# The Costs of Job Displacement over the Business Cycle and Its Sources: Evidence from Germany*

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Extended Abstract
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**Abstract**

We document the costs of job loss to displaced workers over the business cycle and its sources using administrative data from Germany. Losses in annual earnings in Germany after displacement are large, persistent, and highly cyclical, nearly doubling in size during economic downturns. We show that part of these losses and their cyclicality is driven by unemployment. As a result, unemployment insurance (UI) plays an important role in buffering the effect of job displacements, especially in recessions. However, the longer-tem earnings losses we find are mainly driven by declines in wages, and hence UI benefits do little to offset life-time losses in earnings. Preliminary results suggest that an important factor behind the long-lasting declines in wages and their cyclicality are changes in employer characteristics, as workers switch to smaller paying firms after job displacement, in particular in recessions.

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## 1 Introduction

A sizable body of research has documented the high costs of job loss and ensuing unemployment on the side of workers. In particular, several papers suggest that workers displaced during mass layoffs experience large losses in annual earnings lasting over 15 to 20 years (Jacobson, Lalonde and Sullivan 1993, Couch and Plazcek 2010, von Wachter, Song, and Manchester 2011). The existing literature has also shown that earnings losses after job displacement have an important cyclical component. Using U.S. data, Davis and von Wachter (2011) show that although life-time earnings losses after job displacements occurring in booms are substantial, the earnings loss due to job displacements occurring in recessions is about twice as high. With displacement rates[1] reaching ten to fifteen percent of employment in large recessions, this implies that a substantial fraction of workers suffers large permanent reductions in their life-time earnings.

The finding of large and persistent effects of job displacement and their cyclicality has potentially important implications for understanding the functioning of the labor market and how it responds and contributes to recessions. However, several important open questions remain that are difficult to answer with currently used data sources. For example, does the cyclicality of earnings losses arise mainly from an increase in the incidence and duration of unemployment and nonemployment in recessions? If so, then cyclical earnings losses can be understood as a byproduct of unemployment, and the focus on unemployment insurance as main policy response to assist affected workers is appropriate. However, a presence of a strong cyclical component in wage losses is more difficult to explain, and poses greater challenges for policy approaches heavily focused on unemployment. For example, changes in the composition of displaced workers, changes in available job types, and wage declines within worker and job categories may all be at play. Yet, an understanding of these dynamics would provide valuable insights in both labor market dynamics in recessions and appropriate policy responses.

In this paper we fill several gaps in the empirical understanding of the costs of job loss using social security data from Germany, covering three decades of job displacements with a detail

[1] As measured for example in the CPS Displaced Worker Survey.

on wages and employment, and job and worker characteristics not curently available elsewhere. Using this data, we provide an analysis of the long-term earnings losses of displaced workers in Germany, carefully ensuring comparability of our results to recent estimates using similar data from the U.S. Second, going beyond existing estimates from the U.S. we decompose the earnings losses into wage and employment losses in terms of days worked over the short and long-run after jobloss. Furthermore we estimate how much of the earnings losses are replaced by the relatively generous German UI benefit system. Third, we analyze how the patterns of wage and employment losses and the role of unemployment insurance varies over the business cycle. Finally, we analyze the sources of cyclical movement in wages, focusing on changes in firm characteristics over the business cycle.

As comparable studies in the U.S., we find that workers in stable jobs separating from their main employer in the course of a mass-layoff during recessions suffer reductions in annual earnings of about 15% lasting at least 15 years. This suggests that job displacement has highly detrimental effects on earnings even in a labor market with a tighter safety net and lower earnings inequality. Exploiting features unique to the German data we also find that although temporary reductions in time worked explain part of the reductions in earnings, the majority of the long-term effect is driven by a lasting decline in daily wages. This suggests that some of the loss and recovery in earnings in the U.S. may be driven by reductions in time worked, information not readily available in the administrative data there. This is despite the fact that unemployment insurance is more generous in Germany and non-employment durations are typically longer. We also find that there is a very high degree of cyclicality in earnings losses in Germany, with losses in recessions more than doubling the losses in booms, mirroring closely comparable findings in the United States. We find this cyclicality is partly explained by longer unemployment durations of job losers during recessions, with the remainder explained by a cyclical pattern in losses of daily wages.

We also show that payments from the generous German unemployment insurance system only replace about 25 percent of displaced workers' lost earnings. This effect is likely to be even smaller in the American labor market, where unemployment insurance is shorter lived

and covers a smaller fraction of the unemployed. However since UI benefits are contingent on not working while not insuring against wage losses, income from UI benefits is also highly cyclical, thus playing a larger role in making up for earnings losses during recessions. In fact when we look at income losses (earnings plus UI income) over the business cycle, we find that income losses are less cyclical than earnings losses, suggesting an important role for UI benefits to smooth income during particularly difficult economic times.

Fluctuations in employment can explain earnings losses and their cyclicality only in the short term. We find that the pattern of longer-term earnings losses after job displacement are entirely explained by cyclical wage losses. In preliminary work, we find that displaced workers experience substantial reductions in firm size and firm wages, and that these reductions are larger in recessions. Simple accounting regressions suggest that about half of wage losses and a large part of their cyclicality could be driven by changes in firm characteristics alone. Hence both changes in job composition over the business cycle and wage losses withing broad job categories appear to play a role in explaining persistent and cyclical declines in wages upon job displacement.

The rest of the paper is organized as follows. Section 2 gives an overview of our definitions of job displacement and describes the data. In Section 3, we first provide basic descriptive estimates of the effect of job displacement on earnings, wages, and time worked. We then present results from a regression-based comparison of displaced workers' earnings with the evolution of earnings of a control group of non-displaced workers over the business cycle. We also discuss the role of unemployment insurance receipt as a means to smooth long-term displacement-related earnings losses.

## 2 Data and Methods

### 2.1 Measuring Job Displacement at Mass-Layoffs

The goal of our empirical approach is to remain as comparable as possible to state-of-the-art studies from the U.S. literature, while exploiting advantages specific to the German data we use. In particular, availability of daily information on both earnings and unemployment

insurance receipt will allow us to better date job separations and analyze time worked and other sources of income as additional outcomes.

To study the long-term effects of job displacement, we exploit a large administrative data base containing longitudinal information on workers and firms since 1975. This data base has high-quality information on earnings, employment transitions, and firm characteristics. However, as for comparable data sources in the U.S. and other countries, there is no direct information regarding the reason of a job separation.

We follow the existing U.S. literature and define a job displacement as the event that a worker with three years of tenure leaves his main employer in the course of a mass-layoff event. The analysis of workers leaving stable jobs has several advantages. It focuses on workers who in all likelihood expected to remain in their job in the absence of a mass-layoff, and thus were likely to be surprised by being displaced. Moreover, given the steep reduction in job mobility with even a few years of job tenure in Germany, very few of these workers were likely to have moved voluntarily. This reduces the potential measurement error in the definition of job displacement.

We work with two definitions of a mass-layoff event. First, we define a mass-layoff to occur either when the firm's employment permanently declines by thirty or more percent over a short period of time. Second, we also consider the case when firms permanently close. To make these definitions meaningful, we consider only workers whose employers had at least 50 employees in the year prior to the employment drop and did not have large employment fluctuations in the years before. This definition allows us to replicate findings in the U.S. literature. Smaller firms are subject to larger percentage fluctuations, such that these measures of mass-layoff are less meaningful.

A key step in measuring mass-layoff events is to distinguish between actual permanent reductions in firms' employment and events such as mergers, takeovers, outsourcing, or changes in firm identification numbers. Since such events occur frequently in administrative data, we have constructed a complete cross-flow matrix of worker flows between establishments. Using this flow matrix, we only consider a reduction an employment a mass-layoff event, if the

majority of laid-off workers is dispersed among new employer (i.e., if there is no large flow of workers to a different establishment). This is a common methodology used, say, by the U.S. Census to adjust longitudinal firm-level employment information. Not adjusting our mass-layoff data in this way would imply potentially serious measurement-error, likely biasing our results towards finding no effect of displacement on earnings.

By focusing on job separations of high-tenured workers during mass-layoffs at medium-sized to large employers we obtain a very clean measure of job displacement that is comparable with the existing literature. A common criticism is that this may focus on workers that are more likely to have larger earnings losses at displacement. Von Wachter et al. (2011) and Hildreth et al. (2009) have shown that this is not the case for the restriction on higher-tenured workers. However, it is well known that larger firms pay more, and loss in a wage premium associated with firm size may be one explanation of the larger earnings losses we find (von Wachter and Bender 2006).

### 2.2 German Administrative Data

We use data from the social security system in Germany, which is generated from employer submitted employment records. This data consists of complete day-to-day information on earnings and time worked in each employment spell occurring in employment covered by social security. The data also contains basic demographic characteristics including education, as well as information on occupation and industry. This data has been complemented with information on receipt of unemployment (from the Leistungsempfängerdatei). In addition, the worker-level data has been merged with information on employers (obtained from the Betriebshistorikdatei).

From this data, the main outcomes we consider in this study are total annual earnings, total annual income (consisting of earnings plus payments form unemployment insurance), the daily wage at a given calendar date, and days worked or in unemployment per year. All earnings, income, and wage measures have been deflated using the Consumer Price Index and thus represent Euros in 2000 prices. Our main outcome variable, total annual earnings, is

comparable to similar measures available in administrative U.S. data. Detailed information on unemployment insurance and days worked is typically not available in comparable U.S. data sources.

Following the existing literature, we make a few additional restrictions. Most notably, we drop workers younger than age 24, since they may not have fully entered the labor force. We also drop workers older than age 50, who had access to partial retirement programs in Germany during that period. We also only use information on individuals that work in covered employment or receive unemployment benefits for at least one day in a given year, since otherwise we have little information on individuals' activities. This is likely to understate our wage losses, since some workers may exit the labor force for more than a year in response to earnings losses. Here, we depart from von Wachter et al. (2011), whose study of U.S. earnings losses includes zero earnings even if an individual drops out of the labor force for multiple years.

### 2.3 Propensity Score Matching

Displaced and non-outsourced workers may differ in many ways that will make them difficult to compare. In order to obtain a comparison group for the displaced workers in our design, we use propensity score matching. We first define find all workers who in a given year are at risk of being displaced in a mass layoff or plant closing according to our sample. Within this sample we then estimate the propensity of being displaced using education, past earnings and age as predictors. For each outsourced worker we assign a comparison worker, using the non-displaced worker with the closest propensity score. Observable characteristics between displaced and non-displaced workers prior to displacement are very similar and the two groups exhibit almost identical pre-displacement trends in wages, earnings and employment.

## 3 Preliminary Results

### 3.1 Average labor market outcomes of displaced workers

Figure 1 shows plant closing and mass layoff rates in Germany from 1975 to 2004. Since we are looking at large stable establishments, plant closings are relatively rare events of about 0.5 to 1 percent of establishments closing down each year. Mass lay-offs are more than twice as common occurring at a rate of 1 to 3 percent per year. Both are highly cyclical and in particular the mass lay-off rate follows almost one to one the year over year change in the unemployment rate.[2]

Figure 2 shows average labor market outcomes in the two groups of workers (displaced and non-displaced). We are here pooling workers who were displaced in any year between 1979 and 2008 as well as their respective non-displaced comparison worker. Due to the propensity score matching method, this yields readily interpretable results even without controlling for any variables (such as worker characteristics, calendar year, or displacement year effects). It is particularly noteworthy that in all 4 sub-figures, the pre-displacement trends up to year -2 are virtually identical suggesting that we have a very comparable control group (we are matching based on characteristics in year -2, in order to allow for displaced worker to have diverging pre-displacement trends in year -1, e.g. due to the fact that they are in declining establishments).

Figure 2 (a) shows total yearly earnings in the two groups. Note that the control group earnings are increasing up to year -1, but show a change in slopes from then onwards. This is explained by the fact that workers in both groups are by definition employed in the years prior to displacement but there is not restriction after year 0. Thus people dropping out of social security liable jobs (e.g. due to unemployment, paternity leave, moving out of Germany, moving into self-employment, ...) reduce average earnings after year 0. It is therefore important to look at earnings losses of displaced workers relative to non-displaced workers in

[2]The importance of using worker flows for defining mass lay-offs is by now well understood. For example in this context, Hethey-Maier and Schmieder (2013) show that not controlling for spurious establishment identifier changes can lead to severe bias.

order to get plausible causal estimates of the displacement effects. The figure reveals stark earnings losses in the year of displacement, earnings are almost 10,000 Euro lower in year 0 for the displaced workers or slightly less than 30 percent. While subsequent years show some recovery, this is slow and even after 10 years, displaced workers still have about 5,000 Euro lower earnings then non-displaced workers.

Figure 2 (b) and (c) show how these losses are explained by employment and wage losses respectively. Employment drops very sharply initially - only about 50 percent of displaced worker are employed on June 30th of the displacement year, but also recovers relatively quickly. In fact after 10 years most of the differences in employment probabilities have disappeared. Wages on the other hand drop by about 8-9 percent initially with the gap actually widening slightly over time to 10 percent. Thus almost all of the long-term losses in earnings are explained by lower wages among the displaced workers, rather than by employment losses.

Figure 2 (d) shows income from UI benefits in the 2 groups. UI income increases sharply at the time of displacement and appears to replace about 25 percent of the earnings losses in the first year. However it then declines quickly and the difference between the two groups disappears after around 5 years, showing - not surprisingly given the short-term nature of UI benefits - that UI benefits do little to compensate long-term earnings losses for displaced workers.

### 3.2 Outcomes over the business cycle

In order to obtain results of the effects of displacement that can control for other characteristics, we estimated regression models of the form:

$$y_{it} = \gamma_0 + \gamma_1 I(disp) + \sum_{j=-4}^{10} \delta_j I(t = t^* + j) I(disp) + \alpha_{tc} + x_{it}\beta + \varepsilon_{it} \tag{1}$$

where $I(disp)$ is an indicator for whether the person is a displaced worker, $t^*$ is now the displacement year (while $t$ is just the year), $\delta_j$ are measure the difference between the displaced on non-displace workers in year $j$ relative to the displacement year $t^*$, $\alpha_{tc}$ are year fixed effects fully interacted with cohort fixed effects, and $x_{it}$ are controls.

In this specification we omit one of the $\delta_j$ (namely $\delta_{t^*-5}$) and one of the year dummies to avoid collinearity. Essentially these are absorbed in the constant ($\gamma_0$ and the coefficient on the displacement indicator $\gamma_1$). This means the $\delta_j$ can be interpreted as the difference between the two groups after taking out the initial difference in year $t^* - 5$.

Figure 3 shows earnings losses of displaced workers by year of displacement by showing coefficient estimates from equation (1). Vertical bars indicate recession years in Germany (negative GDP growth). The figure reveals a strong cyclical pattern. While losses were only about 5000 Euro in the displacement year in 1979-1980, they were more than 10,000 Euros for workers displaced in the 1982 recession. After 1982 losses became smaller until they increased again during the 1993 recession. In the mid 1990s Germany entered a period of prolonged high unemployment rates and sluggish growth (eurosclerosis) and during this time period earnings losses of displaced workers stayed very high, only to come down briefly before the 2003 recession. After 2003 recession (and the Hartz labor market reforms) earnings losses fell again as the economy and the labor market recovered.

Turning to decomposing the earnings losses into employment and wage losses, Figure 4 (a) shows a highly cyclical pattern for number of days worked of displaced workers, with the largest losses for workers who lose their jobs during recessions or in the following year. The cyclicality is similar or even more pronounced than for yearly earnings. Figure 4 (b) shows that wage losses are less cyclical than earnings losses, especially during the early 1980s. This indicates that the bulk of the earnings losses at displacement are driven by employment losses while the impact of wage losses is smaller.

Using the unique features of our data, we can explore to what extent the relatively generous German UI system is able to dampen the cyclicality of earnings losses. Since UI benefits only insure against earnings losses stemming from employment, and since the bulk of the cyclicality of earnings losses is due to employment we would expect that UI benefits may have some impact on the cyclicality. Indeed, Figure 5 shows that the number of days displaced workers receive UI benefits in the first years after jobloss rises sharply in recessions, which is also reflected in a sharp increase in UI income of displaced workers during downturns. This can

be clearly seen by looking at Figure 5 (b) which almost mirrors the employment losses from Figure 4 (a).

That UI benefits reduce the cyclicality of income losses is directly explored in Figure 6, which shows total income, consisting of earnings and UI income, for displaced workers. The cyclicality from Figure 3 is clearly reduced though still present. Given that UI benefits only offer a replacement rate of around 63 - 68 percent over this time period and given that wage losses are not insured, it is not surprising that UI benefits can only reduce the cyclicality up to a certain amount. Nevertheless, this suggests an important role for UI benefits in helping the workers with the largest earnings losses during the most difficult economic times.

We also investigated to what extent displaced workers are working for employers with different characteristics as opposed to non-displaced workers and how these patterns may correlate with the cycle. Figure 7 thus shows changes in the (a) size and (b) wage of the employing establishment relative to non-displaced workers over time. There is clearly a very large decline in both establishment size and the average wage of the employer relative to non-displaced workers: establishment size goes down by about a full 100 log points, while daily wages are reduce by about 5 to 10 Euros. Both of these are somewhat cyclical and thus may explain at least some of the cyclicality of wage losses.

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Figure 1: Mass Layoff and Plant Closing Rates by Year

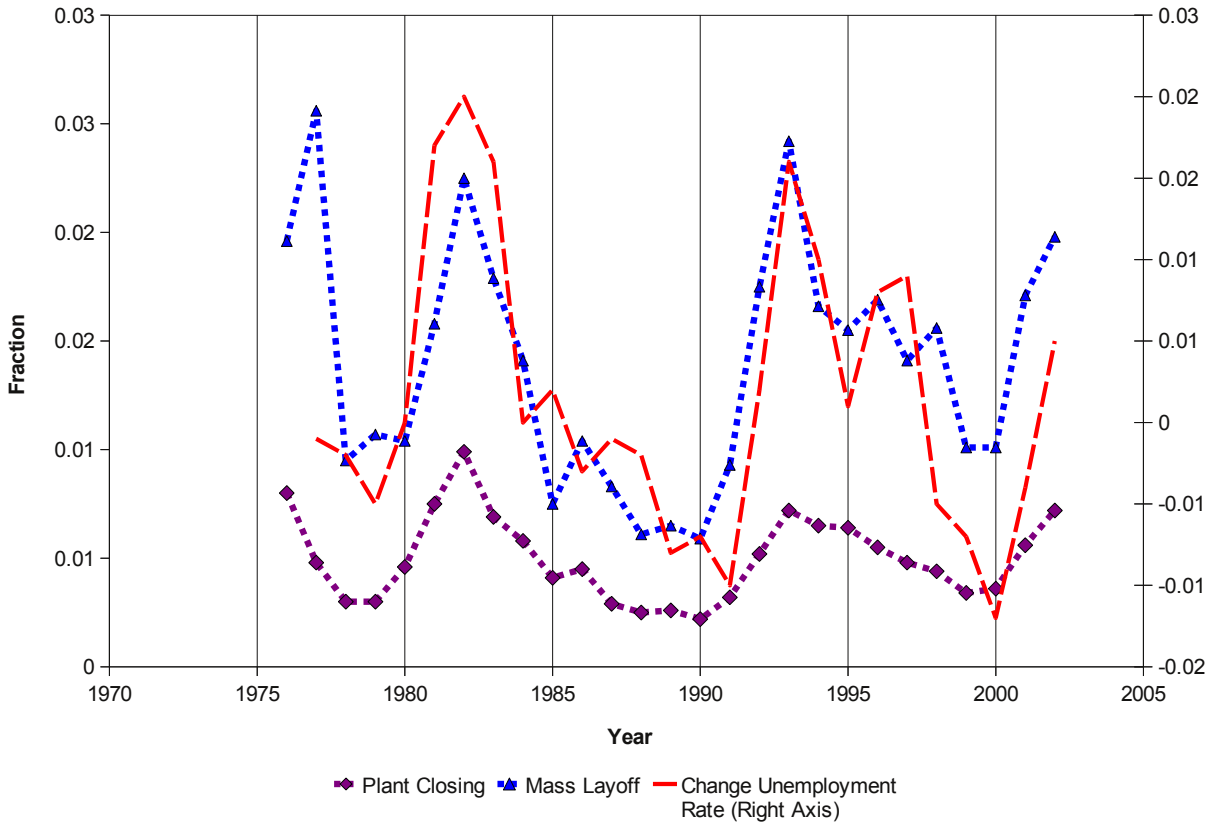
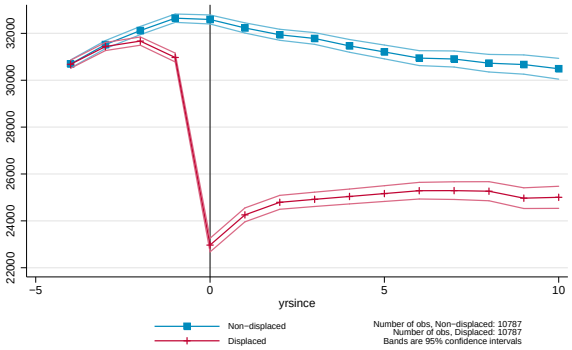
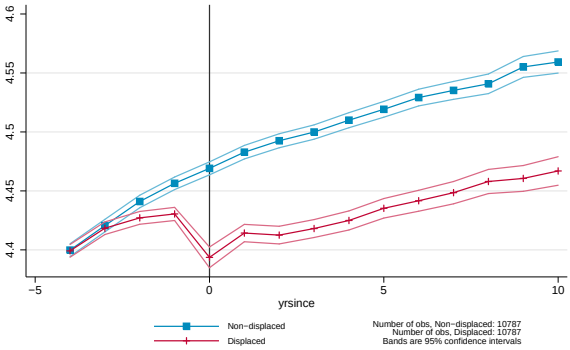


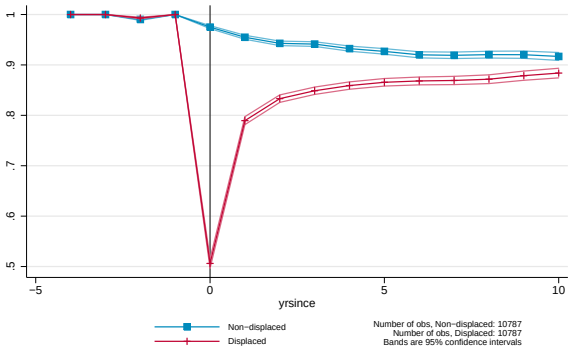
Figure 2: Labor Market Outcomes of Displaced Workers before and after Job Loss



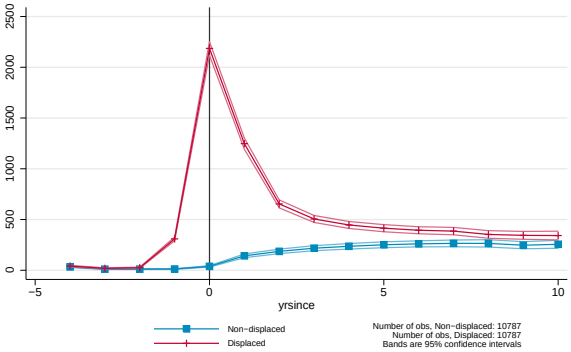

(a) Total Earnings in Year




(b) Log Wage




(c) Employed on June 30th of Year




(d) Income from Unemployment Insurance Benefits

**Notes**: The figures shows labor market outcomes for displaced and non-displaced workers. The red line corresponds to workers who are displaced from year -1 to 0, while the blue line corresponds to the matched control group that is constructed of non-displaced workers via propensity score matching. Each point represents the average value in the respective worker group. The figure is constructed pooling workers displaced between 1979 and 2008, while the outcome data spans 1975-2009.

Figure 3: Earnings Losses of Displaced Workers by Year of Job Loss

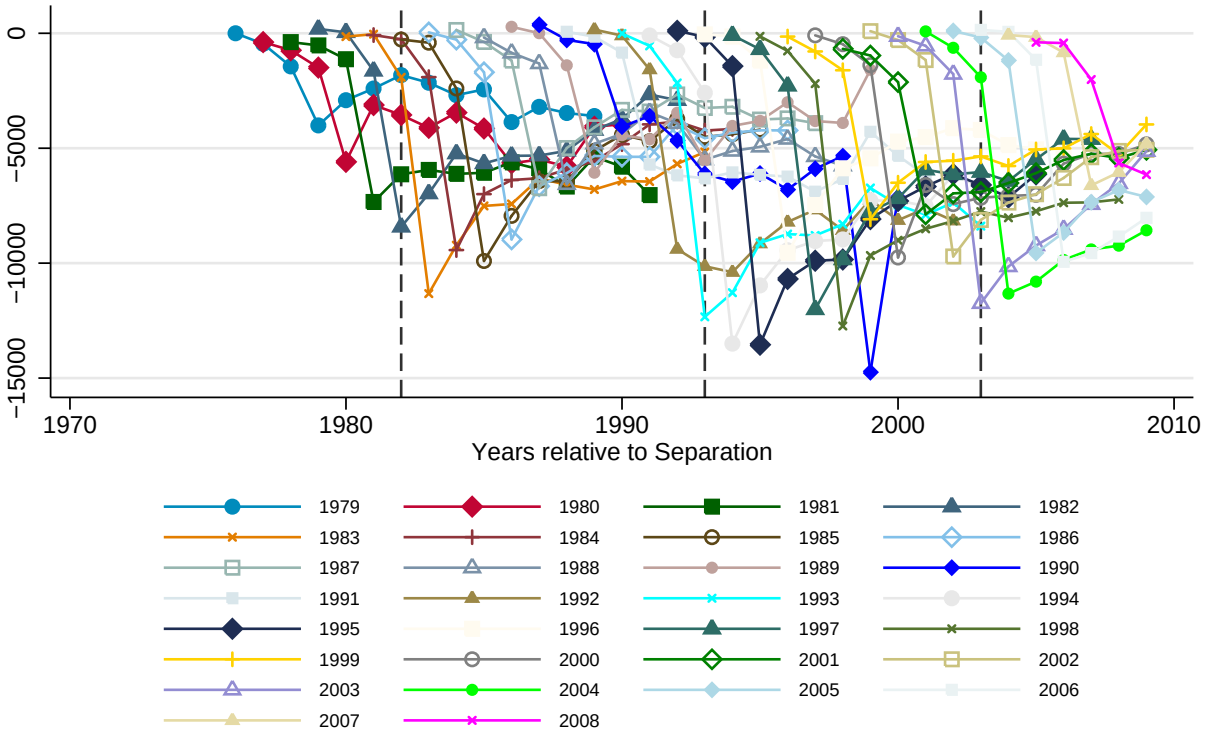
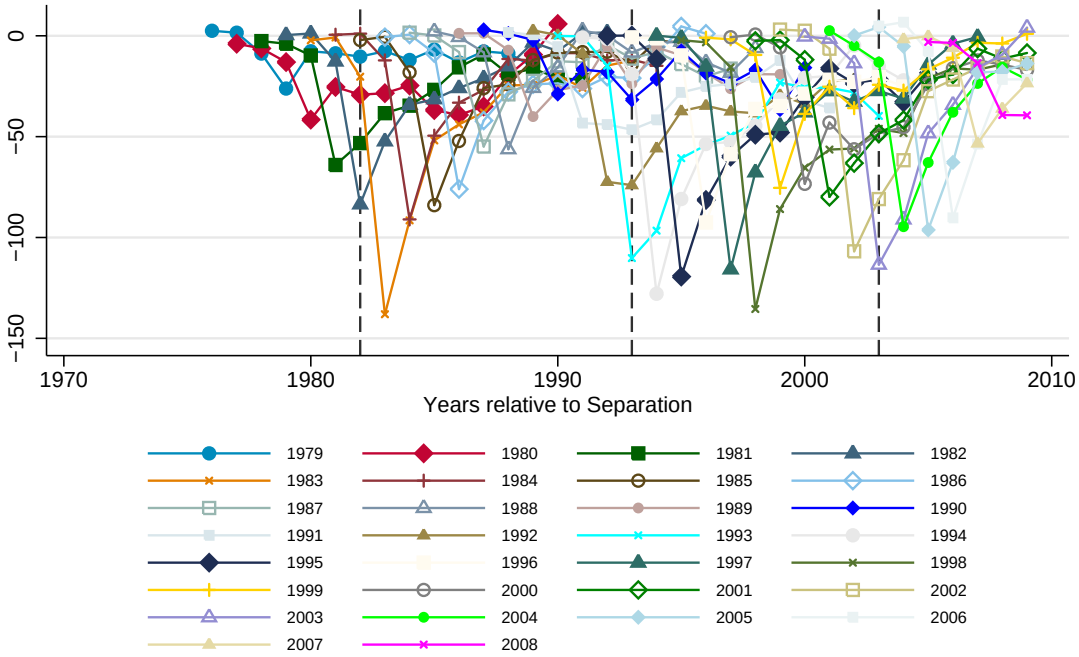
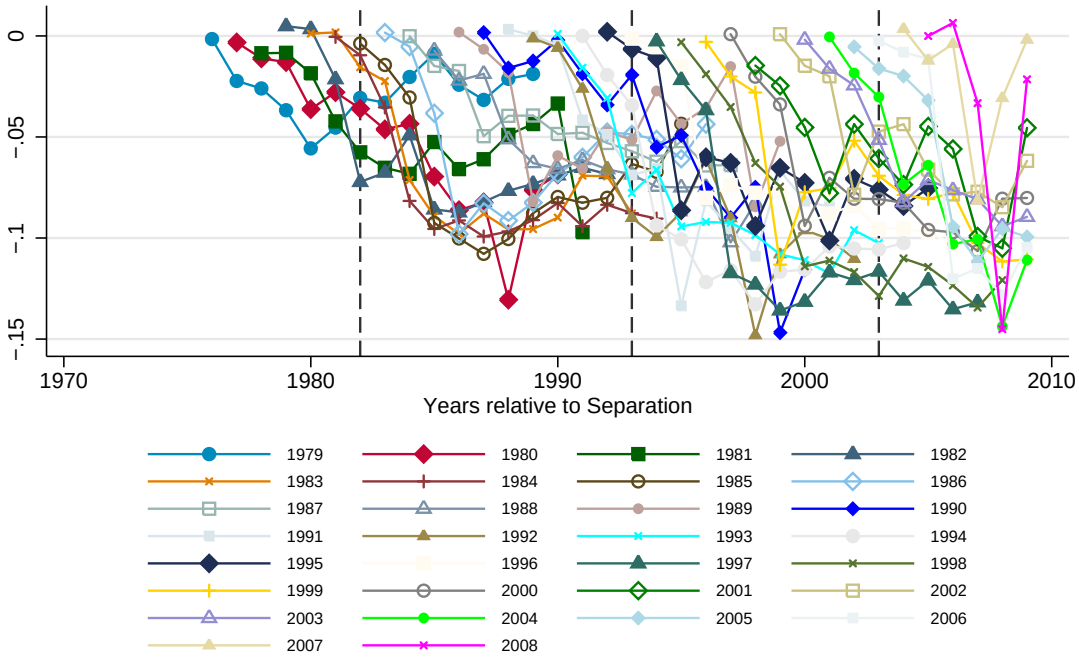


Figure 4: Employment and Wages of Displaced Workers by Year of Job Loss

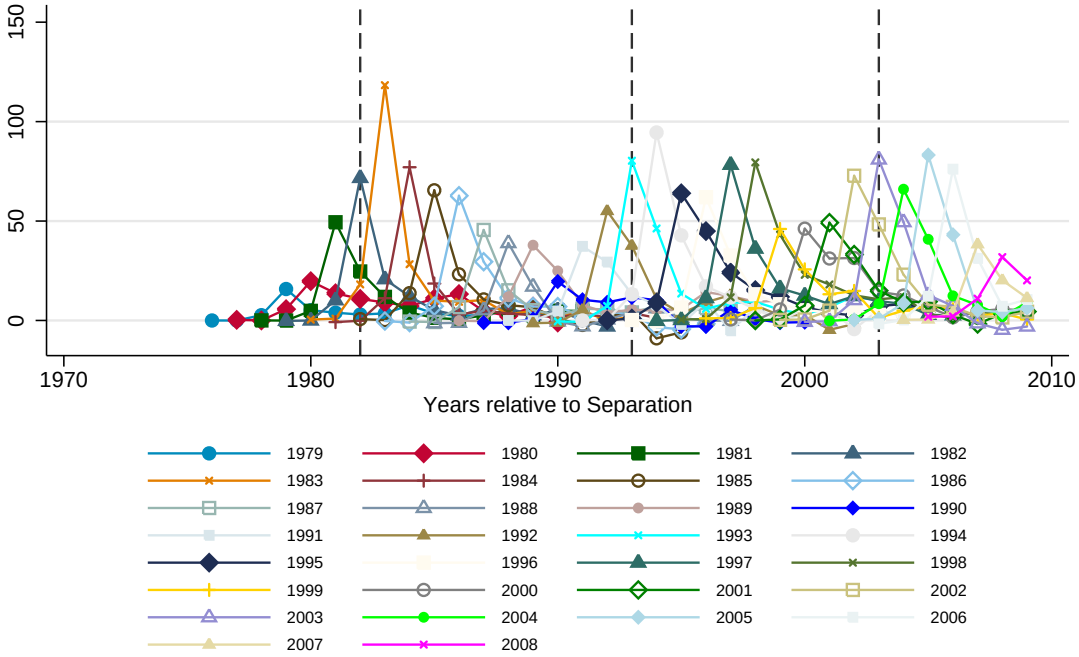



(a) Number of Days Employed in Year

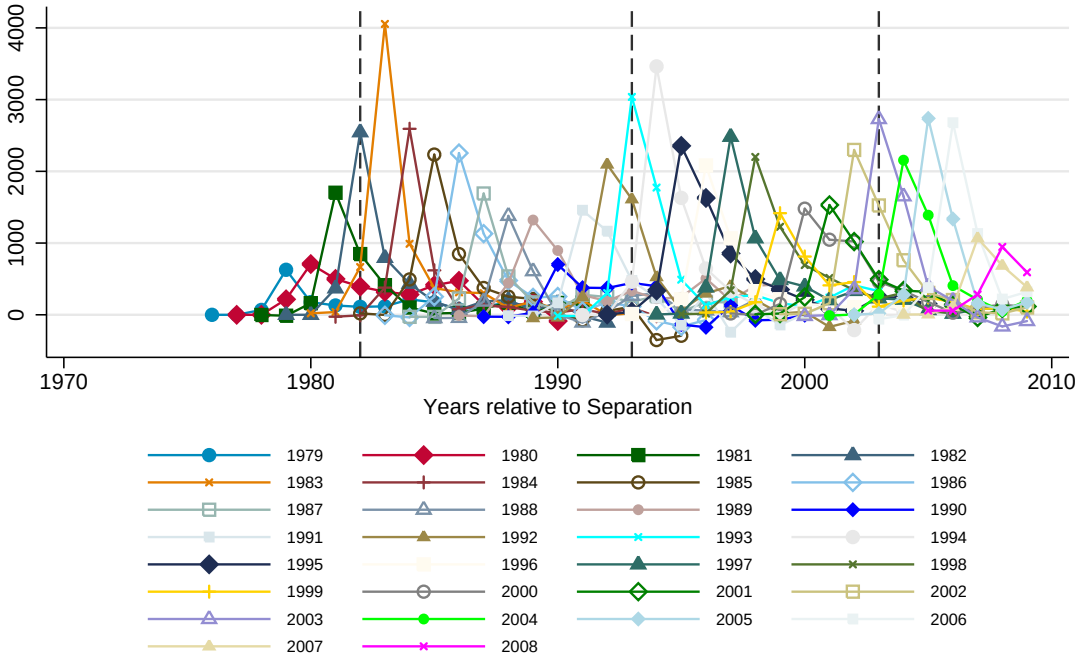



(b) Log Wage

Figure 5: Unemployment Insurance Benefits Receipt: UI Income and Days on UI




(a) Number of Days receiving UI Benefits per Year




(b) UI Benefits in Euro per Year

Figure 6: Income Losses (Earnings + UI Benefits) of Displaced Workers by Year of Job Loss

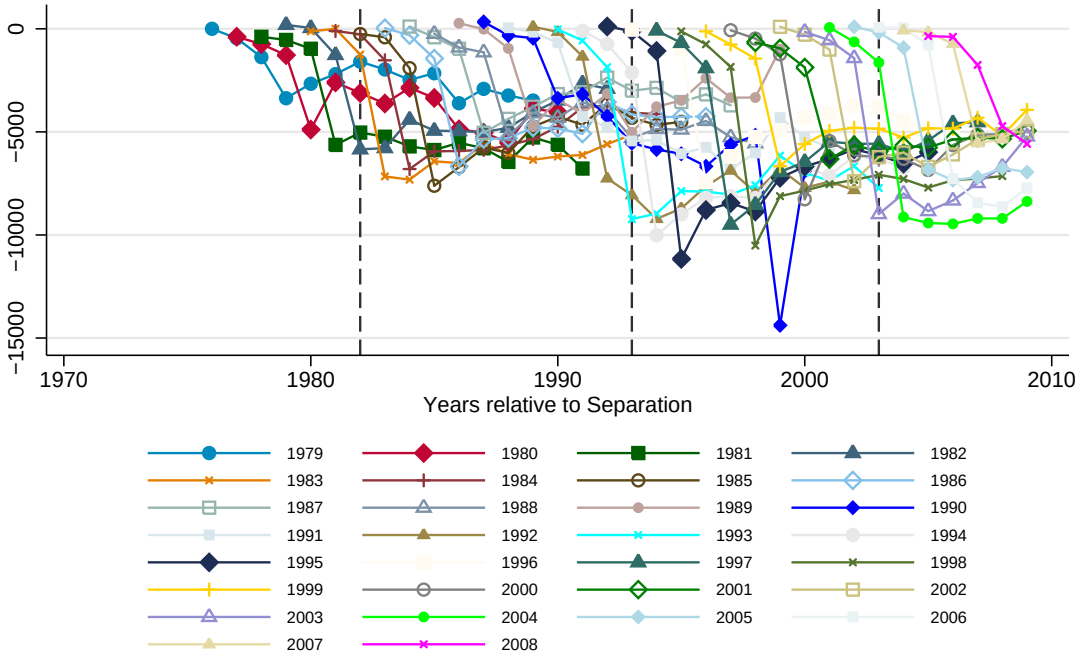
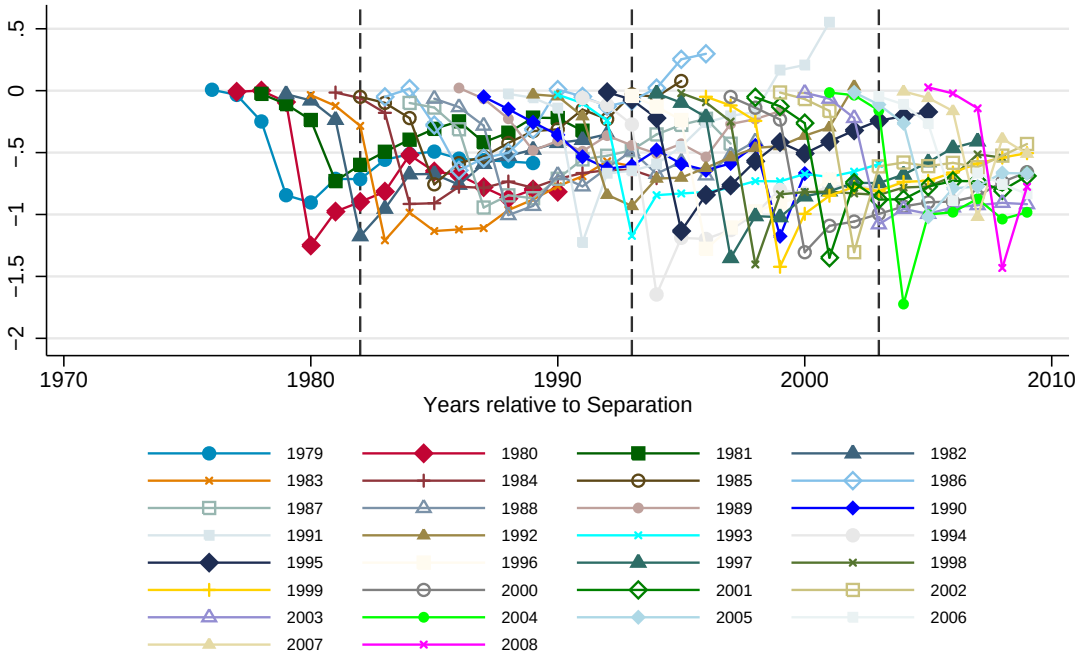
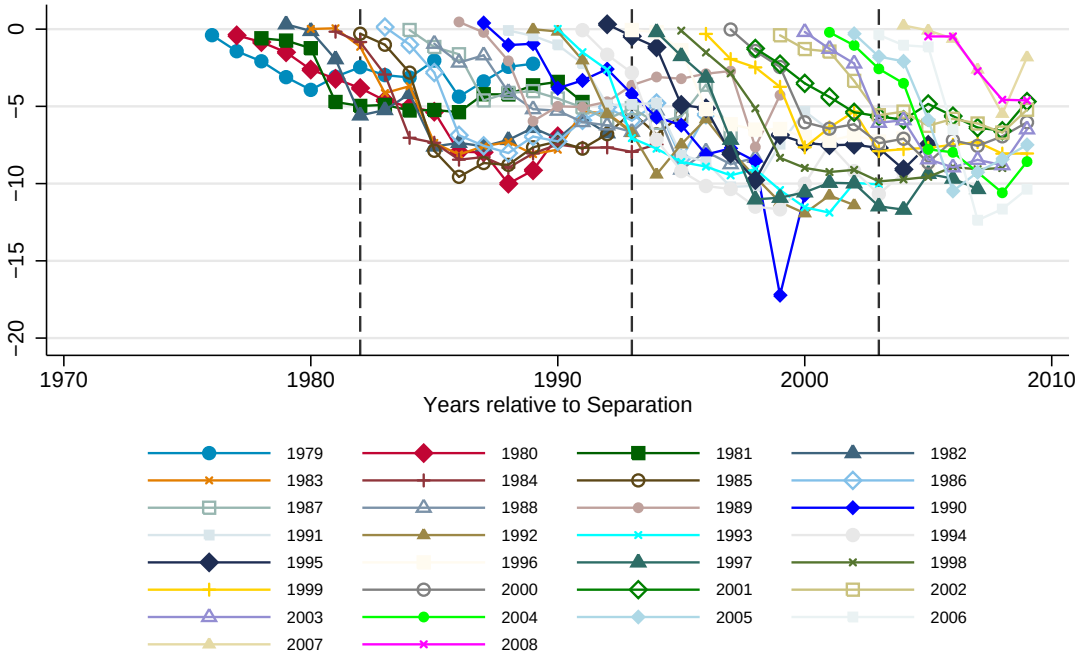


Figure 7: Employer Characteristics of Displaced Workers by Year of Job Loss




(a) Log Number of Employees at Establishment




(b) Average Wage at Establishment in Euro

## Appendix

In order to identify mass-layoffs and plant closings in the German administrative data we used the following approach. After merging the establishment history panel with information on all year to year cross establishment worker flows, we defined mass layoffs as a drop in employment from one year to the next of at least 30 percent in an establishment with at least 50 employees in the year before the employment drop. To assure that these establishments were relatively stable prior to the drop and that the drop did not constitute just temporary fluctuations, we also required that employment did not increase by more than 30 percent in either of the two years before the employment drop and did not re-bounce in the two years after the drop. Furthermore to avoid identifying restructuring of the firm (such as outsourcing of larger parts) as a mass-layoff, we required that not more than 20 percent of the leaving workers were re-employed together at a single establishment in the following year (thus the leaving workers are either unemployed or dispersed over many different establishments). Similarly we defined a plant-closing as a drop in employment of at least 80 percent, again requiring that not more than 20 percent of the leaving workers were re-employed together in the following year.

The establishment history panel and the flow data provide information on the workforce of the establishments on June 30th of each year. We thus consider a mass-layoff as happening in 1982 if a plant loses 30 percent of its workforce between 1981 and 1982. We consider a worker as displaced in 1982 if he permanently left an establishment in 1982 and this establishment had a mass-layoff either in 1982 or 1983.

In order to get precise estimates we use a 20 percent random sample of all male workers in the German administrative data who we follow over the entire time period 1975 to 2009. In order to be in our main analysis sample of displaced workers and the control group, workers had to be continuously employed for at least 3 years at an establishment that was at risk of a mass-layoff. Furthermore we only selected male workers age 24 to 50 in the displacement year.

Yearly earnings were calculated as the sum of all wages during that year measured Euro and deflated to prices of 2000. For these calculations we only used workers who in a given

year had at least one observation (either because they were employed for at least one day or they received unemployment benefits