

# Adjusters and Casualties: The Anatomy of Labor Market Displacement

Eric A. Hanushek\*    Simon Janssen†    Jacob D. Light ‡  
Lisa Simon §

September 25, 2024

**[DRAFT: Click here for latest version]**

## Abstract

Earnings losses after job displacement are highly skewed: a small number of workers experience catastrophic losses, while most workers recover quickly. Thus, average earnings losses as commonly estimated by event studies significantly overstate the losses for a majority of displaced workers. This paper documents the heterogeneity in earnings losses after job displacement and the behavioral differences underlying these adjustment differences. We study workers from firms in West Germany that closed between 2000-2005. By creating a synthetic control for each laid-off worker from similar workers who were not laid off, we can estimate the full distribution of economic losses. As found in other analytic approaches, older, less educated, and female workers suffer larger average losses, but a key result in our analysis is the remarkable overlap of the demographic loss distributions. Fixed characteristics do not predict which workers will experience the greatest losses; instead, these losses are associated with post-layoff adaptability, such as switching professions or geographic relocation.

Keywords: displacement losses, synthetic control groups, distributions of treatment effects

JEL Classification: J24, J64, O30

---

\*Hoover Institution

†Institute for Employment Research (IAB)

‡Hoover Institution

§Revelio Labs

# 1 Introduction

Decades of economic research has consistently highlighted the large and enduring impact of firm closures and job displacements on workers' earnings, revealing substantial and often persistent losses.<sup>1</sup> More recent research highlights the uneven impact across different groups of workers. Important for policy, but not documented in the existing research, is how these losses are distributed across displaced workers. Whether losses are shared broadly or concentrated among a few workers is relevant for designing policies to assist displaced workers, yet existing work cannot yet speak to which of these two stories best characterizes worker displacement.

We extend this prior work through construction of the entire distribution of displaced workers' earnings losses. We estimate losses by comparing earnings of displaced workers to those of an individual-level control group identified by a combination of matching and synthetic-control methods. Analyzing the distributions of earnings and employment trajectories of displaced workers leads to insights that differ substantially from the conventional wisdom on the nature and scope of such displacements. We find that the distribution of individual earnings losses is far from normal, implying that the average loss typically estimated from event-study approaches significantly overstates the effect of firm closure for the majority of workers.

Using administrative data for German plant closures from 2000-2005, we can trace the wage and earnings patterns of displaced workers for five years after a closure. By extending the matching approach of Schmieder et al. (2023) with synthetic-control methods, we develop a control for each displaced worker, allowing us to look more deeply into the underlying distribution of economic losses. The highly skewed distribution shows that the modal displaced worker loses little, a portion actually gains, and a final group loses dramatically.

---

<sup>1</sup>Jacobson et al. (1993), Couch and Placzek (2010), Schmieder et al. (2010), Davis and von Wachter (2011).

We reproduce estimates of average effects documented in standard event study analysis along with the previously identified differences across demographic and worker groups: lower educated workers, women, and older workers suffer above average losses. But the most obvious conclusion from the picture of gains and losses across the demographic groups is the near complete overlap of the underlying distributions. Observable characteristics explain only a small fraction of the overall variance in losses,

There are dramatic differences in adjustment choices between those who fare best after closure (“adjusters”) and those who fare worst after closure (“casualties”). When adjusters move to change occupation or geographic location, they do so quickly and decisively. Casualties, on the other hand, keep changing both occupation and location without recovering to their pre-closure earnings levels.

We make three main contributions to the large literature analyzing displaced workers’ earnings losses. First, we develop a methodology for estimating the full distribution of earnings losses and show that it is feasible to trace this distribution for a complete set of firm closures. Second, we refine the existing research that documents average displacement losses differing by education,<sup>2</sup> gender,<sup>3</sup> tenure,<sup>4</sup>, worker-firm match,<sup>5</sup> and firm characteristics.<sup>6</sup> This refinement shows that the observable characteristics explain little of the overall variance in losses, suggesting that programs targeted at such observable characteristics will not distinguish well between the truly needy and the rest of the displaced population.<sup>7</sup> Third, by track-

---

<sup>2</sup>Schwerdt et al. (2010), Hanushek et al. (2017).

<sup>3</sup>Illing et al. (2021).

<sup>4</sup>Chan and Stevens (1999), Chan and Huff Stevens (2001).

<sup>5</sup>Moore and Scott-Clayton (2019), Lachowska et al. (2020), Gulyas et al. (2021), Fackler et al. (2021), Graham et al. (2023).

<sup>6</sup>Fackler et al. (2021) show that workers who are displaced by larger firms forgo larger firm wage premiums than those who are displaced by smaller firms, and Raposo et al. (2021) show that job titles account for 37 percent of the average earnings losses.

<sup>7</sup>Two other lines of research into firm closures that are beyond the scope of this project consider country-specific institutions and business cycles. On the first, Bertheau et al. (2022) finds that displacement losses tend to be lower in countries with more generous welfare systems and Janssen (2018) shows that displacement losses are larger under flexible than under rigid wage bargaining systems. On the second, Davis and von Wachter (2011) and Schmieder et al. (2023) show that the magnitude of displaced workers’ earnings losses strongly varies with the business cycle. These

ing outcomes over time, it is possible to describe the behavioral differences between those emerging from a firm closure in a good economic position and those who end up significantly harmed.

The paper proceeds as follows. Section 2 outlines the synthetic control strategy used to estimate individual-level earnings losses. Section 3 describes the data sources used for our analysis. Section 4 illustrates the approach through a case study of one manufacturing firm. We summarize our main results in Section 5. In Section 6, we document margins of adjustment that explain some of the variation in earnings losses among displaced workers. Section 7 concludes.

## 2 Empirical strategy

The canonical approach to estimating the effects of worker displacement relies on standard event study methods that contrast the outcomes of displaced workers with those of workers in firms not closing who provide the comparison group. While these methods allow for the analysis of mean effects, they cannot recover the full distribution of earnings losses among displaced workers, especially those with the same pre-treatment characteristics who experience heterogeneous outcomes.<sup>8</sup> Thus, standard event studies cannot, for example, identify any workers who adjust to firm closures without incurring significant earnings losses.

To overcome these challenges, we estimate individual-level earnings losses using a synthetic control group strategy for each displaced worker. This approach builds on the work of Schmieder et al. (2023), who use a classical matching procedure to pair

---

business cycle effects might alter the magnitude of overall losses, but they do not seem likely to change the overall conclusions of our work.

<sup>8</sup>A growing literature uses machine learning techniques to estimate heterogeneous treatment effects. Most recently, Gulyas et al. (2021) and Athey et al. (2023) have used generalized random forest models to estimate displaced workers' earnings losses in Sweden and Austria. The papers estimate heterogeneous conditional average treatment effects based on high-dimensional interactions of the workers' pre-treatment characteristics. Our estimates are unconditional on the workers' pre-treatment characteristics and allow us to analyze the variance of displacement losses not only across different combinations of observable worker and firm characteristics but also within them. At the same time, we show that we can reproduce the overall results of the machine learning estimates with our approach.

each job loser with a statistical twin to calculate average short-term wage losses across individuals. We extend this methodology by overlaying synthetic control techniques onto an initial matching of displaced workers, enabling us to estimate dynamic displacement losses for each individual.

Synthetic control methods have traditionally been applied to estimate the effects of aggregate interventions on large units, such as cities or regions (Abadie, 2021). However, recent studies have adapted these methods for disaggregated data, and Arkhangelsky and Hirshberg (2023) have shown that synthetic control approaches serve as a natural alternative to event study difference-in-difference estimators in settings with numerous treated and control units. Our application of synthetic controls at the individual level allows us to capture the distributional effects of displacement.

The *potential* donor pool of non-displaced workers is extensive, but the *relevant* donor pool — those who serve as suitable comparisons for displaced workers — is much smaller. For example, comparing a late-career professor to a young manufacturing worker, even if they have similar earnings trajectories before the closure, would not be appropriate. Instead, we seek to compare displaced workers with non-displaced workers who share similar job characteristics and career stages.<sup>9</sup>

We implement this comparison through a two-step procedure. First, we partition workers into cells based on gender, education, one-digit industry, and three-digit occupation. From this pool, we calculate the root mean squared difference (RMSD) between the earnings trajectory of each displaced worker and potential donors within the matched sample over the five years prior to firm closure. We then select the 20 donors with the lowest RMSDs relative to the treated worker.<sup>10</sup> This pre-matching

---

<sup>9</sup>Implicitly, any synthetic control strategy defines a relevant donor pool from the set of all possible comparison units. For example, in the classic Abadie et al. (2010), all US states besides California are in the donor pool to estimate the effect of California’s Proposition 99 on tobacco consumption. It is certainly possible that including Canadian provinces or Mexican states in the donor pool may increase pre-treatment fit, but they would be unsuitable controls for reasons unrelated to minimizing pre-treatment fit.

<sup>10</sup>We arbitrarily selected 20 donors to reduce the computational burden, though our results are robust to using 10 or 30 donors.

approach minimizes interpolation bias by ensuring that the donor pool consists of non-displaced workers with very similar pre-displacement careers.<sup>11</sup> Note, however, that the set of individuals with nonzero weights in constructing the synthetic control for each worker is invariably less than the 20 possible donors.

After identifying the relevant donor pool  $J_i$  for each displaced worker  $i$ , we construct synthetic control weights  $w_{ij}^*$  for each  $j \in J_i$  that minimize the difference in pre-treatment outcomes between worker  $i$  and their synthetic control during the four years leading up to the year of displacement (backdated by one year to account for potential anticipation effects). These weights are based on continuous measures of age, firm size in the fifth year before closure, and annual earnings during the pre-intervention period.<sup>12</sup>

Using these synthetic controls, we estimate the effect of firm closure on worker earnings ( $\hat{\tau}_{it}$ ) as follows:

$$\hat{\tau}_{it} = \left( Y_{it} - \sum_{j \in J_i} w_{ij}^* Y_{jt} \right) \quad (1)$$

where  $Y_{it}$  represents the annual earnings of worker  $i$  in year  $t$ , and  $Y_{jt}$  are the donor outcomes in year  $t$ .<sup>13</sup> By constructing an explicit synthetic control group that remains unaffected by the treatment throughout the observation window,<sup>14</sup> we avoid issues commonly encountered in two-way fixed effects models with multiple treatment times (e.g., Goodman-Bacon (2021) and Roth et al. (2023)).

---

<sup>11</sup>To further reduce the influence of unrelated transitory shocks, we impose additional restrictions that match our restrictions on displaced workers: all treated workers and donors must have had at least two years of tenure, five years of positive wage observations, and worked in firms with at least 50 employees before the firm closure. Moreover, we exclude firms that exhibited size changes greater than 30 percent prior to the closure.

<sup>12</sup>The four-year pre-intervention period is chosen to balance estimation bias and sample restrictions, though our results remain consistent when using a longer period (e.g., 10 years).

<sup>13</sup>For some displaced workers, it is not possible to find weights such that their pre-trends perfectly balance. We exclude the one percent of displaced workers with the most extreme negative and positive earnings deviations. Appendix C provides a robustness check that only includes displaced workers whose pre-trends never deviate by more than one percent from their average pre-treatment earnings.

<sup>14</sup>We drop the small number of workers who suffer more than one firm closure during our observation period of 2000-2005

### 3 Data

Our analysis is based on the Integrated Employment Biographies (IEB) provided by the German Federal Employment Agency. The IEB includes comprehensive social security records for Germany from 1975 to 2022, covering employees subject to social security contributions and recipients of unemployment benefits.<sup>15</sup> For each worker, the IEB records earnings, time spent in each job, and various demographic and job characteristics. Unique identifiers for individuals and establishments allow us to track workers and firms over time. We supplement the IEB data with the Establishment History Panel (BHP), which provides firm-level information such as size, median wages, and industry for establishments with at least one socially insured worker as of June 30th each year.

We focus on individuals who had at least one employment spell in the private sector in West Germany between 2000 and 2005.<sup>16</sup> We follow these individuals throughout their entire careers, which may start before 2000 and extend beyond 2005. This longitudinal approach allows us to observe long-term trends and outcomes for workers affected by firm closures during this period.

Our treatment group consists of all workers who separated from closing firms between 2000 and 2005.<sup>17</sup> Identifying firm closures is challenging due to the potential for misinterpreting simple changes in establishment identification numbers as closures. To address this, we follow the methodology of Hethey-Maier and Schmieder (2013), considering a vanishing establishment identification number as a firm closure only if fewer than 30% of the workers from the closing firm transfer to the same subsequent establishment. This approach helps to accurately identify genuine closures

---

<sup>15</sup>The data exclude students, military personnel, civil servants, self-employed workers, and individuals who entirely leave the labor market.

<sup>16</sup>We exclude firms in agriculture and mining.

<sup>17</sup>While many previous studies examine displacements triggered by both firm closures and mass layoffs, our analysis focuses solely on layoffs resulting from firm closures. This restriction serves two purposes: first, it reduces the likelihood of mis-classifying internal workforce shifts within the same firm as layoffs and, second, it addresses concerns about potential adverse selection among workers laid off in partial layoffs.

and exclude cases of mere administrative changes.

We restrict our analysis to closing firms that had at least 50 employees and did not experience large employment fluctuations in the three years prior to closure.<sup>18</sup> At the individual level, we include workers who were between the ages of 21 and 55, had at least two years of tenure with their firm, and remained in the sample with positive earnings for five years before the closure. We also include all workers who left their closing firms within two years prior to the closure to capture potential anticipation effects. Some workers permanently leave the sample for reasons such as retirement, self-employment, or government employment. Following Schmieder et al. (2023) and Davis and von Wachter (2011), we retain these individuals in the sample with zero earnings.

Our primary labor market outcome of interest is annual earnings, which includes the sum of earnings from all employment spells within each year. We standardize earnings to 2010 Euros and remove only a few observations with earnings below the social security thresholds, as these are likely to reflect data entry errors.

In addition to annual earnings, we can also estimate firm closure effects on wages. Daily wages are measured as of June 30th each year to align the individual-level data from the IEB with the firm data from the BHP. However, daily wages are more volatile due to variations in working hours and bonuses, and we are unable to calculate hourly wages because we lack data on hours worked.

Our earnings data are top-coded for approximately 10 percent of workers with earnings above the annual German social security contribution ceiling. To impute the missing upper tail of the earnings distribution, we use a two-stage stochastic imputation procedure to estimate the missing upper tail of the earnings distribution.<sup>19</sup>

---

<sup>18</sup>Specifically, we exclude firms where employment fluctuated by more than 30 percent in any of the three pre-closure years.

<sup>19</sup>Following Card et al. (2013), we first fit a series of Tobit models for each year and education group. We then calculate imputed values for each censored observation using the estimated parameters from these models and a random draw from the left-censored distribution. Control variables include gender, age, age squared, a dummy for older individuals, tenure, and tenure squared. A second round of imputations incorporates each worker's average log wage in all other periods and the average annual wage of their current co-workers (leave-out means). If a worker is observed only



In addition to earnings, we observe each worker’s annual days of employment and unemployment, tenure with each firm, experience, gender, age, occupation (four-digit level), industry (three-digit level), and the location of work and residence (municipality level). The education variable, which is not required for administrative purposes, is sometimes missing or inconsistent. To address this, we follow the imputation procedure of Fitzenberger et al. (2006) to correct and impute missing values.<sup>20</sup>

Table 1 presents descriptive statistics for our main analysis variables. The first column provides statistics for displaced workers in the base period, i.e., one year before they leave the closing firm. The second column presents statistics for non-displaced workers in the potential donor pool, from which we select the most comparable workers for each displaced worker. Non-displaced workers meet the analytical restrictions for displaced workers, including employment in large firms with stable workforce, at least two years of tenure, and positive earnings for at least five years.

Our sample contains 161,135 displaced workers who lost their jobs due to firm closures between 2000 and 2005. The entire potential donor pool of non-displaced workers contains more than 560,000 workers.

— Table 1 about here —

On average, non-displaced workers earn approximately 48,000 Euros per year while displaced workers only earn approximately 45,000 Euros. Non-displaced workers in the potential donor pool are also slightly more likely to be female, have less tenure, and are somewhat older. Moreover, displaced workers are slightly less likely to have a university degree and more likely to have completed an apprenticeship. Most displaced workers were employed in the manufacturing sector (45 percent),

---

once, we set their mean wage to the sample mean and include a dummy variable in the model.

<sup>20</sup>We perform an imputation in the style of the IP1 procedure described in Fitzenberger et al. (2006). If an individual is observed in multiple parallel spells within the same period, we assign the highest education category observed. Since a worker’s highest education cannot decline over time, we then carry forward their highest educational degree to all subsequent spells. For missing data, we backdate the degree to the typical age of attainment.

the wholesale and retail sector (22 percent), or the construction sector (16 percent). Although there are statistically significant differences in the distribution of workers across industries, these differences are relatively modest.

## 4 Case study of a single manufacturing firm

To illustrate and motivate our focus on the heterogeneity of outcomes for displaced workers, we begin with the example of a single manufacturing firm that closed between 2000 and 2005. For this firm, 30 displaced workers met our criteria of having at least two years of tenure at displacement and positive wages throughout the five years before leaving the closing firm. All of these workers were men. Twenty of them held an apprenticeship degree, and ten of them had no degree in the year before the firm closed. The majority (24 out of 30) held jobs in the occupation of industrial process and plant engineering for ceramic materials, while five were machine builders, and one was an accountant.

Figure 1 plots the trend in average earnings for these workers around the firm closure. The figure shows that, on average, these workers experienced earnings losses of approximately 1,500 Euros in the first year after the closure. Relative to their average pre-closure earnings of around 46,000 Euros, this translates to a small average displacement effect of approximately 3 percent per year.

— Figure 1 about here—

However, focusing on average losses obscures substantial heterogeneity in individual outcomes. Figure 2 examines the extent of this heterogeneity by separately plotting the individual loss estimates relative to the synthetic control for each of the 30 displaced workers. The solid black line represents the earnings gap of each displaced worker relative to their synthetic control. In contrast, the light grey lines show the results of a permutation exercise, where we re-estimated the earnings gaps

for each non-displaced worker in the donor pool relative to a synthetic control group composed of other donors and/or the treated worker.<sup>21</sup>

The permutation exercises confirm a good fit before the treatment and significant displacement effects for the workers who experienced the firm closure. Importantly, Figure 2 reveals that, while some workers suffered substantial earnings losses — up to 50,000 Euros in the years following the closure — many others did not experience any significant losses and continued to follow the earnings trajectories of their synthetic controls even after the firm closed. This stark variation in outcomes among observably similar workers highlights the substantial heterogeneity in earnings losses due to firm closures. Importantly, the average earnings losses depicted in Figure 1 do not adequately represent the experiences of those workers who faced severe disruptions nor those who adjusted with minimal impact.

— Figure 2 about here—

## 5 The distribution of displacement losses

In this section, we analyze the distribution of economic losses for displaced workers by comparing their actual earnings post-closure to the earnings of their synthetic controls. To benchmark the losses, we report losses relative to the worker’s earnings in the year before firm closure.

We begin by examining the overall distribution of losses across the population of closures, comparing our results to conventional estimates from event studies. We then investigate heterogeneity among displaced workers.

---

<sup>21</sup>This permutation exercise serves as a placebo test, demonstrating that the observed earnings effects are due to the firm closure rather than the selection of control observations (Abadie, 2021). As expected, the placebo estimates show parallel pre-trends before the closure and no treatment effects post-closure. When a treated worker is included in the synthetic control group for a donor, we observe an apparent “treatment” effect in the opposite direction of the layoff’s impact. This occurs because the synthetic control absorbs some of the treated worker’s earnings losses from the layoff.

## 5.1 *Dynamic Losses*

Figure 3 plots the dynamic development of the loss distributions. The figure tracks each displaced workers over five years before and five years after their firm closes. The solid line in the figure represents the progression of average earnings losses of displaced workers over this period.

By construction, there are no average pre-treatment differences between the earnings of displaced workers and their synthetic controls, as our methodology imposes balanced pre-trends. However, following displacement, average earnings losses rise to approximately 20 percent of the worker’s average pre-displacement earnings. This result aligns with previous findings by Schmieder et al. (2023), who estimate short-term earnings losses ranging from 18 to 25 percent in Germany during the same period.<sup>22</sup>

— Figure 3 about here—

Unlike classical event study figures, the shaded areas in Figure 3 summarizes the distributions of individual deviations between the earnings of displaced workers and their synthetic controls using standard kernel density estimators. The grey shaded region shows the distribution of relative differences between treated and synthetic control earnings in the pre-closure period, while the red shaded region shows the post-closure distributions of displaced workers’ earnings losses.

It is important to note that achieving perfect balance in pre-trends for all displaced workers is not possible. Consequently, there is some distribution in the pre-treatment differences between displaced workers and their synthetic controls. Nevertheless, the distributions for all five pre-treatment periods are closely centered around zero, and we cannot reject the null hypothesis of normality for any of them. Furthermore, these pre-treatment distributions do not systematically correlate with

---

<sup>22</sup>While Schmieder et al. (2023) include both firm closures and mass layoffs in their analysis, our focus solely on firm closures likely accounts for the slightly larger estimated losses, as firm closures generally lead to more significant earnings and wage reductions (e.g., Hijzen et al., 2010).

the post-treatment distributions of displaced workers' earnings losses (Appendix D).

Post-closure, earnings losses for displaced workers are clearly not distributed normally. Each year's distribution is strongly left-skewed and bimodal, indicating that the modal loss of annual earnings is considerably smaller than the average loss. A substantial proportion of workers experience small earnings changes that are close to zero or even positive, while a smaller group suffers severe losses.

Figure 4 further highlights the bimodality of the loss distribution by comparing the five-year accumulated earnings losses of displaced workers to a normal distribution. The distribution of accumulated earnings is markedly left-skewed (with skewness of  $-0.43$ ). On average, displaced workers experience a loss equivalent to 1.28 years of earnings over the five years post-displacement, but the modal loss is significantly lower, at just  $-0.41$  earnings years.

— Figure 4 about here—

Interestingly, a non-negligible share of displaced workers actually profits from displacement, earning more than their synthetic controls in the long run. Over the five years post-closure, nearly one-fifth (3631 individuals) of displaced workers exhibit positive earnings gains relative to their non-displaced controls. While this result may seem counter-intuitive, it is consistent with findings from the U.S. For example, Farber (2017) reports that 28 percent of full-time workers secured jobs with relatively higher earnings following a job displacement. Several factors could explain these gains: workers may switch to higher-paying jobs when forced to change jobs, or they might have previously underestimated the benefits of job mobility, as suggested by recent evidence from Germany (Jäger et al., 2024).

While our estimates of the earnings loss distribution could be influenced by measurement error, we take two additional steps to reinforce our findings. First, we compare our synthetic control group estimates with results from a conventional event study (see Appendix A for details). We align the sample of displaced workers with a control group selected through propensity score matching, based on the

same variables used in our analysis (age, gender, education, three-digit occupation, and one-digit industry). The event study estimates are qualitatively similar to our synthetic control estimates, both for the entire sample and for the top and bottom quartile of workers by earnings loss.<sup>23</sup>

Second, we conduct a permutation exercise similar to a bootstrap approach, where we re-estimate the earnings distribution using a large number of small control samples that mimic our synthetic controls. Given the nature of our synthetic control approach, the influence of random outliers in these samples will be larger than in our main sample. Nevertheless, the distributions of estimates from these alternative control samples consistently present a similar picture, with similarly shaped distributions of earnings losses (Appendix B).

## *5.2 Earnings loss heterogeneity by worker and firm characteristics*

Previous research has shown that the average earnings losses from job displacement vary significantly across workers of different age (e.g., Kletzer and Fairlie, 2003), education (e.g., Farber, 2017), gender (e.g., Illing et al., 2021), and firm size (e.g., Lachowska et al., 2020; Fackler et al., 2021). In this section, we explore the extent to which these observable worker and firm characteristics can explain not only the average losses but also the distribution of earnings losses among displaced workers. Specifically, we investigate whether observationally similar workers within the same occupation or firm experience similar earnings losses.

Figure 5 shows the heterogeneous losses of cumulative earnings (scaled to pre-closure earnings) across three sets of subgroups of displaced workers. Panel A plots the distributions by education level: high (university degree), medium (apprenticeship degree), and low (no formal education beyond a high school diploma). Panel B plots the distributions by age, comparing younger workers (below 30) to older workers (above 45). Panel C plots the distributions for women and men.

---

<sup>23</sup>Specifically, we use our method to select workers with the top/bottom 25th percentile, then run an event study regression only on those individuals and a corresponding set of control workers.

For all subgroups, the average earnings losses, indicated by the red vertical lines, align with the average losses documented in the literature. Specifically, we find that displaced workers with lower education levels experience substantially larger earnings losses (1.9 years) than those who are medium (1.2 years) or highly educated (0.8 years). Older workers experience on average larger losses (1.5 years) than younger ones (1.14 years), and women experience larger losses (1.6 years) than men (1.15 years).

However, the distributions of earnings losses overlap substantially across all subgroups, revealing significant within-group heterogeneity. Even among women, low-educated workers, and older workers—who, on average, experience larger losses—many individuals suffer only moderate losses or even gains following displacement.

Panel C illustrates this pattern most strikingly for women and men. Women lose, on average, approximately 1.6 years of their pre-displacement earnings over the five years following firm closure, compared to 1.15 years for men. However, while the distribution of women’s earnings losses is bimodal, with a second peak at approximately  $-4$  years, the distribution of men’s earnings losses is also strongly left skewed. A large fraction of both women and men experience only moderate losses. Indeed, about 26 percent of men and 22 percent of women lose less than one month’s worth of their pre-displacement earnings (spread across five years of post-displacement experience). The bimodality in the distribution of women’s losses indicates that a relatively large minority of women may withdraw entirely from the labor market, earning nothing in the five years post-displacement.

— Figure 5 about here—

The striking overlap in the distribution of earnings losses across subgroups suggests that observable pre-treatment characteristics have limited explanatory power. We assess this hypothesis formally by decomposing the variance of the earnings losses. We begin by estimating a linear regression of the following form:

$$Y_i = X'_{i(-1)}\beta + \theta_{i(-1)} + \vartheta_{i(-1)} + r_{i(-1)} + u_{i(-1)} \quad (2)$$

where the dependent variable  $Y_i = \sum_{t=1}^{t=5} Loss_{it}$  represents worker  $i$ 's cumulative earnings losses over the five years following firm closure. The vector  $X'_{i(-1)}$  includes fixed worker characteristics such as education, a cubic function of age, gender, and citizenship. The terms  $\theta_{i(-1)}$ ,  $\vartheta_{i(-1)}$ , and  $r_{i(-1)}$  control for firm, three-digit occupation, and municipality fixed effects, respectively. The error term is denoted by  $u_{i(-1)}$ .

We then decompose the variance of the accumulated earnings losses as follows:

$$\begin{aligned} Var(Y_i) = & Var(X'_{i(-1)}\hat{\beta}) + Var(\hat{\theta}_{i(-1)}) + Var(\hat{\vartheta}_{i(-1)}) + Var(\hat{r}_{i(-1)}) + \\ & 2Cov(X'_{i(-1)}\hat{\beta}, \hat{\theta}_{i(-1)}) + \dots + 2Cov(X'_{i(-1)}\hat{\beta}, \hat{r}_{i(-1)}) + Var(\hat{u}_{i(-1)}) \end{aligned} \quad (3)$$

where the  $Var(\cdot)$  terms represent the variances of the outcomes and controls, the covariance terms capture all potential combinations, and  $Var(\hat{u}_{i(-1)})$  is the variance of the error term.

Table 3 presents the decomposition results. The first column shows the variance decomposition for the entire sample, revealing that observable pre-displacement characteristics (e.g., education, gender, age, firm, and occupation fixed effects) explain only 17 percent of the total variance in earnings losses. The remaining 83 percent of the variance occurs within these subgroups. Among the characteristics considered, the closing firm of the displaced worker is the strongest predictor of earnings losses, followed by pre-displacement occupation. We emphasise here that we have firm fixed of the workers pre-displacement firms, because we are interested in understanding to whether workers who are displaced from the same firm experience similar earnings losses. Instead, we did not incorporate firms' akms as previous studies did to infer whether displaced workers switch from high to low wage firms.



Other factors, such as gender, education, or citizenship, explain relatively small portions of the variance.

These findings suggest that many factors not observable to researchers or policymakers — such as minor ability differences, family-related factors, or pure luck — significantly influence the degree to which a worker’s labor market activities are disrupted by firm closures.

— Table 3 about here —

A potential concern, however, is that this finding is driven by noise in our synthetic control group estimates of counterfactual earnings. We provided some suggestive aggregate evidence against this in the last section, but we can provide more micro evidence here. The second column of Table 3 decomposes the variance of the level of the estimated counterfactual earnings. In other words, instead of using the estimated earnings losses as a dependent variable, we only use the control group earnings as the dependent variable. If the counterfactual earnings were driven by random noise, observable pre-treatment characteristics should explain little of their variance. However, the results show that observable characteristics account for approximately 70 percent of the counterfactual variance—much more than in the estimated displacement losses—indicating that most of the variance in earnings losses stems from differences in individual post-displacement career paths rather than noise in our synthetic control group estimates.

We have extended this analysis to different subgroups, revealing substantial variation in the explanatory power of pre-treatment worker and firm characteristics. For example, pre-displacement firms explain a larger fraction of earnings losses for low-educated workers than for those with medium or high education, while occupations play a more significant role in explaining variance among high-educated workers.

## 6 Adjusters and casualties

We now shift our focus from pre-closure characteristics to the post-closure dynamics that influence workers' recovery from displacement. The previous section highlighted that even among observably similar individuals, recovery patterns can differ significantly. In this section, we begin by providing an overview of the earnings patterns for individuals in different deciles of the loss distribution. We then examine how the observed behaviors of individuals in the top quartile of losses (“casualties”) differ from those in the bottom quartile of losses (“adjusters”). It is important to note that these groups are defined based on their outcomes; the goal here is not to identify causal mechanisms but to characterize key behavioral choices made during the adjustment process, with the aim of encouraging further research into these dynamics.

To set the stage, Figure 6 divides the sample of displaced workers into deciles based on their accumulated five-year losses and plots the pattern of average annual earnings losses that underlie the overall distribution. Workers in the lowest six deciles (those with the largest accumulated losses) never fully recover from their job loss, with those in the lowest decile experiencing particularly severe earnings losses. In contrast, workers in the top two deciles (those with the smallest accumulated losses) experience little to no losses and, in some cases, even higher earnings post-closure than would have been expected had their firm not closed. Notably, the synthetic control estimates of pre-closure earnings closely match the actual earnings of treated workers across all deciles, indicating that the ranking of workers by earnings losses is not systematically influenced by the quality of the match between treated workers and their synthetic controls.

—Figure 6 about here—

The rest of this section explores the distinct labor market trajectories that define the successful transitions of adjusters and the unsuccessful transitions of casualties.

Earnings losses following a job loss can arise for several reasons: a worker might take a job with a lower wage trajectory compared to their previous position, experience unemployment due to their firm’s closure, or work fewer hours in their new role. Conversely, a worker might adjust or even benefit from a layoff by securing a job with a better wage path or one that allows them to work more hours.

Table 4 details which of these channels of earnings loss or gain apply to casualties and adjusters. The table examines the various states a worker might find themselves in based on wages (relative to their synthetic control)<sup>24</sup> and days worked relative to full employment over the five years following firm closure. The left panel presents the percentage of adjusters in each labor market state, while the right panel shows the percentage of casualties in each labor market state.

—Table 4 about here—

The left panel shows that adjusters rapidly move into jobs that pay wages similar to — or often higher than — estimates of the counterfactual wages they would have earned had they stayed with their previous firm. In the year following the firm closure, over 60 percent of adjusters are earning a higher wage than their synthetic control, and nearly three-quarters are employed full-time. Five years post-closure, nearly all adjusters have returned to full-time work, with more than 80 percent earning higher wages than expected absent the firm closure. These wage gains are consistent with the insight from Figure 6, which shows that workers in the two deciles with the smallest earnings loss have higher earnings, on average, than their synthetic controls. The firm closure may have prompted these workers to find better opportunities in new jobs (Farber, 2017). Note that, as seen in Figure 6, their synthetic counterfactual workers remained at a struggling firm where real earnings

---

<sup>24</sup>The IEB data record worker wages as of June 30th each year. Wages are missing for workers not employed on that date. We exclude a small number of observations (less than 0.5 percent of casualties and up to 4 percent of adjusters) where workers are recorded as being employed for the full year but have missing wages. We calculate a counterfactual wage by applying the synthetic control weights from our primary approach for annual labor earnings to the daily wages of workers in the donor pool.

were on a slight decline.

The right panel of Table 4 summarizes the wage and employment transitions for casualties. Here, any recovery from the more severe loss is slower, if it happens at all. Notably, 30-40 percent of casualties are fully unemployed in any given year during the first four years post-closure. By five years after the closure, only a quarter are completely out of gainful employment, but another quarter are not full-time employed. The casualties who are employed, either full- or part-time, often have wages substantially lower than those predicted by their synthetic control.<sup>25</sup> Unlike adjusters, of those casualties who re-enter the labor force, just seven percent have a wage comparable to that in the closed firm.

The broader takeaway from Table 4 is that the paths of adjusters and casualties diverge almost immediately after the firm closure, and this divergence remains consistent in the years following. Adjusters recover quickly, re-enter the labor force, and maintain stable employment after their firm's closure. Strikingly, many adjusters end up earning higher wages in the years after the layoff than would have been expected absent their layoff. Casualties, on the other hand, face immediate adverse economic outcomes following their firm's closure and continue to experience these disadvantages throughout the post-layoff period.

Previous research has shown that establishment effects account for a significant portion of displaced workers' average wage losses. For instance, Schmieder et al. (2023) found that establishment effects could explain nearly half of the negative wage impact on reemployment wages. Figure 7 examines whether this finding holds true for adjusters and casualties, who are located at the extreme ends of the loss distribution. The left panel of Figure 7 presents the average log wage losses for both groups. As shown in the previous figure, casualties experience substantial wage losses that persist over time, while adjusters experience increasing wage gains.

---

<sup>25</sup>In fact, casualties make up three-quarters of the workers in the bottom quartile for earnings losses in the fifth year post-closure. This suggests that casualties are not merely those who temporarily exit the labor force, and therefore suffer earnings losses when they are not employed, but are workers who face persistent earnings penalties upon re-entering employment.

—Figure 7 about here—

To estimate the persistent differences in employer daily wages, we use an Abowd et al. (1999) (hereafter, “AKM”) model, following the AKM implementation by Card et al. (2013) for Germany. We then apply the synthetic control weights estimated from our earnings regressions to create a synthetic counterfactual path of AKM effects for each displaced worker.

The impact of firm changes can be seen in Figure 7. The left panel traces the losses of wages for adjusters and casualties after the closure — illustrating the average wage improvements of the adjusters and the precipitous fall in wages for the casualties. The right panel traces the changes in firm components from the AKM estimates.

The results reveal that, on average, casualties switch to lower-paying firms, while adjusters move to slightly better-paying firms. However, the gap between the log wage losses of adjusters and casualties is significantly larger than the gap between their changes in AKM establishment fixed effects. Casualties tend to move to lower-paying firms, but their extreme wage losses primarily result from earning lower wages than other workers within their post-displacement firms. Adjusters, meanwhile, benefit primarily by earning higher wages than others within their post-displacement firms, rather than from switching to higher-paying firms.

These findings contrast with research suggesting the average wage effect after displacement that is largely driven by establishment effects Schmieder et al. (2023). Averaging across these heterogeneous workers obscures the highly variable adjustment patterns of displaced workers.

The adjustment patterns of groups are informative. Adjusters move quickly and decisively into new labor market positions, while casualties struggle to find new positions. Figure 8 illustrates the labor mobility patterns of casualties and adjusters over time. The upper left panel begins with firm mobility. The solid line represents the fraction of adjusters who switch firms between any consecutive years  $t - 1$  and  $t$ , while the dashed line shows the fraction of switchers among casualties. We do

not count switches into unemployment as switches; however, workers who become non- or unemployed are coded as switchers upon reentering the labor market in a different firm.

Necessarily, nearly all adjusters have an immediate firm change upon displacement, but the fraction of adjusters who switch firms after their first year post-displacement decreases to less than ten percent, suggesting that adjusters quickly find stable matches. Among casualties, only about 40 percent switch firms immediately after displacement, with the rest remain non- or unemployed. As casualties gradually re-enter the labor force, their firm switching remains elevated compared to adjusters. Interestingly, by the end of the five-year period post-closure, adjusters and casualties have made a similar number of cumulative firm switches.

—Figure 8 about here—

The upper right panel shows mobility across 5-digit industries. On average, both adjusters and casualties switch industries more than once in the long run. However, these long-run results mask significant differences in short-term dynamics. More than 60 percent of adjusters switch their 5-digit industry immediately after displacement. In contrast, only about 30 percent of casualties leave their industry, but this comparison is affected by the fact that only 40 percent of casualties manage to reenter employment in the first year post-displacement. Thus, the relative share of industry switchers is very high—three-quarters of employed casualties switch industries. Industrial mobility remains high for casualties in the long run.

The lower left panel shows the occupational mobility of adjusters and casualties. Short-term occupational mobility is high for both groups. Approximately 40 percent of adjusters and 30 percent of casualties switch occupations immediately after displacement. However, after the first year, adjusters are substantially more stable in their occupations, while casualties continue to switch occupations. In the long run, casualties switch occupations approximately 1.35 times, while adjusters

switch on average only 0.85 times. This higher occupational mobility for casualties supports the argument that casualties may forgo more of the returns on their occupation-specific human capital. However, adjusters also exhibit substantial immediate post-displacement flexibility, suggesting they may be better at transferring their human capital across occupations.

The lower right panel of Figure 8 examines geographic mobility across 50 large German local labor markets. While a minority of workers move geographically, both loss groups eventually change regions to a similar extent with, however, adjusters again being much more likely to make any move immediately.

Overall, Figure 8 suggests that adjusters demonstrate significant flexibility in the short run, while casualties struggle to secure employment in the short run and follow unstable adjustment patterns in the long run.

There are some obvious differences between the groups that might enter into these adjustment patterns. The group of casualties, for example, contains more low educated and slightly older workers than the adjusters, and such factors might help to explain why the casualties are less flexible. To provide some evidence on the importance of such demographic and background difference, we analyze whether workers with the same pre-treatment characteristics who were hit by the same shock adjust in different ways. Specifically, we perform an exact match between adjusters and casualties: for each casualty, we select a statistical twin among the adjusters who were displaced from the same firm, held a job in the same three digit occupation, had the same gender, and were in the same age category before the displacement occurred. Although this rigid exact matching between adjusters and casualties leaves us with only 384 individuals in each group, it allows us to infer whether even workers who were in the exact same circumstances when they were hit by the exact same shock do in fact adjust differently.

In Figure 9, we reproduce the prior comparisons of mobility patterns for the matched sample of adjusters and casualties. The results remain virtually the same:

adjusters move decisively into their next labor market position, whereas casualties are slower and more prone to faulty steps.

—Figure 9 about here—

## 7 Conclusion

The earnings losses from firm closures are very unevenly distributed across the displaced workers. This paper exploits administrative data on the universe of firm closures in Germany between 2000 and 2005. These data allow us to construct the full distribution of earnings losses across individuals using a novel approach that constructs a synthetic control worker for each individual worker displaced by a firm closure. The results reveal large and skewed distributions of earnings losses suggesting that average earnings losses, as commonly estimated using classical event studies, significantly overstate the losses for the large fraction of workers who readily adjust to the closures. At the same time, they miss the extent of loss for the minority of workers who are catastrophically impacted by firm closures.

Worker and firm characteristics that are commonly observable to the researcher explain only a small fraction of the workers' displacement losses. Looking at the behavioral differences between the economic winners (adjusters) and economic losers (casualties) indicates that adjusters quickly find stable new circumstances – changing occupations, industry, and geographic regions immediately if necessary. Casualties are slower to adjust and frequently do not move into stable situations.

Because those who are truly harmed by firm displacements are difficult to identify ex ante, policies to deal with firm closures must necessarily be more refined and to deal with displaced workers after market opportunities unfold.



## References

- Abadie, Alberto**, “Using Synthetic Controls: Feasibility, Data Requirements, and Methodological Aspects,” *Journal of Economic Literature*, June 2021, *59* (2), 391–425.
- , **Alexis Diamond**, and **Jens Hainmueller**, “Synthetic control methods for comparative case studies: Estimating the effect of California’s tobacco control program,” *Journal of the American statistical Association*, 2010, *105* (490), 493–505.
- Abowd, John M, Francis Kramarz, and David N Margolis**, “High wage workers and high wage firms,” *Econometrica*, 1999, *67* (2), 251–333.
- Arkhangelsky, Dmitry and David Hirshberg**, “Large-sample properties of the synthetic control method under selection on unobservables,” *arXiv preprint arXiv:2311.13575*, 2023, *5*.
- Athey, Susan, Lisa K. Simon, Oskar N. Skans, Johan Vikstrom, and Yaroslav Yakymovych**, “The Heterogeneous Earnings Impact of Job Loss Across Workers, Establishments, and Markets,” 2023.
- Bertheau, Antoine, Edoardo Maria Acabbi, Cristina Barcelo, Andreas Gulyas, Stefano Lombardi, and Raffaele Saggio**, “The Unequal Consequences of Job Loss across Countries,” 2022.
- Card, David, Jörg Heining, and Patrick Kline**, “Workplace Heterogeneity and the Rise of West German Wage Inequality,” *The Quarterly journal of economics*, 2013, *128* (3), 967–1015.
- Chan, Sewin and Ann Huff Stevens**, “Employment and retirement following a late-career job loss,” *American Economic Review*, 1999, *89* (2), 211–216.

- **and Ann Huff Stevens**, “Job loss and employment patterns of older workers,” *Journal of labor economics*, 2001, *19* (2), 484–521.
- Couch, Kenneth A and Dana W Placzek**, “Earnings losses of displaced workers revisited,” *American Economic Review*, 2010, *100* (1), 572–589.
- Davis, Steven J and Till von Wachter**, “Recessions and the Costs of Job Loss,” *Brookings Papers on Economic Activity*, 2011, *43* (2), 1–72.
- Fackler, Daniel, Steffen Mueller, and Jens Stegmaier**, “Explaining wage losses after job displacement: Employer size and lost firm wage premiums,” *Journal of the European Economic Association*, 10 2021, *19*, 2695–2736.
- Farber, Henry S.**, “Employment, Hours, and Earnings Consequences of Job Loss: US Evidence from the Displaced Workers Survey,” *Journal of Labor Economics*, 7 2017, *35*, S235–S272.
- Fitzenberger, Bernd, Aderonke Osikominu, and Robert Völter**, “Imputation Rules to Improve the Education Variable in the IAB Employment Subsample,” *Schmollers Jahrbuch: Journal of Applied Social Science Studies/Zeitschrift für Wirtschafts-und Sozialwissenschaften*, 2006, *126* (3), 405–436.
- Goodman-Bacon, Andrew**, “Difference-in-differences with variation in treatment timing,” *Journal of Econometrics*, 2021.
- Graham, John R, Hyunseob Kim, Si Li, and Jiaping Qiu**, “Employee costs of corporate bankruptcy,” *The Journal of Finance*, 2023, *78* (4), 2087–2137.
- Gulyas, Andreas, Krzysztof Pytka et al.**, *Understanding the sources of earnings losses after job displacement: A machine-learning approach*, Verein für Socialpolitik, 2021.

- Hanushek, Eric A, Guido Schwerdt, Ludger Woessmann, and Lei Zhang,** “General education, vocational education, and labor-market outcomes over the lifecycle,” *Journal of human resources*, 2017, 52 (1), 48–87.
- Hethy-Maier, Tanja and Johannes F. Schmieder,** “Does the Use of Worker Flows Improve the Analysis of Establishment Turnover? Evidence from German Administrative Data,” *Schmollers Jahrbuch*, 12 2013, 133, 477–510.
- Hijzen, Alexander, Richard Upward, and Peter W. Wright,** “The Income Losses of Displaced Workers,” *Journal of Human Resources*, 2010, 45, 243–269.
- Illing, Hannah, Johannes Schmieder, and Simon Trenkle,** “The Gender Gap in Earnings Losses after Job Displacement,” 2021.
- Jacobson, Louis S, Robert J LaLonde, and Daniel G Sullivan,** “Earnings losses of displaced workers,” *The American economic review*, 1993, pp. 685–709.
- Janssen, Simon,** “The decentralization of wage bargaining and income losses after worker displacement,” *Journal of the European Economic Association*, 2 2018, 16, 77–122.
- Jäger, Simon, Christopher Roth, Nina Roussille, and Benjamin Schoefer,** “Worker Beliefs About Outside Options,” *The Quarterly Journal of Economics*, 1 2024.
- Kletzer, Lori G. and Robert W. Fairlie,** “The Long-Term Costs of Job Displacement for Young Adult Workers,” *Industrial and Labor Relations Review*, 2003, 56, 682.
- Lachowska, Marta, Alexandre Mas, and Stephen A Woodbury,** “Sources of displaced workers’ long-term earnings losses,” *American Economic Review*, 2020, 110 (10), 3231–3266.

**Moore, Brendan and Judith Scott-Clayton**, “The Firm’s Role in Displaced Workers’ Earnings Losses,” Technical Report, National Bureau of Economic Research 2019.

**Raposo, Pedro, Pedro Portugal, Anabela Carneiro, Pedro Raposo, Pedro Portugal, and Anabela Carneiro**, “The Sources of the Wage Losses of Displaced Workers The Role of the Reallocation of Workers into Firms, Matches, and Job Titles,” *Journal of Human Resources*, 6 2021, 56, 586–820.

**Roth, Jonathan, Pedro HC Sant’Anna, Alyssa Bilinski, and John Poe**, “What’s trending in difference-in-differences? A synthesis of the recent econometrics literature,” *Journal of Econometrics*, 2023, 235 (2), 2218–2244.

**Schmieder, Johannes F., Till von Wachter, and Jörg Heining**, “The Costs of Job Displacement over the Business Cycle and Its Sources: Evidence from Germany,” *American Economic Review*, 2023, 113 (5), 1208–54.

**Schmieder, Johannes F, Till Von Wachter, and Stefan Bender**, “The long-term impact of job displacement in Germany during the 1982 recession on earnings, income, and employment,” Technical Report, IAB-Discussion Paper 2010.

**Schwerdt, Guido, Andrea Ichino, Oliver Ruf, Rudolf Winter-Ebmer, and Josef Zweimüller**, “Does the color of the collar matter? Employment and earnings after plant closure,” *Economics Letters*, 2010, 108 (2), 137–140.

## Figures in the Text

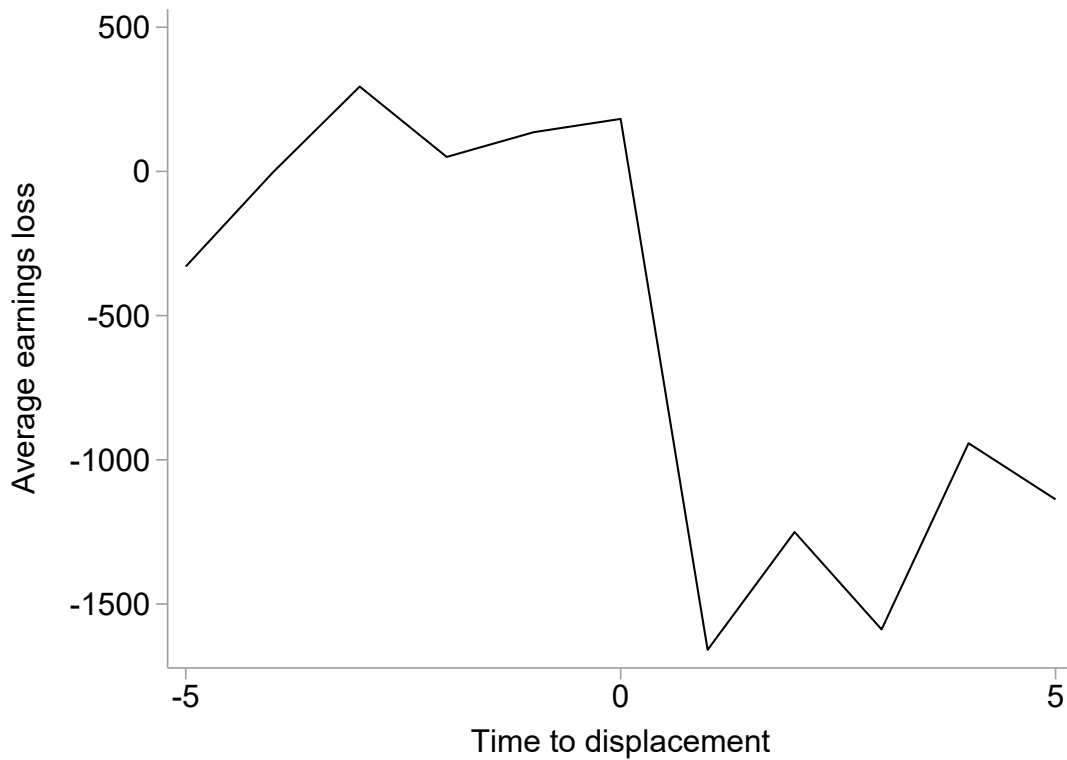


Figure 1: Average earnings loss of a closing firm in the manufacturing sector (case study)

*Notes:* The figure displays the absolute average earnings losses of the displaced workers of one single closing firm in the manufacturing sector. The y-axis measures the earnings losses in 2010 Euros. The x-axis displays the time before/after the firm closure in years. Source: IEB.

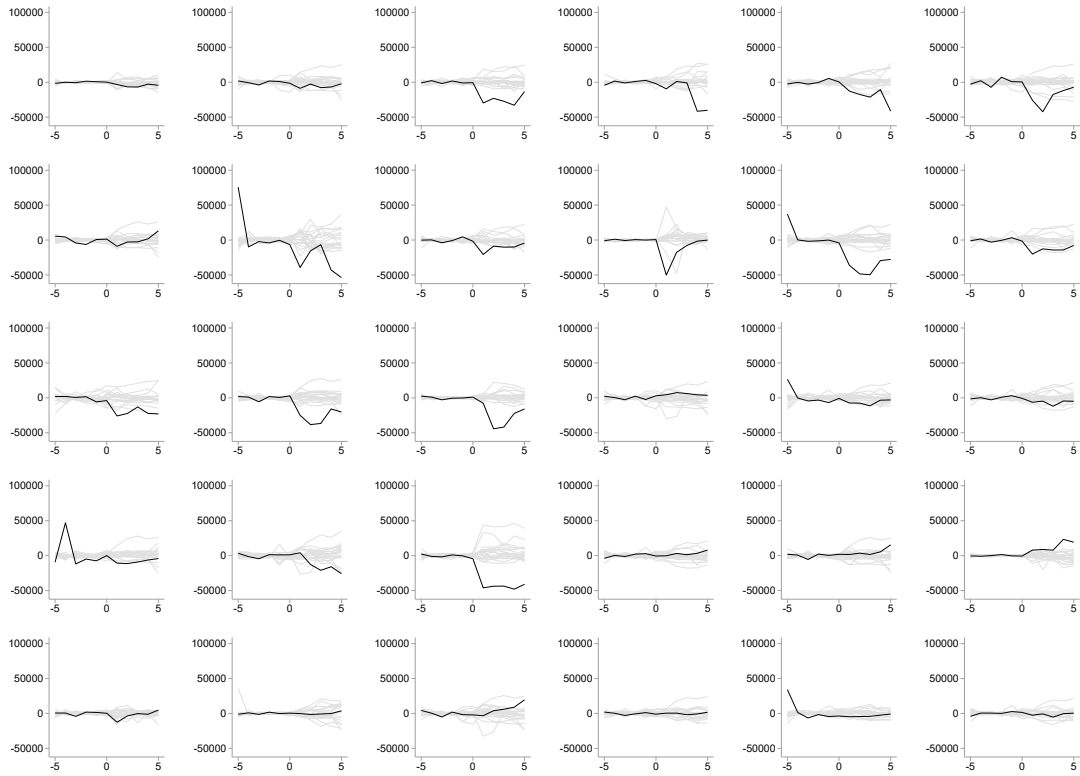


Figure 2: Individual earnings loss of a closing firm in the manufacturing sector (case study)

*Notes:* The figure plots the estimated earnings losses of 30 workers displaced from a single closing firm in the manufacturing sector. In each panel, the solid black line plots the earnings losses (in 2010 Euros) of a single displaced worker relative to their synthetic control. To demonstrate that the earnings effects of the layoff arise from exposure to the firm closure, rather than due to the selection of control observations, the grey lines plot results from a permutation exercise where, for each of the treated worker’s 20 control “donor” workers, we construct a synthetic control from the remaining donors and plot the difference in earnings trends for each of these 20 workers. The y-axis measures the earnings losses in 2010 Euros. The x-axis displays the time before/after the firm closure in years. Source: IEB.

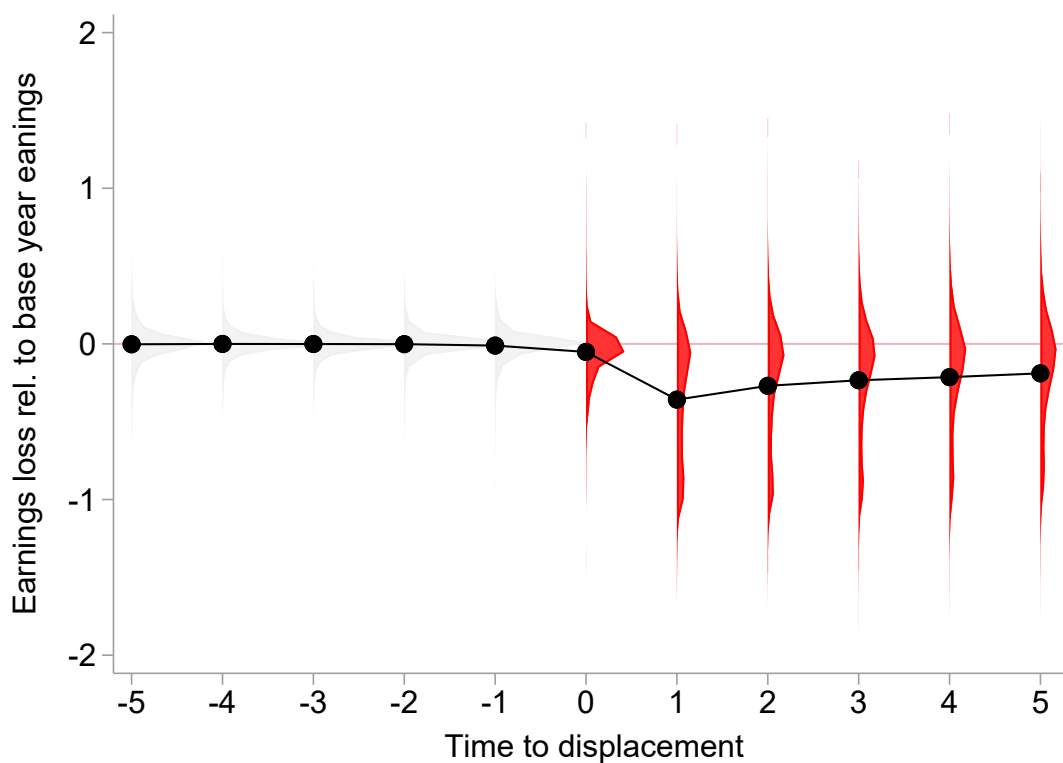


Figure 3: Distribution of relative earnings losses after firm closure (unconditional)

*Notes:* The figure displays the distribution of displaced workers' earnings losses throughout a period of five years before until five years after a firm closure. The earnings losses are measured relative to the individual worker's baseline earnings measured as the average earnings throughout a period of three years before the displacement. The dots represent the mean earnings losses for each period respectively. The shaded areas represent the distribution of the displaced workers' earnings losses. To estimate the distribution of earnings losses, we, first, use a synthetic control group approach to estimate the earnings losses for each individual displaced worker in the data. Second, we use an Epanechnikov kernel to estimate the distribution of earnings losses from the individual earnings losses in each period. Source: IEB.

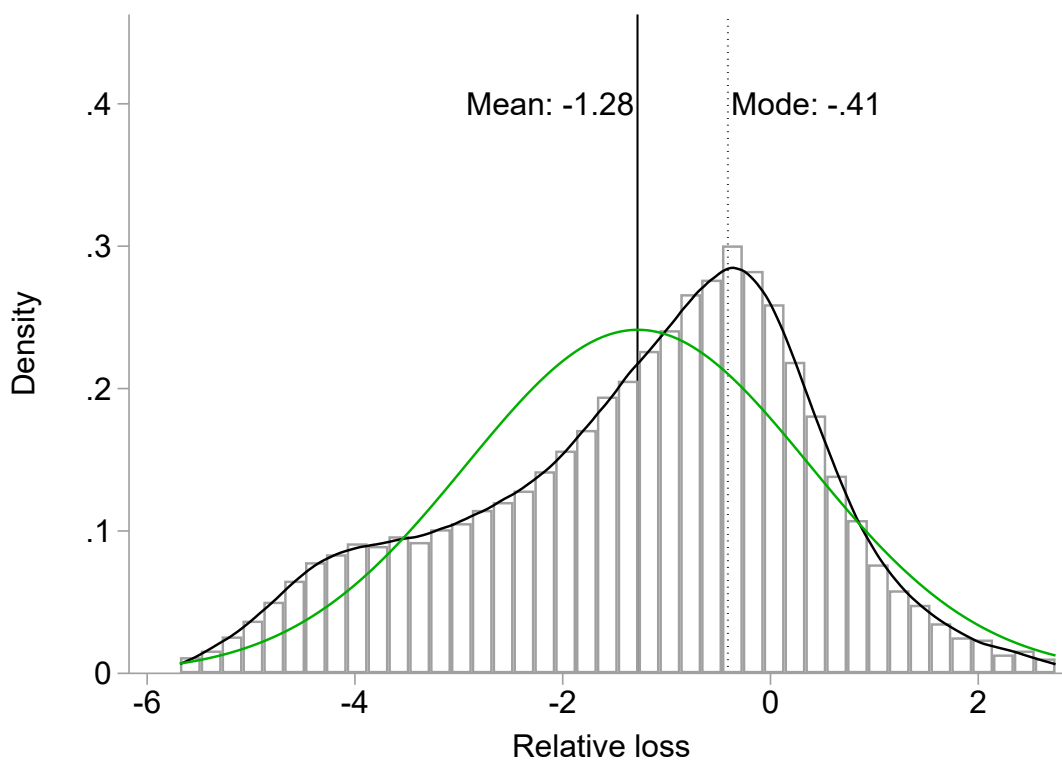


Figure 4: Distribution of five-year cumulative earnings loss relative to normal distribution

*Notes:* The figure plots the distribution of displaced workers' unconditional cumulative earnings losses over the five-year period after firm closure. Earnings losses are measured as the sum of the difference in actual and synthetic control earnings in the five years after firm closure, normalized by the displaced worker's baseline earnings. To estimate the distribution of earnings losses, we, first, use a synthetic control group approach to estimate the earnings losses for each individual displaced worker in the data. Second, we use an Epanechnikov kernel to estimate the distribution of earnings losses from the individual earnings losses in each period. The solid line plots the mean of the distribution; the dashed line plots the mode. Source: IEB.



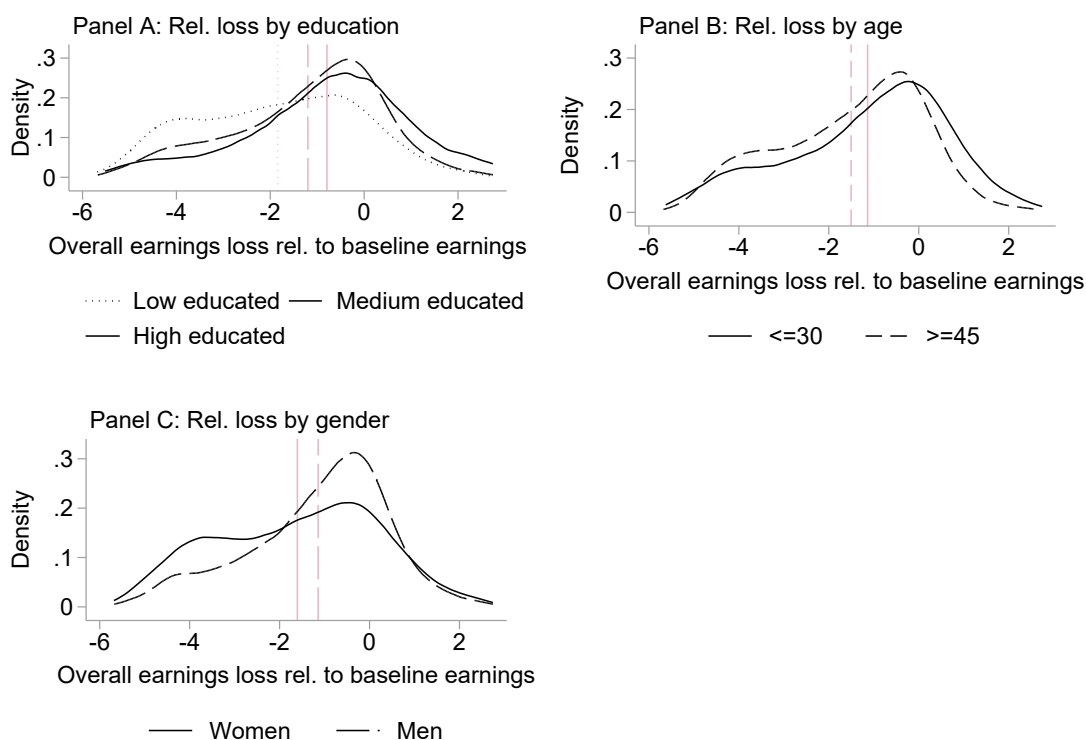


Figure 5: Distributions of earnings losses by pre-treatment characteristics

*Notes:* The figure displays the distribution of displaced workers' overall earnings losses throughout a period of five years after a firm closure by different worker and labor market characteristics in the base year (i.e., one year before the displacement). Panel A shows separate distributions by education, Panel B by age, Panel and Panel C by gender. To estimate the distribution of earnings losses, we first use a synthetic control group approach to estimate the earnings losses for each individual displaced worker in the data. Second, we use an Epanechnikov kernel to estimate the distribution of earnings losses from the individual earnings losses in each period. The red lines represent the mean earnings in each cell. Source: IEB.

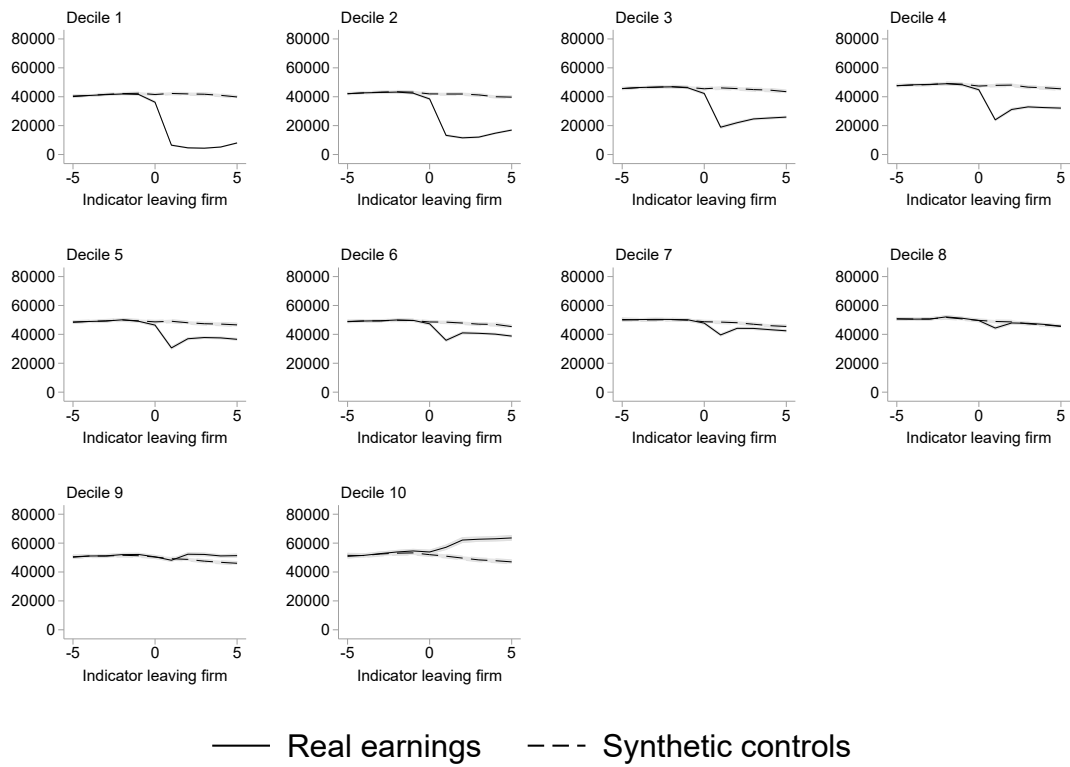


Figure 6: Average earnings for treatment and synthetic control group at deciles of the cumulative loss distribution

*Notes:* The figure displays the average earnings for the treatment and synthetic controls within the deciles of their loss distribution. For this purpose we have binned the treated workers in 10 deciles according to the magnitude of their estimated cumulative earnings losses. The first sub-figure displays the average earnings of displaced workers and their synthetic controls for those workers whose earnings losses lay below the ten percent decile of the total loss distribution. The second figure presents the same results for the second decile and so forth.

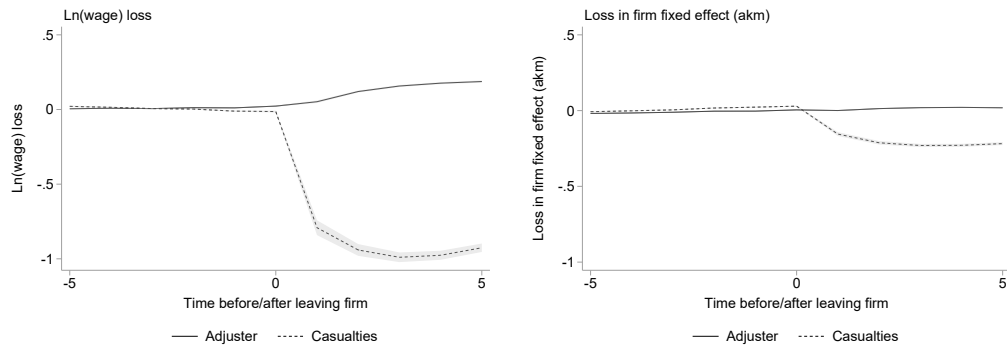


Figure 7: Contribution of closing firm fixed effect (AKM) to wage losses

*Notes:* The plots compare overall wage losses from firm closure to the change in the firm fixed effect (AKM) for workers who are displaced, and subsequently switch firms, following a firm closure. Each panel plots the trends separately for “adjusters” (in the lowest quartile of earnings losses) and “casualties” (in the highest quartile of earnings losses). The left panel plots the trend in average log wage for each of these groups relative to the worker’s wage in the year pre-closure. The figure restricts to workers with positive wage. The right panel plots the firm AKM for these workers based on the firm at which the workers is employed. Bootstrap standard errors are plotted as the shaded region.

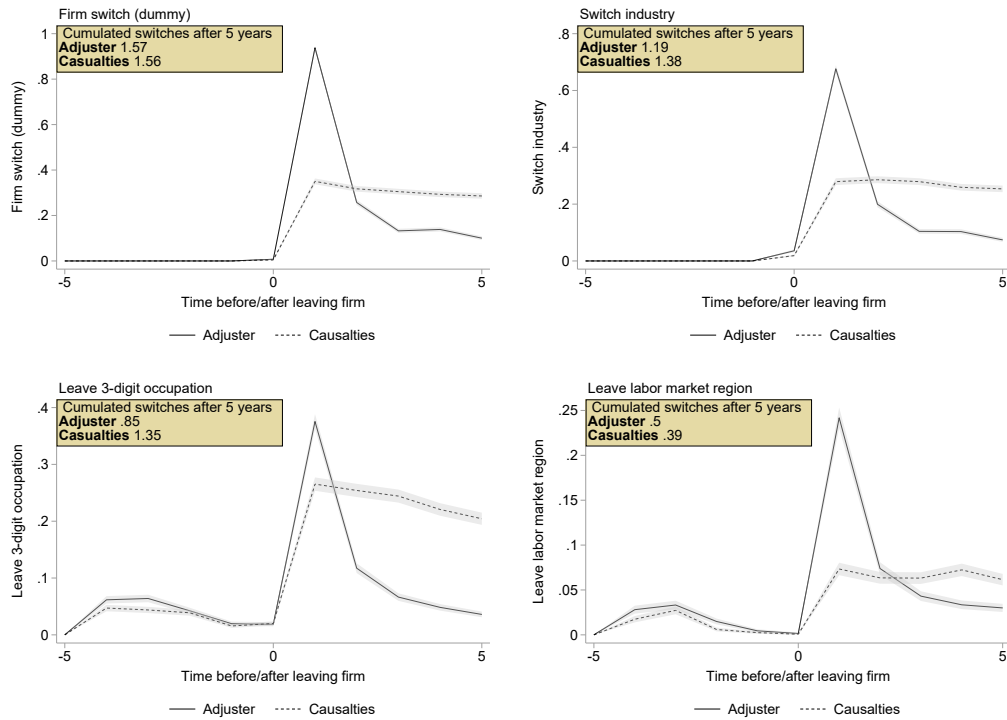


Figure 8: Fraction of workers who switch firm, industry, occupation, and region after firm closure

*Notes:* The figure compares the frequency of different margins of response to firm closure for “adjusters” (in the lowest quartile of earnings losses, plotted by the solid line) and “casualties” (in the highest quartile of earnings losses, plotted by the dashed line) around firm closures (time = 0). The panels plot (starting in the upper left and moving clockwise) the share of workers who change, year-over-year, their firm, industry, three-digit (KldB) occupation, and labor market region (LLM50). All changes are conditional on being employed during that year. The box in the corner of each panel plots the average number of switches by type, cumulative over the five years post-firm closure, separately for adjusters and casualties. Bootstrap standard errors are plotted as the shaded region surrounding each line.

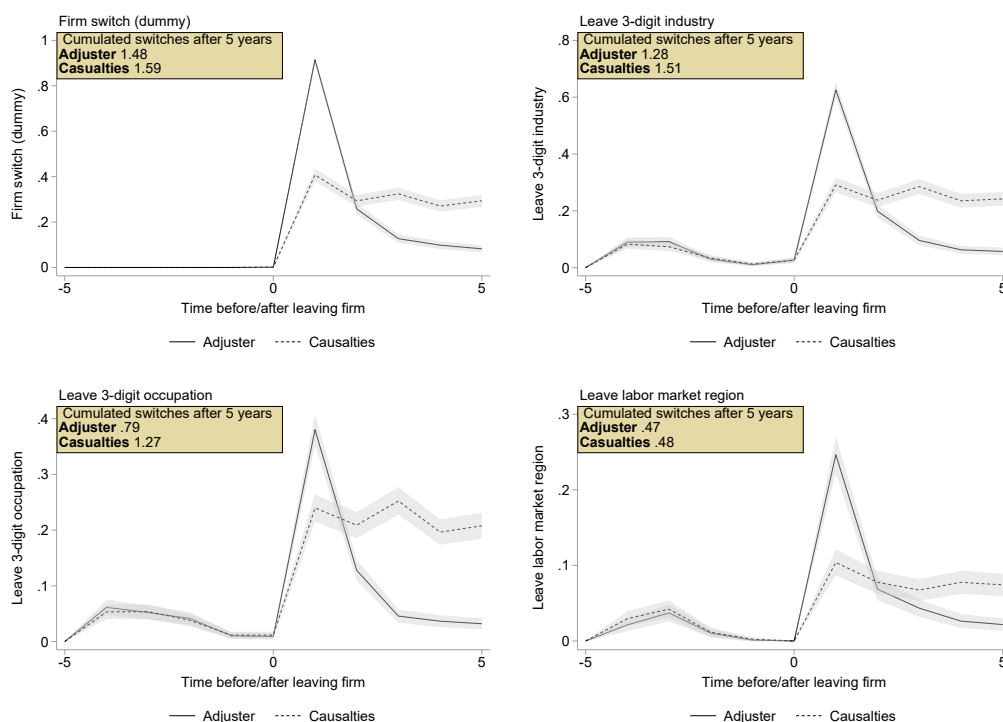


Figure 9: Fraction of workers who switch firm, industry, occupation, and region after firm closure (matched sample)

*Notes:* The figure compares the frequency of different margins of response to firm closure for “adjusters” (in the lowest quartile of earnings losses, plotted by the solid line) and “casualties” (in the highest quartile of earnings losses, plotted by the dashed line) around firm closures (time = 0). The figure restricts to a matched sample comprised of a sub-sample of workers who come from a firm that produces at least one “adjuster” and at least one “casualty.” The panels plot (starting in the upper left and moving clockwise) the share of workers who change, year-over-year, their firm, industry, three-digit (KldB) occupation, and labor market region (LLM50). All changes are conditional on being employed during that year. The box in the corner of each panel plots the average number of switches by type, cumulative over the five years post-firm closure, separately for adjusters and casualties. Bootstrap standard errors are plotted as the shaded region surrounding each line.

## Tables in text

Table 1: Raw descriptive statistics of displaced and non-displaced workers

	Non-displaced	Displaced	Difference	P-value
Total labor earnings per calendar year	48380.874	45737.346	2643.528	0.000
Gender	0.318	0.290	0.028	0.000
Real tenure	3.618	6.616	-2.997	0.000
Age (in years)	39.375	39.176	0.199	0.021
Low educated (no vocational degree)	0.190	0.137	0.053	0.000
Medium educated (apprenticeship degree)	0.746	0.838	-0.093	0.000
High educated (university degree)	0.064	0.025	0.039	0.000
No. employees total	553.937	151.535	402.403	0.000
Manufacturing	0.457	0.449	0.008	0.054
Wholesale and retail	0.170	0.217	-0.047	0.000
Construction	0.093	0.165	-0.072	0.000
Individuals	567508	16135		

*Notes:* The table summarizes characteristics of displaced workers (all workers at a German firm that closed between 2000-05) and non-displaced workers. Source: IEB 1984-2010.

Table 2: Characteristics of relative loss distribution

	All	Education			Gender	
		<i>Low</i>	<i>Medium</i>	<i>High</i>	<i>Women</i>	<i>Men</i>
Mean	-1.277	-1.842	-1.198	-0.798	-1.606	-1.143
Mode	-0.405	-0.284	-0.284	-0.466	-0.494	-0.334
Skewness	-0.419	-0.057	-0.476	-0.466	-0.105	-0.537
P25	-2.371	-3.273	-2.209	-1.781	-3.106	-2.070
P75	-0.087	-0.466	-0.052	0.346	-0.209	-0.053
Loss < 1 month	0.249	0.166	0.260	0.354	0.222	0.260
<i>N</i>	16135	2238	13499	398	4678	11457

*Notes:* The table summarizes moments from the distribution of cumulative earnings losses for displaced workers. Losses are log differences for displaced workers relative to their synthetic control over the five years following firm closure. Education takes three levels: low educated (less than an apprenticeship), medium educated (apprenticeship), and high educated (university degree).

Table 3: Variance decomposition of displacement losses

	Share of variation	
	Treated earnings losses	Synthetic counterfactual estimates
Individual char.	0.016	0.101
Education	0.001	0.081
Pre-displacement firm f.e.	0.125	0.265
Pre-displacement occupation f.e.	0.030	0.172
Pre-displacement region f.e.	0.006	0.052
Citizenship	0.006	0.002
Residuals	0.830	0.291
Covariances	-0.014	0.037
Total variance of loss	1.000	1.000

*Notes:* The table decomposes the variance in earnings losses into portions explained by individual and displacement firm fixed characteristics. “Individual characteristics” include age and gender. Education takes three levels: low educated (less than an apprenticeship), medium educated (apprenticeship), and high educated (university degree). Firm and occupation fixed effects are recorded in the year prior to firm closure.

Table 4: Wage and employment states for adjusters and casualties (percentages)

Years after closure	Adjusters					Casualties				
	1	2	3	4	5	1	2	3	4	5
<b>No wage</b>										
Unemployed full year	1.1	0.2	0.2	0.2	0.4	35.3	39.9	37.4	31.9	23.4
Partial year employed	5.9	1.4	0.6	0.6	0.4	31.6	15.4	9.2	7.1	5.6
<b>Wage loss &gt; 50%</b>										
Partial year employed	0.5	0.1	0.1	0.0	0.1	5.8	8.6	8.4	8.1	8.2
Full year employed	0.5	0.3	0.1	0.2	0.2	4.4	10.3	17.0	21.1	23.7
<b>Wage loss 10-50%</b>										
Partial year employed	2.4	0.4	0.2	0.3	0.4	7.2	10.3	9.2	8.2	8.6
Full year employed	8.2	5.7	3.8	4.5	4.7	5.9	9.1	14.9	19.3	23.5
<b>Wage loss 0-10%</b>										
Partial year employed	4.5	0.6	0.3	0.3	0.6	2.3	1.9	1.4	0.9	0.6
Full year employed	15.6	15.1	12.5	10.7	11.7	1.9	1.1	0.9	1.0	2.1
<b>Wage gain</b>										
Partial year employed	11.2	4.3	2.6	2.2	3.0	3.1	2.0	1.2	1.0	1.1
Full year employed	50.2	71.8	79.6	81.1	78.7	2.5	1.4	0.5	1.3	3.2

*Notes:* This table shows a set of the following post-displacement outcomes as a percentage of adjusters and of casualties by year over the first five years after displacement. The table splits workers into three employment categories: non- or unemployed for the entire year, employed for part of the year (between 0 – 300 days), and employed for the full year (> 300 days). The table compares the worker’s wage in a given year to a counterfactual wage calculated by applying the synthetic control weights of our main approach for annual labor earnings to the daily wages of workers in the donor pool.



# Appendix

## A Event study

Figure A.1 compares the results from a standard event study approach to the results from our synthetic control group approach. In more detail, we ran event studies that compare the earnings trajectories of workers who lost their jobs in firm closures to those of comparable workers who did not lose their jobs in firm closures. Before running the event studies, we used propensity score matching to align the displaced workers of the treatment group to the non-displaced workers of the control group. We match the treatment and control group workers on the same base line variables that we have used for the synthetic control group approach (i.e., age, gender, education, three-digit occupation, two-digit industry, and firm size). Moreover, we apply the same sample restriction as in our baseline data and only consider workers who worked in large firms with more than 50 employees and had at least two years of tenure before the respective displacement year. See the data section for more details.

Afterwards, we separately ran the following event studies for each displacement year between 2001 and 2005 and aggregate the coefficient estimates using the observations from each separate regression as weights.

$$Y_{it} = \alpha + \lambda_t + \sum_{k=-5}^5 \delta_k + X_{it}\beta + \epsilon_{it} \quad (\text{A.1})$$

where  $Y_{it}$  is the dependent variable of annual earnings,  $\lambda_t$  are the year fixed effects.  $\sum_{k=-5}^5 \delta_k$  are the event-time dummies that follow all treated workers throughout five years before until five years after the treatment.  $X_{it}$  denotes a set of control variables that we restrict to three age categories and  $\epsilon_{it}$  is the error term. As we ran the event studies separately for each displacement year and only compare the treated displaced workers to the group of non-displaced workers who are never treated, we avoid common problems that arise in two-way fixed effects models with multiple

treatment times that rely on varying observation periods and use *not yet treated* observations as controls.

We plot estimates from three event studies. The first contains all displaced workers in our sample such that we can compare the average earnings losses between the event study approach and our individual-level synthetic control group approach. For the second and the third event studies, we use the estimates of our synthetic control group approach to restrict the sample to the quartiles of workers with the largest and lowest losses, respectively. We estimate event study regressions on a given quartile of workers and the workers in their synthetic control pools. Thus, the regressions fix subsets of workers and estimate average earnings losses for these subgroups of workers, thereby allowing us to compare the two estimation strategies in the upper and lower quartiles of the loss distribution.<sup>26</sup>

Figure A.1 presents the results. The solid line shows the aggregated average displacement losses from our event studies. The dashed lines represent the average displacement losses from the synthetic control group approach on the individual level. The first and second panel of the figure show that the event study approach and the synthetic control group approach produce virtually the same average effects for the quartile of workers with the largest losses and for all displaced workers.

The approaches produce slightly different average effects for the quartile of workers who experienced the smallest losses (including gains) according to the estimated loss distribution of our synthetic control group approach. More specifically, the synthetic control group approach produces slightly larger gains at the upper part of the loss distribution than the event study approach. It is not obvious whether estimates from either of the methods is more biased at the upper tail of the distribution than the event study approach. Indeed, Arkhangelsky and Hirshberg (2023) show that synthetic control group approach are under many circumstances even less biased

---

<sup>26</sup>We emphasize here that the results do not show quartile effects that would be obtained from quantile regressions. Instead, the results show estimates of the average losses for workers who fall in the lowest and largest quartile of the estimated loss distribution.

than regular diff-in-diff estimators.

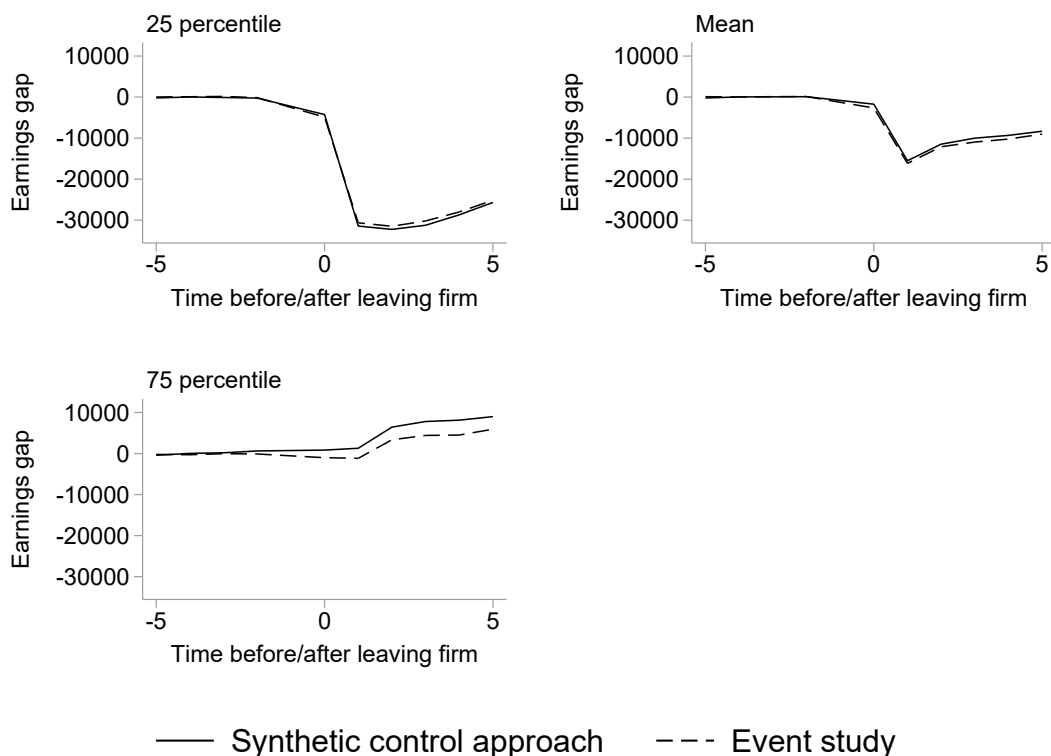


Figure A.1: Regular event study vs. synthetic control group approach

*Notes:* This figure compares estimated earnings losses between synthetic control and event study approaches. The synthetic control series plots average earnings differences between displaced workers and their synthetic controls, averaged across all such comparisons. The event study series plots average coefficients from event study regressions centered on the time of firm closure, using propensity score weighting based on characteristics used for synthetic control matching. Separate event studies are estimated for each displacement year; the figure plots the average of these estimates. The figure plots comparisons separately for the earnings losses at the 25th percentile, mean, and 75th percentiles.

## B Permutation exercise

The following figure presents the results from a permutation exercise for which we have drawn 200 ten-percent samples of our data to re-estimate the distribution of displaced workers earnings losses. Unlike in a bootstrapping exercise for which we would randomly pull samples of the same size, we purposefully only used ten percent sample to increase the likelihood of outliers to influence the results. The grey lines

represent the results from the permutation exercise, the black line shows the results from the entire sample. The figure reveals that the shape of the distribution of displacement losses is fairly robust.

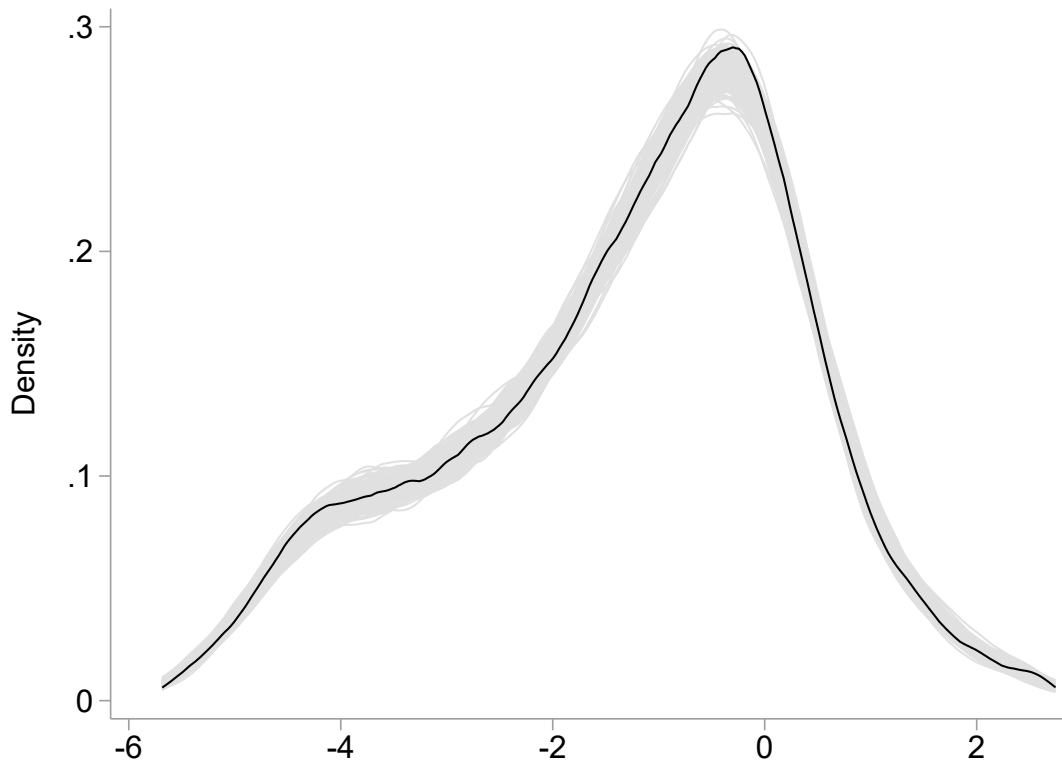


Figure B.1: Permutation of loss distribution on 100 ten percent samples

*Notes:* This figure plots the distribution of earnings losses derived from 100 ten-percent samples from our broader sample of displaced workers. Earnings losses represent the cumulative log difference between actual and synthetic control earnings over the five years following a worker's firm closure.

## C Narrow deviation robustness

This Appendix provides a robustness check for the estimates of the dynamic development of the loss distribution on a sample of displaced workers with perfectly matching pre-trends. More specifically, we reproduce our main result as displayed in Figure 3 on a sample that only includes displaced workers for whom we found synthetic control group weights such that the gap between their pre-treatment earnings and those of their synthetic controls never exceeds five percent of their average

pre-treatment earnings.

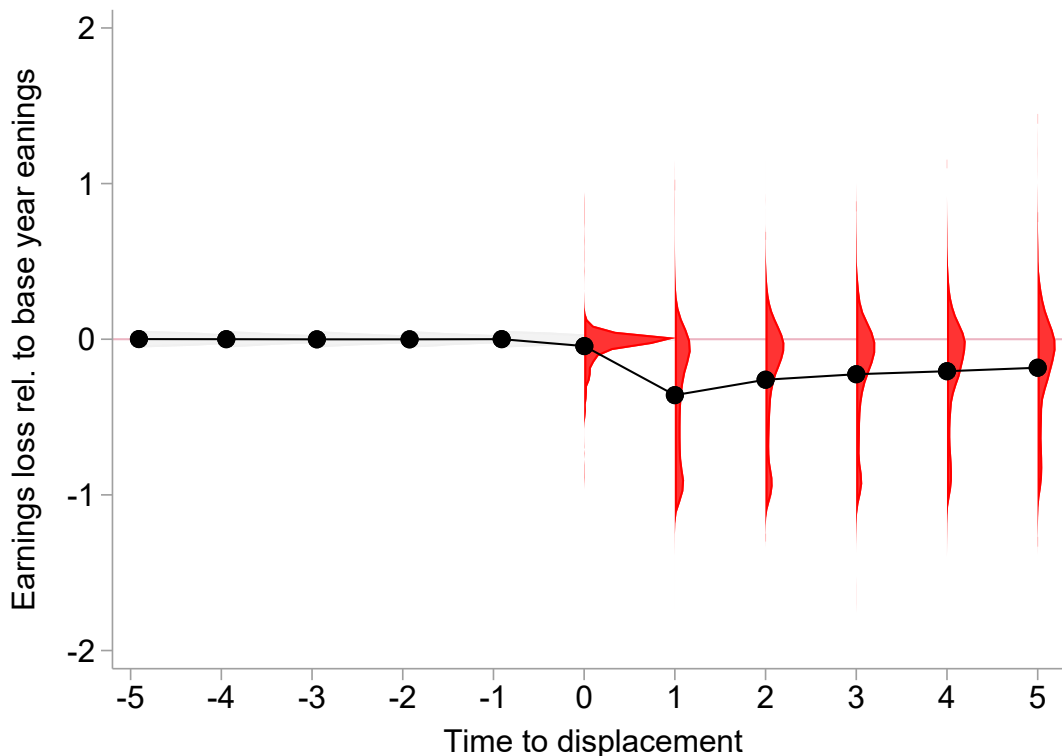


Figure C.1: Distribution of relative earnings losses with perfect pre-trends

*Notes:* This figure plots the distribution of earnings losses derived from 100 ten-percent samples from our broader sample of displaced workers. Earnings losses represent the cumulative log difference between actual and synthetic control earnings over the five years following a worker’s firm closure.

Figure D.1 reveals that the pre-treatment earnings gaps between the displaced workers and their synthetic controls are very strongly centered around zero with virtually no tails in the distribution. However, the distributions of the post-displacement earnings losses are qualitatively the same as in Figure 3.

## D Pre-treatment deviations uncorrelated with post-treatment

One potential concern might be that the quality of our synthetic control group approach might systematically differ between casualties and adjusters. This problem

were to arise if the synthetic controls weights were of lower quality in the tails of the treatment effect distribution than at the mean or median, such that the earnings losses were systematically upward biased for casualties and systematically downward biased for adjusters. Figure D.1 presents separate distributions of earnings differences between displaced workers and their synthetic counterfactual before the treatment. The figure reveals that the distributions of pre-displacement earnings differences are strongly centered around zero and virtually identical for casualties and adjusters. Thus, Figure D.1 does not reveal any evidence that the estimates are systematically biased for adjusters or casualties.

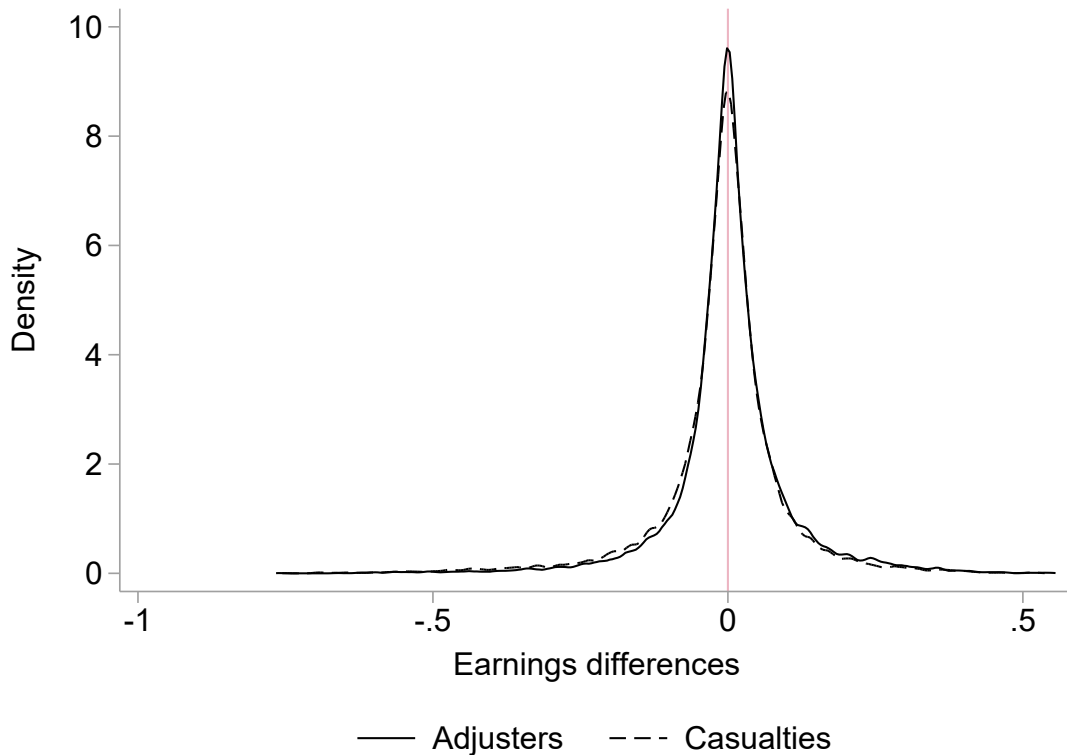


Figure D.1: Pre-displacement distributions of earnings differences between displaced workers and their synthetic controls

*Notes:* This figure plots the distribution of the differences in earnings between displaced workers and their synthetic controls before the treatment. The solid line shows the results for adjusters and the dashed line for casualties.