Compensating Wage Differentials and the Health Cost of Job Strain*

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December, 2025

Abstract

We estimate the trade-off between earnings and healthcare utilization resulting from strenuous working conditions, using rich administrative data from Upper Austria that link employment histories with healthcare claims over two decades. To address selection bias, we leverage mass layoffs as quasi-exogenous shocks that push workers out of strenuous jobs. By comparing workers with varying opportunities to re-enter strenuous employment, we can isolate the causal impact of job strain on earnings and health outcomes. We find that a 1% increase in wages due to strenuous work is associated with a 0.5% rise in healthcare expenditures. Our findings provide the first unified causal evidence of compensating wage differentials and their hidden health costs, showing that higher pay in strenuous jobs comes at a measurable and persistent cost to worker health.

Keywords: Job Strain, Compensating Wages, Health Effects
JEL codes: I18, J31, J81

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Marco Caliendo gratefully acknowledges funding from the German Research Foundation (Deutsche Forschungsgemeinschaft, RU Labor Market Transformation, DFG project 518302089), Alexander Ahammer gratefully acknowledges financial support from the Anniversary Fund of the Oesterreichische Nationalbank (OeNB) under project no. 18796. We thank Anna Bindler, Jan Nimczik, Markus Nagler, Shushanik Margaryan and Steffen Künn as well as seminar participants at the University of Cagliari, the University of Maastricht, the University of Passau, the BeNA Winter Workshop 2023, ESPE Conference 2023, VfS Conference 2024 and AASLE Conference 2024 for useful comments.

1 Introduction

Recent research has renewed interest in the theory of compensating wage differentials, which posits that workers in undesirable jobs receive higher wages to offset adverse job characteristics (Rosen, 1986; Maestas et al., 2023). While this theory has been extensively tested across various job characteristics, less attention has been paid to systematic evidence on physically strenuous work, which affects a substantial share of the workforce across different sectors. For instance, in the European Union, more than 20% of workers are frequently or always exposed to strenuous working conditions (Eurofound, 2021). The health consequences of job strain have received even less attention, despite growing acknowledgement in recent literature (Wissmann, 2022; Nagler et al., 2023), such that causal evidence on compensating wage differentials and health costs of strenuous working conditions remains scarce.

In this paper, we causally quantify the joint trade-off between higher earnings and the negative health effects of job strain. Using rich Austrian administrative data, we link detailed employment histories and earnings with objective measures of healthcare utilization over two decades. Unlike in the U.S., Austrian workers maintain employment-independent health insurance with minimal out-of-pocket medical costs, which minimizes income effects on healthcare utilization and makes it a good proxy for measuring the health consequences of job strain. A key innovation of our study is the use of a linked task-based, individual-level measure of job strain that is based on hardship-related wage allowances reported in official payroll records. This measure captures actual exposure to physically demanding, hazardous, or irregular working conditions, such as shift or night work. Unlike most prior work, our approach does not rely on self-reports or coarse occupation-based proxies, enabling more precise identification of job strain effects.

Our identification strategy exploits mass layoffs as quasi-exogenous shocks that displace workers from strenuous employment. Since mass layoffs themselves adversely affect health outcomes (Sullivan and Von Wachter, 2009; Ahammer et al., 2023a), we compare post-mass layoff trajectories between workers displaced from industries with high versus low concentrations of strenuous jobs. Building on Dodini et al. (2024), this approach leverages cross-industry variation in strenuous job availability while holding constant the mass layoff shock itself. This design constructs a counterfactual wherein the alternative to strenuous work is non-strenuous work, rather than unemployment or labor force exit. The key idea is that, in highly concentrated industries, the likelihood that workers can find a strenuous job again after a mass layoff will be lower than in less concentrated sectors. This generates plausibly exogenous variation in strenuous work exposure among otherwise similar workers, enabling identification of both wage and health effects over a ten-year horizon. We implement comprehensive tests of our identifying assumption that industry-level concentration of strenuous jobs affects post-mass layoff outcomes only through differences in individual exposure to strenuous working conditions.

We present two central findings. First, workers who are pushed out of strenuous jobs experience a substantial earnings decline of around 14%, which is consistent with the theory of compensating wage differentials. Notably, this decline is not attributable to extended unemployment spells or increased reliance on disability insurance.

Second, we find significant improvements in various health outcomes for workers pushed out of strenuous jobs. On average, their healthcare expenses decrease by 5%, with effects increasing over time. This reduction is largely driven by improvements in pulmonary health, while the incidence of workplace accidents or hospitalizations remains relatively stable. This is consistent with recent medical research showing that night and rotating shift work is associated with an increased risk of respiratory conditions, such as asthma and chronic obstructive pulmonary disease (Li et al., 2024; Maidstone et al., 2021). These results suggest that the adverse health effects of job strain extend beyond immediate physical strain, highlighting the need to account for both direct and indirect health effects when estimating the overall impact of job strain.

Taken together, our findings reveal a pronounced trade-off: while strenuous jobs offer substantial compensating wage differentials, they also impose considerable hidden health costs. Specifically, we estimate that a 1% increase in wages due to strenuous work is on average associated with a 0.5% rise in healthcare expenses, with a maximum of 0.9% ten years after the mass layoff. This underscores the importance of considering both explicit wage premiums and hidden health costs when evaluating labor market inequalities.

To ensure that our findings are indeed driven by exposure to strenuous working conditions rather than other factors, we implement a placebo analysis. This analysis examines workers laid off from non-strenuous jobs, who do not experience a comparable reduction in exposure to job strain but face the same differences in labor market concentration. Consistent with our main findings, the placebo group shows no significant changes in healthcare expenses, and observed earnings differences are notably smaller. Moreover, our results remain robust when varying the definitions of both strenuous work and mass layoffs, further validating the robustness of our empirical strategy.

Our work contributes to and bridges two main strands of literature. First, we contribute to research on compensating wage differentials (Rosen, 1986). While recent studies have tested this theory using stated choice experiments focused on disamenities such as flexibility, job stress, and schedule autonomy (Mas and Pallais, 2017; Nagler et al., 2023; Maestas et al., 2023), empirical evidence on compensating differentials for job strain typically relies on observational or survey data and is estimated with hedonic wage regressions, often using industry-level proxies or self-reported measures (Duncan and Holmlund, 1983; Kostiuk, 1990; Cole et al., 2009). These approaches generally fail to adequately address unobserved heterogeneity and selection bias. Two notable exceptions provide quasi-experimental evidence on related disamenities: one strand of literature focuses on hazardous jobs with high occupational risk (Lee and Taylor, 2019; Lavetti, 2020), but these represent extreme disamenities concentrated in specific occupations and are not representative of broader job strain. The other is Wissmann (2022), who exploits a smoking ban in the German hospitality sector as an exogenous improvement in workplace conditions and finds a corresponding decline in wages. We build on and extend this work by providing the first causal estimates of compensating wage differentials across a broader definition of job strain, spanning multiple industries and occupations. Our task-based measure of job strain captures within-job variation in exposure, allowing for more precise identification than occupation- or industry-level proxies.

Second, we contribute to the literature on the health effects of working conditions. A substantial body of work links specific job exposures—such as pollutants, shift work, or physical strain—and certain occupations to adverse health outcomes (e.g., Petsonk et al., 2013; Coenen et al., 2018; Li et al., 2024; Maidstone et al., 2021; Kunst et al., 1999; Ravesteijn et al., 2018). However, most studies in this literature rely on self-reported health outcomes or perceived exposure, and few address the "healthy worker effect," whereby healthier individuals select into or remain in more demanding jobs (Baillargeon, 2001; Barnay, 2016). As a result, causal evidence is limited, often based on selective or retrospective samples (Defebvre, 2018). More recent work exploits variation induced by technological change to estimate the effects on workplace injuries (Gihleb et al., 2022) and health outcomes (Arntz et al., 2024). We advance this literature by providing the first causal evidence on the health consequences of job strain, using comprehensive administrative data on medical expenditures, hospitalizations, and prescription drug use for a large and heterogeneous population across sectors and occupations.

Our study directly integrates these two strands of literature by quantifying the trade-off between wage compensation and health costs resulting from job strain within a unified causal framework. It is the first study to causally address the growing recognition that health effects should be considered when evaluating compensating differentials in a broader context (Wissmann, 2022; Nagler et al., 2023). While prior work has evaluated similar trade-offs focusing on occupational hazards, our study examines more common, chronic exposures across multiple sectors, where adverse health effects arise not only from singular events but also from sustained strain. Our findings have important policy implications, underscoring the need to account for both wage compensation and hidden health costs when assessing labor market inequalities and designing workplace regulations and compensation schemes.

2 Institutional setting and data

Austria shares many characteristics with other Continental European countries, such as a generous welfare system and strong occupational safety regulations. However, compared to other European countries, Austria has a relatively flexible labor market, weak job protection, and high turnover rates (Ahammer et al., 2023a). In this paper, we focus on Upper Austria, for which we have detailed health information. Upper Austria, one of the nine Austrian federal states, has approximately 1.5 million residents, constituting around one-fifth of Austria's population. The Austrian population is generally homogeneous, making Upper Austria representative of the broader national context (Ahammer et al., 2023a). Geographically, Upper Austria is relatively compact, with a substantial portion of the population concentrated around the economically strong cities of Linz, Wels, and Steyr (see Figure A.1).

2.1 Healthcare, labor market, and strenuous working conditions

Austria operates a universal healthcare system financed through social security contributions. Enrollment in the system is automatic and independent of employment status, resulting in 99.9% of Austrian residents being covered by health insurance (Ahammer et al., 2023b). The system provides a comprehensive range of services, including visits to outpatient general practitioners (GPs) and specialists, inpatient care, and prescription drugs. While Austria does not have a mandatory gatekeeping system, GPs traditionally serve as the primary point of access to healthcare. Out-of-pocket expenses are minimal, although there are small co-payments for prescription drugs (around €5 per prescription) and every night spent in hospital (€20). Workers are entitled to sick leave with full wage compensation for at least six weeks, provided they submit a medical certificate. Austria's social security system also ensures universal access to accident insurance, pensions, disability benefits, and unemployment benefits.

Austria's labor market is highly flexible, characterized by high turnover rates and weak job protection. While unilateral terminations require a statutory notice period, they typically do not require justification. The Austrian unemployment office enforces a system of advance layoff reporting, which we use to identify mass layoff events, following Ahammer et al. (2023a).

Despite this flexibility, Austria has strong industrial relations, centralized wage bargaining, and high occupational safety standards. Compensation for strenuous working conditions—such as dirty, hard, or dangerous conditions and working shifts or at night—is generally determined through collective bargaining agreements (*Schmutz-, Erschwernis- und Gefahrenzuschlag; Sonntags-, Feiertags- und Nachtzuschlag*, "allowances for strenuous conditions" hereafter, see Ahammer et al., 2023a; International Labour Organization, 2025). Such allowances can be substantial, particularly for night work where they can reach up to 100% of the initial hourly wage. This results in a significant stipulated wage premium for strenuous working conditions that are among the highest globally (World Bank, 2024). In addition, allowances for working in strenuous conditions of up to € 540 per month are also exempt from income taxes.

The Austrian legal framework explicitly acknowledges the potential health risk of strenuous working conditions. Workers in such jobs benefit from easier access to disability insurance (DI)[1] and early retirement options. The Strenuous Night Work Act (*Nachtschwerarbeitsgesetz*) of 1981 and the Strenuous Work Act (*Schwerarbeitsgesetz*) of 2006 allow workers with extensive exposure to pension-relevant strenuous conditions defined by the authorities to retire earlier.[2]

2.2 Data

We use high-quality administrative data from the Austrian Social Security Database (ASSD; see Zweimüller et al., 2009), linked with healthcare claims from the Upper Austrian Health Insurance Fund (UAHIF). The ASSD, structured as a linked employer-employee panel, covers the entire Austrian workforce since the 1970s. It provides comprehensive administrative records originally intended for verifying pension claims. Through the ASSD, we acquire information on mass layoffs, employment histories, wages, and various demographic characteristics. Additionally, it contains indicators of employment in pension-relevant strenuous jobs while limitations include top-coded wages and the absence of information on working hours.

For data on prescriptions and hospitalizations, we link the ASSD to the UAHIF database. The UAHIF is the main statutory health insurance provider for private-sector workers in Upper Austria, covering approximately 75 percent of the population between 1998 to 2018. The prescription data include the names of all medications that require a prescription in Austria. While over-the-counter drugs are not recorded, many medications that are freely available in the US, such as acetaminophen—a non-opioid pain reliever—require a prescription in Austria. Since Austria does not allow prescription refills, our data capture all prescribed medications during the study period. Diagnosis codes are available for inpatient hospital stays or sick leaves,

[1] In order to be granted the disability insurance, workers in general have to show that they cannot work at all due to their bad health. Workers in strenuous jobs have an easier access to the DI as they have to show that they cannot work in their current—strenuous—job due to bad health.

[2] For legal details and specific conditions see Fink (2016) and `https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20004642&ShowPrintPreview=True`, accessed 21 April, 2025

but not for doctor's visits. Thus, while we have information on outpatient visits and expenses, we cannot analyze outpatient diagnoses. The UAHIF data enable us to examine various measures of healthcare utilization, including total physician visits, healthcare expenses, long-term sick leave, and inpatient stays. Lastly, we supplement our analysis with workplace accident data from the Austrian Social Insurance for Occupational Risks, allowing us to isolate workplace accidents as a potential channel of health deterioration.

Information on working conditions is derived from payslip data provided by the Austrian Ministry of Finance, which records allowances for strenuous working conditions at the individual level between 1994 and 2012. Each worker's yearly information contains the total sum of allowances paid for working in strenuous conditions. Since the allowances are transparently reported on employees' payslips and reported to the authorities by the firm once a year and are used to determine the amount exempt from income taxes, they are highly reliable and we have no reason to believe that there are incentives for misreporting. However, the data do not distinguish between different types of job strain. The wage we observe in our data reflects taxable income after deducting the strenuous work allowance and other tax allowances. In the next step, we carefully describe the variation of allowances paid for strenuous working conditions and, in particular, use the total sum of allowances as a proxy for exposure to strenuous working conditions and validate this proxy using pension-relevant strenuous job classifications from the ASSD.[3]

3 Descriptive statistics

We restrict our sample to full-time private sector workers in Upper Austria between 1998 and 2012, a period and sample for which we have information of all three main data bases.

3.1 Defining strenuous job workers

Figure 1 presents the number of person-year observations along with the share receiving a positive allowance for strenuous conditions between 1998 and 2012. Throughout the sample period, around 60% of workers receive a positive allowance, suggesting that a large part of the private-sector workforce receives some allowance for strenuous working conditions. This share is higher than suggested by survey evidence (in Austria, for example, dusty or polluted

[3] We do not use the information on pension-relevant strenuous jobs in the ASSD as a proxy for several reasons. Workers covered by the Heavy Night Work Act are typically clustered in only a few occupations in heavy industries, while the take-up of early retirement covered by the Strenuous Work Act has been limited due to competing retirement regulations. Working times that are potentially relevant for the Strenuous Work Act are also only reported for individuals 20 years before their potential retirement. We are, however, interested in all workers—and not only workers above 40—and hence rely on the sum of allowances as a proxy (Federal Chancellery Austria, 2025b).

environments affect over 20% of workers, and up to 15% work at night, see Eichmann et al., 2010; Statistik Austria, 2022), likely capturing workers with intermittent exposure to strenuous conditions.

Figure 2(a) shows the distribution of yearly allowances for private-sector employees in Upper Austria, indicating that many workers receive relatively low allowances, with the median being at around €300. To test whether those are the workers with only temporary exposure to strenuous conditions we utilize data on pension-relevant strenuous jobs in the ASSD. Figure 2(b) shows that the distribution for workers in pension-relevant strenuous jobs is clearly shifted to the right in comparison to including all workers. This indicates that higher allowances reflect higher exposure to strenuous conditions, as the pension-relevant strenuous jobs in the ASSD are defined such that they cover only workers with a relatively high exposure.[4] Figure 2(c) further restricts the sample to only workers in pension-relevant night shift and heavy night work, two types of job strain with particularly high allowances, which shifts the distribution even further to the right and shows that the majority of workers affected by night work receive over €3,000 annually in allowances.

To take individual- and industry-specific differences into account, we regress the sum of allowances on dummies for the different types of pension-relevant job strain categories and control for gender, blue-collar occupation, education, tenure, firm age, firm size and the median wage in a worker's firm. Column (1) of Table A.1 shows that the sum of allowances is substantially correlated with the different categories of pension-relevant job strain, most strongly so for night shift work and heavy night work. Although the pension-relevant job strain categories do not perfectly correspond with the definitions used for the tax deductions on allowances, this shows that substantial parts of the variation in allowances can be explained by the pension-relevant job strain types. Column (2) additionally controls for the 4-digit industry and highlights that our measure captures individual exposure and is not based on an industry-wide measure used in many other studies, a key strength of our study.

We classify workers receiving positive allowances as strenuous job workers to emphasize the importance of accounting for selection into and out of strenuous jobs. This essentially separates workers with at least some exposure to strenuous conditions from those we definitely know have no exposure. While the definition includes some workers with only temporary exposure to strenuous conditions, it also avoids setting an overly restrictive threshold for strenuous work. Below we show that our causal estimates are robust to the choice of the threshold and stronger

[4]Firms have to report the number of months an employee worked in pension-relevant strenuous conditions on a yearly basis. A month is considered a strenuous month if strenuous work has been performed at least at 15 days (Federal Chancellery Austria, 2025a).

if we impose higher thresholds for the definition of strenuous job workers.

3.2 Descriptive differences in observable characteristics and outcomes

Table 1 compares socioeconomic, job-specific, and health characteristics between non-strenuous and strenuous job workers in Upper Austria, with strenuous job workers defined as those receiving a positive allowance in the current year.

First, we note that strenuous job workers differ from non-strenuous job workers across several dimensions, though the differences are less pronounced than those observed for hazardous job workers in previous studies (DeLeire and Levy, 2004). Strenuous job workers are less likely to be female (28% vs. 52%) and more likely to be blue-collar workers (62% vs. 47%). Strenuous job workers are also less likely to have college degrees but tend to have more experience and slightly higher job tenure. Notably, they earn substantially more on average, but potentially also due to their employment in higher-paying and larger firms.[5] However, they also have lower healthcare expenses, which cannot be explained by age differences or the proportion of blue-collar workers among strenuous job workers, as this group may be more likely to engage in less healthy behaviors, such as smoking and obesity (Kelly et al., 2014).

To get a better sense for the association between strenuous work conditions and the potential trade-off between healthcare utilization and wages, we estimate the following regression which controls for observable characteristics that contribute to the unconditional differences in earnings and health outcomes (without accounting for selection):

$$y_{it} = \beta \cdot \text{strenuous}_{it} + \Gamma X_{it} + \theta_i + \lambda_t + \mu_{it}, \tag{1}$$

with the outcome variable y_{it} being log earnings and healthcare expenses of worker i in period t.

The dummy for working in a strenuous job, strenuous_{it}, is defined as the sum of allowances being larger than 0 for worker i in year t, worker fixed effects θ_i and year fixed effects λ_t absorb individual-specific and time-specific variation. Covariates contained in X_{it} are age, dummies for female, education level, blue-collar occupation; tenure in current job, industry, firm size, firm age, and median wage in the firm. The estimated coefficient $\hat{\beta}$ therefore reflects outcome differences between strenuous job workers and workers in non-strenuous jobs, accounting for differences in observable firm and worker characteristics and individual fixed effects.

Table 2 shows that the large unconditional earnings differences persist, with workers in

[5] We estimate Abowd et al. (1999, AKM hereafter) firm-wage fixed effects as a proxy for a firm's and AKM worker fixed effects as a proxy for a worker's inherent productivity. We estimate the AKM model on a full panel of all Austrian workers between 1998–2021 with wage information in a given year.

strenuous jobs estimated to earn approximately 10% more than workers in non-strenuous jobs. At the same time, unconditional differences in healthcare expenses also persist and are significantly different from zero, suggesting that higher earnings associated with strenuous conditions are accompanied by lower healthcare expenses. While earnings differences may also be influenced by unobservable characteristics and selection bias, the unexpected direction of differences in healthcare utilization likely reflects the "healthy worker effect." We explore whether selection out of strenuous jobs could be an issue by regressing the likelihood of staying in a strenuous job on observable characteristics and health outcomes. Table A.2 shows that health outcomes are negatively correlated with the likelihood of staying in a strenuous job, meaning that, e.g., higher healthcare expenses in t reduce the likelihood of remaining in a strenuous job in $t+1$. Together with the unexpected differences in healthcare expenses, this highlights the importance of accounting for selection both into or out of strenuous jobs. Our empirical design leverages mass layoffs as a source of exogenous variation that pushes workers out of strenuous jobs, thereby addressing selection issues that arise because workers leave strenuous jobs due to declining health.

3.3 Causal analysis sample

For our main analysis, we further restrict our descriptive sample to only strenuous job workers and focus on those who were exposed to a mass layoff between 2001 and 2009 in Upper Austria. The idea is to circumvent selection into strenuous jobs by focusing our analysis on strenuous job workers only. This restriction is important because individuals initially selecting into strenuous work may have systematically different tolerance for such conditions. Our sample period gives us a window of three years pre- and nine years post-mass layoff in which we can observe labor market and health outcomes for each affected worker. The control group are strenuous job workers that do not experience a mass layoff between 2001 and 2009, and we randomly assign a treatment year between 2001 and 2009 for those workers.[6] Specifically, we only consider workers if their yearly strenuous work allowance was above €0 in the four years prior to the mass layoff, which is consistent with our previous definition of strenuous work. We test sensitivity to different thresholds below.

We identify mass layoffs in the ASSD by employing the so-called worker flow approach as outlined in Fink et al. (2010). We first build a quarterly panel measuring the number of employees in each plant. Drops in firm sizes between two quarters are considered mass layoffs whenever they exceed the thresholds stipulated by the system of advance layoff reporting described in

[6] We draw from a discrete uniform distribution with support $\{2001, 2002, ..., 2009\}$.

section 2, similar to Ahammer et al. (2023a).[7] Events in which a larger group of employees moves to the same plant identifier are excluded (this indicates a change in plant identifiers or a corporate spinoff instead of a true mass layoff).

Our baseline estimation sample has 10,914 mass layoffs with 46,779 treatment group workers. The control group is composed of 57,547 workers. Figure A.2 shows that the number of mass layoffs is quite uniformly distributed over time, so our effects do not depend on single time periods.

4 Empirical strategy and results

4.1 Empirical strategy

Our empirical approach leverages mass layoffs as quasi-exogenous shocks combined with cross-sectoral variation in strenuous job concentration to identify causal effects on earnings and health outcomes. This translates into a difference-in-difference-in-differences (DDD) strategy that addresses two fundamental challenges: first, selection into and out of strenuous employment, and second, the confounding health effects of job displacement itself (Sullivan and Von Wachter, 2009; Ahammer et al., 2023a). By comparing workers experiencing mass layoffs in industries with varying concentrations of strenuous employment, we isolate the causal effect of differential exposure to job strain from the general consequences of job loss.

To operationalize this strategy, we restrict our sample to workers already employed in strenuous positions before mass layoff events, thereby mitigating concerns about selection into strenuous jobs. To measure labor market concentration, we then construct Herfindahl–Hirschman indices (HHI) using the market shares of firms that employ strenuous job workers for each NACE08 2-digit sector k:

$$HHI_k = \sum_{j=1}^{n} s_{j,k}^2, \tag{2}$$

where $s_{j,k}$ is the market share of firm j (i.e., strenuous job workers in firm j over all strenuous job workers in industry k). Our approach builds on Dodini et al. (2024) but, importantly, uses a measure of labor market concentration that is based on the sectoral concentration of strenuous jobs, not overall jobs. Higher HHIs indicate higher concentration and therefore fewer alternative strenuous job options for displaced workers. The key idea is to isolate variation in access to alternative strenuous jobs—by comparing workers displaced from industries with different levels of concentration—while holding overall reemployment opportunities constant.

[7] Note that these thresholds are relatively small, and we also consider smaller mass layoffs where only 5 workers may be laid off. This gives us a more conservative set of estimates. Below, we show that our results are robust if we look at larger mass layoffs.

This allows us to construct a counterfactual in which the alternative to working in a strenuous job is working in a non-strenuous job. We test whether this identifying assumption holds below.

Because zip codes are often missing for workers, we treat Upper Austria as one labor market. Its relatively small size, a centrally located cluster of a large part of the population and jobs around the largest cities Linz, Wels and Steyr, and the findings by Nimczik (2023), who identifies large parts of Upper Austria as one labor market, strongly support this assumption. Figure A.3 shows the distribution of HHIs over sector-years and indicates quite a strong dispersion of labor market concentration among sectors, with only some sectors being extremely concentrated.

We estimate difference-in-difference-in-differences (DDD) models that further distinguish between workers in industries with high and low labor market concentration as a proxy for the opportunities to find a strenuous job again:

$$\begin{aligned} y_{itk} = \sum_{p \neq -1} \Big[& \gamma_p (\mathbb{1}_{t=p}) + \lambda_p \left(\mathbb{1}_{t=p} \cdot \text{high HHI}_k\right) \\ & + \delta_p \left(\mathbb{1}_{t=p} \cdot \text{treated}_i\right) \\ & + \beta_p \left(\mathbb{1}_{t=p} \cdot \text{treated}_i \cdot \text{high HHI}_k\right) \Big] + \theta_i + \text{age FEs} + \varepsilon_{itk}, \end{aligned} \tag{3}$$

where y_{itk} is the outcome for worker i at relative time $t = [-3, 9]$ in sector k, treated_i is a dummy equal to 1 if worker i is exposed to a mass layoff and zero else, high HHI_k is a dummy equal to 1 if sector k has an above-median HHI, and θ_i are worker fixed effects. We call workers with above-median HHI the high-treatment group and workers with below-median HHI the low-treatment group. Additionally, we control for a flexible set of age fixed effects that allow for arbitrary changes in wages and healthcare utilization over the life cycle.

Our main parameters of interest are β_p, which capture the difference between the high- and low-treatment group at different years before and after being exposed to a mass layoff, netting out any outcome trends in a control group that has not been exposed to a mass layoff. To relate differences in labor market and health outcomes to variation in job strain, it is crucial that job strain actually changes when workers are exposed to a mass layoff. We can test this by assessing differences in the strenuous work allowances paid to high- and low-treatment groups after the mass layoff. Observing smaller allowances paid to the high-treatment group after the layoff relative to the low-treatment group means that this group is pushed out of strenuous jobs, effectively indicating an exogenous variation in job strain. We therefore interpret β_p on labor market and health outcomes as intention-to-treat effects of pushing workers out of strenuous jobs.

Additionally, we need a valid control group to the high-treatment strenuous workers who have been exposed to a mass layoff. In particular, this requires that high- and low-treatment group outcomes are on similar counterfactual outcome trends. As Olden and Møen (2022) point out, one parallel trends assumption is sufficient for identification in a DDD design, as long as biases for both groups compared to the control group go in the same direction. We address this by inspecting differences in pre-treatment trends below.

Descriptives of our mass layoff sample are in Table 3. Workers in the high-treatment group (column 1) are slightly older, have a little more labor market experience and tenure in their current job, and are more likely to be female and white-collar workers compared to low-treatment workers (column 2). These differences can, to some degree, be explained by differences in firm size, as high treatment workers are working in substantially larger firms by construction, since more concentrated sectors have a higher share of larger firms. While we note that our design allows for baseline differences between the treatment groups and the control group, we also provide estimates where we reweight our sample such that high-treatment, low-treatment, and control group workers have similar covariate distributions using the entropy balancing approach suggested by Hainmueller (2012). Columns (3) and (5) report sample means with unit entropy weights based on the worker-level covariates in the first panel of Table 3.

4.2 Causal effects on earnings and health outcomes

Main results Panel (a) of Figure 3 presents estimates of differences in allowances between the high- and low-treatment groups, relative to the control group, where workers have not been exposed to a mass layoff. Following the mass layoff event at $t = 0$, workers in the high-treatment group are pushed out of strenuous jobs, whereas those in the low-treatment group seem to transition back, as reflected in differences in allowances. The discrepancy is substantial, amounting to approximately 35% of the pre-mass layoff mean over the post-treatment period. These findings validate our identification strategy, demonstrating a quasi-exogenous mechanism pushing only high-treatment workers out of strenuous jobs.

Workers being pushed out of strenuous jobs also experience significant negative earnings effects, as shown in Panel (b) of Figure 3. On average, the high-treatment group earns around 14% less than the low-treatment group over the post-mass layoff period, a pattern that is consistent with observed differences in allowances. This suggests that earnings differences stem primarily from differences in exposure to strenuous working conditions, consistent with the theory of compensating wage differentials. Importantly, we will show that earnings disparities are not driven by differences in unemployment post-mass layoff, and we will explore alternative explanations and further labor market outcomes below.

Panel (c) of Figure 3 presents effects on healthcare expenses within the same framework. In the nine years following exposure to the mass layoff, a clear divergence emerges between high- and low-treatment workers. Those being pushed out of strenuous jobs and thus working in less strenuous conditions show significantly lower healthcare expenses. Trends diverge over time, with differences between high- and low-treatment workers averaging to around 5.1% lower healthcare expenses over nine years relative to the pre-mass layoff mean, with a maximum reduction of over 10% ten years post-mass layoff. The initial increase in expenses in the mass layoff year is likely reflecting health investments during unemployment and potential negative health effects from mass layoff exposure, while diverging trends in healthcare expenses align with existing literature indicating that cumulative exposure to strenuous conditions significantly impacts health outcomes (Fletcher et al., 2011). Unlike the potentially biased descriptive outcomes, our causal estimates indicate a negative and highly significant effect on healthcare expenses.

Elasticities To get a sense for the importance of the wage-health expenditure trade-off, we calculate elasticties for changes in health expenditures y_h relative to changes in wages y_w due to the mass layoff as follows:

$$\varepsilon_w^h = \frac{\Delta\%\, y_h}{\Delta\%\, y_w} = \frac{\hat{\beta}_h/\bar{y}_h}{\hat{\beta}_w/\bar{y}_w}, \tag{4}$$

where $\hat{\beta}_h$ and $\hat{\beta}_w$ are the coefficients from equation (3) for the differential mass layoff effects on health expenditures and wages, estimating both outcomes in levels (in which case the relative change in wages is 10.6%), and $\bar{y}_h$ and $\bar{y}_w$ are pre-mass layoff average health expenditures and wages in our sample.[8] Estimating equation (4) returns an elasticity of $\varepsilon_w^h = 0.499$ with a 95% confidence interval of $[0.206, 0.792]$, meaning that a 1% increase in wages due to working in a strenuous job is associated with a 0.5% increase in healthcare expenditures. We regard this as our main result. During the ten years after the mass layoff, the wage-health expenditure trade-off becomes stronger, with the highest elasticity of $\varepsilon_w^h = 0.897$ being observed in the last period post-mass layoff.

Drivers in healthcare expenditures What drives changes in healthcare expenditures? Table 4 shows the effects on different components of healthcare utilization. In columns (1) and (2), we report effects on physician visits and drug prescription. Both categories exhibit substantial declines for the high-treatment group, with drug expenses showing a more pronounced reduction.

Columns (3) and (4) of Table 4 indicate that the overall reduction in health spending is

[8] If we estimate equation (3) on wage levels, we obtain a coefficient estimate of 2,552.27—this suggests that wages decrease overproportionally relative to the hardship allowance.

also reflected in reduced inpatient days and sick leave days, two alternative health indicators. Inpatient days, which are perhaps the most severe health outcome in our data and are possibly driven by severe disease onset or workplace accidents, are not significantly different from zero.[9] Moreover, Figure A.4 shows that workplace accidents do not differ post-mass layoff, suggesting that improvements in health outcomes are not driven by accident avoidance. Instead, our findings indicate an overall enhancement in health following the transition out of strenuous jobs, with the most substantial effects observed in less severe but more frequent health indicators.

Table A.3 provides more granular breakdowns of the effects on doctor visits and drug prescriptions. The most significant reductions occur in visits to primary care practitioners, pulmonologists, and diagnostic specialists (such as radiologists). In Austria, primary care practitioners serve as the first point of contact for health concerns, so it is expected that primary care practitioners visits decrease if general health improves. The negative effect on pulmonologists is particularly interesting. Recent medical research associates night and rotating shift work with an increased risk of respiratory conditions, such as asthma and chronic obstructive pulmonary disease (Li et al., 2024; Maidstone et al., 2021). We also find that it is primarily respiratory system drugs that decrease when workers are pushed out of strenuous jobs, while other classes of drugs are unaffected (Panel B of Table A.3). This suggests that our negative effects on healthcare utilization are primarily driven by improvements in pulmonary health.

Heterogeneity for subgroups We next show how our main results vary along the observable characteristics gender, education, age, occupation, and tenure. Figure A.5 shows that the estimated elasticities are positive for all groups, implying that a reduction of wages for strenuous working conditions is associated with a reduction in healthcare expenses for high-treatment workers. The elasticities are larger for men, lower-educated workers, blue-collar workers and workers with a longer exposure to strenuous conditions prior to the mass layoff, which is consistent with prior literature suggesting that cumulative exposure amplifies health effects (Fletcher et al., 2011).

Heterogeneity by treatment intensity Finally, we test whether our main results change for different definitions of strenuous job workers. Throughout our analysis, we defined strenuous job workers as receiving a positive allowance prior to the mass layoff, also including workers with intermittent exposure to strenuous conditions (see section 3). To assess how our estimated effects change when the definition of strenuous job workers is limited to those with higher

[9] Though emergency department visits are not captured in our data, surviving an emergency department visit often leads to overnight hospital stays.

allowances, we repeat the analysis using baseline thresholds above each quintile of the allowance distribution. Figure 4 shows that, strikingly, the effects on allowances, earnings and healthcare expenses become stronger as we focus on workers with higher pre-mass layoff allowances. This reinforces our conclusion that exposure to strenuous conditions is the key driver of effects on earnings and healthcare expenses.

4.3 Robustness analysis

In this section, we address the key threats to our identification strategy and perform robustness checks.

Testing the variation induced by our design A potential concern is that labor market concentration alone may negatively affect earnings and career outcomes for high-treatment workers (Dodini et al., 2024), which could confound our causal estimates. However, we find no significant differences in unemployment duration between high- and low-treatment workers (see column (1) of Table 5). Similarly, column (2) of Table 5 shows no evidence that high-treatment workers systematically substitute unemployment with disability insurance (DI). Column (3) of Table 5 shows that the likelihood of job separations are significantly higher for the high-treatment group in the years following the mass layoff, indicating challenges in finding a similarly strenuous job. Additionally, the average AKM firm fixed effects (FEs) post-mass layoff are significantly lower for high-treatment workers, suggesting difficulty finding firms offering strenuous jobs. On one hand, both results may simply reflect the effects of reduced earnings due to a shift away from strenuous working conditions, and the intensified search effort for a similarly strenuous and high paying job. On the other hand, they may negatively affect earnings, thereby intensifying our estimates for compensating wage differentials.

To address the concern that the earnings effects may be driven primarily by higher job separations and lower AKM firm FEs, rather than differences in strenuous working conditions, we conduct a placebo test using non-strenuous job workers (i.e., those with zero allowances in the four years prior to the mass layoff). In this test, we repeat our main analysis with the same firms, mass layoff thresholds, and high- and low-HHI sector classifications as before, but focus on non-strenuous workers. If our argument holds, these non-strenuous workers should be subject to the same HHI-specific effects from the mass layoff, while their labor market and health outcomes should not be influenced by challenges in finding a similarly strenuous job.

Figure 5 confirms that the differences in allowances between high- and low-treatment placebo workers are minimal and negligible compared to strenuous job workers. The small differences likely reflect employment changes triggered by the mass layoff rather than exposure to strenuous conditions. While earnings losses are evident for both groups compared to the control group, the differential impact between high- and low-treatment workers does not follow the same pattern as for the strenuous workers and is much smaller (averaging to around 6% over the pre-mass layoff period). Moreover, Table A.4 shows that placebo group workers experience longer unemployment spells and higher job separations than strenuous job workers. Their pre-mass layoff earnings are also significantly lower (Table 3), complicating direct effect-size comparisons. However, even under the most conservative interpretation, our findings strongly suggest that differences in strenuous working conditions—not labor market concentration alone—drive the observed earnings gaps.

Regarding health outcomes, our design would only lead to biased estimates if job separations and lower earnings led to deteriorating health, as suggested by previous research (Zweifel, 2012). However, since Austria's healthcare system basically does not require out-of-pocket payments, financial constraints are unlikely to explain differences in health expenses. Panel (c) of Figure 5 confirms this by showing no significant differences in healthcare expenses for the placebo group, further strengthening our identification strategy.

Robustness to baseline characteristics and choice of thresholds We next note that our findings could be driven by differences in baseline characteristics. High-treatment workers are, for example, more likely to be female and have higher average allowances (Table 3). The validity of our results would be affected if these factors alone influenced earnings or health trends.

Above we show that our main results are robust along several observable characterstics. To address the concern more directly, we reweight our sample using the entropy balancing approach proposed by Hainmueller (2012). This method generates balancing weights for the worker-level covariates listed in Table 3, ensuring that high-treatment, low-treatment, and control group workers share the same covariate distribution for these characteristics. While differences in firm-level outcomes decrease, they still persist. Column (2) of Table 6 shows that the reweighted estimates for allowances, earnings, and healthcare expenses remain consistent with our main findings, suggesting that baseline differences do not explain much of the disparities between high- and low-treatment workers after the mass layoff.

We further test whether our results depend on the chosen mass layoff thresholds. Column (3) of Table 6 shows that our findings hold when increasing the mass layoff threshold to include only cases where at least 15% of workers were laid off. Column (4) confirms robustness when instead weighting the estimates by the mass layoff size. Finally, column (5) of Table 6 shows that changing the definition of strenuous job workers to those receiving above-median allowances (around €300) creates robust yet stronger results—as described above. Importantly, this is also true when using the sum of allowance as weights for the estimation, showing that our results do not depend on specific choices of thresholds (see column 6).

5 Discussion and conclusion

Our findings provide compelling causal evidence that strenuous working conditions entail a distinct trade-off: while they offer wage compensation, they also impose significant hidden health costs. Across various specifications and subsamples, our results consistently support the theory of compensating wage differentials and, for the first time, establish a causal link between earnings and health outcomes in strenuous jobs—an effect previously suggested but not rigorously tested (Wissmann, 2022; Nagler et al., 2023).

Leveraging a quasi-experimental design based on mass layoffs across industries with varying labor market concentration, we provide causal evidence that workers displaced from strenuous jobs experience a substantial decline in earnings—reflecting the loss of compensating differentials—while simultaneously exhibiting notable health improvements. Specifically, we document reductions in physician expenses, sick leave days, and prescription drug usage, driven primarily by improvements in pulmonary health. Importantly, these health improvements are not attributable to a decline in workplace accidents, suggesting that the health costs of strenuous work extend beyond acute hazards to encompass more gradual but persistent health deterioration.

Our findings also underscore the critical role of accounting for selection bias when estimating the health effects of strenuous work. Before accounting for selection, we observe that workers in strenuous jobs exhibit lower healthcare expenses despite higher exposure to strenuous working conditions. This counterintuitive pattern aligns with the "healthy worker effect," wherein healthier individuals self-select into strenuous jobs, effectively obscuring the true health costs. By implementing a quasi-experimental design, we circumvent this bias, providing the first causal estimates of the health impacts of strenuous work that are not confounded by selection effects.

To further contextualize our findings, we calculate the elasticity of healthcare expenses relative to changes in earnings associated with working in a strenuous job. We find that a 1% increase in wages is on average associated with a 0.5% increase in healthcare expenditures that becomes larger over time and reaches its maximum of 0.9% after 10 years. This suggests that while wages adjust to compensate for strenuous conditions, healthcare expenses simultaneously rise, reflecting the hidden health costs of such jobs. Importantly, as Austria has minimal out-of-pocket medical expenses, these healthcare costs should not be directly equated with earnings losses. Rather, our broader set of health outcomes consistently indicates a decline in health for workers in strenuous jobs, underscoring the need to account for both explicit wage premiums and implicit health costs.

The observed increases in healthcare expenses due to strenuous working conditions are substantial when contextualized against other labor market and health shocks in Austria. For instance, surviving a mass layoff leads to a 3.7% increase in healthcare expenses within the first six quarters, likely driven by heightened stress and job insecurity (Ahammer et al., 2023a). In contrast, women diagnosed with breast cancer experience a 22.8% (€878) increase in healthcare expenses relative to a control group five years post-diagnosis (Ahammer et al., 2024). Over a 10-year period following a mass layoff, workers in our low-treatment group—those who return to strenuous jobs—incur approximately 5% (€510) more in healthcare expenses, with effects peaking at over 10%. These comparisons underscore the significant and persistent health costs associated with strenuous working conditions, illustrating that the health impacts of such jobs are not only substantial but also long-lasting.

Overall, our findings underscore the importance of considering both economic and health consequences when assessing the true costs of strenuous work, particularly in the context of wage inequality and labor market policies. More broadly, our findings indicate that the integration of health effects into wage-setting frameworks is crucial for accurately capturing the full economic impact of job strain, thereby informing more effective policy interventions.

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Tables and Figures

Table 1: Non-strenuous- vs. strenuous job worker characteristics

	Non-strenuous job worker (1)	Strenuous job worker (2)
Observations	1,486,012	2,496,500
Share	0.37	0.63
Worker information		
Female (share)	0.52	0.28
College degree (share)	0.10	0.07
Children present (share)	0.68	0.62
AKM worker fixed effect	0.16	0.24
Age (years)	36.76	37.86
Experience (years)	20.41	21.48
Job tenure (years)	7.39	8.21
Blue collar (share)	0.47	0.62
Main outcomes		
Hardship allowance (EUR)	0.00	1,288.66
Log wages	9.80	10.15
Total healthcare expenses (EUR)	305.66	275.02
Firm Information		
Firm age	20.54	21.31
Firm size	686.30	1,515.54
AKM firm fixed effect	0.21	0.43
Industry sector		
Manufacturing	0.24	0.41
Construction	0.11	0.11
Tourism	0.05	0.02
Transportation	0.01	0.03
Finance and real estate	0.05	0.02
Retail	0.10	0.05
Other	0.36	0.27
Industry sector information		
Share of hardship workers	0.00	0.02
Share of female workers	0.44	0.36
Average age	37.01	37.57

Notes: This table presents summary statistics for the full sample of Upper Austrian workers in private sector full-time employment between 1998 and 2012. Strenuous job workers are defined as those receiving an allowance €> 0.Strenuous job workers are defined as those receiving an allowance €> 0. For computational reasons, we include a 50% sample of Upper Austrian workers who receive zero allowances throughout the sample period and the full sample of workers with positive allowance for strenuous conditons. Differences between groups, numbers of observations and shares are weighted accordingly. Sectoral information is calculated on the 2-digit sector level for every year separately.

Table 2: Descriptive differences between non-strenuous and strenuous job workers

	Log wages (1)	Total healthcare expenses (2)
Strenuous Job	0.095***	−7.968***
	(0.001)	(0.845)
Outcome mean	10.09	284.12

Notes: This table presents estimates for β based on equation (1) for descriptive differences between strenuous job workers and non-strenuous job workers in private sector full-time employment between 1998 and 2012 in Upper Austria. Strenuous job workers are defined as those receiving an allowance €> 0. Estimations include individual and year fixed effects and age, dummies for female, education level, blue-collar occupation and industry, tenure in current job, firm size, firm age and median wage in firm. Total healthcare expenses are measured in €. For computational reasons, both estimations are based on a 50% sample of workers with zero allowance throughout the sample period and the full sample of workers with positive allowance for strenuous conditons. Estimands are weighted accordingly. The number of observations is 2,447,991 in both columns, standard errors in round brackets. Stars indicate significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Mass layoff sample summary statistics by treatment status, unweighted vs. weighted

	Treatment group			Control group	
	HHI high	HHI low			
		unweighted	weighted	unweighted	weighted
	(1)	(2)	(3)	(4)	(5)
Worker information					
Female (share)	0.43	0.27	0.45	0.19	0.44
College degree (share)	0.11	0.04	0.11	0.05	0.11
Children present (share)	0.66	0.63	0.67	0.59	0.66
AKM worker fixed effect	0.24	0.29	0.24	0.28	0.24
Age (years)	33.89	32.55	33.93	36.89	34.04
Experience (years)	16.05	14.25	16.15	19.08	16.17
Job tenure (years)	5.50	3.82	5.56	8.49	5.49
Blue collar (share)	0.57	0.76	0.55	0.70	0.56
Main outcomes					
Hardship allowance (EUR)	1,040.93	595.10	1,061.39	1,003.15	1,084.95
Log wages	9.76	9.53	9.69	10.04	9.84
Total healthcare expenses (EUR)	273.13	231.61	260.60	227.15	234.99
Firm information					
Firm age	19.52	16.74	18.79	20.80	19.21
Firm size	1,930.27	776.26	1,146.24	694.23	1,398.49
AKM firm fixed effect	0.40	0.37	0.36	0.40	0.37
Industry sector					
Manufacturing	0.63	0.53	0.53	0.45	0.44
Construction	0.06	0.12	0.06	0.36	0.26
Tourism	0.03	0.05	0.04	0.07	0.13
Transportation	0.02	0.09	0.07	0.03	0.03
Finance and real estate	0.07	0.02	0.03	0.04	0.05
Retail	0.04	0.17	0.25	0.03	0.07
Other	0.16	0.01	0.03	0.02	0.03
Industry sector information					
Share of hardship workers	0.02	0.01	0.01	0.02	0.01
Share of female workers	0.44	0.34	0.40	0.29	0.38
Average age	37.09	35.92	36.17	36.86	36.81

Notes: This table presents summary statistics for our mass layoff sample used for our causal analysis. The sample consists of strenuous job workers exposed to a mass layoff between 2001 and 2009 in Upper Austria (treatment group), or not exposed to a mass layoff (control group) that is assigned a placebo mass layoff between 2001 and 2009 in Upper Austria. Details on the sample construction can be found in section 3.3. Strenuous job workers are defined as those receiving an allowance €> 0. Workers in HHI high- (low-) treatment group are laid off from 2-digit sectors with above (below) median HHI. Columns (5) and (7) are based on Hainmueller (2012) entropy reweighting. Sectoral information is calculated on the 2-digit sector level for every year. All columns display pre-mass layoff means.

Table 4: Effects of being pushed out of strenuous job on health outcomes

	Physician expenses (1)	Drug expenses (2)	Inpatient days (3)	Sick days (4)
Triple-diff estimate	−5.24**	−6.79***	−0.04	−0.81***
	(2.47)	(2.56)	(0.06)	(0.29)
	[−3.1%]	[−10.4%]	[−3.6%]	[−5.4%]
Pre-ML mean	169.1	65.2	1.0	15.1

Notes: This table presents estimates based on equation (3) for the differential impact of mass layoffs on workers in strenuous jobs between those in high- and low-treatment sectors, netting out outcome trends in a control group that has not been exposed to a mass layoff, on different outcomes measuring healthcare utilization. We omit the mass layoff year from all estimations, the number of observations is 944,638 in all columns. Percentage effects relative to the pre-mass layoff mean (Pre-ML mean) are in square brackets, robust standard errors are in round brackets. Stars indicate significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Effects of being pushed out of strenuous job on career outcomes

	UI days (1)	DI days (2)	Separations (3)	AKM firm FEs (4)
Triple-diff estimate	−0.57	−0.35	0.06***	−0.04***
	(0.61)	(0.41)	(0.00)	(0.00)
	[−3.6%]	[−87.0%]	[32.8%]	[−10.5%]
Pre-ML mean	16.1	0.4	0.2	0.4

Notes: This table presents estimates based on equation (3) for the differential impact of mass layoffs on workers in strenuous jobs between those in high- and low-treatment sectors, netting out outcome trends in a control group that has not been exposed to a mass layoff, on different employment and career outcomes. We omit the mass layoff year from all estimations, the number of observations is 944,638 in all columns. Percentage effects relative to the pre-mass layoff mean (Pre-ML mean) are in square brackets, robust standard errors are in round brackets. Stars indicate significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Robustness to baseline differences, mass layoff size, and allowance minimums

			mass layoff size		Hardship allowance	
	Baseline	Balanced	> 15%	Weighted	≥ median	Weighted
	(1)	(2)	(3)	(4)	(5)	(6)
Hardship allowance	−283.06***	−319.11***	−122.07***	−185.35***	−414.56***	−528.51***
	(11.66)	(10.44)	(14.14)	(12.92)	(16.58)	(25.84)
Log wages	−0.13***	−0.14***	−0.04***	−0.05***	−0.20***	−0.25***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Total healthcare expenses	−13.14***	−12.03***	−21.08***	−17.36***	−15.93***	−18.79***
	(5.06)	(3.85)	(5.26)	(5.08)	(5.24)	(6.51)

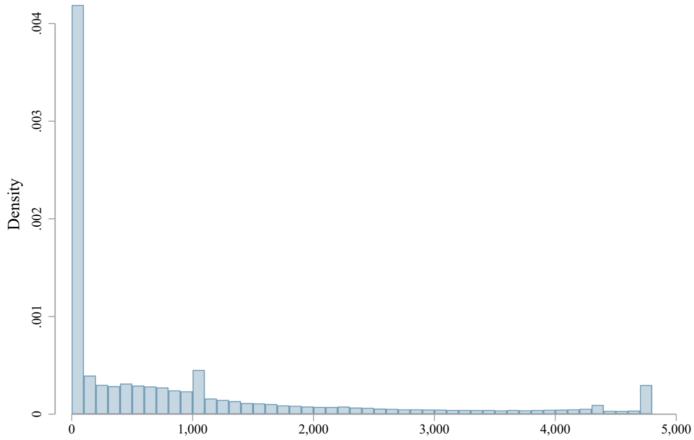
Notes: This table presents estimates based on equation (3) for the differential impact of mass layoffs on workers in strenuous jobs between those in high- and low-treatment sectors, netting out outcome trends in a control group that has not been exposed to a mass layoff, on different outcomes measuring healthcare utilization. We omit the mass layoff year from all estimations, the baseline number of observations is 944,638. Robust standard errors are in round brackets. Column (2) is based on Hainmueller (2012) entropy reweighting. Estimates in column (4) are weighted by the mass layoff size, estimates in column (6) are weighted the allowance sum for strenuous working conditions. Stars indicate significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 1: Person-year observations

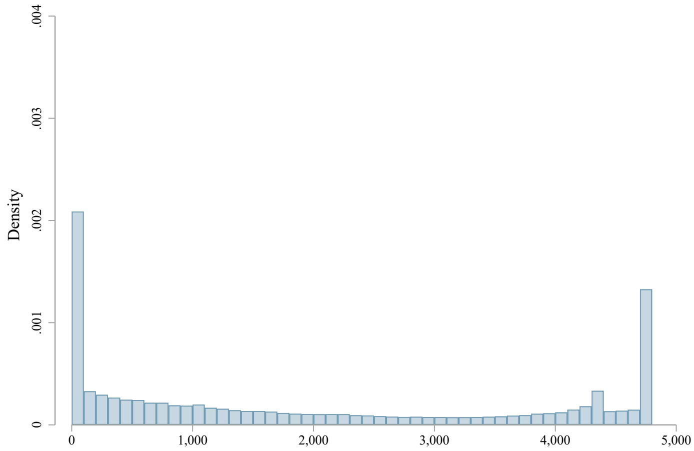
Notes: This figure shows the number of all person-year-observations for the full sample of all Upper Austrian workers in private sector full-time employment between 1998 and 2012 (white bars, left axis). The blue-shaded bars presents the share of strenuous job workers, defined as those receiving an allowance €> 0 (right axis).

Figure 2: Distribution of allowances paid for strenuous working conditions

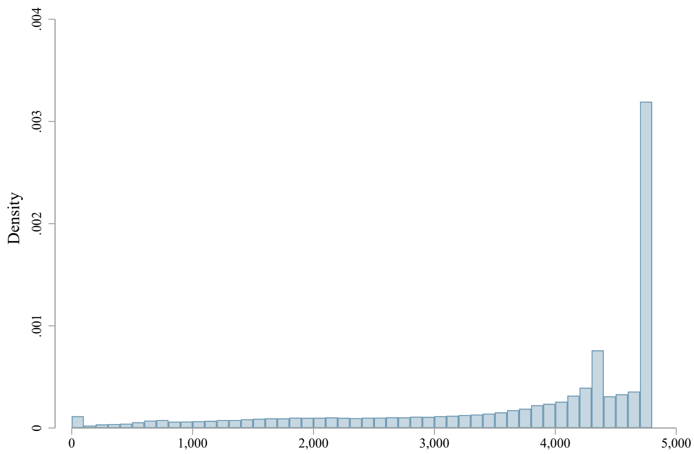
(a) All workers



(b) All workers in pension-relevant strenuous jobs



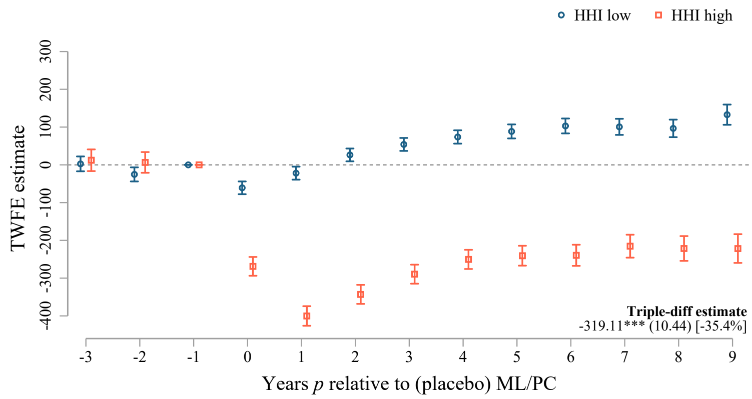
(c) All workers in pension-relevant night shift or heavy night work



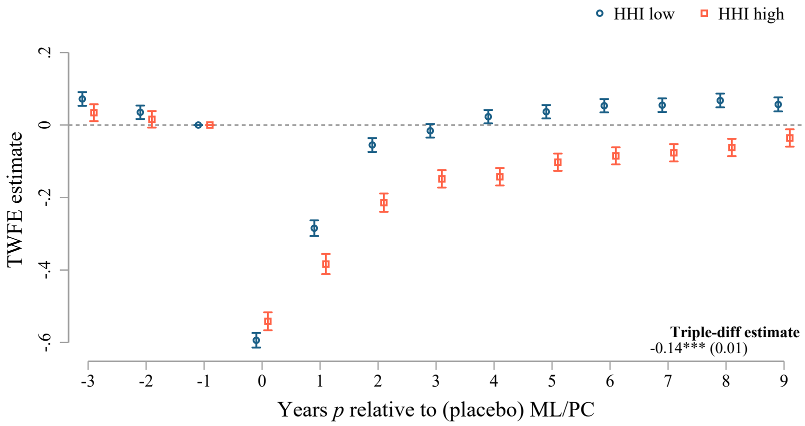
Notes: This figure shows the histogram of allowances paid for strenuous working conditions for all Upper Austrian workers in private sector full-time employment between 1998 and 2012 (Panel a), only those who work in a pension-relevant job (Panel b), and only those who work in a pension-relevant shift or heavy night job as defined in section 2 (Panel c). We top-code allowances at the 99th percentile as wages are also top-coded in the ASSD. Note that information for pension-relevant strenuous jobs is only available for male (female) workers older than 40 (35) and after 2009. We restrict the sample in all panels to this.

Figure 3: Changes in allowances, wages, and healthcare expenses

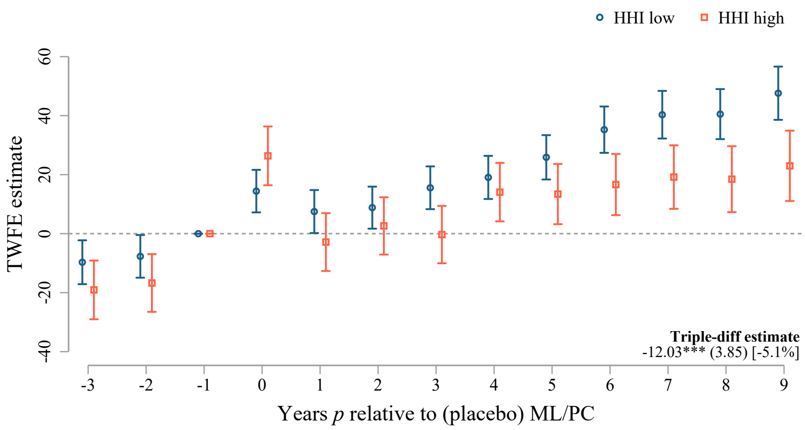
(a) Change in allowance sum (EUR)



(b) Change in log wages

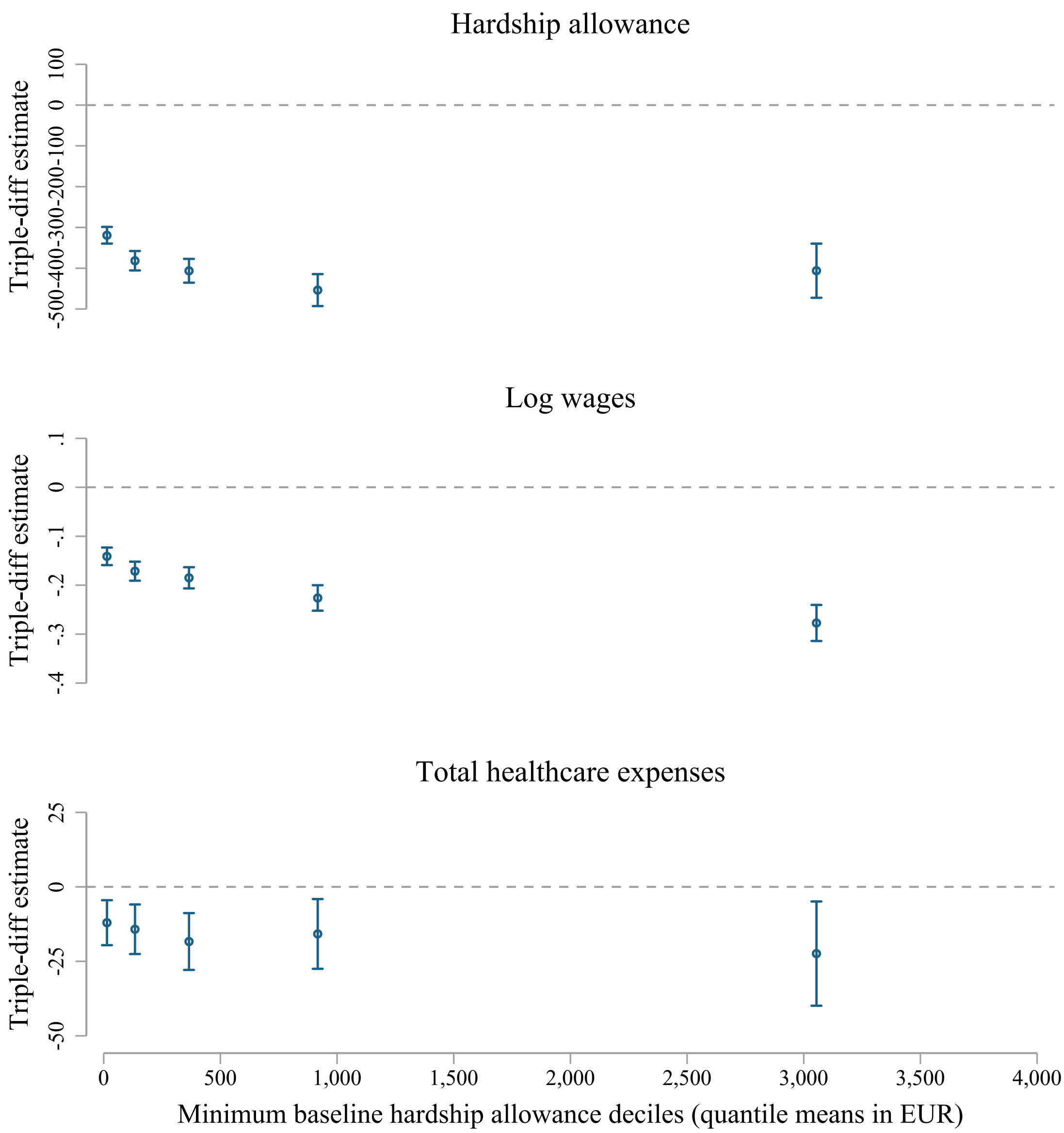


(c) Change in healthcare expenses (EUR)



Notes: This figure presents estimates based on equation (3) for the impact of mass layoffs on workers in strenuous jobs in low-treatment sectors (δ_p, in blue) and high-treatment sectors ($\delta_p + \beta_p$, in orange) on our main outcomes, netting out outcome trends in a control group that has not been exposed to a mass layoff (ML). Bars show 95% confidence intervals. We omit the mass layoff year from all estimations for the estimation of the average effect. The number of observations is 944,638 in all panels. Percentage effects relative to the pre-mass layoff mean are in square brackets, robust standard errors are in round brackets. Stars indicate significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

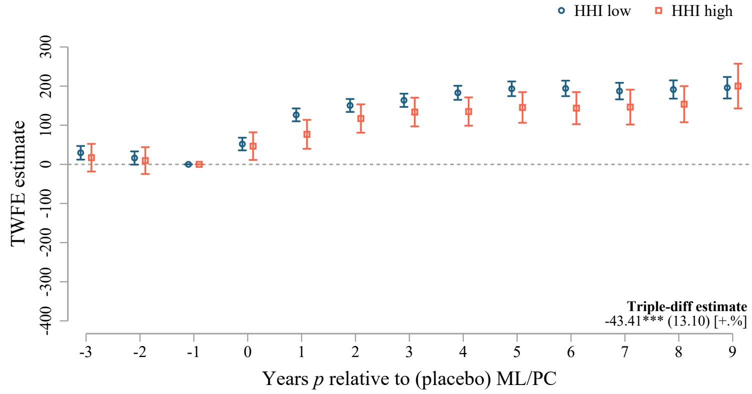
Figure 4: Main results by minimum baseline allowance



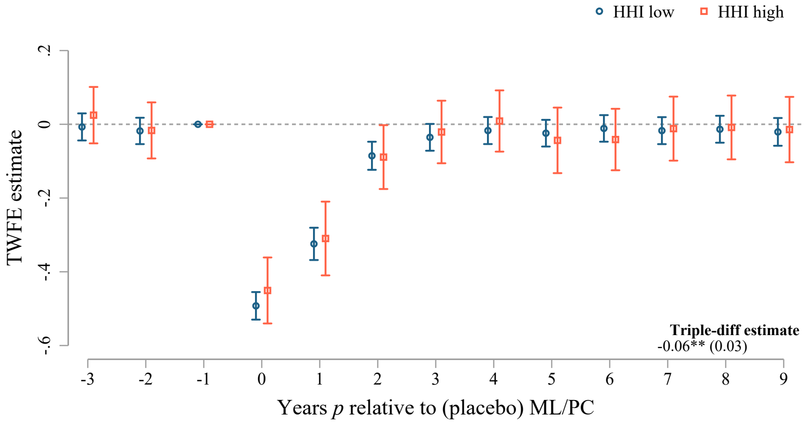
Notes: This figure plots estimates based on equation (3) by the minimum baseline hardship allowance in € after which workers are classified as strenuous job workers. The five minima depicted on the x-axis are based on quantiles of the hardship allowance distribution in our sample. The bars show 95% confidence intervals.

Figure 5: Changes in allowances, wages, and healthcare expenses for non-strenuous workers

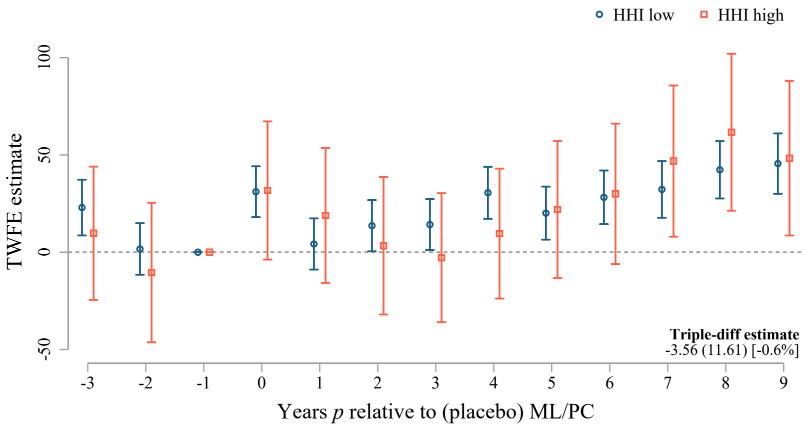
(a) Change in allowance sum (EUR)



(b) Change in log wages



(c) Change in healthcare expenses (EUR)



Notes: This figure presents estimates for the placebo group that consists workers in non-strenuous jobs and is based on equation (3) for the impact of mass layoffs on workers in non-strenuous jobs in low-treatment sectors (δ_p, in blue) and high-treatment sectors ($\delta_p + \beta_p$, in orange) on our main outcomes, netting out outcome trends in a control group that has not been exposed to a mass layoff (ML). Bars show 95% confidence intervals. We omit the mass layoff year from all estimations for the estimation of the average effect. The number of observations is 699,179 in all panels. Percentage effects relative to the pre-mass layoff mean are in square brackets, robust standard errors are in round brackets. Stars indicate significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A Supplementary Tables and Figures

Table A.1: Pension-relevant job strain categories as explainers of variation in allowances

	Sum of Allowances	
	(1)	(2)
Shift work	1,845.500***	1,752.692***
	(8.914)	(8.395)
Hot or cold conditions	574.440***	430.802***
	(36.785)	(33.112)
Heavy night work	2,665.725***	2,352.555***
	(12.891)	(13.114)
Heavy physical work	105.856***	83.784***
	(4.872)	(3.794)
Chemical or physical strain	−196.972	−29.162
	(126.182)	(115.001)
Professional care	1,449.484***	1,351.639***
	(9.888)	(12.108)
Industry Controls		✓
R^2	0.44	0.54

Notes: This table shows the estimates and R^2 from a regression of the sum of allowances on a dummy for female and blue-collar, dummies for education, tenure, firm age, firm size and median wage in firm as well as variables shown in the table. Sample includes all Upper Austrian workers in private sector full-time employment older than 40 and between 2009 and 2012 since pension-relevant strenuous working conditions are only available since 2009 and for male (female) workers older than 40 (35). The number of observations is 421,474 in both columns, standard errors in round brackets. Stars indicate significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2: Likelihood to stay in strenuous job dependent on healthcare utilization

	Likelihood to stay in strenuous job		
	(1)	(2)	(3)
Total healthcare expenses	−0.004***		
	(0.000)		
Sick days		−0.001***	
		(0.000)	
Inpatient Days			−0.004***
			(0.000)
Outcome mean	0.91	0.91	0.91

Notes: This table presents estimates based on regressing health outcomes shown in the table on a dummy for working in a strenuous job in $t+1$. Sample includes only workers in strenuous jobs in t defined as those receiving an allowance €> 0. Estimations are based on the sample of all Upper Austrian workers in private sector full-time employment between 1998 and 2012 and includes controls for age, dummies for female, education level, blue-collar occupation and industry, firm size, firm age and median wage in firm. The number of observations is 1,815,816 in all columns, standard errors in round brackets. Stars indicate significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.3: Estimates for different specialists and drugs

Panel A: Specialists	PCPs	Pulmonologists	Orthopedists	Psychiatrists[a]	Diagnostics	Others
	(1)	(2)	(3)	(4)	(5)	(6)
Triple-diff estimate	−5.97***	−0.37*	0.13	0.52	−2.10***	−0.45
	(0.88)	(0.23)	(0.44)	(0.57)	(0.52)	(0.65)
	[−9.9%]	[−14.8%]	[2.5%]	[20.1%]	[−13.9%]	[−2.8%]
Pre-ML mean	60.3	2.5	5.0	2.6	15.2	15.9

Panel B: Drugs	Alimentary tract	Cardiovascular	Musculoskeletal	Nervous system	Respiratory system	Others
	(1)	(2)	(3)	(4)	(5)	(6)
Triple-diff estimate	−0.10	0.93	−0.41	−0.71	−1.60**	10.89
	(0.64)	(0.73)	(0.28)	(1.38)	(0.65)	(8.33)
	[−1.2%]	[11.1%]	[−8.6%]	[−8.6%]	[−30.2%]	[33.3%]
Pre-ML mean	8.5	8.4	4.7	8.2	5.3	32.7

Notes: This table presents estimates based on equation (3) for the differential impact of mass layoffs on workers in strenuous jobs between those in high- and low-treatment sectors, netting out outcome trends in a control group that has not been exposed to a mass layoff, on expenditures for different types of doctors and drugs. We omit the mass layoff year from all estimations, the number of observations is 944,638 in all columns. Percentage effects relative to the pre-mass layoff mean (Pre-ML mean) are in square brackets, robust standard errors are in round brackets. Stars indicate significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

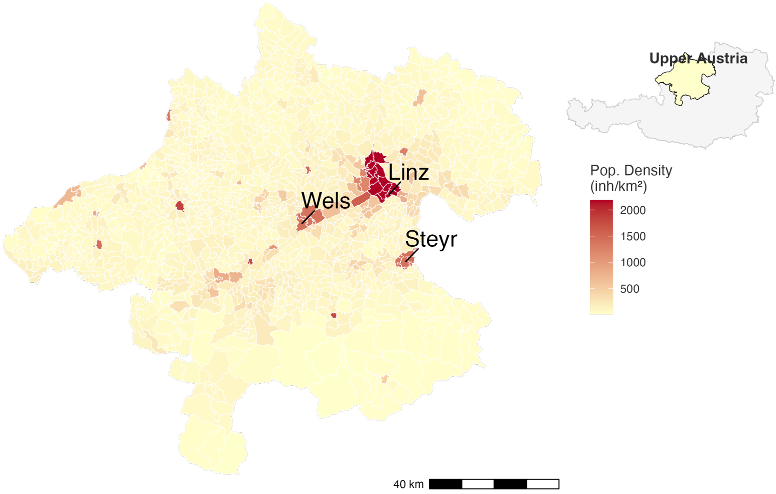
[a]The category 'psychiatrists' also include neurologists and psychologists.

Table A.4: Placebo employment and career effects for non-strenuous workers

	UI days (1)	DI days (2)	Separations (3)	AKM firm FEs (4)
Triple-diff estimate	11.75***	10.86***	0.11***	−0.03***
	(2.19)	(1.21)	(0.01)	(0.01)
	[121.4%]	[18.3%]	[86.4%]	[−28.8%]
Pre-ML mean	9.68	59.35	0.127	0.10

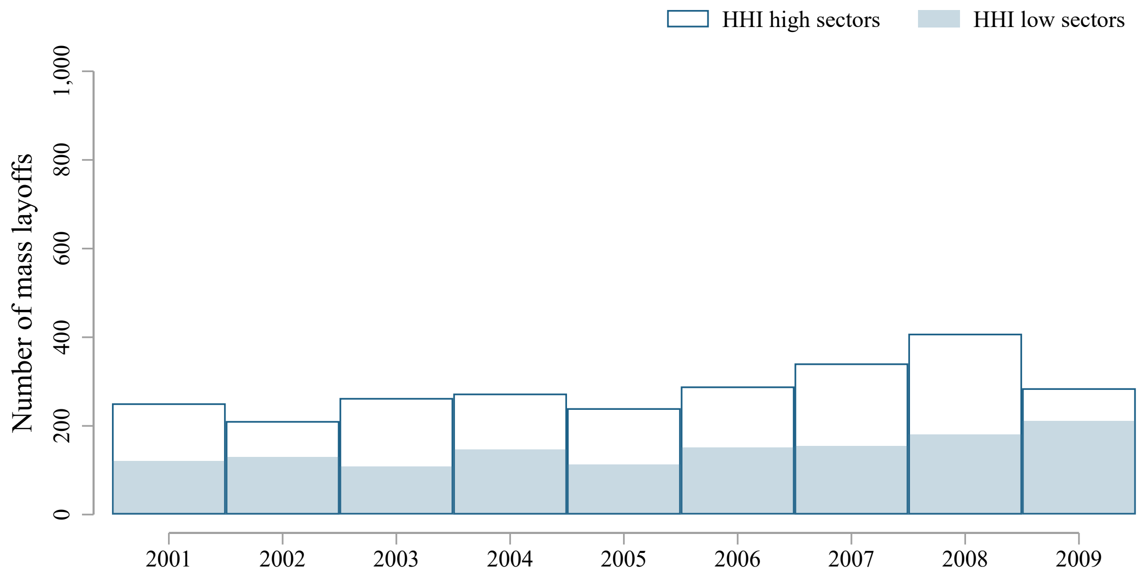
Notes: This table presents estimates for the placebo group that consists of workers in non-strenuous jobs and is based on equation (3) for the differential impact of mass layoffs on workers in strenuous jobs between those in high- and low-treatment sectors, netting out outcome trends in a control group that has not been exposed to a mass layoff, on different employment and career outcomes. We omit the mass layoff year from all estimations, the number of observations is 699,179 in all columns. Percentage effects relative to the pre-mass layoff mean are in square brackets, robust standard errors are in round brackets. Stars indicate significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A.1: Upper Austria's population density and location within Austria



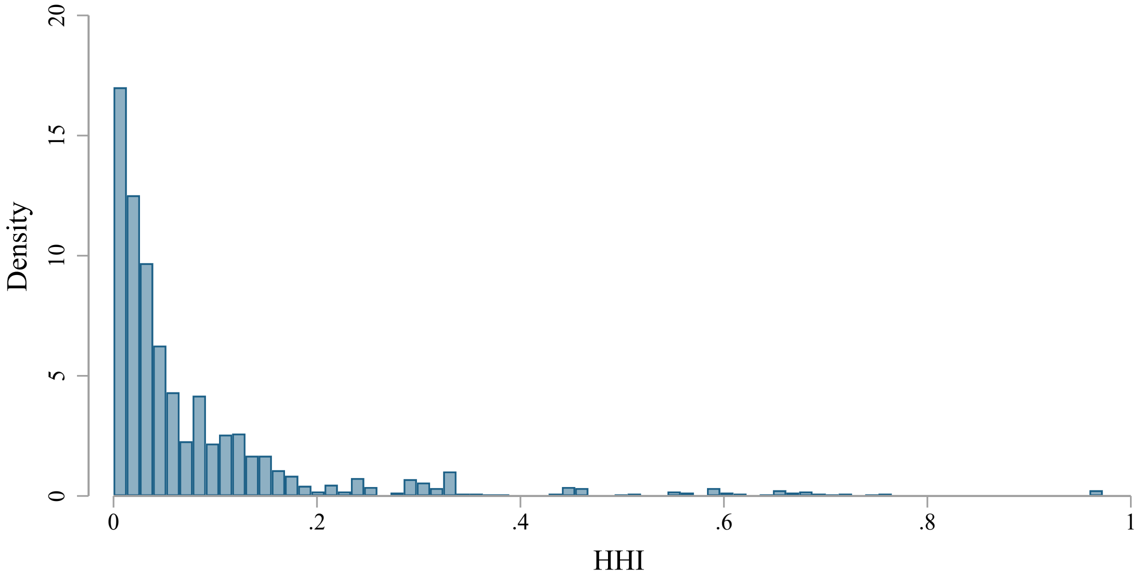
Notes: This figure plots the population density of Upper Austrian communities (Gemeinden) for the year 2024 based on data provided by Statistik Austria. See https://www.statistik.at/atlas/?mapid=them_bevoelkerung_bevoelkerungsdichte&layerid=layer1&sublayerid=sublayer0&, accessed 24 April, 2025

Figure A.2: Number of mass layoffs per year



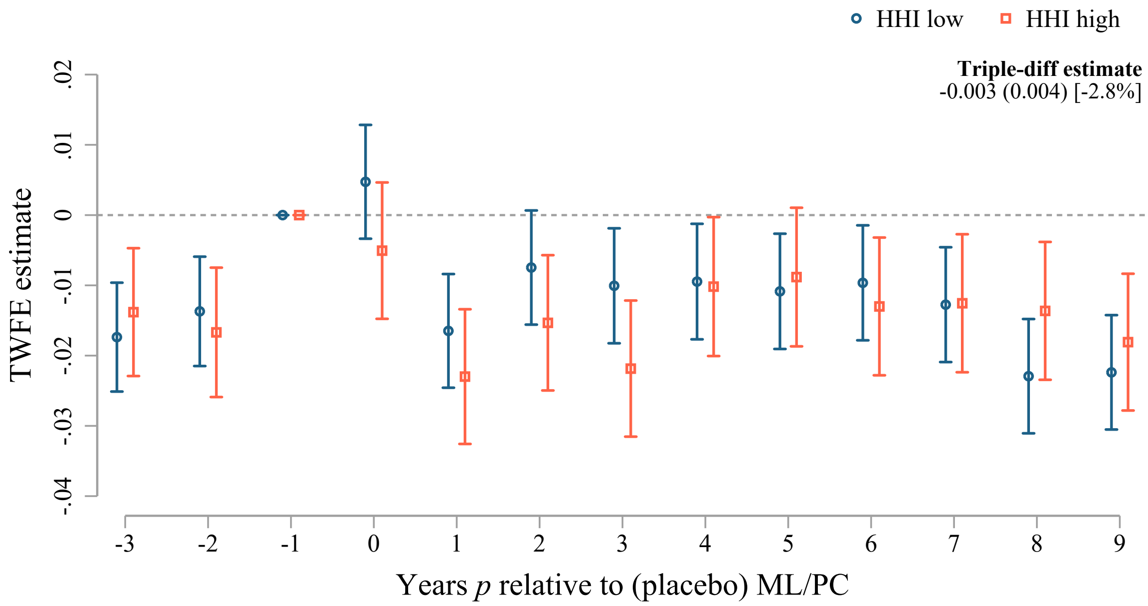
Notes: This figure shows the number of mass layoffs based on our main threshold throughout the sample period for HHI high sectors (white) and HHI low sectors (shaded blue). Respective bars show the full number of mass layoff per HHI-type-year.

Figure A.3: HHI distribution over sector-years



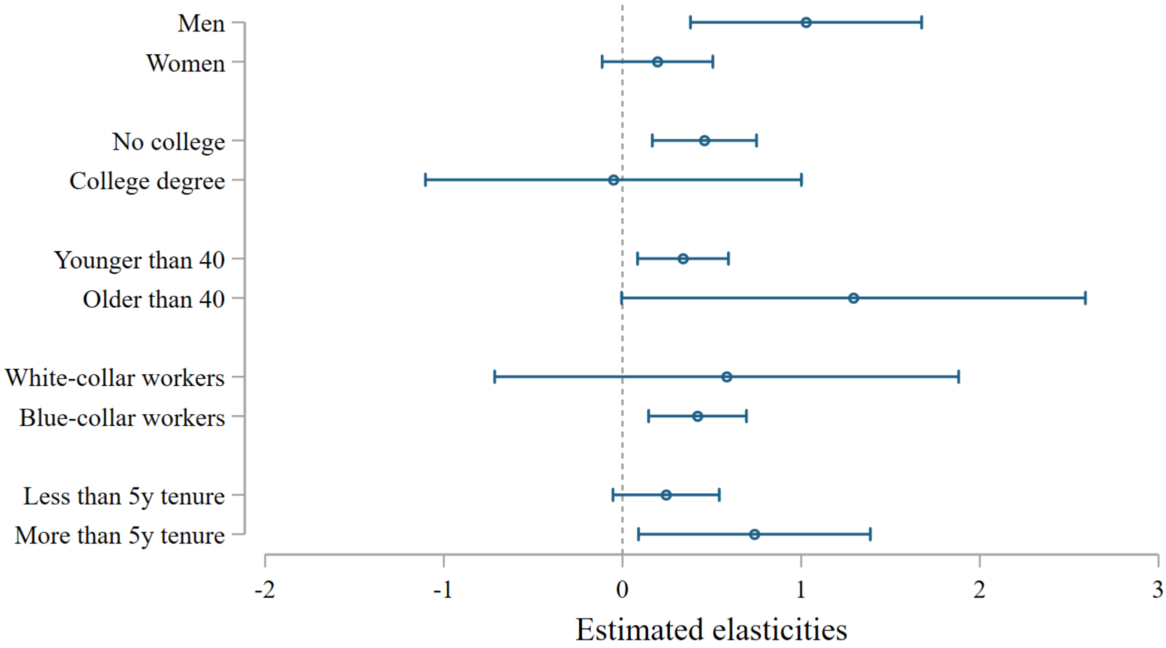
Notes: This figure shows the distribution of calculated HHIs for all sector-years. HHIs are calculated based on equation (2).

Figure A.4: Change in Workplace Accidents



Notes: This figure presents estimates based on equation (3) for the impact of mass layoffs on workers in strenuous jobs in low-treatment sectors (δ_p, in blue) and high-treatment sectors ($\delta_p + \beta_p$, in orange) on a dummy for having a workplace accident, netting out outcome trends in a control group that has not been exposed to a mass layoff. Bars show 95% confidence intervals. We omit the mass layoff year from all estimations for the estimation of the average effect. The number of observations is 944,638. Percentage effects relative to the pre-mass layoff mean are in square brackets, robust standard errors are in round brackets. Stars indicate significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure A.5: Strenuous health expense / wage elasticities by observable characteristics



Notes: This figure plots elasticity estimates based on equation (4) by observable characteristics. The bars show 95% confidence intervals.