

The Rat Race at Work: Technology and Burnout

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Abstract

Technological advancements like artificial intelligence can raise employee productivity, yet evidence suggests they may also lead employees to work more. In this paper, we examine how productivity-enhancing technology affects employee burnout and welfare. We develop a model in which employees choose their work intensity, productivity increases in both work intensity and technology quality, and a high work intensity raises the risk of burnout, which interrupts production and is costly for both the employee and the firm. We show that the effects of technology depend on how employees are rewarded: when pay depends sufficiently strongly on performance relative to peers, productivity gains can incentivize even more work, creating a “rat race” that erodes welfare. In particular, as technology improves, employee welfare can initially fall due to intensified competition, but eventually rebound as competition cools and employees reap the productivity benefits. For the firm, burnout risk can lead to decreasing marginal returns to technology, reversing the increasing returns that arise when employees face no burnout. When the firm chooses performance incentives, improvements in working conditions that reduce underlying burnout risk can lead to higher realized burnout and lower employee welfare in equilibrium. Finally, when technology quality is low, a profit-maximizing firm may invest more in burnout mitigation than a social welfare-maximizing firm, which instead promotes welfare by suppressing workplace competition through weaker performance incentives.

1. Introduction

Productivity-enhancing technologies like generative artificial intelligence are transforming the workplace. An emerging body of empirical evidence documents productivity gains across several types of knowledge work: AI assistance has been shown to reduce completion time and improve output quality in professional writing (Noy and Zhang, 2023) and management-consulting tasks (Dell’Acqua et al., 2023). AI has also been observed to increase the number of tasks completed among customer-support agents (Brynjolfsson et al., 2025) and software developers (Cui et al., 2025). Together, these findings show that AI has the potential to boost employee productivity across a wide range of job types.

Improvements in workplace technology, however, need not translate into lighter workloads for employees. In fact, recent empirical evidence suggests AI may be having exactly the opposite effect: Using U.S. time-diary data, Jiang et al. (2025) find that workers in occupations with greater AI exposure work longer hours, with stronger effects when AI complements employee work. Similarly, Ranganathan

and Ye (2026) find that employees at a technology firm took on more tasks and worked longer hours following the adoption of AI, often without being asked. A study of workplace activity data from 10,000 AI users also found that digital activity (e.g., email, messaging) increased dramatically after AI adoption (ActivTrak Productivity Lab, 2026).

Whether technology improvements compel employees to work more intensely matters because high workloads are costly for both firms and employees. In particular, excessive workloads may lead to employee *burnout*, which refers to the exhaustion and reduced effectiveness caused by chronic workplace stress (World Health Organization, 2019; Maslach et al., 2001). For the firm, burnout can reduce productive capacity through lower work quality (Corbeanu et al., 2023; Smith et al., 2018), increased sickness absence (Schaufeli et al., 2009; Consiglio et al., 2013), or employee departures (Salvagioni et al., 2017). Recent estimates place the annual cost of burnout at approximately \$5 million for an average U.S. company with 1,000 employees, largely through missed work (Martinez et al., 2025). Technological improvements can therefore create an operational tradeoff: they can raise individual employee productivity, but may also intensify work and increase burnout, reducing the firm’s productive capacity.

In recognition of the costs imposed by burnout, many firms explicitly invest in employee well-being, with workplace wellness programs now covering more than 50 million U.S. workers (Jones et al., 2019). For example, HubSpot combines coaching, therapy, and meditation in what it calls a “long-term framework to prevent and battle burnout” (HubSpot, 2021), and Salesforce and Adobe reimburse employees for activities that support mental well-being (Hyder, 2022; Adobe, 2026). Many companies view employee well-being as a strategic priority: In a Deloitte survey, 83 percent of executives said well-being should be discussed by the board (Fisher et al., 2023). Beyond wellness programs, firms can also reduce burnout by changing the work environment itself. For example, giving employees greater flexibility over their work schedules may reduce burnout (Moen et al., 2016). Supportive coworkers and supervisors may also weaken the relationship between job demands and burnout (Demerouti et al., 2001; Bakker et al., 2005). These practices suggest that firms consider burnout mitigation to be a necessary investment, one which may become increasingly important if technological improvements increase employee workloads.

Taken together, these observations suggest that the productivity gains from technology may come at the cost of more intense work and greater burnout. We therefore ask: How does productivity-enhancing technology affect employee burnout and welfare, and to what extent can improvements in working conditions protect employees as technology intensifies work?

We show that the answer depends on how employees are rewarded: When employees are compensated based on their performance relative to peers, better technology can make production easier for everyone,

leading employees to work harder for the same rewards.¹ This type of strategic overwork can create a “rat race” in which employees work harder to preserve their position relative to coworkers, even though they would collectively prefer a less demanding equilibrium (Nalebuff and Stiglitz, 1983; Landers et al., 1996). OpenAI CEO Sam Altman makes a similar prediction about how AI will affect work: “It’s like a relative game. People are very focused on how they’re doing relative to other people ... I think we’re all going to be much busier than we thought we were supposed to be in a post-superintelligence world” (Altman, 2026). Although a rich literature examines how relative-performance rewards shape workplace competition (Lazear and Rosen, 1981; Connelly et al., 2014), much less is known about how such competition responds to technological improvements when high workloads carry a risk of burnout. Relative performance evaluations of employees are common in practice, particularly in the technology sector. In 2025, Meta set a target for teams with at least 150 employees to place 15 to 20 percent of employees in the lowest performance category, and described the review process as an opportunity to make exit decisions (Dixit and Mann, 2025). Microsoft and Amazon have also used similar ranking systems (Eichenwald, 2012; Soper, 2022). However, ranking-based systems are not necessary for employees to compete: Bonuses, raises, and promotions are often limited, so employees may internalize that compensation and career advancement implicitly depend on how their performance compares with coworkers. In such settings, an across-the-board productivity gain from technology can heighten workplace competition, even when the firm leaves its formal evaluation system unchanged.

1.1. Summary of Model and Results

We develop a single-period model in which n identical employees in a firm simultaneously choose their work intensities at the start of the period. Technology increases the output produced by work, and employees are rewarded based on both their absolute output and output relative to the group average. We focus on employee welfare by incorporating a stark cost of high work intensity: the risk of employee burnout. We model burnout through a time-to-failure process in which greater work intensity raises the hazard rate of burnout, and a burnout event incurs a fixed cost for the employee and immediately ends their production for the remainder of the period. The firm’s payoff is total output less employee payments, making burnout costly for the firm through reduced production. We consider three settings: one in which the strength of the relative-performance incentive is fixed, one in which the firm chooses it, and one in which the firm also invests in burnout mitigation.

We first examine how technology affects employee welfare when relative performance incentives are fixed. We show that better technology can initially reduce employee welfare, despite making every employee more productive, but that welfare can recover as technology improves further. At low technology

¹Nalebuff and Stiglitz (1983) note this possibility; we analyze it formally and show how burnout risk can change the result.

quality, an improvement induces a “rat-race effect”: employees work more intensely to keep up with more productive coworkers, and the resulting strain outweighs the direct benefit of access to better technology. At higher technology quality, however, competition cools. Better technology magnifies the output advantage of employees who remain productive when their coworkers burn out, allowing them to earn large relative-performance rewards simply by avoiding burnout. This “strategic survival” behavior weakens the marginal incentive to work intensely, so work intensity can rise more slowly or eventually decline in technology quality. The resulting moderation allows the direct productivity benefit of better technology to dominate and for employee welfare to recover.

We next show that employees’ strategic work intensity decisions in light of burnout risk also shape the firm’s marginal return to technology. Without burnout, better technology both raises the value of completed work and induces employees to work more intensely. These direct and strategic effects reinforce one another, making firm profit convex in technology quality. With the possibility of burnout, however, the strategic moderation of work intensity described above can be strong enough to make the firm’s marginal return to technology decrease at high technology quality; we provide conditions under which this occurs.

Naturally, better working conditions ought to protect employees. Yet we show that, when performance incentives are endogenous, a reduction in underlying burnout risk can lead to higher burnout and lower employee welfare in equilibrium. The intuition is that lower burnout exposure allows the firm to sustain more work at a given burnout risk, prompting it to strengthen performance incentives and demand more work from employees. When exposure is already sufficiently low, the resulting increase in work intensity more than offsets the direct reduction in risk, causing a “burnout rebound.” Employees then bear more strain and burnout, and the change in expected compensation does not offset these costs, leaving them worse off despite the improvement in working conditions.

Finally, we consider investments in burnout mitigation. In particular, we examine how a profit-maximizing firm and a social welfare-maximizing firm differ in their choice of the performance incentive and mitigation investments. We find that when technology quality is low, the profit-maximizing firm invests *more* in burnout mitigation than the social welfare-maximizing firm. The social welfare-maximizing firm instead chooses a weaker incentive, which suppresses employee competition and limits burnout. Because moderating competition sacrifices output, this result arises at low technology levels, where the output loss is limited; when technology quality is high, we find numerically that the social welfare-maximizing firm invests more in mitigation than the profit-maximizing firm. This result suggests that mitigation spending alone can be a misleading indicator of how well a workplace protects its employees.

1.2. Related Literature

Our paper relates to the people-centric operations literature, which studies how employee behavior shapes operational performance (Boudreau et al., 2003; Roels and Staats, 2021). This literature has shown that workers adjust their pace to the load on the system and to their coworkers’ pace (Schultz et al., 1998; KC and Terwiesch, 2009; Delasay et al., 2016), but these adjustments can be difficult to sustain. For example, KC and Terwiesch (2009) find that hospital workers speed up as load increases, but that prolonged periods of high load slow them down and are associated with worse patient outcomes, a pattern that Delasay et al. (2016) capture in a queueing model that distinguishes load effects from overwork effects. More broadly, beyond a point, high workloads reduce productivity and service quality (Tan and Netessine, 2014; Kuntz et al., 2015; Berry Jaeker and Tucker, 2017), and they may also increase absenteeism (Green et al., 2013).

Our paper also draws on research on employee burnout, which identifies workload and job demands as its central drivers (Cordes and Dougherty, 1993; Maslach et al., 2001; Schaufeli and Bakker, 2004). Burnout is costly for both employees and firms and is associated with worse job performance (Corbeanu et al., 2023). Goh et al. (2016) estimate that workplace stressors are associated with more than 120,000 deaths and 5–8% of healthcare spending each year in the United States. However, the same job demands need not lead to the same level of burnout. Job resources such as employee autonomy and strong supervisor relationships can buffer the effect of job demands on burnout (Bakker et al., 2005). Our model captures this distinction by separating employees’ chosen work intensity from an underlying burnout exposure, which the firm can lower by investing in employee well-being. Improvements in employee health have been linked to higher productivity (Gubler et al., 2018), but the effects of workplace interventions also depend on how firms respond. For example, Jiao et al. (2026) show that interventions intended to reduce excessive overtime in global supply chains can backfire once firms adjust their monitoring behavior. We build on this literature by studying how firms should design incentives and mitigation as technology changes the demands placed on employees.

Our paper also relates to the operations management literature on how firms organize work around AI. This literature shows that the benefits of AI depend on how tasks are allocated between humans and AI, how their interaction is designed, and their relative capabilities (Fügener et al., 2026; Fang et al., 2026; Hu et al., 2026). Working with AI can also be demanding: AI assistance can increase the cognitive effort and time pressure that workers face (Boyacı et al., 2024, 2026; Legros and de Véricourt, 2026). Other work studies how AI interacts with worker incentives. Dai and Taylor (2025) examine how firms jointly design AI and employee incentives, and Lu and Tomlin (2026) and Guan et al. (2025) show that limiting the information or precision of AI can motivate workers to acquire information themselves. Bastani and Cachon (2025) show that more reliable AI can make human oversight more

costly to induce, and Siderius et al. (2026) show that better AI can weaken workers' incentives to check its output, causing skill atrophy.

A growing empirical literature also examines how new workplace technologies affect employee welfare. AI assistance has been shown to improve task satisfaction (Noy and Zhang, 2023) and lower employee attrition (Brynjolfsson et al., 2025), but new technologies can also raise work demands, leading to more overtime and greater work intensity (Giebel and Lammers, 2025), expectations of constant availability (Mazmanian et al., 2013), and longer workdays with less leisure, particularly in more competitive labor and product markets (Jiang et al., 2025). We complement this work with a theoretical model of how AI interacts with employees' performance incentives to shape welfare.

Relative performance pay can motivate employees while filtering out shocks that affect everyone (Lazear and Rosen, 1981; Green and Stokey, 1983; Nalebuff and Stiglitz, 1983; Mookherjee, 1984). Performance pay has been found to raise worker output (Lazear, 2000), and feedback on relative performance can change how much employees work (Casas-Arce and Martínez-Jerez, 2009; Song et al., 2018). Our work is closest to studies of the unintended consequences of performance incentives, which can encourage workers to undermine coworkers (Lazear, 1989), increase stress and burnout (Habel et al., 2021), or push workers to overexert (Landers et al., 1996; Greiner et al., 2026). Waiser et al. (2025) model burnout as an intertemporal effort-cost spillover, and show that strong incentives can lead employees to overwork and eventually quit.

2. Model

2.1. Work and Burnout

Consider a firm with $n \geq 3$ ex ante identical employees, indexed by $i \in \mathcal{N} \equiv \{1, \dots, n\}$. There is one period, normalized to unit length, with continuous time $t \in [0, 1]$. At the beginning of the period, employees simultaneously choose sustained work intensities $x_i \in [0, \infty)$, which remain fixed while they are productive. Let $\mathbf{x} = (x_1, \dots, x_n)$ denote the intensity profile and $\mathbf{x}_{-i}$ the profile excluding employee i . Work intensity captures the pace at which the employee accepts and completes work during a performance evaluation cycle or a long project.

Let $\tau_i(x_i) \in (0, 1]$ denote the time for which employee i remains productive during the period. If employee i does not burn out during the period, then $\tau_i(x_i) = 1$. Continued work generates strain, which raises burnout risk. We assume a power-law relationship between cumulative work and strain: after working for time t , accumulated strain is $(x_i t)^\alpha / \alpha$, with accumulation rate $x_i^\alpha t^{\alpha-1}$. For $t \in [0, 1]$, conditional on remaining productive until t , the burnout hazard is assumed proportional to this strain

rate:

$$h_i(t) = \rho x_i^\alpha t^{\alpha-1}. \quad (1)$$

Here, $\rho > 0$ denotes underlying burnout *exposure*: it captures how readily a given work intensity leads to burnout under the prevailing working conditions. For example, two teams may sustain the same pace of work while differing in employees' control over their work schedules (Moen et al., 2016), or in the support available from coworkers and supervisors (Cordes and Dougherty, 1993; Demerouti et al., 2001; Bakker et al., 2005). We represent the effect of these conditions through ρ , which is common across employees. Treating ρ as common reflects that work conditions apply at the level of the team or firm rather than at the individual.

The parameter $\alpha > 2$ is burnout work *sensitivity* and determines how sharply the hazard rises with work intensity. The hazard rises as strain accumulates, and is higher at greater work intensity for a given strain level. The restriction $\alpha > 2$ is a technical condition that ensures that the firm's optimal induced work intensity in Sections 5 and 6 is finite.

For $t \in [0, 1]$, integrating the hazard function (1) from 0 to t gives

$$\begin{aligned} \Pr(\tau_i(x_i) < t \mid x_i) &= 1 - \exp \left\{ - \int_0^t h_i(s) ds \right\} \\ &= 1 - e^{-\rho x_i^\alpha t^\alpha / \alpha}. \end{aligned} \quad (2)$$

This is a Weibull time-to-failure model, censored at the end of the period (Weibull, 1951).² Figure 1 shows the cumulative burnout probability for different levels of exposure, sensitivity, and work intensity.

²This specification has parallels in reliability engineering, where machine failure depends on cumulative strain through a power-law relationship (Miner, 1945; Manson, 1953).

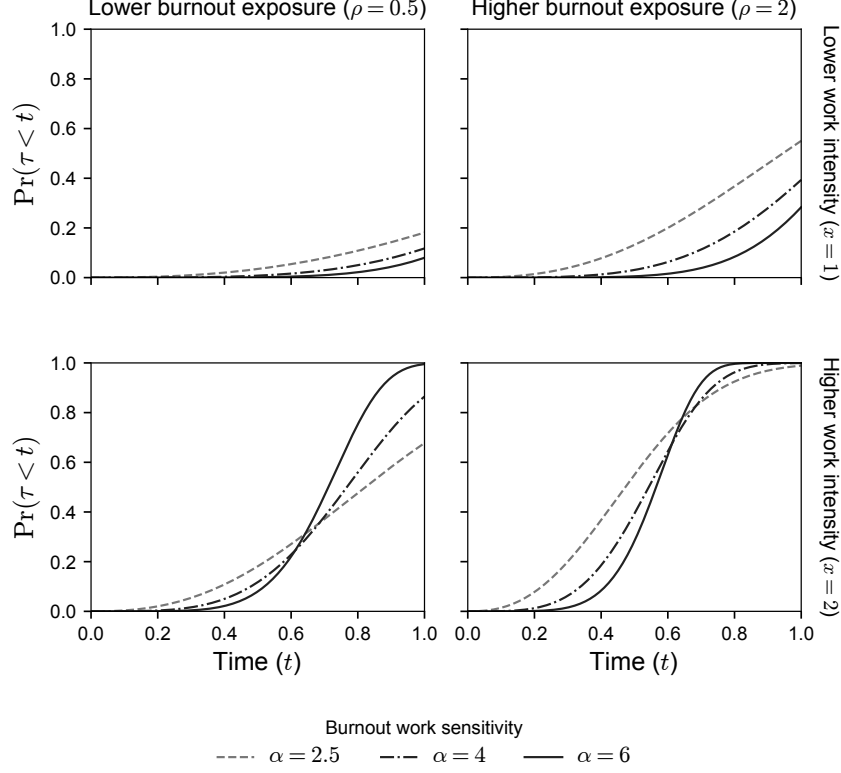


Figure 1: Burnout probability over the performance period. Columns compare burnout exposure $\rho \in \{0.5, 2\}$, rows compare work intensity $x \in \{1, 2\}$, and line types compare burnout work sensitivity α in (1). Higher α makes burnout more sensitive to work intensity, as the comparison across rows shows.

If $\tau_i(x_i) < 1$, employee i stops producing for the rest of the period, with no recovery or reassignment of work. This captures episodes such as extended sickness absence (Schaufeli et al., 2009) or severe disengagement (Cordes and Dougherty, 1993).³ Completed work is therefore $x_i \tau_i(x_i)$. The variables $\tau_i(x_i)$ are independent across employees conditional on their intensity choices. The burnout hazard (1) and all model parameters are common knowledge; employees choose intensities before burnout is realized and have no information about their susceptibility.

An active employee bears the instantaneous work cost $x_i^\alpha t^{\alpha-1}$ (i.e., work cost is linear in accumulated strain, with cost per unit of strain normalized to one). Burnout imposes an employee cost $\phi^w > 0$, which captures its health and career consequences (Goh et al., 2016; Salvagioni et al., 2017). A burnout episode also imposes an employer burnout cost $\phi^f > 0$, which captures additional expenses such as employer-funded counseling.

³We conjecture that milder forms of burnout, in which an employee continues to produce at reduced quality, would temper our main results but not change them qualitatively.

2.2. Technology Quality and Performance Incentives

All employees use a common technology of quality $\theta \in [1, \theta^m]$, where $\theta^m > 1$ is an upper bound on technology quality. We assume throughout that θ is determined by external forces (e.g., market-wide advances in AI), and is thus exogenous. Technology multiplies the output produced by work: Employee i 's realized output as a function of work intensity is $y_i(x_i) \equiv \theta x_i \tau_i(x_i)$, and $\mathbf{y}(\mathbf{x}) = (y_1(x_1), \dots, y_n(x_n))$ is the realized output profile across workers. This multiplicative specification follows Nalebuff and Stiglitz (1983) and is also consistent with an O-ring production technology (Kremer, 1993), which has been widely used to model productivity gains from AI (Gans and Goldfarb, 2025).

The employee is paid for their realized output y_i ; we normalize payment per unit of output to one. The firm values each unit of output at $v > 1$. Motivated by the tournament and multi-agent contracting literature, we also allow compensation to depend on performance relative to coworkers (Lazear and Rosen, 1981; Nalebuff and Stiglitz, 1983; Mookherjee, 1984). We do so by including a relative-performance adjustment, r_i , so the firm's total payment to the employee is $y_i(x_i) + r_i$.

To define r_i , for any $z \in \mathbb{R}$, write $(z)_+ \equiv \max\{z, 0\}$. Let $\bar{y} = n^{-1} \sum_j y_j$ denote average output, and let $\gamma \geq 0$ denote the strength of the relative-performance incentive, equivalently the relative-output advantage at which the reward reaches its maximum. Employee i 's relative-pay adjustment is then

$$r_i(\mathbf{y}, \gamma) = \int_0^{y_i - \bar{y}} (\gamma - z)_+ dz. \quad (3)$$

Because firms' exact pay schedules are rarely observable, we use (3) as a tractable approximation – it rewards performance relative to the group average, up to a maximum that depends on γ . Larger γ rewards high performers more aggressively; for simplicity, we refer to γ as the *incentive*. All parties are risk neutral.

3. Preliminaries

This section derives the expected payoffs of employees and the firm and characterizes the equilibrium of the work-intensity game. Setting $t = 1$ in (2), the probability that burnout ends production during the period is $\psi(x_i, \rho) \equiv \Pr(\tau_i(x_i) < 1 \mid x_i) = 1 - e^{-\rho x_i^\alpha / \alpha}$. The remaining probability mass is at $\tau_i = 1$. Then, because the instantaneous work cost is $x_i^\alpha t^{\alpha-1}$, an employee's total expected work cost over the

period is

$$\begin{aligned}\mathbb{E} \left[\int_0^{\tau_i(x_i)} x_i^\alpha t^{\alpha-1} dt \middle| x_i \right] &= \int_0^1 x_i^\alpha t^{\alpha-1} e^{-\rho x_i^\alpha t^\alpha / \alpha} dt \\ &= \frac{1}{\rho} \left(1 - e^{-\rho x_i^\alpha / \alpha} \right) \\ &= \frac{1}{\rho} \psi(x_i, \rho).\end{aligned}$$

Incorporating the burnout cost ϕ^w , the employee's total expected cost is

$$c(x_i, \rho) \equiv \left(\frac{1}{\rho} + \phi^w \right) \psi(x_i, \rho). \quad (4)$$

Taking coworkers' intensities $\mathbf{x}_{-i}$ as given, employee i chooses x_i to maximize $u_i(x_i, \mathbf{x}_{-i}) = \mathbb{E}[y_i(x_i) + r_i(\mathbf{y}(\mathbf{x}), \gamma) \mid \mathbf{x}] - c(x_i, \rho)$, the expected compensation net of the cost in (4). An intensity that maximizes this expected payoff is a best response to $\mathbf{x}_{-i}$. Total expected employee welfare for an arbitrary intensity profile is then

$$\sum_{i=1}^n u_i(x_i, \mathbf{x}_{-i}). \quad (5)$$

Let $L(\mathbf{x}, \rho)$ denote the total expected work completed by employees during the period:

$$L(\mathbf{x}, \rho) \equiv \sum_{i=1}^n \mathbb{E}[x_i \tau_i(x_i) \mid \mathbf{x}] = \sum_{i=1}^n x_i \int_0^1 \Pr(\tau_i(x_i) > t \mid \mathbf{x}) dt = \sum_{i=1}^n \int_0^{x_i} e^{-\rho k^\alpha / \alpha} dk.$$

This includes work completed by employees who later burn out. Expected aggregate output is then $\theta L(\mathbf{x}, \rho)$. Incorporating payments to all employees, the firm's expected profit is

$$\pi(\mathbf{x}, \theta, \rho, \gamma) \equiv \underbrace{(v-1)\theta L(\mathbf{x}, \rho)}_{\text{Net value of labor output}} - \underbrace{\mathbb{E} \left[\sum_{i=1}^n r_i(\mathbf{y}(\mathbf{x}), \gamma) \middle| \mathbf{x} \right]}_{\text{Incentive payments}} - \underbrace{\phi^f \sum_{i=1}^n \psi(x_i, \rho)}_{\text{Employer burnout cost}}. \quad (6)$$

A pure-strategy Nash equilibrium is an intensity profile in which every employee's intensity is a best response to coworkers' intensities. Formally, $\mathbf{x}^*$ is an equilibrium if $u_i(x_i^*, \mathbf{x}_{-i}^*) \geq u_i(z, \mathbf{x}_{-i}^*)$ for all $z \geq 0$ and $i \in \mathcal{N}$. Intensities are chosen before burnout is realized, so outputs and payoffs remain random at the time of choice.

Lemma 1 (Best responses and Nash equilibrium). *For each profile of coworkers' intensities, each employee has a unique best response. The work-intensity game has a unique Nash equilibrium, and this*

equilibrium is symmetric. The equilibrium intensity x^* is the unique positive solution to

$$(1 + \rho\phi^w)(x^*)^{\alpha-1} = \theta \left[1 + \frac{n-1}{n} \mathbb{E} \left[\left(\gamma - \frac{\theta x^*}{n} \sum_{j=1}^{n-1} [1 - \tau_j(x^*)] \right)_+ \right] \right]. \quad (7)$$

The equilibrium condition balances the rewards from additional work against its strain and burnout costs. The term $x^*[1 - \tau_j(x^*)]$ captures the work lost when coworker j burns out. This lost work gives employees who remain productive a relative-performance advantage. Because the marginal reward from relative performance declines as this advantage grows, coworker burnout can weaken the incentive to work more.

We write the symmetric equilibrium profile as $\mathbf{x}^* = \mathbf{x}^*(\theta, \rho, \gamma) = (x^*, \dots, x^*)$, and equilibrium burnout probability as $\psi^* = \psi(x^*, \rho)$. Evaluating (5) and (6) at this profile gives equilibrium employee welfare $W(\theta, \rho, \gamma) \equiv \sum_{i=1}^n u_i(x_i^*, \mathbf{x}_{-i}^*)$ and firm profit $\Pi(\theta, \rho, \gamma) \equiv \pi(\mathbf{x}^*, \theta, \rho, \gamma)$. For fixed ρ , write $L(x) \equiv L((x, \dots, x), \rho)$. Holding ρ and γ fixed, equilibrium expected total work is $L(x^*(\theta))$, and expected aggregate output is $\theta L(x^*(\theta))$.

4. Technology, Employee Welfare, and Firm Profit

This section examines how improvements in technology quality affect employee welfare and firm profit when the incentive γ is fixed. Lemma 2 first characterizes how equilibrium work intensity x^* and burnout probability ψ^* change with technology quality θ . These responses drive Propositions 1 and 2, which characterize the effects of better technology on employee welfare W and firm profit Π .

4.1. Rat Race Effect: Impact of Technology on Work Intensity

Lemma 2. *Let $\bar{\gamma}_R \equiv n/(n-1)$. The following statements hold.*

- (i) *If $\gamma \in [0, \bar{\gamma}_R]$, then equilibrium work intensity x^* and burnout probability ψ^* strictly increase in technology quality θ on $[1, \theta^m]$.*
- (ii) *Suppose $\theta^m > 1 + \bar{\gamma}_R$. For each $\gamma \in (\bar{\gamma}_R, \theta^m - 1)$, there exists an exposure threshold $\bar{\rho} > 0$ such that if $\rho > \bar{\rho}$, there are burnout-cost thresholds $0 \leq \underline{\phi}^w < \bar{\phi}^w$ with the following property: If $\phi^w \in (\underline{\phi}^w, \bar{\phi}^w)$, then both x^* and ψ^* strictly decrease in θ on $[\bar{\theta}, \theta^m]$ for some $\bar{\theta} \in (1, \theta^m)$.*

Two forces determine how the equilibrium work intensity x^* changes as technology quality θ increases. The first is the *rat-race effect*: Each employee anticipates that better technology will raise their coworkers' output. This creates an incentive to increase their own work intensity to avoid falling behind their peers and being penalized through the relative-performance component of pay. Consequently, an

increase in θ creates upward pressure on the equilibrium work intensity x^* .

Second, better technology creates a *competition cooling effect*. When coworker j burns out, they lose $\theta x[1 - \tau_j(x)]$ units of output, lowering the group average and giving employees who remain productive a relative-performance advantage. Higher technology quality magnifies this advantage, reducing the additional relative reward from working harder. This encourages a “strategic survival” behavior: employees benefit simply by remaining productive and avoiding burnout, which incentivizes them to moderate their work intensity, putting downward pressure on x^* .

The conditions in Lemma 2(ii) describe when the competition cooling effect dominates the rat-race effect, leading equilibrium work intensity x^* to decrease as technology improves. The condition $\gamma > \bar{\gamma}_R$ ensures that employees’ relative performance is a large enough component of their total payoff for coworkers’ burnout to meaningfully impact their strategic work intensity. Requiring burnout exposure to be sufficiently high, $\rho > \bar{\rho}$, plays a similar role. The bounds on ϕ^w keep work intensity high enough for coworker burnout to create a meaningful relative-output advantage, but low enough that relative rewards remain below the maximum amount. The equilibrium burnout probability ψ^* moves in the same direction as x^* because $\psi(x, \rho)$ increases in x .

4.2. Employee Welfare

We now examine how the strategic work behavior described above shapes employee welfare. Because better technology makes each unit of work more productive, one might expect it to benefit employees. Our first result shows that this need not be the case: it characterizes when better technology lowers welfare without burnout, and shows that with burnout the rat-race effect from Lemma 2 can initially dominate, causing employee welfare to fall before eventually recovering.

Proposition 1 (Technology and employee welfare). *Let $\bar{\gamma}_W \equiv n(\alpha - 1)/(n - 1)$. The following statements hold.*

- (i) *In the absence of burnout, $\rho = 0$, employee welfare W is strictly increasing, constant, or strictly decreasing in θ on $[1, \theta^m]$ according as $\gamma < \bar{\gamma}_W$, $\gamma = \bar{\gamma}_W$, or $\gamma > \bar{\gamma}_W$.*
- (ii) *For any $\gamma > \bar{\gamma}_W$ and $\phi^w > 0$, sufficiently high exposure ρ implies that W strictly decreases in θ on $[1, \theta_d]$ for some $\theta_d \in (1, \theta^m)$.*
- (iii) *For each $\gamma > \bar{\gamma}_W$, there exists a threshold $\bar{\phi}^w(\gamma) > 0$ such that if $\phi^w \in (0, \bar{\phi}^w(\gamma))$, then for sufficiently large ρ there exist a finite $\theta^m > 1$ and thresholds $1 < \theta_d < \theta_u < \theta^m$ with the following property: W strictly decreases in θ on $[1, \theta_d]$, while equilibrium work intensity x^* and burnout probability ψ^* strictly decrease and W strictly increases on $[\theta_u, \theta^m]$. Consequently, W has at least one interior minimum over $[1, \theta^m]$.*

The no-burnout benchmark in Proposition 1(i) shows that strong relative-performance incentives alone can make productivity improvements reduce employee welfare. To understand the effects with burnout, let $\widehat{W}(x, \theta)$ denote total employee welfare when all employees choose the same work intensity x , holding ρ and γ fixed. Since equilibrium welfare is $W(\theta) = \widehat{W}(x^*(\theta), \theta)$, the total effect on welfare as θ increases is

$$\frac{dW}{d\theta} = \underbrace{\frac{\partial \widehat{W}}{\partial \theta}}_{\text{Direct technology effect}} + \underbrace{\frac{\partial \widehat{W}}{\partial x} \frac{dx^*}{d\theta}}_{\text{Strategic work-intensity effect}} \quad (8)$$

Under the conditions in part (ii), the direct technology effect in (8) is positive. For the strategic work-intensity effect, note that when burnout exposure is high and θ is low, equilibrium work intensity x^* is also low, which makes coworker burnout rare. In this low-burnout setting, the rat-race effect dominates, yielding $dx^*/d\theta > 0$. This additional work lowers total welfare, $\partial \widehat{W}/\partial x < 0$, because employees end up working more intensely than they would collectively prefer. The strong incentive condition $\gamma > \bar{\gamma}_W$ makes this negative strategic effect outweigh the positive direct effect of better technology.

Part (iii) shows that, if the employee burnout cost is also sufficiently small, welfare recovers over a higher-technology interval where competition cools and work intensity decreases, $dx^*/d\theta < 0$. Here the direct technology effect is positive and $\partial \widehat{W}/\partial x < 0$, so both terms in (8) are positive. Note that falling intensity is sufficient but not necessary for this rebound: welfare can recover while intensity is still rising, provided competition has cooled enough for the direct effect to dominate (Figure 2).

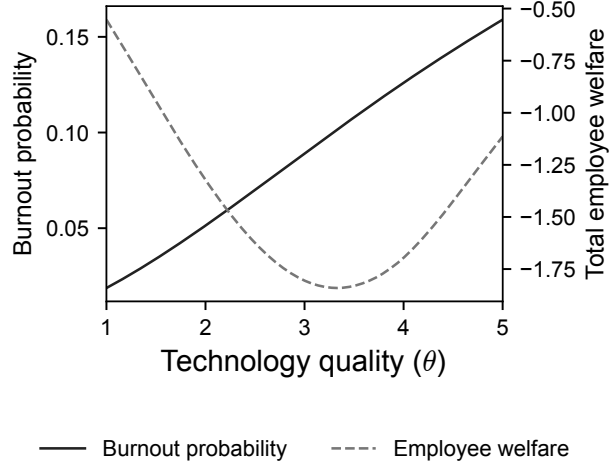


Figure 2: Technology and employee outcomes under a fixed incentive. Total employee welfare (dashed, right axis) reaches a minimum near $\theta = 3.3$ and then recovers as the rat race cools, even as burnout probability (solid, left axis) continues to rise. Parameters: $\alpha = 3$, $n = 4$, $\gamma = 3$, $\rho = 0.01$, $\phi^w = 2$.

What does Proposition 1 imply for firms adopting new technology? Advancements in technology can raise output while lowering employee welfare if relative performance incentives are strong. Each employee is incentivized to increase their work intensity to keep up with more productive coworkers, even though all employees would benefit from collectively moderating their response. Employees' seemingly voluntary decisions to take on more work following AI adoption (Ranganathan and Ye, 2026) may therefore reflect competitive pressure to keep up with coworkers, rather than productivity gains alone.

This welfare loss arises even though the firm leaves its reward structure unchanged. A firm seeking to protect employee welfare may therefore consider weakening relative-performance incentives as technology improves, much as firms may compress pay differentials to curb harmful competition among employees (Lazear, 1989). Section 5 examines the firm's own incentives in light of these competitive dynamics.

4.3. Firm Returns to Technology

At a fixed work intensity, output increases linearly in technology quality. Employees' work responses can therefore determine whether the firm's marginal returns rise or fall as technology improves. Our next result gives the no-burnout benchmark, shows that marginal returns can initially increase even with burnout, and provides conditions under which they later decrease as competition cools.

Proposition 2 (Burnout and marginal returns to technology). *The following statements hold.*

- (i) *In the absence of burnout risk, $\rho = 0$, the return to technology $d\Pi/d\theta$ is positive and strictly increases in θ on $[1, \theta^m]$.*
- (ii) *For any $\gamma > 0$ and $\phi^w > 0$, sufficiently large ρ implies that, for sufficiently large v , the return to technology is positive and strictly increases in θ on $[1, \theta_a]$ for some $\theta_a \in (1, \theta^m)$.*
- (iii) *For each $\gamma > \bar{\gamma}_R$, there exists a threshold $\bar{\phi}_P^w(\gamma) > 0$ such that if $\phi^w \in (0, \bar{\phi}_P^w(\gamma))$, then for sufficiently large ρ there exist a finite $\theta^m > 1$ and thresholds $1 < \theta_a < \theta_b < \theta^m$ with the following property: For sufficiently large v , the return to technology is positive and strictly increases on $[1, \theta_a]$, while it is positive and strictly decreases on $[\theta_b, \theta^m]$. On the latter interval, equilibrium work intensity x^* and burnout probability ψ^* also strictly decrease. Consequently, $d\Pi/d\theta$ has at least one interior maximum over $[1, \theta^m]$.*

To interpret the result, consider how the net value of employee output, $(v - 1)\theta L(x^*)$, changes as technology quality θ increases. Similar to the decomposition in (8), a direct effect arises from the productivity gain at a fixed level of expected total work $L(x)$. A second, strategic effect arises because employees adjust their work intensity $x^*(\theta)$ as technology improves, changing expected total work. The firm's marginal return to technology therefore depends on both the level of expected total work $L(x^*)$ and how the equilibrium work intensity x^* adjusts.

Proposition 2(i) gives the no-burnout benchmark when $\rho = 0$. Without burnout, better technology always intensifies the rat race. Equilibrium work intensity is proportional to $\theta^{1/(\alpha-1)}$, so profit is proportional to $\theta^{\alpha/(\alpha-1)}$. The firm's marginal return therefore rises with technology quality.

Part (ii) shows that marginal returns can also initially increase with burnout. As in Proposition 1(ii), high underlying exposure induces low work intensity at low technology levels, making realized burnout rare. Better technology then encourages additional work, and the firm's marginal return rises when the value of output is sufficiently high.

Part (iii) shows that, under stronger conditions, this initial increase reverses at higher technology levels within the same environment. Strong relative-performance incentives allow coworker burnout to cool competition, while a sufficiently small employee burnout cost allows work intensity to reach a level at which this effect becomes important. Near the point where work intensity turns downward, expected output continues to rise but at a decreasing rate. The large- v condition ensures that this output effect dominates changes in incentive payments and employer burnout costs. Technology therefore continues to raise profit on the higher-technology interval, but by progressively smaller amounts.

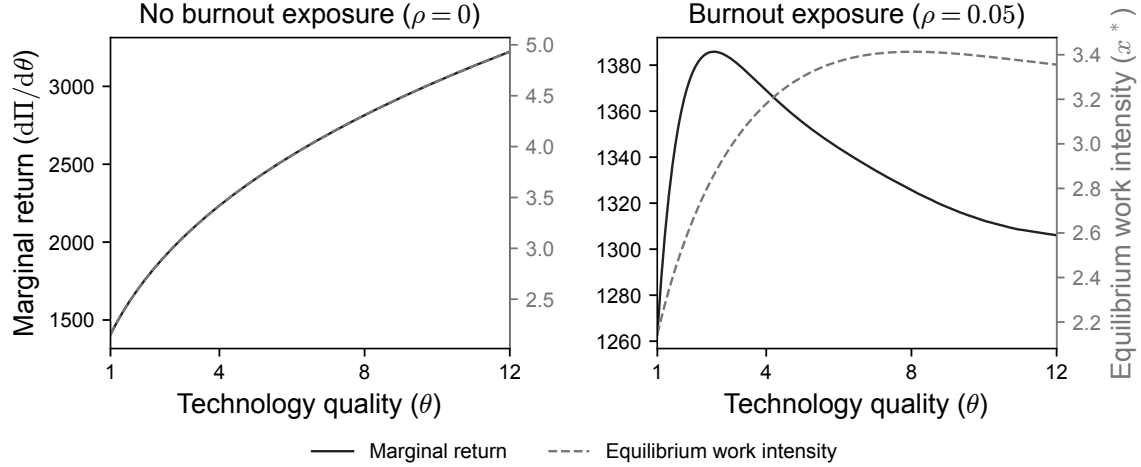


Figure 3: Marginal returns to technology with and without burnout exposure. Without burnout (left), the marginal return $d\Pi/d\theta$ is proportional to equilibrium work intensity x^* , so the two curves overlap and both increase in θ . With burnout (right), the marginal return peaks and then declines as competition cools, while work intensity turns downward only at higher θ . Parameters: $\alpha = 4$, $n = 10$, $\gamma = 10$, $v = 50$, $\phi^w = 0.1$, $\phi^f = 0.1$.

Proposition 2 suggests that improvements in technology may yield successively smaller gains in environments where employees face burnout risk. For managers, this implies that extrapolating from early gains may overstate the returns to further improvements, particularly in competitive environments. The competition cooling effect that drives Proposition 2(iii) is also consistent with evidence that contest leaders reduce effort as their lead grows (Casas-Arce and Martínez-Jerez, 2009). Our result also supports the view that organizational practices shape the returns to technology (Brynjolfsson and Hitt, 2000), in this case with respect to how employee performance is compared and rewarded.

5. Working Conditions and the Firm's Incentive Response

Section 4 shows that productivity-enhancing technology can intensify competition and reduce employee welfare. These effects may be tempered by improvements in working conditions, such as greater flexibility over work hours (Moen et al., 2016), which we capture as a reduction in burnout exposure ρ . Such improvements are often determined outside the firm's incentive decision, for example by regulation, company-wide policy, or broader changes in workplace norms. We therefore treat ρ as exogenous and ask: to what extent do improvements in working conditions benefit employees once the firm adjusts its performance incentive? We first hold technology quality θ fixed, allowing the firm to choose the performance incentive γ before employees choose their work intensities, and return to technology at the end of the section. Section 6 allows the firm to choose working conditions as well.

The firm chooses its performance incentive to maximize equilibrium profit:

$$\gamma^*(\theta, \rho) \in \arg \max_{\gamma \geq 0} \Pi(\theta, \rho, \gamma).$$

We write $x^*(\theta, \rho)$, $\psi^*(\theta, \rho)$, and $W^*(\theta, \rho)$ for equilibrium work intensity, burnout probability, and total employee welfare under this incentive.

Proposition 3 characterizes the effect of an improvement in workplace conditions when the firm can freely adjust the incentive γ .

Proposition 3 (Burnout exposure and employee outcomes). *Fix θ and $\phi^f > 0$. The following statements hold.*

- (i) *For any fixed incentive $\gamma > 0$, there exists an exposure threshold $\bar{\rho}_\gamma > 0$ such that as ρ decreases within $(0, \bar{\rho}_\gamma)$, equilibrium work intensity x^* strictly increases but burnout probability ψ^* strictly decreases.*
- (ii) *When the firm chooses the incentive γ , there exists an exposure threshold $\bar{\rho} > 0$ such that as ρ decreases within $(0, \bar{\rho})$, the optimal incentive γ^* , work intensity x^* , and burnout probability ψ^* strictly increase, while employee welfare W^* strictly decreases.*
- (iii) *If $1 < (v - 1)\phi^w/\phi^f < \alpha$, there exists a threshold $\underline{\rho} > \bar{\rho}$ such that as ρ decreases within $(\underline{\rho}, \infty)$, the firm's optimal incentive induces strictly higher work intensity x^* , burnout probability ψ^* , and employee welfare W^* .*

Part (i) establishes a benchmark with a fixed incentive. Lower burnout exposure encourages employees to work more, but when exposure is already low, the protection offered by better working conditions is strong enough that realized burnout still falls. Part (ii) reverses this conclusion: once the firm adjusts its incentive, the additional work it induces outweighs the improvement in working conditions, and burnout rises.

To understand this reversal, it is helpful to consider the two effects of a reduction in burnout exposure. The first is a direct “protection effect”: at a fixed work intensity, lower exposure reduces burnout and keeps employees productive for longer. However, lower exposure also triggers an “incentive effect”: the firm responds to improved working conditions by ratcheting up the incentive γ^* and demanding more work. Under the conditions in part (ii), the incentive effect dominates.

Why would the firm accept higher burnout? Because $\psi(x, \rho) = 1 - e^{-\rho x^\alpha/\alpha}$, lower exposure ρ lets employees work more intensely at the same burnout probability and with the same distribution of burnout times $\tau_i(x)$ (Lemma 3), so each employee's output $\theta x \tau_i(x)$ grows in both mean and dispersion.

Both benefit the firm: higher output is more valuable, and greater dispersion reduces total relative pay because the schedule (3) penalizes falling behind more than it rewards getting ahead (Lemma 5). Since each increase in burnout probability now buys more work while the expected burnout cost $n\phi^f\psi$ is unchanged, the firm targets a higher ψ^* and implements it through a higher γ^* .

Figure 4(b) illustrates a numerical example of the firm's choice for two exposure levels, $\rho_1 < \rho_2$. Because equilibrium intensity is strictly increasing in γ , the firm's choice of incentive is equivalent to a choice of target intensity x . At each exposure level ρ_1 and ρ_2 , the firm's preferred target intensity x lies where its marginal return from additional work and marginal burnout cost intersect. A decrease in the exposure ρ shifts this intersection to a higher value of x , which, by monotonicity, the firm implements through a higher incentive γ^* . The shaded area under each crossing in Figure 4(b) is proportional to the cumulative burnout hazard $\rho(x^*)^\alpha/\alpha$, meaning the larger region corresponding to ρ_1 reflects a higher equilibrium burnout probability $\psi^* = 1 - e^{-\rho(x^*)^\alpha/\alpha}$.

For employees, the welfare effect depends on how much additional work strain they experience. Lower exposure does not reduce the strain generated by a given amount of work; instead, it allows employees to accumulate more strain before burning out. Expected work cost is ψ^*/ρ , which rises as exposure falls and equilibrium burnout increases. When exposure is sufficiently low, this higher work cost outweighs the change in expected compensation, and employee welfare falls (Figure 4(a)).

Finally, part (iii) shows that employee welfare need not decrease as ρ decreases. At sufficiently high exposure, lower exposure again induces more work and more burnout, but employee welfare now rises. The condition $1 < (v - 1)\phi^w/\phi^f < \alpha$ places the employer's burnout cost in an intermediate range where the firm still prefers a positive relative-performance incentive, and the additional compensation outweighs employees' additional costs. An increase in burnout can therefore accompany either a welfare gain or a welfare loss. Figure 4(a) displays both cases.

One may interpret part (ii) as a form of risk compensation (Peltzman, 1975), in which a safety improvement is offset by riskier behavior. Here, the riskier behavior is prompted by the firm: its change in the incentive induces employees to work more, which more than offsets the safety improvement.

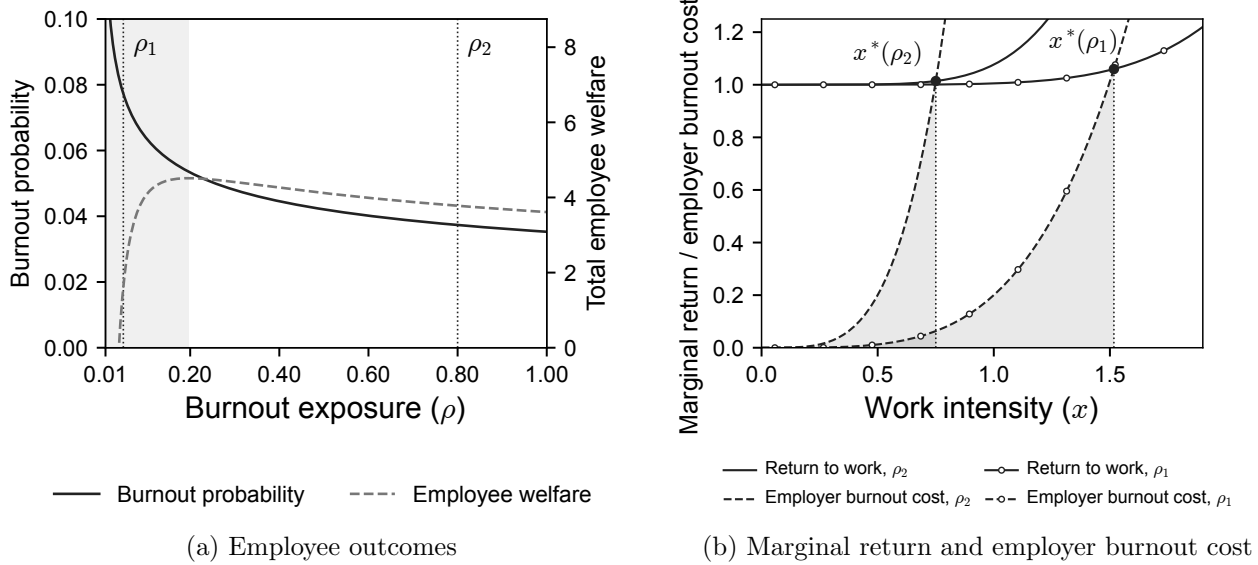


Figure 4: Burnout exposure under the firm's optimal incentive. Panel (a) shows equilibrium burnout and employee welfare; shading marks the low-exposure region in which a further decrease in exposure lowers welfare (Proposition 3(ii)). Panel (b) shows the firm's normalized marginal return (solid) and marginal employer burnout cost (dashed) at $\rho_1 = 0.05$ (circles) and $\rho_2 = 0.8$; their intersections give the firm's implemented work intensities. Parameters: $\alpha = 5$, $n = 4$, $\theta = 2$, $v = 1.5$, $\phi^w = 13.35$, $\phi^f = 4$.

The firm's incentive response also changes how technology affects employees, as the following result shows.

Corollary 1 (Technology under endogenous incentives). *Fix $\phi^f > 0$. When the firm chooses the incentive γ , there exists an exposure threshold $\bar{\rho}_T > 0$ such that, for any $\rho \in (0, \bar{\rho}_T)$, equilibrium work intensity x^* and burnout probability ψ^* strictly increase in technology quality θ on $[1, \theta^m]$.*

Corollary 1 shows that, when exposure is sufficiently low, work intensity and burnout continue to rise as technology improves under the firm's optimal incentive. The decline in intensity and burnout that can arise under fixed incentives in Section 4 is therefore absent in this region.

Proposition 3 adds an important caveat to the view that improved working conditions buffer employees against burnout (Bakker et al., 2005): the firm can optimize away these protections by adjusting its performance incentives. We next examine how the objective guiding workplace design shapes the combination of competitive pressure and preventive support the firm chooses.

6. Mitigation Spending and Employee Welfare

Investments in employee well-being, such as wellness programs, provide a natural starting point for assessing how well a workplace protects its employees. However, Section 5 shows that working conditions

and performance incentives are closely linked: when working conditions improve, a profit-maximizing firm may respond by strengthening its incentive and inducing more work. Here we assume the firm now invests in burnout mitigation jointly with choosing the performance incentive. We then compare the profit-maximizing design with one that maximizes social welfare, which also accounts for employees' costs. This benchmark reflects the choices of a regulator, or of a firm that fully internalizes employee welfare, so the comparison isolates the effect of the firm ignoring employees' costs of work and burnout. Formally, we allow the firm to choose ρ , a stylized representation of the investments or policy choices, such as greater scheduling flexibility, through which it shapes employees' working conditions. Let $C(\rho)$ denote the per-employee cost required to achieve ρ . The firm chooses ρ jointly with the performance incentive γ , after which employees choose their work intensities.

Assumption 1 (Burnout mitigation). *Mitigation spending per employee is $C(\rho) > 0$, where C is continuously differentiable with $C'(\rho) < 0$, $\lim_{\rho \downarrow 0} \rho C(\rho) = \infty$, and $\lim_{\rho \uparrow \infty} \rho C(\rho) = 0$.*

Assumption 1 imposes regularity conditions on $C(\rho)$ such that it is optimal for the firm to choose a strictly positive and finite value of ρ .

We consider both profit-maximizing and social welfare-maximizing objectives. Using the equilibrium profit $\Pi(\theta, \rho, \gamma)$ defined from (6), the profit-maximizing design $(\rho^F(\theta), \gamma^F(\theta))$ maximizes $\Pi(\theta, \rho, \gamma) - nC(\rho)$ over $\rho > 0$ and $\gamma \geq 0$. For social welfare, combining firm profit in (6) with employee welfare in (5), and subtracting mitigation spending, gives the objective

$$\Pi(\theta, \rho, \gamma) + W(\theta, \rho, \gamma) - nC(\rho) = v\theta L(\mathbf{x}^*, \rho) - n \left[\left(\phi^f + \frac{1}{\rho} + \phi^w \right) \psi(x^*, \rho) + C(\rho) \right]. \quad (9)$$

Note that the employee payment terms cancel in the sum of firm profit and employee welfare. Each unit of output thus contributes its full gross value v to the social objective in (9).

Let $(\rho^S(\theta), \gamma^S(\theta))$ denote any design that maximizes (9), and let $\psi^S(\theta)$ and $\psi^F(\theta)$ denote the equilibrium burnout probabilities under the social welfare-maximizing and profit-maximizing designs. We suppress the dependence on θ when it is clear. To compare the designs under common working conditions, we also fix ρ and write $x^F(\rho)$ and $x^S(\rho)$ for the work intensities each design prefers when it chooses only γ , with associated incentives $\gamma^F(\rho)$ and $\gamma^S(\rho)$ and burnout probabilities $\psi^F(\rho)$ and $\psi^S(\rho)$. Lemma 8 in Appendix A characterizes $x^S(\rho)$.

Proposition 4 characterizes the optimal choice of ρ and γ under both the profit- and social welfare-maximizing designs, and the implications for employees' equilibrium burnout probabilities.

Proposition 4 (Social welfare and burnout mitigation). *The following statements hold.*

- (i) *At any exposure $\rho > 0$, the profit-maximizing design induces at least as much work, competitive pressure, and burnout as the social design: $x^F(\rho) \geq x^S(\rho)$, $\gamma^F(\rho) \geq \gamma^S(\rho)$, and $\psi^F(\rho) \geq \psi^S(\rho)$. All three inequalities are strict whenever $\gamma^S(\rho) > 0$.*
- (ii) *Suppose Assumption 1 holds. There exist thresholds $\underline{\phi}^w > 0$, $\bar{\phi}^f > 0$, and $\underline{\theta} > 1$ such that if $\phi^w > \underline{\phi}^w$, $\phi^f \in (0, \bar{\phi}^f)$, and $\theta \in [1, \underline{\theta}]$, the joint social design chooses higher exposure, $\rho^S > \rho^F$, and therefore spends less on mitigation. It also chooses a weaker incentive, $\gamma^S < \gamma^F$, and induces lower burnout, $\psi^S < \psi^F$.*

Part (i) gives a comparison at the same working conditions. Stronger competition raises work intensity and reduces equilibrium employee welfare at a fixed exposure. The firm therefore has a stronger reason to induce work than the social design, which also counts employees' costs. Part (ii) delivers a more striking contrast: once both designs can choose working conditions, the social design can induce less burnout while spending less on mitigation.

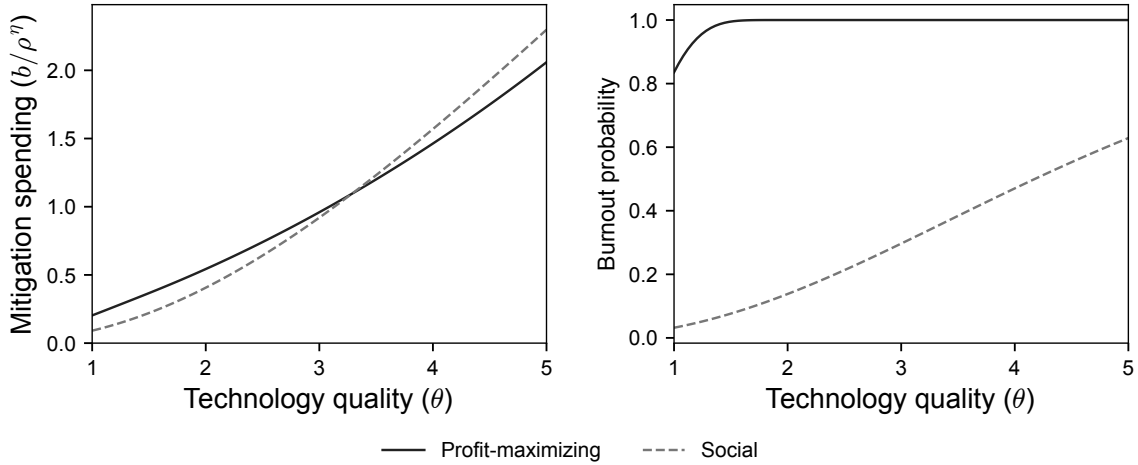


Figure 5: Profit-maximizing and social welfare-maximizing workplace designs. Under the mitigation cost $C(\rho) = b/\rho^\eta$, which satisfies Assumption 1, the social design spends less on mitigation (left) at low technology quality and more at high technology quality. Burnout probability (right) approaches one under the profit-maximizing design but remains much lower under the social design. Parameters: $\alpha = 3$, $n = 4$, $v = 3$, $\phi^w = 4$, $\phi^f = 0.25$, $b = 20$, $\eta = 1.5$.

The joint-design comparison in part (ii) is driven by the different ways in which the two designs value burnout. In Π , burnout affects expected total work, employee payments, and the employer burnout cost $n\phi^f\psi$, whereas the social objective in (9) also counts employees' active-work cost, $n\rho^{-1}\psi$, and burnout loss, $n\phi^w\psi$. When ϕ^w is high and ϕ^f is low, the social design therefore has a stronger reason to reduce work, which it does by weakening the incentive ($\gamma^S < \gamma^F$).

A weaker incentive also lowers the return to mitigation, which is valuable only to the extent that there is work to protect. Further, for the social design, keeping employees productive for longer means they also bear the cost of that work for longer. When technology quality is low, the output sacrificed by reducing work is small, so the social design prefers to reduce work rather than protect it ($\rho^S > \rho^F$). Although higher exposure raises burnout risk at a given intensity, the reduction in work is large enough that cumulative exposure is lower under the social design, $\rho^S(x^S)^\alpha < \rho^F(x^F)^\alpha$, so $\psi^S < \psi^F$. The incentive determines how much work is performed, and mitigation protects that work; a design that values employee welfare uses less of both.

In the numerical example in Figure 5, the profit-maximizing design induces near-certain burnout once technology quality is sufficiently high. This reflects the parameters chosen to satisfy Proposition 4(ii) (namely, a high employee burnout cost ϕ^w and a low employer burnout cost ϕ^f), under which the firm extracts the maximum work each employee can sustain and absorbs burnout as the cost of doing so. At higher technology quality, however, reducing work sacrifices more valuable output, and mitigation can become the better way to protect employees, which is why the social design spends more on mitigation in this range.

What does Proposition 4 imply for evaluating investments in employee well-being? Part (ii) shows that mitigation spending can be a misleading measure of employee protection. The profit-maximizing firm spends more on mitigation because it generates more intensive work through strong incentives, and therefore must spend more on mitigation to protect employee productivity from burnout. A firm's spending on well-being may therefore reflect the demands a firm places on employees through induced competition.

7. Discussion

Productivity-enhancing technologies such as artificial intelligence promise substantial gains for firms, yet early evidence suggests they may also intensify work (Jiang et al., 2025; Ranganathan and Ye, 2026). Motivated by this, we offer guidelines on when improvements in technology and investments in employee well-being benefit or harm employees and firms. Our findings suggest that these outcomes are shaped by three key characteristics: technology quality (θ), the strength of relative-performance incentives (γ), and employees' underlying burnout exposure (ρ).

When adopting productivity-enhancing technology, it is natural to expect that employees would benefit from lighter workloads. Our results challenge this expectation: when employees are evaluated relative to their peers, better technology can intensify competition and lower employee welfare, even when the firm leaves its incentive scheme unchanged. Firms should therefore evaluate the impact of new

technologies using employee-centered metrics, such as work hours, absences, and turnover, rather than inferring benefits from employees’ willingness to take on more work. Similarly, one might expect firm profit to rise in step with the productivity gains from technology. Instead, the marginal return to technological improvements can decline as employees strategically moderate their work intensity.

Similar considerations apply to interventions that address employee well-being. Improving working conditions can backfire once the firm adjusts its incentives, raising burnout and lowering employee welfare (Proposition 3). Because observed burnout reflects both working conditions and the demands employees face, the relevant question is how much protection remains once the firm’s incentives and employees’ work intensity respond. Likewise, a firm may spend more on burnout mitigation precisely because it demands more intensive work, exposing employees to greater burnout as a result (Proposition 4). In both cases, neither employees’ willingness to work harder nor the firm’s willingness to spend more on support necessarily indicates that employees benefit, which suggests that productivity, work intensity, and employee outcomes should be evaluated together.

Naturally, firms could also use other design levers beyond those considered here. In particular, team-based rewards may dampen competition among coworkers, although they may also weaken individual incentives and invite free-riding. Further analysis is needed to determine when such rewards might protect employees without sacrificing excessive output. Firms may also tailor technology access, mitigation, or performance evaluation across employees, which would require relaxing our assumption that employees are identical.

Lastly, our model abstracts away from several features that may matter in practice. Employees are identical and face independent burnout events, and the firm uses a common technology and incentive across employees. Relaxing these assumptions would introduce richer dynamics. For instance, employees may differ in how effectively they use technology, burnout may shift work onto coworkers, and work intensity may change over time. Technology quality is also exogenous throughout our analysis. Endogenizing the firm’s technology adoption decision may uncover new results that inform how firms should address questions of performance incentives, workplace competition, and employee welfare as technology continues to progress.

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A Proofs

Throughout this appendix, $x\tau_i(x)$ and $x[1 - \tau_i(x)]$ denote employee i 's completed work and work lost to burnout at intensity x .

Lemma 3 (Completed work). *For each $x > 0$ and $\rho > 0$, $\Pr(x\tau_i(x) > k) = e^{-\rho k^\alpha/\alpha}$ for $0 \leq k < x$ and $\Pr(x\tau_i(x) > k) = 0$ for $k \geq x$. Therefore,*

$$\mathbb{E}[x\tau_i(x)] = \int_0^x e^{-\rho k^\alpha/\alpha} dk, \quad \mathbb{E}[(x\tau_i(x))^2] = \int_0^x 2k e^{-\rho k^\alpha/\alpha} dk. \quad (10)$$

Completed work and lost work are both stochastically increasing in x . For any differentiable function g ,

$$(\partial/\partial x)\mathbb{E}[g(x\tau_i(x))] = [1 - \psi(x, \rho)]g'(x), \quad (\partial/\partial x)\mathbb{E}[g(x[1 - \tau_i(x)])] = \mathbb{E}[g'(x[1 - \tau_i(x)])\mathbf{1}\{\tau_i(x) < 1\}]. \quad (11)$$

In particular, $(\partial/\partial x)\mathbb{E}[x\tau_i(x)] = 1 - \psi$, $(\partial/\partial x)\mathbb{E}[x(1 - \tau_i(x))] = \psi$, and $(\partial/\partial x)\psi = \rho x^{\alpha-1}(1 - \psi)$. For every x , $\mathbb{E}[x\tau_i(x)] \leq \rho^{-1/\alpha}\alpha^{1/\alpha-1}\Gamma(1/\alpha)$ and $\mathbb{E}[(x\tau_i(x))^2] \leq 2\rho^{-2/\alpha}\alpha^{2/\alpha-1}\Gamma(2/\alpha)$, where Γ is the gamma function. As $x \rightarrow \infty$, $\psi \rightarrow 1$ and $\mathbb{E}[x\tau_i(x)]/x \rightarrow 0$.

Lastly, $\Pr(\tau_i(x) \geq t) = e^{-ut^\alpha}$ for $t \in [0, 1]$, where $u = \rho x^\alpha/\alpha$ is cumulative exposure. Therefore, the distribution of $\tau_i(x)$ depends on x and ρ only through u . As $u \rightarrow 0$, $\mathbb{E}[\tau_i(x)] \rightarrow 1$ and $\text{Var}(\tau_i(x)) \rightarrow 0$. As $u \rightarrow \infty$, $\mathbb{E}[\tau_i(x)] \rightarrow 0$ and $\text{Var}(\tau_i(x))/\mathbb{E}[\tau_i(x)] \rightarrow 0$.

Proof. Note that $x\tau_i(x) > k$ if and only if $\tau_i(x) > k/x$, so setting $t = k/x$ in (2) gives the stated survival function. The expressions in (10) then follow from $\mathbb{E}[x\tau_i(x)] = \int_0^\infty \Pr(x\tau_i(x) > k) dk$ and $\mathbb{E}[(x\tau_i(x))^2] = \int_0^\infty 2k \Pr(x\tau_i(x) > k) dk$. The survival function of completed work is weakly increasing in x , as is the survival function of lost work, $\Pr(x[1 - \tau_i(x)] > l) = 1 - e^{-\rho(x-l)^\alpha/\alpha}$ for $0 \leq l < x$. Therefore, completed work and lost work are both stochastically increasing in x .

Next, completed work has a point mass of $1 - \psi(x, \rho)$ at x and density $(\partial/\partial k)\psi(k, \rho) = \rho k^{\alpha-1}e^{-\rho k^\alpha/\alpha}$ on $(0, x)$. Therefore,

$$\begin{aligned} \mathbb{E}[g(x\tau_i(x))] &= g(x)[1 - \psi(x, \rho)] + \int_0^x g(k) (\partial/\partial k)\psi(k, \rho) dk, \\ \mathbb{E}[g(x[1 - \tau_i(x)])] &= g(0)[1 - \psi(x, \rho)] + \int_0^x g(x - k) (\partial/\partial k)\psi(k, \rho) dk. \end{aligned}$$

When we differentiate either expression with respect to x , the terms involving $(\partial/\partial x)\psi(x, \rho)$ cancel, which

gives (11). Setting $g(k) = k$ gives the first two identities that follow it, and the third follows by differentiating $\psi = 1 - e^{-\rho x^\alpha/\alpha}$ directly.

Next, extending the upper limits of integration in (10) to infinity and substituting $w = \rho k^\alpha/\alpha$ gives the stated bounds. Because $\mathbb{E}[x\tau_i(x)]$ is bounded in x , $\mathbb{E}[x\tau_i(x)]/x \rightarrow 0$ as $x \rightarrow \infty$, and $\psi \rightarrow 1$ by definition.

Lastly, by (2), $\Pr(\tau_i(x) \geq t) = e^{-ut^\alpha}$, so $\mathbb{E}[\tau_i(x)] = \int_0^1 e^{-ut^\alpha} dt$ and $\mathbb{E}[\tau_i(x)^2] = \int_0^1 2t e^{-ut^\alpha} dt$. As $u \rightarrow 0$, both integrals converge to one, so $\mathbb{E}[\tau_i(x)] \rightarrow 1$ and $\text{Var}(\tau_i(x)) \rightarrow 0$. As $u \rightarrow \infty$, substituting $w = u^{1/\alpha}t$ shows that $u^{1/\alpha}\mathbb{E}[\tau_i(x)]$ and $u^{2/\alpha}\mathbb{E}[\tau_i(x)^2]$ converge to positive constants. Therefore, $\mathbb{E}[\tau_i(x)] \rightarrow 0$, and $\text{Var}(\tau_i(x))/\mathbb{E}[\tau_i(x)] \leq \mathbb{E}[\tau_i(x)^2]/\mathbb{E}[\tau_i(x)] \rightarrow 0$ because $u^{1/\alpha}$ times the right-hand side converges to a positive constant. $\square$

Lemma 4 (Effects of burnout exposure). *For each $x > 0$ and $\rho > 0$, $\alpha\rho(\partial/\partial\rho)\mathbb{E}[x\tau_i(x)] = x(1 - \psi) - \mathbb{E}[x\tau_i(x)]$ and $\alpha\rho(\partial/\partial\rho)\mathbb{E}[(x\tau_i(x))^2] = 2\{x^2(1 - \psi) - \mathbb{E}[(x\tau_i(x))^2]\}$. Also, $(\partial/\partial\rho)\psi = x^\alpha(1 - \psi)/\alpha$. Therefore, expected completed work strictly decreases in ρ , and expected lost work $\mathbb{E}[x(1 - \tau_i(x))]$ and burnout probability strictly increase in ρ .*

Proof. Integrating $(d/dk)[k e^{-\rho k^\alpha/\alpha}] = e^{-\rho k^\alpha/\alpha} - \rho k^\alpha e^{-\rho k^\alpha/\alpha}$ over $[0, x]$ gives $\rho \int_0^x k^\alpha e^{-\rho k^\alpha/\alpha} dk = \mathbb{E}[x\tau_i(x)] - x(1 - \psi)$. Differentiating the first expression in (10) with respect to ρ and substituting this identity, we have

$$(\partial/\partial\rho)\mathbb{E}[x\tau_i(x)] = -\frac{1}{\alpha} \int_0^x k^\alpha e^{-\rho k^\alpha/\alpha} dk = \frac{x(1 - \psi) - \mathbb{E}[x\tau_i(x)]}{\alpha\rho} < 0,$$

where the inequality holds because $e^{-\rho k^\alpha/\alpha} > 1 - \psi$ for $k < x$. The second identity follows by the same argument applied to $(d/dk)[k^2 e^{-\rho k^\alpha/\alpha}]$, and the expression for $(\partial/\partial\rho)\psi$ follows by direct differentiation. Lastly, expected lost work $x - \mathbb{E}[x\tau_i(x)]$ strictly increases in ρ because expected completed work strictly decreases in ρ . $\square$

Proof of Lemma 1. Step 1. Fix $\mathbf{x}_{-i}$. Employee i 's expected compensation depends on $\tau_i(x_i)$ only through $x_i\tau_i(x_i)$, which is independent of coworkers' completed work, and $(\partial/\partial y_i)r_i = \frac{n-1}{n}[\gamma - (y_i - \bar{y})]_+$. Applying (11) conditional on coworkers' completed work, and differentiating (4) using $(\partial/\partial x)\psi = \rho x^{\alpha-1}(1 - \psi)$ (Lemma 3), we have

$$(\partial/\partial x_i)u_i = [1 - \psi(x_i, \rho)] \left\{ \theta \left[1 + \frac{n-1}{n} \mathbb{E} \left[\left(\gamma - \frac{n-1}{n} \theta x_i + \frac{\theta}{n} \sum_{j \neq i} x_j \tau_j(x_j) \right)_+ \right] \right] - (1 + \rho \phi^w) x_i^{\alpha-1} \right\}. \quad (12)$$

At $x_i = 0$, the term in braces is at least $\theta > 0$. As x_i increases, the marginal reward (the first term in braces) weakly decreases, and the marginal cost $(1 + \rho \phi^w) x_i^{\alpha-1}$ strictly increases without bound. Therefore, the term in braces crosses zero exactly once, from above, and because $1 - \psi(x_i, \rho) > 0$, each employee has a unique best response, which is positive and sets the term in braces to zero.

Step 2. If all employees choose x , then $\frac{n-1}{n} \theta x - \frac{\theta}{n} \sum_{j \neq i} x \tau_j(x) = \frac{\theta}{n} \sum_{j \neq i} x [1 - \tau_j(x)]$, so setting the term in braces in (12) to zero gives (7). The left-hand side of (7) strictly increases in x , from 0 at $x = 0$ to infinity as $x \rightarrow \infty$, whereas the right-hand side is positive, bounded, and weakly decreasing in x because lost work is stochastically increasing in x (Lemma 3). Therefore, (7) has a unique positive solution x^* , which gives the unique symmetric equilibrium.

Step 3. Suppose, to the contrary, that an equilibrium has $x_i > x_j$. By Step 1, both employees' first-order

conditions hold with equality. In employee i 's condition, the argument of the positive part is $\gamma - \frac{n-1}{n}\theta x_i + \frac{\theta}{n}x_j\tau_j(x_j) + \frac{\theta}{n}\sum_{m \notin \{i,j\}} x_m\tau_m(x_m)$, and in employee j 's condition, it is the same expression with i and j interchanged. Compared with employee j 's argument, the second term in employee i 's argument is strictly lower because $x_i > x_j$, and the third term is stochastically smaller because $x_j\tau_j(x_j)$ is stochastically smaller than $x_i\tau_i(x_i)$ (Lemma 3), while the last sum is common to both and independent of $x_i\tau_i(x_i)$ and $x_j\tau_j(x_j)$. Therefore, employee i 's marginal reward is at most employee j 's, whereas employee i 's marginal cost is strictly higher, which contradicts both first-order conditions holding with equality. Therefore, every equilibrium is symmetric, and by Step 2, the equilibrium is unique. $\square$

We say that the positive part in (7) *does not bind* if its argument is nonnegative in every realization. Because each coworker's lost work is at most x , this holds whenever $\frac{n-1}{n}\theta x < \gamma$, in which case the expectation in (7) equals $\gamma - \frac{n-1}{n}\theta \mathbb{E}[x(1 - \tau_j(x))]$.

Because lost work $x[1 - \tau_j(x)]$ equals 0 with positive probability and has a density on $(0, x)$, for $\gamma > 0$ the sum $\frac{\theta}{n}\sum_{j=1}^{n-1} x[1 - \tau_j(x)]$ equals γ with probability zero, so the expectation in (7) is continuously differentiable in x , θ , ρ , and γ (for $\gamma = 0$, it is identically zero). Because the left-hand side of (7) has a strictly positive derivative in x and the right-hand side weakly decreases in x , the implicit function theorem implies that x^* , and therefore equilibrium welfare $W(\theta, \rho, \gamma)$ and profit $\Pi(\theta, \rho, \gamma)$, are continuously differentiable in θ , ρ , γ , and ϕ^w . Where the positive part does not bind, x^* is infinitely differentiable because $\mathbb{E}[x(1 - \tau_j(x))] = x - \int_0^x e^{-\rho k^\alpha/\alpha} dk$ is infinitely differentiable.

Lemma 5 (Aggregate welfare and profit). *For each realized output profile,*

$$\sum_{i=1}^n r_i(\mathbf{y}, \gamma) = -\frac{1}{2} \sum_{i=1}^n (y_i - \bar{y})^2 + \frac{1}{2} \sum_{i=1}^n (y_i - \bar{y} - \gamma)_+^2 \leq 0. \quad (13)$$

At a symmetric intensity x ,

$$\mathbb{E} \left[\sum_{i=1}^n r_i(\mathbf{y}, \gamma) \right] = -\frac{n-1}{2} \theta^2 \text{Var}(x\tau_i(x)) + \frac{n}{2} \mathbb{E}[(y_1 - \bar{y} - \gamma)_+^2]. \quad (14)$$

Let $W(x, \theta, \rho, \gamma)$ and $\pi(x, \theta, \rho, \gamma)$ denote total expected employee welfare and expected firm profit when every employee chooses x . Then

$$W(x, \theta, \rho, \gamma) = n \{ \theta \mathbb{E}[x\tau_i(x)] - c(x, \rho) \} + \mathbb{E} \left[\sum_{i=1}^n r_i(\mathbf{y}, \gamma) \right], \quad (15)$$

$$\pi(x, \theta, \rho, \gamma) = n \{ (v-1) \theta \mathbb{E}[x\tau_i(x)] - \phi^f \psi(x, \rho) \} - \mathbb{E} \left[\sum_{i=1}^n r_i(\mathbf{y}, \gamma) \right]. \quad (16)$$

If mitigation spending is $C(\rho)$ per employee, total social welfare, $\pi + W - nC(\rho)$, is $n\{v\theta \mathbb{E}[x\tau_i(x)] - (\phi^f + 1/\rho + \phi^w)\psi(x, \rho) - C(\rho)\}$.

Proof. By (3), $r_i = \gamma(y_i - \bar{y}) - (y_i - \bar{y})^2/2 + (y_i - \bar{y} - \gamma)_+^2/2$. Summing over employees and using $\sum_i (y_i - \bar{y}) = 0$ gives (13), where the inequality holds because $0 \leq (y_i - \bar{y} - \gamma)_+ \leq |y_i - \bar{y}|$ for $\gamma \geq 0$. At a symmetric intensity, outputs are i.i.d., so $\mathbb{E}[\sum_i (y_i - \bar{y})^2] = (n-1)\theta^2 \text{Var}(x\tau_i(x))$ and the terms $(y_i - \bar{y} - \gamma)_+^2$ are identically distributed. Taking expectations in (13) then gives (14). Lastly, summing employee payoffs gives (15), and subtracting

employee payments and the employer burnout cost from the gross value of output gives (16). Adding (15) and (16), all payments cancel, and subtracting $nC(\rho)$ gives $\pi + W - nC(\rho)$. $\square$

Proof of Lemma 2. Step 1. Write $x = x^*(\theta, \rho, \gamma)$. Differentiating (7) with respect to θ , and applying (11) to each coworker's lost work, we have

$$\begin{aligned} & \left\{ (1 + \rho\phi^w)(\alpha - 1)x^{\alpha-2} + \frac{(n-1)\theta^2}{n^2} \mathbb{E} \left[\sum_{j=1}^{n-1} \mathbf{1}\{\tau_j(x) < 1\} \mathbf{1} \left\{ \frac{\theta}{n} \sum_{j=1}^{n-1} x[1 - \tau_j(x)] < \gamma \right\} \right] \right\} (d/d\theta)x \\ &= 1 + \frac{n-1}{n} \mathbb{E} \left[\left(\gamma - \frac{2\theta}{n} \sum_{j=1}^{n-1} x[1 - \tau_j(x)] \right) \mathbf{1} \left\{ \frac{\theta}{n} \sum_{j=1}^{n-1} x[1 - \tau_j(x)] < \gamma \right\} \right]. \end{aligned} \quad (17)$$

The coefficient on $(d/d\theta)x$ is positive, so $(d/d\theta)x$ has the same sign as the right-hand side. Because $\psi(x, \rho)$ strictly increases in x , ψ^* moves in the same direction as x^* .

Step 2. If $\gamma = 0$, the event in the indicator is empty, and the right-hand side of (17) equals one. If $\gamma > 0$, the term in parentheses exceeds $\gamma - 2\gamma = -\gamma$ on the event in the indicator, which has positive probability because it contains the event that no coworker burns out. Therefore, the right-hand side exceeds $1 - \frac{n-1}{n}\gamma$, which is nonnegative when $\gamma \leq \bar{\gamma}_R$. In both cases, $(d/d\theta)x^* > 0$, which establishes part (i).

Step 3. Fix $\gamma \in (\bar{\gamma}_R, \theta^m - 1)$. If $\frac{n-1}{n}\theta x < \gamma$, then the positive part does not bind, the indicator in (17) equals one in every realization, and $\mathbb{E}[\sum_{j=1}^{n-1} \mathbf{1}\{\tau_j(x) < 1\}] = (n-1)\psi(x, \rho)$, so (17) simplifies to

$$\left[(1 + \rho\phi^w)(\alpha - 1)x^{\alpha-2} + \left(\frac{n-1}{n} \right)^2 \theta^2 \psi(x, \rho) \right] (d/d\theta)x = 1 + \frac{n-1}{n}\gamma - 2 \left(\frac{n-1}{n} \right)^2 \theta \mathbb{E}[x(1 - \tau_i(x))]. \quad (18)$$

It follows that equilibrium intensity strictly decreases in θ if and only if

$$\mathbb{E}[x(1 - \tau_i(x))] > \frac{n[n + (n-1)\gamma]}{2(n-1)^2\theta}. \quad (19)$$

Because expected lost work is zero at $x = 0$ and strictly increases to infinity in x (Lemma 3), there is a unique intensity $\bar{x}$ at which (19) holds with equality at $\theta = \theta^m$. It suffices to show that $\bar{x} < x^*(\theta^m) < n\gamma/[(n-1)\theta^m]$ for suitable ρ and ϕ^w . The second inequality ensures that the positive part does not bind at θ^m , and the first ensures that (19) holds there, so the result then follows on some interval $[\bar{\theta}, \theta^m]$ by continuity of $(d/d\theta)x^*$ and Step 1.

Because $\gamma > n/(n-1)$, the right-hand side of (19) at θ^m is less than $n\gamma/[(n-1)\theta^m]$. Using $\gamma < \theta^m - 1$, and hence $\theta^m > 1 + n/(n-1) = (2n-1)/(n-1)$, it is also less than

$$\frac{n[(n-1)\theta^m + 1]}{2(n-1)^2\theta^m} < \frac{n}{2(n-1)} + \frac{n}{2(n-1)(2n-1)} = \frac{n^2}{(n-1)(2n-1)} < 1,$$

where the last inequality holds because $n \geq 3$. Because $\bar{x}$ equals this right-hand side plus $\mathbb{E}[\bar{x}\tau_i(\bar{x})] \leq \rho^{-1/\alpha}\alpha^{1/\alpha-1}\Gamma(1/\alpha)$ (Lemma 3), there exists $\bar{\rho}$ such that $\bar{x} < \min\{1, n\gamma/[(n-1)\theta^m]\}$ for all $\rho > \bar{\rho}$.

Lastly, fix $\rho > \bar{\rho}$. By (7), $x^*(\theta^m)$ is continuous and strictly decreasing in ϕ^w , satisfies $x^*(\theta^m) \geq (\theta^m)^{1/(\alpha-1)} > 1 > \bar{x}$ at $\phi^w = 0$, and converges to zero as $\phi^w \rightarrow \infty$. Therefore, there exist $0 \leq \underline{\phi}^w < \bar{\phi}^w$ such that $\bar{x} < x^*(\theta^m) < n\gamma/[(n-1)\theta^m]$ for all $\phi^w \in (\underline{\phi}^w, \bar{\phi}^w)$, as desired. $\square$

Proof of Proposition 1. (i). At $\rho = 0$, no employee burns out, and the private cost is x^α/α , the limit of $c(x, \rho)$ as $\rho \rightarrow 0$. By (7), $x^* = \{[1 + (n-1)\gamma/n]\theta\}^{1/(\alpha-1)}$, so $(d/d\theta)x^* = x^*/[(\alpha-1)\theta]$. Relative pay is zero, so $W = n[\theta x^* - (x^*)^\alpha/\alpha]$, and using $(x^*)^{\alpha-1} = [1 + (n-1)\gamma/n]\theta$, we obtain $(d/d\theta)W = nx^*\{1 - (n-1)\gamma/[n(\alpha-1)]\}$, which has the sign of $\bar{\gamma}_W - \gamma$, as claimed.

(ii). Fix $\gamma > \bar{\gamma}_W$ and $\phi^w > 0$. Where the positive part does not bind, (7) becomes $(1 + \rho\phi^w)x^{\alpha-1} = \theta[1 + (n-1)\gamma/n - (\frac{n-1}{n})^2\theta\mathbb{E}[x(1 - \tau_i(x))]]$, and Lemma 5 gives $W/n = \theta\mathbb{E}[x\tau_i(x)] - c(x, \rho) - \frac{n-1}{2n}\theta^2\text{Var}(x\tau_i(x))$. We differentiate W along $x = x^*(\theta)$, using $(\partial/\partial x)c = (1 + \rho\phi^w)x^{\alpha-1}(1 - \psi)$ together with the first-order condition above, and $(\partial/\partial x)\text{Var}(x\tau_i(x)) = 2(1 - \psi)\mathbb{E}[x(1 - \tau_i(x))]$, which follows from (11). This gives

$$\frac{1}{n}(d/d\theta)W = \mathbb{E}[x\tau_i(x)] - \frac{n-1}{n}\theta\text{Var}(x\tau_i(x)) - \frac{n-1}{n}\theta(1 - \psi)\left[\gamma + \frac{\theta}{n}\mathbb{E}[x(1 - \tau_i(x))]\right](d/d\theta)x, \quad (20)$$

where the first two terms are the direct technology effect and the last term is the strategic work-intensity effect.

Set $\theta = 1$. By (7), $(x^*)^{\alpha-1} \leq [1 + (n-1)\gamma/n]/(1 + \rho\phi^w)$, so $x^* \rightarrow 0$ and $\rho(x^*)^\alpha \rightarrow 0$ as $\rho \rightarrow \infty$. By Lemma 3, it follows that $\mathbb{E}[x^*\tau_i(x^*)]/x^* \rightarrow 1$, $\text{Var}(x^*\tau_i(x^*)/x^*) = x^*\text{Var}(\tau_i(x^*)) \rightarrow 0$, and $\psi \rightarrow 0$. In particular, the positive part does not bind for large ρ , and because expected lost work is at most x^* , both $(1 + \rho\phi^w)(x^*)^{\alpha-1}$ and the right-hand side of (18) converge to $1 + (n-1)\gamma/n$. Because $\psi \leq \rho(x^*)^\alpha/\alpha$, the ratio of the second coefficient to the first coefficient on $(d/d\theta)x$ in (18) is at most $(n-1)^2\rho(x^*)^2/[n^2\alpha(\alpha-1)(1 + \rho\phi^w)]$, which converges to zero. Dividing both sides of (18) by $(1 + \rho\phi^w)(\alpha-1)(x^*)^{\alpha-1}$, we have $(1/x^*)(d/d\theta)x^* \rightarrow 1/(\alpha-1)$.

Substituting these limits into (20) at $\theta = 1$ and dividing by x^* , we have $(1/(nx^*))(d/d\theta)W \rightarrow 1 - (n-1)\gamma/[n(\alpha-1)] < 0$, where the inequality follows because $\gamma > \bar{\gamma}_W$. The same limits imply that the direct technology effect is positive and $(d/d\theta)x^* > 0$ at $\theta = 1$. For sufficiently large ρ , these signs and $(d/d\theta)W < 0$ therefore hold at $\theta = 1$, and by continuity, they hold on $[1, \theta_d]$ for some $\theta_d \in (1, \theta^m)$, proving part (ii).

(iii). Fix $\gamma > \bar{\gamma}_W$. Because $(n-1)\gamma/n > \alpha-1 > 1$, we can choose z such that $n[n + (n-1)\gamma]/[2(n-1)^2] < z < n\gamma/(n-1)$. For each intensity $x > 0$, set $\theta = z/x$. Then $\frac{n-1}{n}\theta x < \gamma$, so the positive part does not bind. Multiplying both sides of the first-order condition in part (ii) by x and substituting $\theta x = z$ and $(1 + \rho\phi^w)x^\alpha = \alpha(\phi^w + 1/\rho)u$, we have that x is the equilibrium intensity at $\theta = z/x$ if and only if

$$\alpha\left(\phi^w + \frac{1}{\rho}\right)u = z\left\{1 + \frac{n-1}{n}\gamma - \left(\frac{n-1}{n}\right)^2 z\mathbb{E}[1 - \tau_i(x)]\right\}. \quad (21)$$

By Lemma 3, the right-hand side of (21) depends only on u , decreases in u , and lies between z and $z[1 + (n-1)\gamma/n]$, whereas the left-hand side strictly increases in u , from 0 at $u = 0$ to infinity as $u \rightarrow \infty$. Therefore, (21) has a unique solution, at which $u \geq z/[\alpha(\phi^w + 1/\rho)]$. Let $\bar{x}$ denote the corresponding intensity and set $\theta^m = z/\bar{x}$, so that $\bar{x} = x^*(\theta^m)$.

Next, by Lemma 3, $\mathbb{E}[\tau_i(x)] \rightarrow 0$ and $\text{Var}(\tau_i(x))/\mathbb{E}[\tau_i(x)] \rightarrow 0$ as $u \rightarrow \infty$. Therefore, there exists $\bar{\phi}^w(\gamma) > 0$ such that, whenever $u \geq z/[2\alpha\bar{\phi}^w(\gamma)]$,

$$z\mathbb{E}[1 - \tau_i(x)] > \frac{n[n + (n-1)\gamma]}{2(n-1)^2} \quad \text{and} \quad \frac{n-1}{n}z\text{Var}(\tau_i(x)) < \mathbb{E}[\tau_i(x)]. \quad (22)$$

Suppose $\phi^w < \bar{\phi}^w(\gamma)$ and $\rho > 1/\bar{\phi}^w(\gamma)$. Then $\phi^w + 1/\rho < 2\bar{\phi}^w(\gamma)$, so (22) holds at $x = \bar{x}$. Because $\theta^m\bar{x} = z$, the first inequality in (22) is equivalent to (19) at $(x, \theta) = (\bar{x}, \theta^m)$, so $(d/d\theta)x^* < 0$ at θ^m by (18). The direct effect

in (20) at θ^m equals $\bar{x}\{\mathbb{E}[\tau_i(\bar{x})] - \frac{n-1}{n}z \text{Var}(\tau_i(\bar{x}))\}$, which is positive by the second inequality in (22), and the strategic effect is also positive because $(d/d\theta)x^* < 0$. Therefore, $(d/d\theta)W > 0$ at θ^m .

Lastly, fix $\phi^w \in (0, \bar{\phi}^w(\gamma))$. By (21), $(1 + \rho\phi^w)\bar{x}^\alpha \leq z[1 + (n-1)\gamma/n]$, so $\bar{x} \rightarrow 0$ and $\theta^m \rightarrow \infty$ as $\rho \rightarrow \infty$. For sufficiently large ρ , part (ii) therefore gives $(d/d\theta)W < 0$ at $\theta = 1$, and $\theta^m > 1$. Because the derivatives are continuous in θ , there exist $1 < \theta_d < \theta_u < \theta^m$ such that W strictly decreases on $[1, \theta_d]$, while x^* and ψ^* strictly decrease, W strictly increases, and the direct technology effect remains positive on $[\theta_u, \theta^m]$. Because W is continuous, it attains a minimum on $[1, \theta^m]$, and every minimum is interior because $(d/d\theta)W < 0$ at $\theta = 1$ and $(d/d\theta)W > 0$ at θ^m , as desired. $\square$

Proof of Proposition 2. (i). In the absence of burnout, relative pay is zero, (7) gives $x^* = \{[1 + (n-1)\gamma/n]\theta\}^{1/(\alpha-1)}$, and profit is $\Pi = n(v-1)\theta x^*$. Therefore, $(d/d\theta)\Pi = n\alpha(v-1)x^*/(\alpha-1) > 0$, which strictly increases in θ because x^* does.

(ii). Fix $\gamma > 0$ and $\phi^w > 0$, and write $x = x^*(\theta)$. The argument in the proof of Proposition 1(ii) applies for any $\gamma > 0$ and shows that, at $\theta = 1$, we have $x \rightarrow 0$, $\rho x^\alpha \rightarrow 0$, and $(1/x)(d/d\theta)x \rightarrow 1/(\alpha-1)$ as $\rho \rightarrow \infty$, and the positive part does not bind for large ρ . Differentiating (18) with respect to θ , we have

$$\begin{aligned} & \left[(1 + \rho\phi^w)(\alpha-1)x^{\alpha-2} + \left(\frac{n-1}{n}\right)^2 \theta^2 \psi \right] (d^2/d\theta^2)x \\ &= -2 \left(\frac{n-1}{n}\right)^2 \left\{ \mathbb{E}[x(1 - \tau_i(x))] + 2\theta\psi(d/d\theta)x \right\} \\ & \quad - \left[(1 + \rho\phi^w)(\alpha-1)(\alpha-2)x^{\alpha-3} + \left(\frac{n-1}{n}\right)^2 \theta^2 \rho x^{\alpha-1}(1 - \psi) \right] ((d/d\theta)x)^2. \end{aligned} \quad (23)$$

Dividing by x times the coefficient on $(d^2/d\theta^2)x$ and using the preceding limits at $\theta = 1$, we obtain $(1/x)(d^2/d\theta^2)x \rightarrow (2 - \alpha)/(\alpha - 1)^2$.

Next, expected output per employee is $\mathbb{E}[y_i] = \theta \mathbb{E}[x\tau_i(x)]$. By Lemma 3,

$$\begin{aligned} (d/d\theta)\mathbb{E}[y_i] &= \mathbb{E}[x\tau_i(x)] + \theta(1 - \psi)(d/d\theta)x, \\ (d^2/d\theta^2)\mathbb{E}[y_i] &= (1 - \psi) \left[2(d/d\theta)x + \theta(d^2/d\theta^2)x - \rho\theta x^{\alpha-1}((d/d\theta)x)^2 \right], \end{aligned}$$

so at $\theta = 1$, $(1/x)(d/d\theta)\mathbb{E}[y_i] \rightarrow \alpha/(\alpha-1) > 0$ and $(1/x)(d^2/d\theta^2)\mathbb{E}[y_i] \rightarrow \alpha/(\alpha-1)^2 > 0$. Fix sufficiently large ρ . By continuity, both derivatives are positive and the positive part does not bind on $[1, \theta_a]$ for some $\theta_a \in (1, \theta^m)$. On this interval, Lemma 5 gives

$$\Pi = n(v-1)\mathbb{E}[y_i] - n\phi^f\psi(x, \rho) + \frac{n-1}{2}\theta^2\text{Var}(x\tau_i(x)). \quad (24)$$

Because x does not depend on v , the first two derivatives of the last two terms in (24) do not depend on v and are bounded on $[1, \theta_a]$, whereas those of $\mathbb{E}[y_i]$ are positive and continuous on $[1, \theta_a]$, and hence have a positive minimum there. Therefore, $(d/d\theta)\Pi > 0$ and $(d^2/d\theta^2)\Pi > 0$ on $[1, \theta_a]$ for sufficiently large v , proving part (ii).

(iii). Fix $\gamma > \bar{\gamma}_R$. We first construct a technology level $\bar{\theta}$ at which work intensity turns downward. Where the positive part does not bind, (18) gives $(d/d\theta)x^* = 0$ if and only if (19) holds with equality, in which case the right-hand side of (7) equals $\theta[n + (n-1)\gamma]/(2n)$. By Lemma 3, $\mathbb{E}[1 - \tau_i(x)]$ depends on x and ρ only

through u and strictly increases in u , from 0 at $u = 0$ to 1 as $u \rightarrow \infty$. Because $\gamma > n/(n-1)$, we have $[n + (n-1)\gamma]/[2(n-1)\gamma] < 1$, so there exists $\bar{\phi}_P^w(\gamma) > 0$ such that $\mathbb{E}[1 - \tau_i(x)] > [n + (n-1)\gamma]/[2(n-1)\gamma]$ whenever $u \mathbb{E}[1 - \tau_i(x)] \geq [n + (n-1)\gamma]^2/[8\alpha(n-1)^2\bar{\phi}_P^w(\gamma)]$.

Suppose $0 < \phi^w < \bar{\phi}_P^w(\gamma)$ and $\rho > 1/\bar{\phi}_P^w(\gamma)$. Because $u \mathbb{E}[1 - \tau_i(x)]$ strictly increases in u , from 0 at $u = 0$ to infinity as $u \rightarrow \infty$, there is a unique intensity $\bar{x}$ at which

$$u \mathbb{E}[1 - \tau_i(x)] = \frac{[n + (n-1)\gamma]^2}{4\alpha(n-1)^2(\phi^w + 1/\rho)}. \quad (25)$$

Because $\phi^w + 1/\rho < 2\bar{\phi}_P^w(\gamma)$, it follows that $\mathbb{E}[1 - \tau_i(\bar{x})] > [n + (n-1)\gamma]/[2(n-1)\gamma]$. Set $\bar{\theta} = n[n + (n-1)\gamma]/\{2(n-1)^2\bar{x} \mathbb{E}[1 - \tau_i(\bar{x})]\}$, so that (19) holds with equality at $(\bar{x}, \bar{\theta})$. Then $\frac{n-1}{n}\bar{\theta}\bar{x} < \gamma$, so the positive part does not bind at $(\bar{x}, \bar{\theta})$. Moreover, using $(1 + \rho\phi^w)\bar{x}^\alpha = \alpha(\phi^w + 1/\rho)u$, (25) gives $(1 + \rho\phi^w)\bar{x}^{\alpha-1} = \bar{\theta}[n + (n-1)\gamma]/(2n)$, which is (7) at $\theta = \bar{\theta}$. Therefore, $\bar{x} = x^*(\bar{\theta})$ and $(d/d\theta)x^* = 0$ at $\bar{\theta}$. At $\bar{\theta}$, the right-hand side of (23) reduces to $-2(\frac{n-1}{n})^2\mathbb{E}[\bar{x}(1 - \tau_i(\bar{x}))] < 0$, so $(d^2/d\theta^2)x^* < 0$. The derivatives of $\mathbb{E}[y_i]$ in part (ii) therefore give, at $\bar{\theta}$,

$$(d/d\theta)\mathbb{E}[y_i] = \mathbb{E}[\bar{x}\tau_i(\bar{x})] > 0, \quad (d^2/d\theta^2)\mathbb{E}[y_i] = \bar{\theta}[1 - \psi(\bar{x}, \rho)](d^2/d\theta^2)x^* < 0.$$

Next, fix $\phi^w \in (0, \bar{\phi}_P^w(\gamma))$. As $\rho \rightarrow \infty$, the value of u solving (25) converges to a finite positive value, so $\bar{x} = (\alpha u/\rho)^{1/\alpha} \rightarrow 0$ and $\bar{\theta} \rightarrow \infty$. Choose ρ large enough that the first two derivatives of $\mathbb{E}[y_i]$ at $\theta = 1$ are positive, as in part (ii), and $\bar{\theta} > 1$. By continuity, there exist a finite $\theta^m > \bar{\theta}$ and thresholds $1 < \theta_a < \theta_b < \theta^m$, with $\theta_b > \bar{\theta}$, such that the positive part does not bind on $[1, \theta_a]$ or $[\theta_b, \theta^m]$, $(d/d\theta)\mathbb{E}[y_i] > 0$ on both intervals, $(d^2/d\theta^2)\mathbb{E}[y_i] > 0$ on the first, and both $(d^2/d\theta^2)\mathbb{E}[y_i] < 0$ and $(d/d\theta)x^* < 0$ on the second. As in part (ii), choosing v sufficiently large gives $(d/d\theta)\Pi > 0$ on both intervals, $(d^2/d\theta^2)\Pi > 0$ on the first, and $(d^2/d\theta^2)\Pi < 0$ on the second. Burnout probability strictly decreases on the second interval because $\psi(x, \rho)$ strictly increases in x . Lastly, $(d/d\theta)\Pi$ is continuous on $[1, \theta^m]$, so it attains a maximum, and every maximum is interior because $(d/d\theta)\Pi$ strictly increases near 1 and strictly decreases near θ^m , as desired. $\square$

The next two lemmas characterize implementable intensities and the firm's optimum at low exposure.

Lemma 6 (Equilibrium work and γ). *Equation (26) defines a unique $\gamma(x, \theta, \rho) \geq 0$ if and only if $x \geq [\theta/(1 + \rho\phi^w)]^{1/(\alpha-1)}$:*

$$\mathbb{E}\left[\left(\gamma - \frac{\theta}{n} \sum_{j=1}^{n-1} x[1 - \tau_j(x)]\right)_+\right] = \frac{n[(1 + \rho\phi^w)x^{\alpha-1} - \theta]}{(n-1)\theta}. \quad (26)$$

If $x = [\theta/(1 + \rho\phi^w)]^{1/(\alpha-1)}$, then $\gamma(x, \theta, \rho) = 0$. If $x > [\theta/(1 + \rho\phi^w)]^{1/(\alpha-1)}$, then $\gamma(x, \theta, \rho) > 0$ and $(\partial/\partial x)\gamma(x, \theta, \rho) > 0$. The positive part in (26) does not bind if and only if

$$\gamma(x, \theta, \rho) \geq \frac{n-1}{n}\theta x, \quad (27)$$

or, equivalently,

$$(1 + \rho\phi^w)x^{\alpha-1} \geq \theta + \left(\frac{n-1}{n}\right)^2 \theta^2 \mathbb{E}[x\tau_i(x)]. \quad (28)$$

If (27) holds, then

$$\gamma(x, \theta, \rho) = \frac{n-1}{n}\theta \mathbb{E}[x(1 - \tau_i(x))] + \frac{n(1 + \rho\phi^w)x^{\alpha-1}}{(n-1)\theta} - \frac{n}{n-1}. \quad (29)$$

Proof. Rearranging (7) gives (26). The left-hand side of (26) equals zero at $\gamma = 0$ and is unbounded in γ , and for $\gamma > 0$, its derivative with respect to γ is $\Pr(\frac{\theta}{n} \sum_{j=1}^{n-1} x[1 - \tau_j(x)] < \gamma) > 0$, because no coworker burns out with positive probability. Therefore, (26) has a unique solution $\gamma \geq 0$ if and only if its right-hand side is nonnegative, i.e., $x \geq [\theta/(1 + \rho\phi^w)]^{1/(\alpha-1)}$, and the solution is $\gamma = 0$ when x equals this lower bound. Above the lower bound, the right-hand side strictly increases in x , whereas the left-hand side weakly decreases in x (Lemma 3) and strictly increases in γ , so implicitly differentiating (26) gives $(\partial/\partial x)\gamma(x, \theta, \rho) > 0$.

Lastly, the sum $\frac{\theta}{n} \sum_{j=1}^{n-1} x[1 - \tau_j(x)]$ has support $[0, \frac{n-1}{n}\theta x]$, so the positive part does not bind if and only if (27) holds, in which case solving (26) for γ gives (29). Substituting (29) into (27) and using $\mathbb{E}[x(1 - \tau_i(x))] = x - \mathbb{E}[x\tau_i(x)]$ gives (28). Conversely, if (28) holds, then the right-hand side of (29) satisfies (27) and solves (26), so it equals $\gamma(x, \theta, \rho)$ by uniqueness. $\square$

We say that an intensity x is *implementable* if $x \geq [\theta/(1 + \rho\phi^w)]^{1/(\alpha-1)}$, in which case the incentive $\gamma(x, \theta, \rho)$ induces x as the equilibrium intensity (Lemma 6). Define $\tilde{P}(x; \theta, \rho) = (v - 1)\theta\mathbb{E}[x\tau_i(x)] - \phi^f\psi(x, \rho) + \frac{n-1}{2n}\theta^2\text{Var}(x\tau_i(x))$. By Lemma 5, profit per employee at an implementable intensity x , $\pi(x, \theta, \rho, \gamma)/n$ with $\gamma = \gamma(x, \theta, \rho)$, equals $\tilde{P}(x; \theta, \rho) - \frac{1}{2}\mathbb{E}[(y_1 - \bar{y} - \gamma)_+^2]$. Because $y_1 - \bar{y} \leq \frac{n-1}{n}\theta x$, $\pi(x, \theta, \rho, \gamma)/n$ is at most $\tilde{P}(x; \theta, \rho)$, with equality whenever $\gamma(x, \theta, \rho) \geq \frac{n-1}{n}\theta x$.

Lemma 7 (Profit-maximizing work intensity at low exposure). *Fix θ and $\phi^f > 0$. For all sufficiently small ρ , $\tilde{P}(\cdot; \theta, \rho)$ has a unique maximizer x^* . This maximizer is implementable and uniquely maximizes actual profit $\pi(x, \theta, \rho, \gamma(x, \theta, \rho))$ over implementable intensities. The corresponding incentive satisfies $\gamma^* > \frac{n-1}{n}\theta x^* > 0$, and x^* solves*

$$(v - 1)\theta + \frac{n-1}{n}\theta^2\mathbb{E}[x^*(1 - \tau_i(x^*))] = \phi^f\rho(x^*)^{\alpha-1}. \quad (30)$$

As $\rho \rightarrow 0$,

$$\rho^{1/(\alpha-2)}x^* \rightarrow \left[\frac{(n-1)\theta^2}{n\phi^f} \right]^{1/(\alpha-2)}. \quad (31)$$

For sufficiently small ρ , x^* is differentiable in ρ , with

$$\frac{\rho}{x^*}(d/d\rho)x^* \rightarrow -\frac{1}{\alpha-2} \quad \text{as } \rho \rightarrow 0. \quad (32)$$

Proof. Step 1. By Lemma 3, $(\partial/\partial x)\tilde{P} = [1 - \psi(x, \rho)]G(x, \rho)$, where $G(x, \rho) = (v - 1)\theta + \frac{n-1}{n}\theta^2\mathbb{E}[x(1 - \tau_i(x))] - \phi^f\rho x^{\alpha-1}$. Note that $G(0, \rho) = (v - 1)\theta > 0$, and because expected lost work is at most x and $\alpha > 2$, $G(x, \rho) \rightarrow -\infty$ as $x \rightarrow \infty$, so G has at least one zero. Every zero satisfies $\phi^f\rho x^{\alpha-1} \geq (v - 1)\theta$, i.e., $x \geq [(v - 1)\theta/(\phi^f\rho)]^{1/(\alpha-1)}$. Combined with $\mathbb{E}[x\tau_i(x)] \leq \alpha^{1/\alpha-1}\Gamma(1/\alpha)\rho^{-1/\alpha}$ (Lemma 3), every zero therefore satisfies $\mathbb{E}[x\tau_i(x)]/x \leq \alpha^{1/\alpha-1}\Gamma(1/\alpha)[\phi^f/((v - 1)\theta)]^{1/(\alpha-1)}\rho^{1/(\alpha-1)}$, and this bound converges to zero as $\rho \rightarrow 0$. At every zero, $G(x, \rho) = 0$ also gives $\phi^f\rho x^{\alpha-2} \geq \frac{n-1}{n}\theta^2\{1 - \mathbb{E}[x\tau_i(x)]/x\}$, so, because $\psi \leq 1$,

$$(\partial/\partial x)G = \frac{n-1}{n}\theta^2\psi - (\alpha-1)\phi^f\rho x^{\alpha-2} \leq \frac{n-1}{n}\theta^2 \left[1 - (\alpha-1) \left(1 - \frac{\mathbb{E}[x\tau_i(x)]}{x} \right) \right],$$

which is negative whenever $\mathbb{E}[x\tau_i(x)]/x < (\alpha-2)/(\alpha-1)$. For small ρ , the bound above ensures that this holds at every zero, so G crosses zero only from above. Therefore, G has exactly one zero x^* , and $\tilde{P}$ strictly increases below x^* and strictly decreases above it. The condition $G(x^*, \rho) = 0$ is (30). Lastly, as $\rho \rightarrow 0$,

we have $x^* \rightarrow \infty$, $\mathbb{E}[x^* \tau_i(x^*)]/x^* \rightarrow 0$, and $\rho(x^*)^\alpha \geq [(v-1)\theta/\phi^f]^{\alpha/(\alpha-1)} \rho^{-1/(\alpha-1)} \rightarrow \infty$, so $\psi \rightarrow 1$ at $x = x^*$. Dividing $G(x^*, \rho) = 0$ by x^* then gives $\phi^f \rho(x^*)^{\alpha-2} \rightarrow \frac{n-1}{n} \theta^2$, which gives (31), and it follows that $(\partial/\partial x)G \rightarrow -(\alpha-2)\frac{n-1}{n}\theta^2$ at $x = x^*$.

Step 2. Dividing both sides of (28) by x^* , the left-hand side is at least $(x^*)^{\alpha-2}$, which diverges, whereas the right-hand side converges to zero because $x^* \rightarrow \infty$ and $\mathbb{E}[x^* \tau_i(x^*)]/x^* \rightarrow 0$. Therefore, (28) holds strictly at x^* for small ρ . By Lemma 6, x^* is implementable, and (29) gives $\gamma^* - \frac{n-1}{n}\theta x^* = n\{(1 + \rho\phi^w)(x^*)^{\alpha-1} - \theta - (\frac{n-1}{n})^2 \theta^2 \mathbb{E}[x^* \tau_i(x^*)]\}/[(n-1)\theta] > 0$. It follows that $\pi/n = \tilde{P}$ at x^* , whereas at every other implementable intensity, $\pi/n \leq \tilde{P}$, which is strictly below $\tilde{P}(x^*; \theta, \rho)$. Therefore, x^* uniquely maximizes π .

Step 3. Because $(\partial/\partial x)G < 0$ at x^* , the implicit function theorem implies that x^* is differentiable in ρ . Differentiating $G(x^*, \rho) = 0$ with respect to ρ , we have, with partial derivatives evaluated at $x = x^*$,

$$\frac{\rho}{x^*} (d/d\rho)x^* = \frac{\frac{n-1}{n}\theta^2 \rho (\partial/\partial \rho) \mathbb{E}[x \tau_i(x)]/x^* + \phi^f \rho(x^*)^{\alpha-2}}{(\partial/\partial x)G} \rightarrow -\frac{1}{\alpha-2}.$$

The limit holds because, by Lemma 4, $\rho (\partial/\partial \rho) \mathbb{E}[x \tau_i(x)]/x = \{(1 - \psi) - \mathbb{E}[x \tau_i(x)]/x\}/\alpha \rightarrow 0$ at $x = x^*$, while by Step 1, the remaining term in the numerator converges to $\frac{n-1}{n}\theta^2$ and the denominator converges to $-(\alpha-2)\frac{n-1}{n}\theta^2$. $\square$

Proof of Proposition 3. (i). Fix $\gamma \geq 0$ and write $x = x^*(\theta, \rho, \gamma)$. At a fixed $x > 0$, increasing ρ strictly raises the left-hand side of (7) and weakly lowers the right-hand side, because the survival function of coworkers' lost work increases in ρ (proof of Lemma 3). Therefore, equilibrium intensity strictly decreases in ρ .

As $\rho \rightarrow 0$, (7) gives $x \rightarrow \{[1 + (n-1)\gamma/n]\theta\}^{1/(\alpha-1)}$. Moreover, $(d/d\rho)x$ remains bounded near $\rho = 0$. For $\gamma = 0$, this follows directly from $x = [\theta/(1 + \rho\phi^w)]^{1/(\alpha-1)}$. For $\gamma > 0$, conditioning on which coworkers burn out shows that the expectation in (7) is continuously differentiable in (x, ρ) at $\rho = 0$, where the derivative of the left-hand side minus the right-hand side with respect to x is $(\alpha-1)x^{\alpha-2} > 0$, so the implicit function theorem applies. Differentiating burnout along the equilibrium path, we have

$$(d/d\rho)\psi(x, \rho) = (1 - \psi) \left[\frac{x^\alpha}{\alpha} + \rho x^{\alpha-1} (d/d\rho)x \right] \rightarrow \frac{1}{\alpha} \left\{ \left[1 + \frac{n-1}{n}\gamma \right] \theta \right\}^{\alpha/(\alpha-1)} > 0.$$

Thus burnout strictly increases in ρ near $\rho = 0$, proving part (i).

(ii). *Step 1.* For small ρ , Lemma 7 gives a unique optimal intensity $x^* = x^*(\theta, \rho)$ at which the positive part does not bind, so Lemma 5 gives $W^*/n = \theta \mathbb{E}[x^* \tau_i(x^*)] - (1/\rho + \phi^w)\psi^* - \frac{n-1}{2n}\theta^2 \text{Var}(x^* \tau_i(x^*))$. Let $u^* = \rho(x^*)^\alpha/\alpha$ denote cumulative exposure, so that $\psi^* = 1 - e^{-u^*}$. By (31), $\rho^{2/(\alpha-2)}u^*$ converges to a positive constant as $\rho \rightarrow 0$, and by (32),

$$\frac{\rho}{u^*} (d/d\rho)u^* = 1 + \alpha \frac{\rho}{x^*} (d/d\rho)x^* \rightarrow -\frac{2}{\alpha-2}. \quad (33)$$

Because $\rho^{1/(\alpha-2)}x^*$ and $\rho^{2/(\alpha-2)}u^*$ both converge to positive constants, the product of $1 - \psi^* = e^{-u^*}$ with any fixed powers of x^* and ρ , or with the bounded elasticity in (32), converges to zero as $\rho \rightarrow 0$.

Step 2. Differentiating W^* with respect to ρ along $x^*(\theta, \rho)$ and multiplying by ρ^2/n , we have

$$\frac{\rho^2}{n} (d/d\rho)W^* = \theta \rho^2 (d/d\rho) \mathbb{E}[x^* \tau_i(x^*)] + \psi^* - (1 + \rho\phi^w)\rho (d/d\rho)\psi^* - \frac{n-1}{2n}\theta^2 \rho^2 (d/d\rho) \text{Var}(x^* \tau_i(x^*)).$$

We show that the right-hand side converges to one. The second term, ψ^* , converges to one. For the third term, (33) gives $\rho(d/d\rho)\psi^* = u^*e^{-u^*}(\rho/u^*)(d/d\rho)u^* \rightarrow 0$. For the first term, Lemma 4 gives

$$\rho^2(d/d\rho)\mathbb{E}[x^*\tau_i(x^*)] = \frac{\rho}{\alpha}\{x^*(1-\psi^*) - \mathbb{E}[x^*\tau_i(x^*)]\} + \rho^2(1-\psi^*)(d/d\rho)x^* \rightarrow 0,$$

because $0 \leq \rho\mathbb{E}[x^*\tau_i(x^*)] \leq \alpha^{1/\alpha-1}\Gamma(1/\alpha)\rho^{1-1/\alpha}$ by Lemma 3, and the remaining terms contain $1-\psi^*$ and converge to zero by Step 1. For the fourth term, Lemma 4 gives

$$\alpha\rho(\partial/\partial\rho)\text{Var}(x\tau_i(x)) = 2\{x^2(1-\psi) - \mathbb{E}[(x\tau_i(x))^2]\} - 2\mathbb{E}[x\tau_i(x)]\{x(1-\psi) - \mathbb{E}[x\tau_i(x)]\}. \quad (34)$$

By Lemma 3, $0 \leq \rho\mathbb{E}[x\tau_i(x)]^2 \leq \rho\mathbb{E}[(x\tau_i(x))^2] \leq 2\alpha^{2/\alpha-1}\Gamma(2/\alpha)\rho^{1-2/\alpha}$, which converges to zero because $\alpha > 2$. Therefore, the terms in $\rho^2(\partial/\partial\rho)\text{Var}(x\tau_i(x))$ that do not contain $1-\psi$ converge to zero, and at $x = x^*$, the terms that do contain $1-\psi$ converge to zero by Step 1. The chain-rule term $2\rho^2(1-\psi^*)\mathbb{E}[x^*(1-\tau_i(x^*))](d/d\rho)x^*$, which uses $(\partial/\partial x)\text{Var}(x\tau_i(x)) = 2(1-\psi)\mathbb{E}[x(1-\tau_i(x))]$, also converges to zero by Step 1. Combining the four terms, we have $(\rho^2/n)(d/d\rho)W^* \rightarrow 1$, so W^* strictly increases in ρ near $\rho = 0$.

Step 3. By (32) and (33), $(d/d\rho)x^* < 0$ and $(d/d\rho)u^* < 0$ near $\rho = 0$. Therefore, x^* and $\psi^* = 1 - e^{-u^*}$ strictly increase as ρ decreases.

Step 4. By (29), we have $\gamma^* = \frac{n-1}{n}\theta\mathbb{E}[x^*(1-\tau_i(x^*))] + \frac{n(1+\rho\phi^w)(x^*)^{\alpha-1}}{(n-1)\theta} - \frac{n}{n-1}$. Because $x^* \rightarrow \infty$ and $\alpha-1 > 1$, dividing each term by $(x^*)^{\alpha-1}$ shows that $x^*/\gamma^* \rightarrow 0$ and $n(x^*)^{\alpha-1}/[(n-1)\theta\gamma^*] \rightarrow 1$. Differentiating γ^* with respect to ρ , using $(\partial/\partial x)\mathbb{E}[x(1-\tau_i(x))] = \psi$, and multiplying by ρ/γ^* , we have

$$\begin{aligned} \frac{\rho}{\gamma^*}(d/d\rho)\gamma^* &= \frac{(n-1)\theta}{n\gamma^*} \left(\psi^*\rho(d/d\rho)x^* - \rho(\partial/\partial\rho)\mathbb{E}[x\tau_i(x)] \Big|_{x=x^*} \right) + \frac{n\rho\phi^w(x^*)^{\alpha-1}}{(n-1)\theta\gamma^*} \\ &\quad + (1+\rho\phi^w)(\alpha-1)\frac{n(x^*)^{\alpha-1}}{(n-1)\theta\gamma^*} \cdot \frac{\rho}{x^*}(d/d\rho)x^*. \end{aligned}$$

The first term converges to zero because $(\rho/x^*)(d/d\rho)x^*$ is bounded, $x^*/\gamma^* \rightarrow 0$, and, by Lemma 4, the absolute value of $\rho(\partial/\partial\rho)\mathbb{E}[x\tau_i(x)]$ is at most x/α . The second term converges to zero because $\rho\phi^w \rightarrow 0$, and the third converges to $-(\alpha-1)/(\alpha-2)$. Therefore, $(d/d\rho)\gamma^* < 0$ near $\rho = 0$, so γ^* strictly increases as ρ decreases. Choosing $\bar{\rho}$ small enough that the signs in Steps 2–4 hold on $(0, \bar{\rho})$ proves part (ii).

(iii). Suppose $1 < (v-1)\phi^w/\phi^f < \alpha$. As in the proof of Lemma 7, $(\partial/\partial x)\tilde{P}$ has the sign of $G(x, \rho)$. Because $\psi \leq \min\{\rho x^\alpha/\alpha, 1\} \leq (\rho x^\alpha/\alpha)^{(\alpha-2)/\alpha}$, we have

$$(\partial/\partial x)G \leq x^{\alpha-2} \left[\frac{n-1}{n}\theta^2(\rho/\alpha)^{(\alpha-2)/\alpha} - (\alpha-1)\phi^f\rho \right] < 0$$

for sufficiently large ρ . Because $G(0, \rho) > 0$ and $G(x, \rho) \rightarrow -\infty$ as $x \rightarrow \infty$, G has a unique zero x , which uniquely maximizes $\tilde{P}$. At this zero, $(v-1)\theta \leq \phi^f\rho x^{\alpha-1} \leq (v-1)\theta + \frac{n-1}{n}\theta^2 x$, so $x \rightarrow 0$ and $\phi^f\rho x^{\alpha-1} \rightarrow (v-1)\theta$ as $\rho \rightarrow \infty$. Consequently, $(1+\rho\phi^w)x^{\alpha-1} - \theta - (\frac{n-1}{n})^2\theta^2\mathbb{E}[x\tau_i(x)] \rightarrow \theta[(v-1)\phi^w/\phi^f - 1] > 0$, which verifies (28). As in Step 2 of the proof of Lemma 7, it follows that the positive part does not bind and $x = x^*(\theta, \rho)$ is the unique firm optimum for sufficiently large ρ .

Next, $u = \rho x^\alpha/\alpha = x \cdot \rho x^{\alpha-1}/\alpha \rightarrow 0$. Because $0 \leq \rho(\partial/\partial\rho)\mathbb{E}[x(1-\tau_i(x))] \leq x/\alpha$ by Lemma 4, at the optimum we have $\rho(\partial/\partial\rho)G \rightarrow -(v-1)\theta$ and $x(\partial/\partial x)G \rightarrow -(\alpha-1)(v-1)\theta$. Implicit differentiation of $G(x, \rho) = 0$

therefore gives

$$\frac{\rho}{x}(d/d\rho)x \longrightarrow -\frac{1}{\alpha-1}, \quad \frac{\rho}{u}(d/d\rho)u = 1 + \alpha \frac{\rho}{x}(d/d\rho)x \longrightarrow -\frac{1}{\alpha-1},$$

so work intensity and burnout strictly decrease in ρ for sufficiently large ρ . Lastly, Lemmas 3 and 4 give

$$\frac{\rho}{x}(d/d\rho)\mathbb{E}[x\tau_i(x)] \longrightarrow -\frac{1}{\alpha-1}, \quad \frac{\rho}{x}(d/d\rho)\psi \longrightarrow -\frac{(v-1)\theta}{\alpha(\alpha-1)\phi^f}.$$

In (34), the first term in braces is at most x^2 in absolute value, and the second term in braces and $\mathbb{E}[x\tau_i(x)]$ are each at most x . Therefore, $|\rho(\partial/\partial\rho)\text{Var}(x\tau_i(x))| \leq 4x^2/\alpha$. Also, $(\partial/\partial x)\text{Var}(x\tau_i(x)) = 2(1-\psi)\mathbb{E}[x(1-\tau_i(x))]$ is at most $2x$. Because $x \rightarrow 0$ and $(\rho/x)(d/d\rho)x$ is bounded, it follows that $(\rho/x)(d/d\rho)\text{Var}(x\tau_i(x))$ converges to zero. Using $W^*/n = \theta\mathbb{E}[x\tau_i(x)] - (1/\rho + \phi^w)\psi - \frac{n-1}{2n}\theta^2\text{Var}(x\tau_i(x))$ and $\psi/(\rho x) \leq x^{\alpha-1}/\alpha \rightarrow 0$, we obtain

$$\frac{\rho}{n\theta x}(d/d\rho)W^* \longrightarrow -\frac{1}{\alpha-1} \left(1 - \frac{(v-1)\phi^w}{\alpha\phi^f}\right) < 0.$$

Choose $\underline{\rho} > \bar{\rho}$ sufficiently large that these signs hold on $(\underline{\rho}, \infty)$. Then lowering exposure in this interval raises x^* , ψ^* , and W^* , as desired. $\square$

Proof of Corollary 1. As in the proof of Lemma 7, the firm's optimal intensity is a zero of $G(x, \rho) = (v-1)\theta + \frac{n-1}{n}\theta^2\mathbb{E}[x(1-\tau_i(x))] - \phi^f\rho x^{\alpha-1}$, which also depends on θ . Because $\theta \geq 1$, Step 1 of that proof shows that every zero of G satisfies $x \geq [(v-1)/(\phi^f\rho)]^{1/(\alpha-1)}$ and $\mathbb{E}[x\tau_i(x)]/x \leq \alpha^{1/\alpha-1}\Gamma(1/\alpha)[\phi^f/(v-1)]^{1/(\alpha-1)}\rho^{1/[\alpha(\alpha-1)]}$. Neither bound depends on θ , and as $\rho \rightarrow 0$, the first diverges and the second converges to zero. Using $G(x, \rho) = 0$ to substitute for $\phi^f\rho x^{\alpha-2}$, and because $\psi \leq 1$, we have

$$\begin{aligned} (\partial/\partial x)G &= \frac{n-1}{n}\theta^2 \left[\psi - (\alpha-1) \left(1 - \frac{\mathbb{E}[x\tau_i(x)]}{x}\right) \right] - (\alpha-1)(v-1)\frac{\theta}{x} \\ &\leq \frac{n-1}{n}\theta^2 \left[1 - (\alpha-1) \left(1 - \frac{\mathbb{E}[x\tau_i(x)]}{x}\right) \right], \end{aligned}$$

which is negative at every zero of G once the bound on $\mathbb{E}[x\tau_i(x)]/x$ is below $(\alpha-2)/(\alpha-1)$. Similarly, after dividing both sides of (28) by x , the left-hand side is at least $x^{\alpha-2} \geq [(v-1)/(\phi^f\rho)]^{(\alpha-2)/(\alpha-1)}$, and the right-hand side is at most $\theta^m/x + (\theta^m)^2\mathbb{E}[x\tau_i(x)]/x$. Neither bound depends on θ , and as $\rho \rightarrow 0$, the first diverges and the second converges to zero. Therefore, Steps 1 and 2 of the proof of Lemma 7 hold with a common threshold $\bar{\rho}_T > 0$: for every $\rho \in (0, \bar{\rho}_T)$ and $\theta \in [1, \theta^m]$, G has a unique zero x^* , which is implementable and uniquely maximizes $\pi(x, \theta, \rho, \gamma(x, \theta, \rho))$.

Lastly, at $x = x^*$, we have $(\partial/\partial\theta)G = (v-1) + 2\frac{n-1}{n}\theta\mathbb{E}[x^*(1-\tau_i(x^*))] > 0$ and $(\partial/\partial x)G < 0$, so the implicit function theorem gives $(d/d\theta)x^* > 0$. Because $(\partial/\partial x)\psi = \rho x^{\alpha-1}(1-\psi) > 0$ (Lemma 3), ψ^* also strictly increases in θ , as desired. $\square$

Lemma 8 (Social design at fixed exposure). *At any fixed exposure $\rho > 0$, the social design chooses*

$$x^S(\rho) = \max \left\{ \left[\frac{\theta}{1 + \rho\phi^w} \right]^{1/(\alpha-1)}, \left[\frac{v\theta}{1 + \rho(\phi^w + \phi^f)} \right]^{1/(\alpha-1)} \right\}. \quad (35)$$

Its incentive is zero if $\rho[\phi^f - (v-1)\phi^w] \geq v-1$, and strictly positive otherwise.

Proof. By Lemma 6, the implementable intensities are exactly those at least $[\theta/(1 + \rho\phi^w)]^{1/(\alpha-1)}$, and this lower

bound is implemented by $\gamma = 0$. By Lemma 3, the derivative of the social objective per employee before mitigation spending, $v\theta\mathbb{E}[x\tau_i(x)] - (\phi^f + \rho^{-1} + \phi^w)\psi(x, \rho)$, with respect to x is $[1 - \psi(x, \rho)][v\theta - \{1 + \rho(\phi^w + \phi^f)\}x^{\alpha-1}]$, which changes sign once, from positive to negative, at $[v\theta/\{1 + \rho(\phi^w + \phi^f)\}]^{1/(\alpha-1)}$. Maximizing over implementable intensities gives (35). The maximizer equals the lower bound if and only if $\rho[\phi^f - (v-1)\phi^w] \geq v-1$, and the incentive claim follows because the implementation map in Lemma 6 strictly increases in x . $\square$

Proof of Proposition 4. (i). Fix θ and $\rho > 0$. We first show that equilibrium employee welfare $W(x, \theta, \rho, \gamma)$ strictly decreases as the implemented intensity x increases at a fixed exposure, where $\gamma = \gamma(x, \theta, \rho)$. Fix an implementable intensity $x > [\theta/(1 + \rho\phi^w)]^{1/(\alpha-1)}$. At the symmetric equilibrium, each employee's own-intensity derivative is zero. For each coworker $j \neq i$, Lemma 3 and (3) give

$$\frac{\partial u_i}{\partial x_j} = -\frac{\theta}{n}(1 - \psi)\mathbb{E}[(\gamma - y_i + \bar{y})_+ | \tau_j(x) = 1] < 0,$$

where the inequality is strict because, with positive probability, employee i burns out while all coworkers remain productive, in which case $y_i - \bar{y} < 0$. Also, symmetry gives $\mathbb{E}[y_i - \bar{y}] = 0$, so differentiating (3) with respect to γ yields $\partial u_i / \partial \gamma = \mathbb{E}[(y_i - \bar{y}) - (y_i - \bar{y} - \gamma)_+] = -\mathbb{E}[(y_i - \bar{y} - \gamma)_+] \leq 0$. Because $(\partial/\partial x)\gamma(x, \theta, \rho) > 0$ by Lemma 6, the derivative of W along the implementation map satisfies

$$\frac{1}{n}(d/dx)W = \sum_{j \neq i} \frac{\partial u_i}{\partial x_j} + \frac{\partial u_i}{\partial \gamma}(d/dx)\gamma < 0.$$

Next, firm profit π equals the social objective before mitigation spending, $\pi + W$, minus W . If $\gamma^S(\rho) > 0$, $\pi + W$ strictly increases for $x < x^S(\rho)$ and has zero derivative at $x^S(\rho)$ by the proof of Lemma 8, so π strictly increases on the implementable intensities up to $x^S(\rho)$ and has a positive derivative at $x^S(\rho)$. Every profit-maximizing intensity therefore exceeds $x^S(\rho)$. If $\gamma^S(\rho) = 0$, every implementable intensity is at least $x^S(\rho)$. A profit-maximizing intensity exists because, for sufficiently large x , (28) holds, so $\pi/n = \tilde{P}$, whose derivative is negative for large x because $G(x, \rho) \rightarrow -\infty$ as $x \rightarrow \infty$ (proof of Lemma 7). Lastly, the incentive and burnout rankings follow because both the implementation map and $\psi(x, \rho)$ strictly increase in x .

(ii). Set $\underline{\theta} = \min\{2, \theta^m\}$ and fix $\theta \in [1, \underline{\theta}]$. The proof proceeds in five steps. First, we characterize the social design at a fixed exposure. Second, we construct an exposure threshold ρ_1 above which the firm's net profit $\Pi - nC(\rho)$ is low. Third, we show that the firm chooses exposure at most ρ_1 , and we characterize its intensity. Fourth, we show that the social design chooses exposure above ρ_1 . Fifth, we compare the incentives and burnout probabilities of the two designs.

Step 1. Choose the cost thresholds so that $(v-1)\phi^w \geq \phi^f$ throughout the stated parameter region. By Lemma 8, the social design's preferred intensity at every exposure is then $x^S(\rho) = [v\theta/\{1 + \rho(\phi^w + \phi^f)\}]^{1/(\alpha-1)}$. Because $1 + \rho(\phi^w + \phi^f) \geq \max\{1, \rho\phi^w\}$, burnout under the social design satisfies $\psi^S \leq \rho x^S(\rho)^\alpha / \alpha \leq (v\theta)^{\alpha/(\alpha-1)} / (\alpha\phi^w)$. Because each coworker's lost work is at most x , the left-hand side of (26) is at least $\gamma - \frac{n-1}{n}\theta x$, so (26) and (35) give

$$\gamma^S \leq \frac{n-1}{n}\theta x^S + \frac{n[(1 + \rho\phi^w)(x^S)^{\alpha-1} - \theta]}{(n-1)\theta} \leq \frac{n-1}{n}\theta(v\theta)^{1/(\alpha-1)} + \frac{n(v-1)}{n-1}.$$

Lastly, at $\gamma = \gamma^S(\rho)$, the social value per employee before mitigation spending, $[\Pi(\theta, \rho, \gamma) + W(\theta, \rho, \gamma)]/n$, is at most $v\theta\mathbb{E}[x^S\tau_i(x^S)] \leq v\theta x^S(\rho)$.

Step 2. For every incentive γ and induced intensity x , Lemma 5 bounds $\Pi(\theta, \rho, \gamma)/n$ by $\tilde{P}(x; \theta, \rho) \leq (v - 1)\theta\mathbb{E}[x\tau_i(x)] + \frac{n-1}{2n}\theta^2\mathbb{E}[(x\tau_i(x))^2]$. By Lemma 3, this is bounded by a constant multiple of $\theta\rho^{-1/\alpha} + \theta^2\rho^{-2/\alpha}$, with constant depending only on v , n , and α . The bound is independent of ϕ^w and ϕ^f and vanishes as $\rho \rightarrow \infty$.

Next, by Lemma 3, $\rho^{1/\alpha}\mathbb{E}[\tau_i(1)]$ converges to a positive constant as $\rho \rightarrow \infty$, whereas $\rho C(\rho) \rightarrow 0$ by Assumption 1. Therefore, there exists ρ_0 such that $C(\rho_0) < (v - 1)\mathbb{E}[\tau_i(1)]/2$, where here and below $\mathbb{E}[\tau_i(1)]$ is evaluated at exposure ρ_0 . Suppose $1 + \rho_0\phi^w \geq \underline{\theta} + (\frac{n-1}{n})^2\underline{\theta}^2$. Because $\mathbb{E}[\tau_i(1)] \leq 1$, (28) then holds at $(x, \rho) = (1, \rho_0)$, so by Lemma 6, $x = 1$ is implementable at exposure ρ_0 and the positive part does not bind. Because $\theta \geq 1$, $\psi \leq 1$, and the variance is nonnegative, $\Pi(\theta, \rho_0, \gamma)/n - C(\rho_0)$ at this design is at least $(v - 1)\mathbb{E}[\tau_i(1)] - \phi^f - C(\rho_0)$, which exceeds $(v - 1)\mathbb{E}[\tau_i(1)]/4$ whenever $\phi^f < (v - 1)\mathbb{E}[\tau_i(1)]/4$.

Lastly, choose $\rho_1 \geq \rho_0$ such that the profit bound above, evaluated at $\underline{\theta}$, is below $(v - 1)\mathbb{E}[\tau_i(1)]/4$ for all $\rho > \rho_1$. Because this bound increases in θ and mitigation spending is positive, every design (ρ, γ) with $\rho > \rho_1$ yields $\Pi(\theta, \rho, \gamma)/n - C(\rho)$ below $(v - 1)\mathbb{E}[\tau_i(1)]/4$. Note that ρ_1 depends only on $\underline{\theta}$, v , n , α , and C .

Step 3. Fix $\rho \in (0, \rho_1]$. By Step 1 of the proof of Lemma 7, every zero of G satisfies $x \geq [(v - 1)\theta/(\phi^f \rho)]^{1/(\alpha-1)} \geq [(v - 1)/(\phi^f \rho_1)]^{1/(\alpha-1)}$ and, because $\theta \geq 1$ and $\rho \leq \rho_1$, $\mathbb{E}[x\tau_i(x)]/x \leq \alpha^{1/\alpha-1}\Gamma(1/\alpha)[\phi^f/(v - 1)]^{1/(\alpha-1)}\rho_1^{1/[\alpha(\alpha-1)]}$. Neither bound depends on θ or ρ , and as $\phi^f \rightarrow 0$, the first diverges and the second converges to zero. Therefore, Steps 1 and 2 of the proof of Lemma 7 apply with $\phi^f \rightarrow 0$ in place of $\rho \rightarrow 0$: for sufficiently small ϕ^f , G has a unique zero $x^F(\rho)$, which is the firm's optimal intensity at exposure ρ , satisfies (30), and is implemented by an incentive greater than $\frac{n-1}{n}\theta x^F(\rho)$.

Next, on $(0, \rho_1]$, $\max_{\gamma \geq 0} \Pi(\theta, \rho, \gamma)/n$ is $\tilde{P}(x^F(\rho); \theta, \rho)$, which is continuous in ρ and, by Step 2, at most a constant multiple of $\theta\rho^{-1/\alpha} + \theta^2\rho^{-2/\alpha}$. Because $\rho C(\rho) \rightarrow \infty$ as $\rho \rightarrow 0$ and $2/\alpha < 1$, $\max_{\gamma \geq 0} \Pi(\theta, \rho, \gamma)/n - C(\rho)$ converges to $-\infty$ as $\rho \rightarrow 0$. By Step 2, this quantity at $\rho_0 \leq \rho_1$ exceeds $(v - 1)\mathbb{E}[\tau_i(1)]/4$, and it is below this level at every $\rho > \rho_1$. Therefore, a profit-maximizing design exists, with $\rho^F \leq \rho_1$, $x^F = x^F(\rho^F)$, and $\gamma^F > \frac{n-1}{n}\theta x^F$. Lastly, (30) gives $x^F \geq [(v - 1)/(\phi^f \rho_1)]^{1/(\alpha-1)}$ and $\rho^F(x^F)^\alpha/\alpha \geq (v - 1)x^F/(\alpha\phi^f)$, so both intensity and cumulative exposure under the profit-maximizing design diverge as $\phi^f \rightarrow 0$.

Step 4. We first consider exposure $\rho \leq \rho_1$. By Step 1 and $x^S(\rho) \leq [v\theta/(\rho\phi^w)]^{1/(\alpha-1)}$, ρ times $(\Pi + W)/n - C(\rho)$ at $\gamma = \gamma^S(\rho)$ is at most $(v\underline{\theta})^{\alpha/(\alpha-1)}(\phi^w)^{-1/(\alpha-1)}\rho_1^{(\alpha-2)/(\alpha-1)} - \rho C(\rho)$. The function $\rho C(\rho)$ is positive and continuous and diverges as $\rho \rightarrow 0$, so it is bounded below by a positive constant on $(0, \rho_1]$. Because ρ_1 does not depend on ϕ^w , the upper bound is negative for all $\rho \leq \rho_1$ when ϕ^w is sufficiently large.

Next, as $\rho \rightarrow \infty$, $x^S(\rho) \rightarrow 0$ and $\rho x^S(\rho)^\alpha \rightarrow 0$, so $\mathbb{E}[\tau_i(x^S)] \rightarrow 1$ and $\alpha\psi(x^S, \rho)/[\rho x^S(\rho)^\alpha] \rightarrow 1$. Substituting (35), $(\Pi + W)/n$ at $\gamma = \gamma^S(\rho)$, divided by $v\theta x^S(\rho)$, converges to $1 - 1/\alpha > 0$. Because $\rho^{1/(\alpha-1)}x^S(\rho)$ converges to a positive constant and $\alpha > 2$, $\rho x^S(\rho) \rightarrow \infty$, whereas $\rho C(\rho) \rightarrow 0$, so $(\Pi + W)/n - C(\rho)$ is positive for large ρ . It is also continuous in ρ and converges to zero as $\rho \rightarrow \infty$. Social optima therefore exist, all with $\rho^S > \rho_1 \geq \rho^F$ and lower mitigation spending because C strictly decreases.

Step 5. By Step 3, $\gamma^F > \frac{n-1}{n}\theta x^F \geq \frac{n-1}{n}x^F$, which diverges as $\phi^f \rightarrow 0$, whereas the bound on γ^S in Step 1 does not depend on ϕ^f . Similarly, $\psi^S \leq (v\underline{\theta})^{\alpha/(\alpha-1)}/(\alpha\phi^w)$ by Step 1, which is small for large ϕ^w , whereas $\psi^F \rightarrow 1$ as $\phi^f \rightarrow 0$ by Step 3. Lastly, choose $\underline{\phi}^w$ sufficiently large and $\overline{\phi}^f$ sufficiently small, with $(v - 1)\underline{\phi}^w \geq \overline{\phi}^f$, so that $\rho^S > \rho^F$, $\gamma^S < \gamma^F$, and $\psi^S < \psi^F$ throughout the stated parameter region, as desired. $\square$