principal-agent models (and we) typically focus on *ex-ante* reactions to potential *ex-post* pay inequality. It is due to this conceptual difference that the behavioral outcomes are consistent with an agency framework too. Whereas the only way to compensate for *ex-post* inequality is to reduce effort, in an ex-ante scenario like ours with incentive pay, workers can undertake effort to affect the expected extent of inequality.

Cullen and Pakzad-Hurson (2018) extend the analysis of wage-transparency effects to a dynamic general-equilibium bargaining setting. In their empirical application, they find that ex-post disadvantageous income inequality reduces wages. They also note that the same translates into lower productivity, forcing firms to eventually raise wages. The latter implies increased employment cost, which is consistent with our other-regarding agency model. Specifically, in

[10] In contrast, Cullen and Perez-Truglia (2022) find that vertical differences raise effort of the subordinate worker, which the authors explain by career concerns.

our model, in the presence of inferiority aversion wage transparency increases total wage cost provided workers receive no rents.

The effects of the informational environment regarding wages is also investigated in the context of peer effects. Much of this literature focuses on "fairness" concerns that are assumed to deter workers from exerting effort and the role of wage transparency in alleviating such concerns (see, e.g., the discussion in Charness and Kuhn (2007)). We, however, consider the effects of potential income comparisons against the background of social preferences and inferiority aversion. In fact, there are increasing indications that making workers aware of the wages of their peers has positive effects on effort.[11] 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, performing 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).[12] 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."[13]

Our theoretical framework is akin to some existing agency models with other-regarding preferences in the firm context. Many of these papers use related theoretical approaches, and, similar to our work, study the effects of social preferences on the efficiency of different incentive schemes. We extend the theoretical analysis by studying how other-regarding preferences affect the optimal organizational design and the impact of wage-transparency policies.

Most of the agency literature on social preferences and incentives in the workplace disregard financial constraints. These studies find mainly adverse effects of wage comparisons on total agency cost, thereby implicitly providing good reasons for existing wage-secrecy norms. In the following, we however limit attention to the few further studies that, in line with our model, consider other-regarding workers who are protected by limited liability. Some of the earliest studies noting the favorable effect of envy on agency costs under limited liability are Demougin and Fluet (2003), Demougin and Fluet (2006), and Itoh (2004). [tbc]

[11] David Burkus of the Harvard Business School refers to Whole Foods Market, Inc., which has implemented a complete transparency policy. Its CEO 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`.

[12] Burn and Kettler (2019) also exploit such legislative actions to analyze their effects on wages of managers. They find that removing secrecy increased wages by 3.5% but had no effect on the gender wage gap, job tenure, or labor supply. They do not have data on productivity, though.

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

2 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 externalities across 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 function 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, for each worker, the employer observes a verifiable effort-related signal $s_i \in \{0, 1\}$. 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 realization of the latter are affected by the employer's organizational design. 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.[14] 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. 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 (which may, for example, arise from the emotional effect of envy). In the sequel, we use the neutral notion of *inferiority aversion* and refer to α as the intensity thereof.[15] Clearly, social

[14] For further discussion, see Section 5.

[15] Notice that income comparisons involve gross-of-effort-cost wages. In our setup with homogenous workers,

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.[16]

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 scenarios. In Section 3, we analyze environments where the employer can exact payments from workers (unlimited liability). Thereafter, in Section 4, we reconsider the optimal organizational design when workers are protected by limited-liability regulations. 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. To derive the optimal organizational policy, we then investigate if imposing wage secrecy is optimal.

3 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.

3.1 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:

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

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.

this assumption turns out to be innocuous since we focus on symmetric equilibrium efforts, rendering gross and net-effort comparisons equivalent.

[16] We consider only symmetric contracts, which we deem to be the plausible case.

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 inferiority aversion 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 Kato and Shu (2009)). Intuitively, workers raise effort to reduce the probability of not getting the bonus and thus suffering additional disutility due to disadvantageous pay inequality:

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

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.[17] To simplify notation, in the following, we denote the design-dependent Nash effort by e.

3.2 The Employer's Problem

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

$$\begin{aligned} \max_{w,b,e} \quad & 2e + \delta_I \cdot \gamma(e)^2 - 2(w + p(e)b) \\ s.t. \quad & b = \frac{c'(e)}{p'(e)(1 + \delta_I \cdot (1 - \delta_S) \cdot \alpha p(e))}, \qquad (IC) \\ & w + p(e)b - c(e) - \delta_I \cdot (1 - \delta_S) \cdot \alpha(1 - p(e))p(e)b \geqslant 0, \quad (PC) \end{aligned} \tag{I}$$

where the participation constraint (PC) ensures that workers accept the contract.[18] The incentive-compatibility constraint (IC) guarantees that effort choices by the workers are utility-maximizing for them.

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

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

Accordingly, the employer's expected wage cost per worker consists of the effort costs and, when $\delta_I = 1$ and $\delta_S = 0$, the well-known *inequality premium*. 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

[17] A sufficient condition for the existence of a Nash equilibrium is that the curvature of the effort costs is increasing. Otherwise, existence may fail if α becomes too big.

[18] We implicitly assume throughout that the maximization problems are well-defined, i.e., the specifications satisfies the second-order conditions.

(PC) in the objective function and simplifying yields:

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

First, observe that, when $\delta_I = 0$, the profit is independent of both α and γ. However, when $\delta_I = 1$, an increased synergy factor γ unambiguously raises the profit. By contrast, with $\delta_S = 0$ an increase in α has countervailing effects on the inequality 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 inequality premium (see Eq. (IP)). As is well known from the related literature, absent productive complementarities, a higher inferiority aversion reduces the optimal profit (Grund and Sliwka (2005), Demougin and Fluet (2006), Kato and Shu (2009), or Bartling and von Siemens (2010)). 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. ■

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

3.3 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. However, as it turns out in Section 4.2, 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.

3.3.1 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 $\alpha^U(\gamma) : \Pi^U(0, \cdot; \cdot, \cdot) = \Pi^U\left(1, 0; \alpha^U, \gamma\right)$ be well defined. Then (i) for $\alpha < \alpha^U(\gamma)$,*

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)* $\alpha^U(0) = 0$ *and* $\alpha^U(\gamma)$ *is increasing in* γ. *(iii) If* $\alpha^U(\gamma)$ *fails to exist, 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 inferiority aversion, $\alpha^U(\gamma)$, for which the profit functions under the two architectural setups intersect. First consider the case when **productive complementarities 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, with inferiority averse workers, worker separation ($\delta_I = 0$) *always* dominates integration. By contrast, in the **presence of productive complementarities**, Corollary 1(i) states that, given γ, the employer chooses integration ($\delta_I = 1$) as long as inferiority aversion 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.

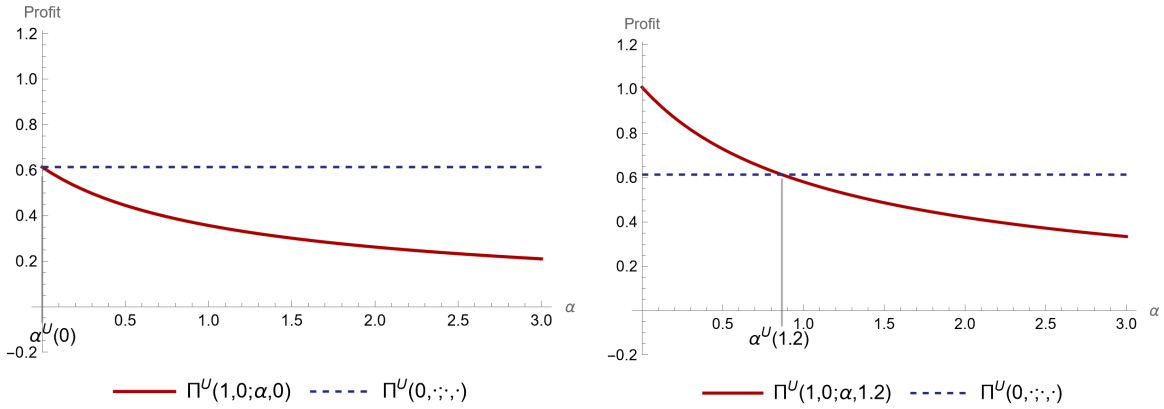

Figure 1: Optimal Organizational Setup under Unlimited Liability (a) without and (b) with Productive Complementarities

The results of Corollary 1 are illustrated in Figure 1.[19] In this and all subsequent figures, the dashed (dark blue) lines represent profits under worker separation ($\delta_I = 0$), where income 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 when productive complementarities are not present. Then, since $\delta_S = 0$, inferiority aversion gives rise to inequity-premium costs that can be avoided by means of worker separation. By contrast, in the presence of productive complementarities, shown in panel (b) for $\gamma = 1.2$, profits under integration shift upwards while profits under worker separation remain constant. Accordingly, for sufficiently low intensities of inferiority aversion, integration becomes superior to worker separation. Beyond that point ($\alpha^U(1.2) = 0.87$), separation dominates. It is in this sense that the synergy factor γ and the workers' intensity of inferiority aversion α are *strategic substitutes* with regard to the optimal

[19] 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., $p(e) \in [0, 1)$.

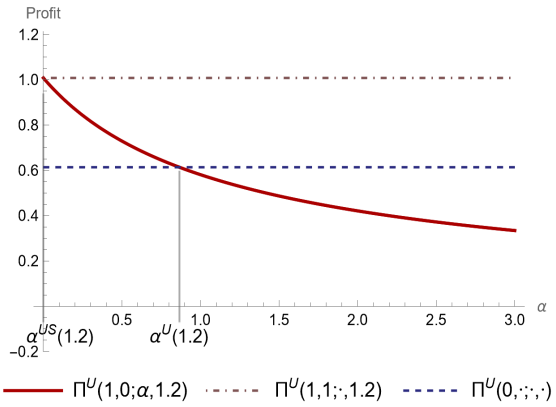

Figure 2: Optimal Organizational Design under Unlimited Liability

organizational design. In fact, very high levels of γ may shift the profit under integration upwards to an extent that renders the productive synergy dominant relative to the inequity premium, and integration becomes the preferred organizational architecture throughout.[20]

3.3.2 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 3 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 $\alpha > 0$. ■

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 inferiority aversion. 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 inferiority aversion. 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)

[20] In fact, in our numerical example (see Footnote 19), productive complementarity may overwhelm the negative impact of inferiority aversion 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 (7) implies $\lim_{\alpha\to\infty} e = \frac{\gamma-1}{\gamma}$. Using this result, it can be shown that, for sufficiently large values of γ, $\Pi^U(1,\infty,\gamma) > \Pi^U(0,\infty,\cdot)$ so that no intersection exists.

horizontal line. As the secrecy clause neutralizes the effect of inferiority aversion, 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.

4 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.

4.1 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 3.1.

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:

$$\begin{aligned}
\max_{w,b,e} \quad & 2e+\delta_I\cdot\gamma\left(e\right)^2-2(w+p(e)b) \\
s.t. \quad & b=\frac{c'(e)}{(1+\delta_I\cdot(1-\delta_S)\cdot\alpha p(e))p'(e)}, && (IC)\\
& w+p(e)b-c(e)-\delta_I\cdot(1-\delta_S)\cdot\alpha(1-p(e))p(e)b\geqslant 0, && (PC)\\
& w\geqslant 0, && (NNC_1)\\
& w+b\geqslant 0, && (NNC_2)
\end{aligned} \tag{II}$$

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

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

This implies that either (PC) or (NNC_1) or both must be binding. Note that, when (PC) does not bind, workers earn a rent. 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 inferiority averse, (PC) starts binding. Intuitively, as workers' inferiority aversion increases, at given effort, also the inequity premium increases eventually exhausting the rent.

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

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

Remark 1 *Consider $\delta_I = 1$ and $\delta_S = 0$. Let $\alpha_L^c(\gamma)$ denote the level of inferiority aversion at which (NNC_1) and (PC) are just binding and $\alpha_U^c(\gamma)$ denote the level of inferiority aversion 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 $\alpha \in [\alpha_L^c(\gamma), \alpha_U^c(\gamma)]$ effort is jointly determined by (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, profit-maximizing effort is determined by the respective first-order condition associated with (9), whereby the employer is forced to pay rents and reduce effort relative to the case without worker protection. Moreover, in that region, absent worker protection, the fixed wage would be strictly negative. This is still true at $\alpha_L^c(\gamma)$, where (NNC_1) still binds, and (PC) just becomes binding. Accordingly, inferiority aversion rises further to the point $\alpha_U^c(\gamma)$, where (NNC_1) stops binding and $w = 0$. In this interval, effort is hence determined solely by the two constraints. Beyond that point, optimal effort is again derived from the appropriate first-order condition of (9).

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):

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

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

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 inferiority averse 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 inferiority aversion 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 inferiority averse ($\alpha = \alpha_L^c(\gamma)$), rents vanish due to the large inequity premium. With a further increase in inequality aversion ($\alpha > \alpha_U^c(\gamma)$) 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.

4.2 The Optimal Organizational Design

4.2.1 Wage Transparency

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. The next Corollary 3 characterizes the optimal organizational architecture for this case, depending on the workers' intensity of inferiority aversion and the synergy factor.

Corollary 3 (Optimal Organizational Setup under Limited Liability) *Consider $\delta_S = 0$. Let $\alpha^L(\gamma) \in \{\alpha : \Pi^L(0,\cdot;\cdot,\cdot) = \Pi^L(1,0;\alpha^L,\gamma)\} \cap \{\alpha \in \mathcal{R}_+\}$ be well defined. 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) $\alpha^L(0) > 0$ and $\alpha^L(\gamma)$ is increasing in γ. (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, at the critical level $\alpha^L(\gamma)$ of inferiority aversion the profit functions under the two organizational setups intersect 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 **productive complementarities are absent**. 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 inferiority averse. Intuitively, whereas under unlimited liability social comparison is always harmful, in this case joint allocation of workers becomes beneficial. Profitability is increased through the exploitation of work incentives triggered by the workers' inferiority aversion. Moreover, in line with the unlimited-liability case, the **presence of productive complementarities**, raises the range of α-values for which integration is chosen 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 comparison across workers, which in turn strengthens work incentives and raises profit.

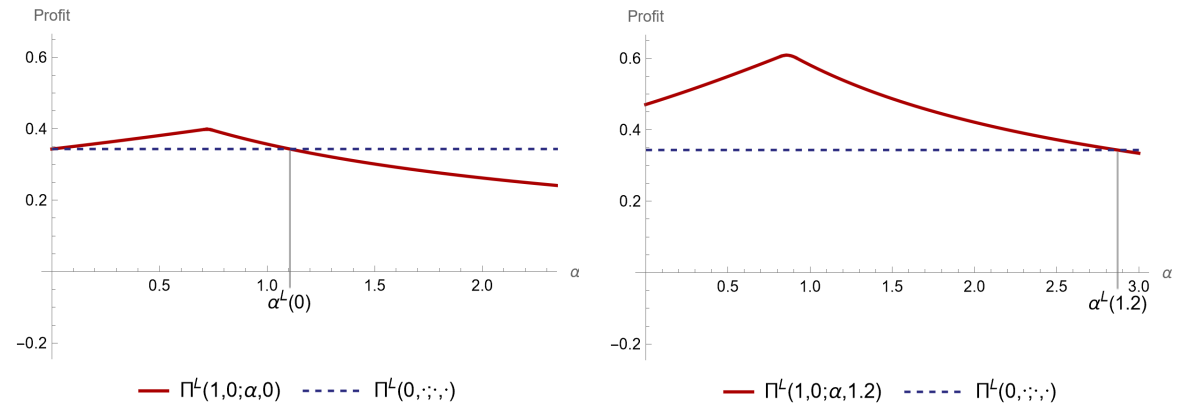

Figure 3: Optimal Organizational Setup under Limited Liability (a) without and (b) with Productive Complementarities

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.[21] 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 shown). Thereafter, the curves coincide exactly with those of Figure 1. Again, panel (a) shows the case where **productive complementarities are not present**. Notably, in contrast to Figure 1, profits under integration exceed those under worker separation for sufficiently low intensities of inferiority aversion ($\alpha < \alpha^L(0) = 2.87$). 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 inferiority aversion. Finally, when workers become sufficiently inferiority averse $\left(\alpha > \alpha^L(0)\right)$, worker separation dominates also under limited liability. When **productive complementarities are present,** shown in panel (b), profit under integration shifts upwards due the profitable impact of γ. 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 so that integration is more often optimal. 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 inferiority aversion is larger than that under unlimited liability. This effect is magnified further by the degree of productive synergy. As before, very high levels of γ may render integration the preferred organizational architecture throughout.

4.2.2 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

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

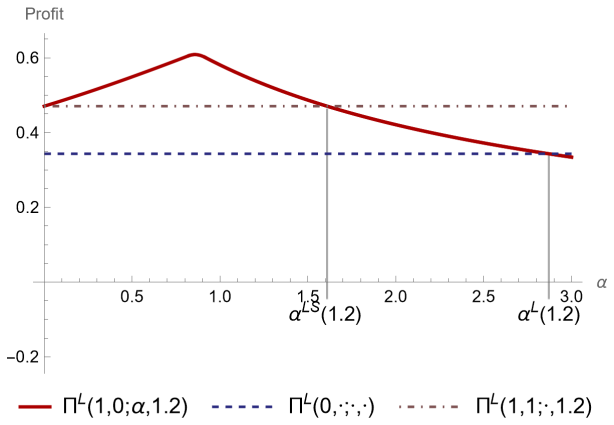

Figure 4: Optimal Organizational Design under Limited Liability

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* $\alpha^{LS}(\gamma) \in \{\alpha : \Pi^L(1,0;\alpha,\gamma) = \Pi^L(1,1;\cdot,\gamma)\} \cap \{\alpha \in \mathcal{R}_+\}$. *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* $\alpha^{LS}(\gamma) > \alpha$, *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 impact of inequality aversion 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, inferiority aversion induces high effort as long as workers receive a rent and even beyond. Clearly, absent inferiority aversion ($\alpha = 0$), 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 intensity of inferiority aversion becomes sufficiently high ($\alpha > \alpha^{LS}(\gamma)$), the inequality-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.

5 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.

5.1 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, imposing a wage-secrecy policy may in fact be illegal.[22] 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 5 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. To clarify, we have also included the critical value of $\alpha(\gamma, \delta_S)$ 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 (for the above parameters, $\alpha^{LS}(1.2, 0.5) = 1.10$). As is obvious from the above-mentioned observational equivalence, for any $\delta_S < 1$, $\alpha^{LS}(\gamma, \delta_S) < \alpha^{LS}(\gamma, 1)$, i.e., as secrecy becomes less enforceable, the employer is inclined to try to impose it for ever lower levels of inferiority aversion characterizing their workforce. 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. In fact, although secrecy is not fully enforceable, it is optimally imposed "more often", i.e., for a broader set of inferiority aversion, relative to the case of perfect secrecy. Intuitively, analogously 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 inferiority aversion for which the employer profits from social comparison is consequently even larger under imperfect wage secrecy as compared to perfect secrecy. Eventually, rents are exhausted by the inequality premia also under imperfect secrecy, however at a higher level of inferiority aversion, and profits start decreasing. This has two obvious consequences. First, when inferiority aversion becomes very

[22] See the introduction for the legal regulations concerning wage transparency.

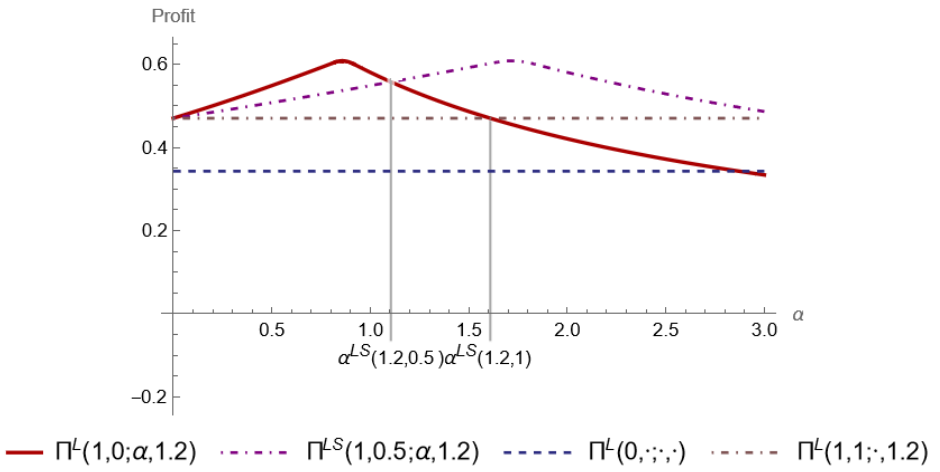

Figure 5: Optimal Organizational Design with Limited Liability and Imperfect Wage Secrecy

high, profits obtained under partial secrecy fall below those that would have emerged under perfect secrecy. Second and more importantly, 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).

5.2 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 inferiority aversion.

Accordingly, under unlimited liability, the employer's problem is equivalent to the individual-bonus case in the presence of wage secrecy (see Section 3.3.2 above). As is briefly shown in the Appendix, the employer in that case 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, when workers are protected by limited liability, the result is also equivalent to that obtained with an individual-bonus scheme under a wage-secrecy policy (see Section 4.2.2), so that profits are given by $\Pi^L(1,1;\cdot,\gamma)$. This happens because, somewhat surprisingly, 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.

6 Discussion

In this section, we make two remarks concerning some of the simplifying features of our model. First, as argued in Footnote 2, we focus on inferiority aversion, reflecting the widely held view that disadvantageous inequality matters more than advantageous inequality. However, in the following we allow for broader specifications of other-regarding preferences and explain how this qualifies our results.

Consider initially the case of *inequality aversion* where workers dislike any deviation from the equitable payoff distribution. i.e., are *both* inferiority and superiority averse. Recall that our main results stem from two particular effects of social preferences on the employer's profits. One the one hand, inferiority aversion implies inequality-premium cost whenever workers earn no rents. The additional presence of superiority aversion would enlarge this premium further. On the other hand, when workers earn rents, inferiority aversion implies an incentive effect that may benefit the employer. This effect is still present, though smaller, for inequality averse workers as long as falling behind has a greater utility effect than forging ahead. This implies that employers find it still advantageous to integrate inequality averse workers and make wages transparent as long as workers earn rents. Similarly, our results extend to the case of *competitive* workers whereby 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 also yield positive, tough smaller, inequality-premium costs when no rents are paid. However, the incentive effect is even stronger for competitive workers. The foregoing would clearly render wage transparency optimal in many cases.

Second, in the main body of the paper, we presumed that wage secrecy and organizational separation are informationally equivalent. This equivalence is grounded in the assumptions 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, under integration and wage secrecy, workers may, od course, form beliefs about their co-worker's wage.[23] Strictly speaking, if such beliefs were rational, i.e., workers were to correctly anticipate the expected outcomes, then, in our setup with risk neutral workers, wage transparency and secrecy would be observationally equivalent.[24] Moreover, this equivalence would hold as long a workers incur

[23] We thank Dana Sisak and Simon Dato for their useful remarks on this issue during the 24th Colloquium on Personnel Economics in Herning.

[24] Notice that, with risk averse workers, the equivalence no longer holds. Specifically, *uncertain* ex-ante *beliefs* about the *actual* ex-post wage discrepancy would then imply greater disutility than correct ex-ante anticipations of *actual ex-post revelations* of such discrepancy. The associated utility effects from uncertainty and risk in the first case would imply additional wage cost for the employer, thereby making wage secrecy relatively less profitable

disutility from pay inequality regardless of whether they actually (ex post) observe the outcome or just anticipate it. Obviously, our assumption that, under wage secrecy, workers are perfectly ignorant of their co-workers' pay is a simplification. It means to capture abundant evidence regarding the striking utility effects of *actually observing* peer-related pay information (Card et al. (2012), Perez-Truglia (2020)). Further supporting our assumption, there is plenty of evidence that people tend to *deliberately ignore* disadvantageous information also in the economic context (see Hertwig and Engel (2016) and the examples therein).

7 Conclusion

This paper investigates the impact of other-regarding preferences on firms' optimal organizational design. When firms can extract payments from inferiority averse workers, worker separation is often optimal because firms save agency costs arising due to pay inequality. But at the same time firms forgo productive benefits due to synergy across workers. Notably, we show that the joint allocation of workers is more often dominant when workers are protected by limited liability. Then firms deliberately choose to place workers in teams allowing for pay comparison and provoking envy because this raises workers' productive efforts. In addition, firms benefit from productive synergy. Moreover, when introducing group-bonus schemes in our setting, it turns out that, in a similar vein, firms may opt for individual performance pay rather than group bonuses when workers earn rents.

under unlimited liability. By contrast, when rents are paid to risk averse workers, the profitable incentive effect would get even more intense for any given sensitivity to inequality. Therefore our results regarding the opposing effects of social preferences with limited vs. unlimited liability would obtain even stronger support in that case.

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:

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

The associated incentive constraint is:

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

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

$$\begin{aligned} \Pi^{UGB} = \quad & \max_{e,b,B} \left\{2e + \gamma e^2 - 2p(e)\left(1 - p\left(e\right)\right) B_1 - 2p^2(e) B_2\right\} \\ & \text{s.t.} \\ & \text{(A.PC)} \\ & \text{(A.IC)} \end{aligned} \tag{A.I}$$

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:

$$\begin{aligned} \Pi^{LGB} = \quad & \max_{e,b,B} \left\{2e + \gamma e^2 - 2p(e)\left(1 - p\left(e\right)\right) B_1 - 2p^2(e) B_2\right\} \\ & \text{s.t.} \\ & \text{(A.PC)} \\ & \text{(A.IC)} \\ & w, B_1, B_2 \geq 0 \end{aligned} \tag{A.II}$$

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:

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

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:

$$\begin{aligned} -2p(e)\left(1 - p\left(e\right)\right) + \lambda p'(e)\left(1 - 2p(e)\right) + \mu_{B_1} &= 0 \\ -2p^2(e) + \lambda p'(e) p\left(e\right) + \mu_{B_2} &= 0 \end{aligned} \tag{A.mult}$$

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 $\lambda = \dfrac{p\,(e)}{p'\,(e)}$. 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 $\lambda = 2\dfrac{p(e)\,(1 - p\,(e))}{p'(e)\,(1 - 2p(e))}$. 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:

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

Finally, the problem (A.I) becomes:

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

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.

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