Displacement Effects in Manufacturing

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Abstract

We investigate the sources of wage losses from displacement in the manufacturing sector. Manufacturing establishments traditionally employed low- and high-wage workers in similar proportions and paid substantial wage premiums to both types of workers. Structural change has led to the disappearance of manufacturing jobs, particularly for low-wage workers. Decomposing displacement wage losses, we show that low-wage workers suffer particularly large losses in establishment premiums following displacement, whereas high-wage workers tend to fall down the match quality ladder. With ongoing structural change, losses in wages and establishment premiums have increased over time, especially for low-wage workers, in part because they are increasingly forced to switch to low-knowledge service jobs where establishment premiums are low.

Keywords: manufacturing decline, displaced workers, cost of job loss, human capital, firm rents

JEL Classification: J22, J24, J31, J63

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1. Introduction

Most industrialized countries have experienced substantial changes in the structure of employment over recent decades, marked by significant shifts of employment away from the manufacturing sector. In the US, the share of workers employed in manufacturing declined from around 20 percent in the early 1980s to less than 10 percent by 2010. Even Germany, the third-largest exporter of manufactured goods, has experienced a pronounced decline, though manufacturing continues to account for 20 percent of jobs in the country. Historically, the manufacturing sector has provided high-wage employment opportunities to both low- and high-skilled workers (see e.g., Gould, 2021). As manufacturing jobs have disappeared, workers have become increasingly more likely to be employed in the expanding service sector. The service sector, however, is much more segmented than the manufacturing sector. While low-knowledge service industries (e.g., retail and hospitality) are typically found at the lower end of the wage distribution, providing manual jobs where few skills are needed, high-knowledge service industries (e.g., software development, finance and insurance) are typically well-paid, abstract jobs that require higher levels of skill.

While part of the decline in manufacturing employment has been absorbed by fewer young workers entering than older workers retiring from the sector, a considerable share of prime-age workers have separated from manufacturing establishments in recent decades (11 percent per year over the 1988-2007 period).[1] More than half of these transitions out of manufacturing were into unemployment and thus likely involuntary. The decline in manufacturing will continue and might even accelerate as technological change continues. For example, the transition from the combustion engine to electric vehicles is predicted to put up to 400,000 manufacturing jobs in Germany at risk (Financial Times, 2020).

In this paper, we investigate the consequences of structural change for workers who are directly affected by it—that is, workers who have lost their manufacturing job. We address the following questions: have the costs of job loss increased over time as manufacturing jobs become scarcer? Given the segmentation of the expanding service sector, are costs of job loss higher for less-skilled workers? What are the sources of wage losses caused by displacement, and do they differ by worker type and change over time?

Our paper builds on the literature on the effects of job displacement, which has consistently found considerable losses in earnings and employment after involuntary layoffs (e.g., Topel, 1990, Ruhm 1990, Jacobson et al., 1993, Couch and Placzek, 2010). Much of the earlier

[1] Own calculations based on the Sample of Integrated Labour Market Biographies, 1975-2010.

literature emphasizes the importance of losses in acquired firm-, industry- or occupation-specific skills (e.g., Jacobson et al., 1993, Neal, 1995, or Poletaev and Robinson, 2008, Huckfeldt, 2021). Displaced workers' skills may also depreciate during a period of unemployment, leading to losses in general human capital, which is equally valued across jobs. In addition to these losses in specific and general human capital, displaced workers may lose valuable match-specific capital, since their search for a good match with a firm may need to start from scratch after displacement (e.g., Jacobson et al., 1993, Lachowska et al., 2020, Burdett et al., 2020, or Jarosch, 2021). The more recent literature, in turn, has focused on the importance of losses in wage premiums that firms or establishments pay to all their workers (e.g. Moore and Scott-Clayton, 2019, for the US; Schmieder et al., 2021, and Fackler et al., 2021, for Germany; and Bertheau et al., 2021, in a cross-country analysis). These establishment premiums may reflect differences in productivities (i.e., higher total surpluses) or rents (i.e., workers capture a higher share of the surplus) across establishments, either across or within industries. As such, establishment premiums partly reflect industry wage premiums (as discussed, for example, in Dickens and Katz, 1987, Krueger and Summers, 1988, Katz and Summers, 1989). Losses in establishment premiums following displacement, then, can be thought of as a fall down the "establishment premium ladder" as workers move up to higher-paying establishments with time in the labor market, either within or between industries. Structural change can amplify displacement losses in establishment premiums, general and specific human capital, as workers faced with a shrinking number of manufacturing jobs may be forced into the lower-paying service sector, may experience longer job searches and time out of work, and may be more likely to switch occupations.

We make three main contributions to the literature. First, we provide a parsimonious approach grounded in a statistical model of wage determination to disentangle displacement wage losses into their sources. We differentiate between general and occupation- and establishment-specific human capital losses on the one hand, and losses in establishment premiums and match quality on the other hand. We estimate the different components using extended regressions based on the Abowd, Kramarz and Margolis (AKM) model (Abowd et al., 1999).[2]

[2] Schmieder et al. (2020) and Gulyas and Pytka (2021) provide alternative approaches for disentangling displacement wage losses. An advantage of our approach is that it is grounded in a statistical model of wage determination, allowing us to formally decompose wage losses based on jointly estimated returns to specific human capital and establishment premiums.

Second, we provide a systematic analysis on how the magnitude and sources of displacement wage losses differ across worker types. While some papers have documented differences in earnings and wage losses by worker skill after displacement (e.g. Hijzen et al., 2010), they do not explicitly study the drivers behind these differences. Our findings here will not only offer novel insights into how job ladders—which may involve movement to better-paying establishments or to jobs that offer better matches—differ by worker type but will also help to reconcile seemingly contradictory findings in the recent literature regarding the size of losses in establishment premiums after displacement (compare for example Lachowska et al., 2020, and Schmieder et al., 2021).

Third, we investigate general time trends in the cost of job displacement and its sources in the manufacturing sector by worker type, and link these to structural change. By contrast, existing studies, including the recent work by Schmieder et al. (2020), have mostly focused on the evolution and drivers of displacement effects over the business cycle (see also Davis and von Wachter, 2011, and Farber, 2004, 2017, for the US). Our findings here will have important implications for two key trends in the labor market observed in many developed countries: job polarization (Autor and Dorn, 2013) and the rise in wage inequality, in particular the increased sorting of high-wage workers into high-wage firms (e.g., Card et al., 2013, Song et al., 2019). Our paper therefore connects the changing and heterogeneous costs of job displacement to these important trends in the labor market.

Specifically, we study trends in wage losses and their sources among workers displaced from the manufacturing sector over two decades between 1988 and 2007, with a particular focus on differences by worker type. We define displaced workers as workers who lost their job in a mass layoff, thus focusing on job losses that can be considered as exogenous from the viewpoint of the worker. Consistent with the existing literature on job displacement, our analysis is restricted to male workers, who make up over 70 percent of the manufacturing workforce, and have been hit particularly hard by the manufacturing decline.[3] Our empirical design combines matching with an event-study approach to flexibly compare the labor market careers of displaced workers with otherwise identical workers. We draw on four decades of administrative data from Germany that links information on workers with information on establishments, allowing us to observe an individual's job and occupational history for at least 15 years prior to a layoff.

[3] The existing literature almost exclusively studies the labor market outcomes of men. One exception is Illing et al. (2021) who compare the costs of displacement for men and women in the German context.

Our results show that a job loss in the manufacturing sector leads to a reduced likelihood of employment and strong and persistent wage losses of around 10 percent on average over the time period considered. Decomposing the displacement wage loss into its sources, we find that losses in establishment premiums are the most important source of displacement wage losses, accounting for around 50 percent of the overall wage loss. Losses in establishment- and occupation-specific human capital are similarly important in the short run, together explaining nearly 40 percent of the immediate wage loss. Their contribution, however, declines over time as displaced workers rebuild specific human capital and because returns to establishment and occupation tenure are concave. In contrast, the importance of missed opportunities for general human capital accumulation due to time away from work increases with time since displacement, representing about 20 percent of the wage loss six years after the layoff. Overall, losses in establishment premiums and human capital account for 95 percent of the overall wage loss from displacement immediately after the layoff and 83 percent after six years. We attribute the remaining residual wage loss to losses in valuable establishment-worker specific matches and provide confirmatory evidence by directly estimating match quality following the approach suggested in Lachowska et al. (2020) in an extension.

We further provide evidence that displaced manufacturing workers face particularly large losses in establishment premiums by comparing the displacement wage losses of manufacturing workers with those of workers displaced from the service sector. Strikingly, 75 percent of the larger establishment premium loss among displaced manufacturing workers can be explained by their transition to the (low-knowledge) service sector, where establishment premiums are considerably lower. The remainder of the loss is due to a fall down the establishment premium ladder within the manufacturing sector.

In a second step, we provide a comprehensive analysis of the consequences of job displacement by worker type. Here, we distinguish between low- and high-wage workers, defined as workers in the bottom and top terciles of the distribution of estimated worker fixed effects from the AKM model. We show that even though high-wage workers on average experience somewhat larger wage losses than low-wage workers, low-wage workers suffer a substantially larger loss in establishment premiums. Six years after the layoff, nearly 80 percent of the overall wage loss of low-wage workers can be attributed to declines in the establishment premium, compared to only 25 percent for high-wage workers. This finding indicates that low-wage workers have a harder time finding jobs in high-paying establishments after displacement. We show that movement out of the manufacturing sector—where establishment premiums are high—and into the low-knowledge service sector—where establishment premiums are

particularly low—are more common for low-wage workers. Such differences in post-displacement sectoral switching can account for more than 50 percent of the differential losses in establishment premiums by worker type. While the patterns and magnitudes of human capital losses are largely similar for both types of workers, losses in match quality are considerably more pronounced for high-wage workers.

Overall, these findings are consistent with the notion that over the life cycle low-wage workers predominantly move to better-paying establishments, while high-wage workers move to establishments that offer better matches, in line with the findings by Haltiwanger et al. (2018). The heterogeneous impacts across worker types help to reconcile somewhat contradictory findings in the recent literature regarding post-displacement establishment premium losses. The lower establishment premium losses and higher match quality losses estimated by Lachowska et al. (2020) compared to our findings (and those of other papers such as Schmieder et al., 2020, and Bertheau et al., 2021) are likely a result of the more high-skilled sample used in their analysis.

The considerable losses in establishment premiums that we uncover may be a consequence of structural change in the labor market that shifts workers away from the manufacturing sector into the service sector when manufacturing jobs disappear, with particularly severe consequences for low-wage workers. In the final part of the paper, we provide a systematic analysis on the evolution of the cost of job displacement from the manufacturing sector over time, separately for low- and high-wage workers, and link these to structural change. We find that the cost of job displacement has indeed substantially increased for low-wage workers, both in absolute terms and relative to high-wage workers. Not only are low-wage workers increasingly less likely to be re-employed after displacement, they also suffer increasingly large wage losses. Whereas low-wage workers laid off at the end of the 1980s experienced wage losses of less than 5 percent three years after displacement, losses increased to nearly 15 percent by the mid-2000s. In contrast, the wage losses of high-wage workers have remained roughly stable over the same period. Losses in the establishment premium are by far the most important driver behind these increasing displacement wage losses of low-wage workers, accounting for more than two thirds of the increase in their overall wage loss. Reduced opportunities to accumulate general human capital contribute an additional 17 percent, in line with the finding that low-wage workers are increasingly less likely to be employed after displacement. We rule out that these trends simply reflect changes in the composition of displaced workers. Rather, they are at least partially related to reduced job opportunities for low-wage workers in the high-paying manufacturing sector: low-wage workers are increasingly less likely to be re-employed

in manufacturing, and increasingly more likely to move to the low-paying low-knowledge service sector after displacement.

Overall, our findings suggest that the decline of manufacturing jobs and the rise of the service sector have hit low-wage workers much harder than high-wage workers. Not only has the share of high-wage workers in the manufacturing sector increased over time, but the rise of the high-knowledge service sector has provided new job opportunities for high-wage workers in establishments that pay relatively high wage premiums. Low-wage workers, in contrast, are increasingly forced to switch to low-knowledge service sector jobs following displacement, which are characterized by lower establishment premiums. Structural change has thus contributed to the rise in displacement wage losses experienced by low-wage workers over time.

As such, the decline in the manufacturing sector may be one driver of increasing wage inequality, and in particular of the increased sorting of high-wage workers to high-wage firms observed in Germany and other countries (e.g., Dustmann et al., 2009, Card et al., 2013, Song et al., 2019). Our findings further support the notion that the disappearance of manufacturing jobs due to structural change can partially explain the employment and wage polarization observed in many developed countries (e.g., Autor and Dorn, 2013, Goos et al., 2014), as proposed by Bárány and Siegel (2018, 2020). The empirical evidence provided in our paper extends this literature by emphasizing the role of establishment premiums for job polarization. Specifically, our findings suggest that the disappearance of jobs in the middle of the wage distribution reflects not only a shift from routine to manual and abstract tasks, as emphasized in the literature, but also a shift away from low-skilled but "good" manufacturing jobs with high establishment premiums to low-skilled service jobs with low establishment premiums.

2. Motivating Evidence

As in other developed countries, there has been a substantial drop in manufacturing employment in Germany over the last few decades. Whereas nearly 45 percent of male workers were employed in the manufacturing sector in 1975, this share had fallen below 35 percent by 2014 (Panel A of Figure 1). Meanwhile, employment in low-knowledge service sectors such as retail, lodging and hospitality or logistics, and high-knowledge service sectors such as software development, finance, insurance and advertising increased steadily over the same period.[4]

[4] We use the definitions provided in Grupp et al. (2000) to define the low- and high-knowledge service sectors.

To describe differences across sectors and by worker type in more detail, we estimate extended AKM regressions that include worker and establishment fixed effects (Abowd et al., 1999; see Section 4.2. for details). We think of the establishment fixed effect as the premium that establishments pay to all their employees, holding worker quality constant. We further differentiate between low- and high-wage workers, defined as workers who fall into the bottom and top third of the distribution of AKM worker fixed effects, respectively.

A remarkable picture emerges when exploring changes in the employment structure by worker type (Panel B of Figure 1). Over our estimation period, between 1988 and 2007, the decline in the share of manufacturing employment is considerably more pronounced for low-wage than high-wage workers (10 percentage points vs. 3 percentage points). Moreover, low-wage workers have become increasingly likely to be employed in the low-knowledge service sector, while high-wage workers are increasingly likely to work in high-knowledge service jobs.

As Table 1 highlights, jobs in the manufacturing sector differ crucially from jobs in either service sector in terms of the premiums that establishments pay to the same worker type.[5] Manufacturing jobs are characterized by exceptionally high establishment premiums: they are nearly 18 percent higher in the manufacturing sector than in the low-knowledge service sector, and nearly 4 percent higher than in the high-knowledge service sector (Panel A).

At the same time, the manufacturing sector has historically provided job opportunities for all types of workers (Panel B of Table 1). The average worker fixed effect is close to zero in this sector, indicating that manufacturing workers are neither negatively nor positively selected relative to the average worker in the economy. Similarly, the education distribution in the manufacturing sector closely resembles that of the economy as a whole. The low- and high-knowledge service sectors are, in contrast, characterized by a negative and positive selection of workers, respectively, both according to the worker fixed effect and education levels.

The three sectors also differ markedly in terms of task content (Panel C of Table 1). Here, we classify occupations as routine, manual, and abstract, drawing on the 1991/92 wave of the German BIBB/IAB Qualification and Career Survey, which considered 19 activities performed at work (see e.g., Battisti et al., 2021). Jobs in the manufacturing sector are characterized by a high share of routine tasks. In contrast, manual jobs are most common in the low-knowledge service sector, while tasks in high-knowledge service sector jobs are largely abstract.

The breakdown of the establishment premium by worker type in Panel A further points to a higher degree of sorting of high-wage workers into high-wage establishments in the service

[5] Establishment and worker fixed effects shown in Table 1 are demeaned such that their averages in the economy are zero.

sectors. The average establishment premium is only slightly higher among high-wage workers in the manufacturing sector, indicating that low- and high-wage workers are employed by similar types of establishments within the manufacturing sector. In contrast, there is a greater difference in the average establishment premiums between worker types in the low- and high-knowledge service sectors. Moreover, establishment premiums are less dispersed (i.e., the standard deviation is lower) in the manufacturing sector than in the two service sectors, particularly among low-wage workers.

While it is beyond the scope of this study to offer a full explanation of why establishment premiums are particularly high in the manufacturing sector, in Table 2 we consider two explanations: productivity differences (i.e., higher total job surplus in the manufacturing sector) and rent-sharing (i.e., workers capture a larger share of the total job surplus). In line with the latter explanation, union coverage rates—the share of workers covered by either sectoral or firm-specific union agreements—are higher in the manufacturing than in the low-knowledge service sector, but not dramatically so. Union coverage rates are lowest in the high-knowledge service sector, where workers are more likely to individually negotiate wages with their employers. Furthermore, work councils—workers' representation at the establishment level—are more common in manufacturing than in either service sector. In line with the productivity explanation, value added per worker appears to be highest in the high-knowledge service sector, followed by the manufacturing sector.

Overall, Table 2 suggests that the higher establishment premiums in the manufacturing sector relative to the low-knowledge service sector is due to a combination of better worker representation in the form of union coverage and work councils, as well as higher productivity. In contrast, the difference in the establishment premiums between the high- and low-knowledge service sector appears to be primarily a result of productivity differences.

3. Data and Sample Restrictions

3.1. Data

Our analysis uses data from German Social Security Records (the so-called *Beschäftigtenhistorik* (BEH)) spanning nearly four decades, from 1975 to 2014. These data include the population of workers and establishments covered by the social security system, comprising roughly 80 percent of the German workforce. Self-employed workers, civil servants, and military personnel are not included in the dataset. We know workers' main

employment relationships as of June 30 of each year, in addition to individual characteristics such as sex, age, education, and citizenship.

We restrict our analysis to West Germany, as this allows us to analyze how the wage effects of job displacement have evolved over time, and because East German workers are only consistently included in the data from 1992 onwards. We further exclude all irregular, marginal, and seasonal employment relationships. Since the definitions of occupations are only consistent until 2010, we discard observations after that year.

Unique establishment identifiers allow us to match individuals to the establishments where they work and to track workers over time across different establishments. These two features, combined with observing all workers covered by the social security system, make the data uniquely suited for our analysis. Our data not only enable us to identify mass layoffs, to trace out the evolution of employment and wages before and after the layoff, but also to estimate establishment and worker fixed effects in AKM-style wage regressions. Establishment identifiers and three-digit occupation codes further allow us to compute the number of years a worker has spent in a given establishment or occupation, and to investigate the role of losses in establishment or occupation tenure in accounting for displacement wage losses. Since we observe workers only once per year, on June 30, we compute establishment and occupation tenure in years.[6] We cap both types of tenure at ten years, since we do not observe workers' full employment history in the earlier data windows. Increasing the cap to 12 or even 15 years has little impact on our findings but does reduce the time window over which we can estimate displacement effects.

We distinguish three skill groups and use the imputation procedure by Fitzenberger et al. (2006) to impute missing observations in the original education variable. Low-skilled workers enter the labor market without post-secondary education, while medium-skilled workers completed an apprenticeship or graduated from high school (*Abitur*). Workers who graduated from college are classified as high-skilled.

The wage variable records the daily wage in the establishment at which the worker was employed as of the reference date, averaged over the entire period the employee worked for the establishment during that year. As is typical for social security data, our wage variable is right-censored at the social security limit. We impute censored wages under the assumption that the error term in the log-wage regression is normally distributed, and follow the procedure proposed

[6] If a worker is employed part-time on June 30, we assume that occupation and establishment tenure increase by half a year during that year.

by Card, Heining and Kline (2013). We deflate wages to 1995 prices using the consumer price index.

When investigating the employment effects of displacement, we consider both part- and full-time employment, and assign values of 0 for non-employment, 0.5 for part-time employment and 1 for full-time employment. In the absence of detailed information on hours worked, we focus on full-time employment when studying the wage effects of displacement.

3.2. Displacement Definition and Sample

Following the existing literature, we define a worker as displaced if he is separated from the establishment because of a mass layoff. Such separations are likely to be involuntary from the worker's point of view and not caused by his behavior. We define mass layoffs as events where at least 30 percent of workers are separated from the establishment from one year to the next, and establishment employment is depressed by 30 percent or more for at least two consecutive years. To ensure that we capture a true mass layoff and not merely a change in the establishment identifier or a spin-off, we follow Hethey and Schmieder (2010) by eliminating cases in which 30 percent or more of those leaving the mass layoff establishment go to a single other establishment. To further rule out breakups into multiple establishments, we require that not more than 70 percent of those leaving the mass layoff establishment go to the same three establishments. We further impose that mass layoff establishments must have between 30 and 500 employees in the year before the mass layoff event. The minimum size restriction is standard in the literature and makes it unlikely that large employment fluctuations due to general turnover are misclassified as a mass layoff. The maximum size restriction ensures that the mass layoff event does not affect the region more broadly, for example through spillover effects on other firms (see Gathmann et al., 2020).

To be able to compare our estimates with findings from the existing literature, we restrict our sample of displaced workers to male, prime-aged, high-tenure workers, as is common in the literature. Specifically, we require that workers are between 25 and 50 years old and were employed full-time at the mass layoff establishment for at least four years at displacement. Our sample excludes recalled workers, who were laid off but are observed again in the mass layoff firm within six years of the layoff.

We then construct two samples. In the "pooled" sample, we consider workers who were displaced from a manufacturing establishment between 1990 and 2004—84,268 laid-off workers in total. In this sample, we are able to follow workers for at least six years before and

after the layoff and to observe workers' establishment and occupation history for at least ten years before the first year of our event study period (six years before the mass layoff). We use the larger "time-series" sample to investigate whether displacement effects have changed over time, focusing on medium-term displacement effects three years after the mass layoff relative to our baseline period (four years prior to the mass layoff), allowing us to consider mass layoffs that occurred between 1988 and 2007—101,557 layoffs in total.

4. Estimating Displacement Wage Losses and their Sources

In this section, we first provide a statistical model of wage determination that allows us to illustrate the various reasons why wages may decline following job displacement (Section 4.1). We then propose an augmented version of the AKM model to estimate the different components that determine wages (Section 4.2). Finally, we outline our empirical strategy to estimate the cost of job loss and explain how we decompose displacement wage losses into its components (Section 4.3).

4.1 A Statistical Model of Wage Determination

Assume that wages are determined by the following relationship:

$$lnw_{it} = \underbrace{\alpha_i}_{\text{worker quality}} + \underbrace{\psi_{J(i,t)}}_{\text{establishment premium}} + \underbrace{f_{1i}(ActExp_{it})}_{\text{general HC}} + \underbrace{f_{2i}(OccT_{it})}_{\text{occ. tenure}} + \underbrace{f_{3i}(EstT_{it})}_{\text{est. tenure}} + \underbrace{m_{iJ(i,t)}}_{\text{match quality}} + \underbrace{\omega_t}_{\text{year effects}} + \underbrace{r_{it}}_{\text{residual component}} \quad (1)$$

Here, α_i denotes worker quality, which captures differences in worker productivity that are constant over time and across establishments, and $\psi_{J(i,t)}$ denotes establishment premiums, which capture the wage premiums that establishments pay to all their employees independent of worker quality, experience, occupation or establishment tenure. $ActExp_{it}$, $OccT_{it}$ and $EstT_{it}$ denote actual experience and occupation- and establishment-specific tenure, respectively, $m_{iJ(i,t)}$ denotes the quality of the match between the worker and the establishment, ω_t calendar year fixed effects, and r_{it} the residual component of wages. The wage equation allows for non-linear returns to actual experience and occupation- and establishment-specific tenure, which may vary across worker types.

The different components of wage determination also capture the potential sources of wage losses following job displacement and therefore determine the severity of wage losses. To illustrate this, consider a worker who has been displaced for exogenous reasons from the manufacturing sector and contrast their wage loss with the wage change experienced by a "twin" control worker with the same worker characteristics who was employed in an identical job prior to the layoff.

First, the displaced worker may face losses in establishment premiums (ψ_j). Such losses may be conceptualized as a fall down the "establishment premium ladder". Workers may move up from lower to higher-paying establishments with time in the labor market. Upon displacement, they are then forced to start searching for "good" establishments from scratch (e.g., Jarosch, 2021, and Burdett et al., 2020). The fall down the establishment premium ladder may occur either within the manufacturing sector or across sectors, as displaced workers may be forced to transition into the service sector, where establishment premiums are, in general, lower (see Table 1). As such, establishment premium losses may partly reflect losses in sectoral or industry wage premiums (as explored in Dickens and Katz, 1987, Krueger and Summers, 1988, Katz and Summers, 1989, among others), stemming from higher average productivity and rents in the manufacturing sector (see Table 2). Structural change may therefore amplify displacement losses in establishment premiums as fewer and fewer high-wage manufacturing jobs are available.

A second potential reason for displacement wage losses is reduced general human capital that is equally valued across establishments and sectors (e.g., Mincer, 1974). Displaced workers may not immediately find new employment after being laid off. Any time out of work means fewer opportunities for accumulating valuable general human capital and may lead to a depreciation of acquired skills. This factor may be particularly important for workers displaced from the manufacturing sector, since these workers may search longer for a new job after displacement in the hope of securing another high-wage manufacturing job.

Third, displaced workers may suffer wage losses relative to control workers because of losses in occupation-specific human capital (e.g., Kambourov and Manovskii, 2009, or Poletaev and Robinson, 2008). When displaced workers switch occupations, they are no longer rewarded for their acquired occupation-specific skills and need to start accumulating skills afresh in their new occupation. Any time out of work further prevents workers from accumulating such skills. A switch out of the manufacturing sector into the service sector may often involve a change in occupation, further amplifying the displacement wage loss over and above the loss in establishment wage premiums.

Fourth, displaced workers lose, by definition, any returns to establishment tenure, which capture any within-establishment wage growth over and above that attributable to general or occupation-specific human capital accumulation. One explanation for such within-establishment wage growth is the accumulation of establishment-specific human capital as proposed by Becker (1964); that is, skills that are valuable only in the particular establishment, such as specific knowledge about production processes or the organization. An alternative explanation relates to optimal contracts whereby establishments prefer to pay their employees initially below their marginal product followed by payments above the marginal product, as in Lazear (1979).

Fifth, displaced workers may lose match-specific capital—human capital that is specific to the worker-establishment match. Workers may be able to climb the "match quality ladder" with time in the labor market, improving the quality of the match as they voluntarily switch from one establishment to another. Upon displacement, displaced workers may have to search from scratch, resulting in a loss of match-specific capital (Lachowska et al., 2020).[7]

4.2 Augmented AKM Regressions

To estimate the different components of the model of wage determination presented above, we augment the AKM model first proposed by Abowd et al. (1999) by incorporating occupation- and establishment-specific human capital accumulation. Ideally, we would also like to flexibly control for actual experience ($ActExp_{it}$) in the augmented AKM regression. However, since returns to actual experience are generally less concave than returns to occupation or establishment tenure and may build up many years after labor market entry, directly estimating returns to actual experience would severely restrict the time window for studying displacement effects. We therefore opt to control for potential experience instead. Due to the perfect collinearity between potential experience and time and cohort effects (captured by the worker fixed effect in regression equation (2)), we adopt a two-step procedure. In a first step, we estimate returns to potential experience by regressing log wages on a cubic in potential experience, year fixed effects and establishment fixed effects.[8] We allow the returns to potential

[7] Krolikowski (2017) and Jung and Kuhn (2019) analyze movements down the job ladder following displacement. However, neither of the two studies explicitly distinguishes between firms and jobs, meaning that they cannot differentiate between movements down the firm premium or match quality ladder.

[8] Returns to potential experience are measured as age minus 16 for low-skilled workers, age minus 19 for medium-skilled workers and age minus 24 for high-skilled workers. If, by contrast, we assume that age profiles are flat at age 40 by omitting the linear age term and including a quadratic and cubic in (age-40), as in Card et al. (2018), estimated establishment premiums are strongly correlated with those obtained from our preferred specification.

experience to vary by worker type ($WType_i$) distinguishing between low-, medium- and high-wage workers. The initial classification of worker types is based on the terciles of worker fixed effects estimated in a standard AKM model that does not control for occupation and establishment tenure. We then compute log wages net of returns to potential experience $\ln(\widetilde{w}_{it})$ and estimate the following augmented AKM regression:

$$\ln(\widetilde{w}_{it}) = \alpha_i + \psi_{J(i,t)} + \sum_g \left(\gamma_{1g} OccT_{it} + \gamma_{2g} OccT_{it}^2 + \gamma_{3g} \mathbb{I}[OccT_{it} \geq 10]\right) \mathbb{I}[WType_i = g]$$

$$+ \sum_g \left(\delta_{1g} EstT_{it} + \delta_{2g} EstT_{it}^2 + \delta_{3g} \mathbb{I}[EstT_{it} \geq 10]\right) \mathbb{I}[WType_i = g]$$

$$+ \omega_t + \epsilon_{it} \qquad (2)$$

In equation (2), α_i denotes worker fixed effects, $\psi_{J(i,t)}$ represents establishment fixed effects and ω_t calendar year fixed effects. $OccT_{it}$ and $EstT_{it}$ measure an individual's (three-digit) occupation and establishment tenure, respectively. Both variables are capped at ten years of tenure, as explained in Section 3.1. We allow for a quadratic relationship between log wages and establishment and occupation tenure, as well as an additional effect if tenure is greater than ten years, to account for the capped nature of the two variables. We further allow the returns to occupation and establishment tenure to vary by worker type, $WType_i$, again distinguishing between low-, medium- and high-wage workers.

We estimate the augmented AKM regression for the years 1984 (i.e., the first year that we are able to observe a worker's employment history for at least ten years) to 2010 (i.e., the last year that includes consistent occupation codes), using spells of all West German men in full-time employment aged 16 to 65. Since a mass layoff may affect the premiums that establishments pay their employees, our sample excludes post-layoff wage observations of displacement establishments and displaced workers.

It should be noted that, unlike the conceptual wage regression given by equation (1), the estimated AKM wage regression given by equation (2) does not include a match-specific component. As is standard in the AKM literature, we assume that workers' mobility decisions are influenced by time-invariant unobserved worker heterogeneity α_i and establishment premiums $\psi_{J(i,t)}$ as well as potential experience, occupation and establishment tenure, and calendar time, but not by match quality. Thus, we assume that $\epsilon_{it} = m_{iJ(i,t)} + \varepsilon_{ijt}$, with neither $m_{iJ(i,t)}$ nor ε_{ijt} influencing mobility decisions.

It is well known that establishment and worker fixed effects estimated from an AKM regression suffer from "limited mobility bias", leading to an overestimate of the variance of establishment fixed effects and an underestimate of the covariance between worker and establishment fixed effects (e.g., Andrews et al., 2008, Bonhomme et al., 2019). Various correction methods have been proposed (e.g., Bonhomme et al., 2020, Kline et al., 2020). The long estimation window in our 27-year analysis should reduce concerns about limited mobility bias. Moreover, as we describe in greater detail in Section 4.3.3, we use the establishment premium as a dependent variable in our regressions when investigating the extent to which losses in the establishment premium account for wage losses following displacement. Hence, any remaining measurement error in the establishment premium should not systematically bias our estimates.

4.3 Empirical Strategy

Our empirical strategy combines matching with an event study approach to flexibly trace out labor market outcomes of displaced workers compared to a control group of matched non-displaced workers. We next outline our matching procedure, then explain our baseline estimation regression, and finally describe how we decompose overall displacement wage losses into their various components.

4.3.1 Matching

Table 3 shows that displaced workers differ from non-displaced workers in various ways. Four years prior to the mass layoff, the wages of displaced workers are 3 percent lower, have an AKM worker fixed effect that is 1.6 percent lower, are slightly more likely to be low-skilled, and are about 1.8 percentage points less likely to be high-skilled than randomly selected male, prime-aged, high-tenure workers in the manufacturing sector (compare columns (1), (3), and (5)).[9] Displaced workers also work in different industries within the manufacturing sector: they are over-represented in the consumer and investment goods sector and under-represented in the food and beverage and producer goods sector. Moreover, mass layoff establishments pay a slightly lower wage premium than the average establishment of a random non-displaced

[9] We impose the same restrictions on non-displaced workers as on displaced workers. Non-displaced workers are male, between 25 and 50 years of age, have worked full-time in the same manufacturing establishment for at least four years, and are employed in an establishment with at least 30 and no more than 500 employees.

worker. Consequently, displaced workers and their establishments appear to be somewhat negatively selected compared to a random sample of non-displaced workers.

To ensure that we compare displaced workers with their "statistical twins" —individuals who resemble displaced workers as much as possible prior to the layoff—we match a control worker with similar observed worker and establishment characteristics pre-layoff to each displaced worker. Our sample of potential control workers consists of all workers that fulfil the same sample restrictions as the displaced workers, but who are not displaced in a mass layoff in any of our sample periods (see Section 3.2).[10] We then apply coarsened exact matching (e.g. Iacus et al., 2012) and match on the following characteristics: wage vigintiles, age deciles, two-year bins of establishment and occupation tenure, skill groups (low-, medium- and high-skilled), citizenship (German or non-German), and the broad industry of the workplace (four broad industries in the manufacturing sector). We further match broadly on worker and establishment fixed effect terciles, as we define low- and high-wage workers according to these terciles. Our matching procedure creates a set of cells such that displaced and non-displaced workers have the exact same coarsened characteristics within each cell. For each displaced worker, we then randomly pick one non-displaced worker from the same cell as a control. If there are more displaced workers than non-displaced workers in a cell, we randomly drop displaced workers to ensure an equal number. Our matching procedure results in a balanced sample of displaced and matched non-displaced workers within each cell and effectively corresponds to one-to-one matching.

We match displaced and control workers four years before the mass layoff to allow for the possibility that the imminent job loss affects the wages of displaced workers even before the actual displacement (similar to Couch and Placzek, 2010). Such pre-displacement losses may, for example, reflect a decline in the establishment premium prior to displacement due to a negative productivity or demand shock in the establishment that ultimately leads to the layoff of a large share of its workforce. Alternatively, they may capture reduced investments into general or specific human capital by workers and establishments. A matching procedure that instead matches on characteristics one year before the mass layoff or conditions on pre-displacement wage trends, which is sometimes done in the literature, would understate the overall wage loss caused by displacement by failing to consider such pre-displacement losses.

Columns (1), (2), and (4) of Table 3 show that our matching procedure works well in eliminating differences between displaced and non-displaced workers. While the design of the

[10] Non-displaced control group workers are allowed to become non-employed or change employers in any period following the mass layoff event.

matching procedure forces displaced and matched non-displaced workers to be in the same skill group, broad sector, and have the same citizenship status (German or non-German), the matched displaced and non-displaced workers are also similar in terms of continuous characteristics like their pre-displacement wage, worker and establishment fixed effects, age, and establishment and occupation tenure.

4.3.2 Estimation Regression

Based on the sample of matched displaced and control workers, we then compare the labor market outcomes of displaced and matched non-displaced workers in the six years before and after displacement. Specifically, we estimate the following model

$$Y_{ic\tau t} = \alpha_i + \sum_{\tau=-6}^{6} \beta_\tau Displ_{i,t}^{\tau} + \theta_{c\tau} + \epsilon_{ic\tau t}, \quad (3)$$

where the subscript τ denotes the time period relative to the year of the mass layoff. While displacement occurs between $\tau = -1$ and $\tau = 0$, we refer to the mass layoff year as $\tau = 0$. $Y_{ic\tau t}$ is the outcome variable of interest, such as whether the individual is employed, the log wage, or the establishment premium of individual i in cell c in a given calendar year t and τ periods before or after job displacement. $Displ_{i,t}^{\tau}$ denotes indicator variables equal to 1 in period τ if the individual has been displaced in a mass layoff, and 0 otherwise. Note that t and τ differ in our case because job displacement occurs in multiple years.

In regression equation (3), we control for individual fixed effects α_i as well as for cell-by-period fixed effects $\theta_{c\tau}$.[11] The inclusion of cell-by-period fixed effects recreates the idea of estimating the effects of job displacement by first differencing the outcome of interest of paired displaced and non-displaced workers within each cell and event period, and then averaging these effects across all cells for each period. This ensures that we compare the outcomes for displaced and matched control workers from the same cell in each period relative to job displacement, thus accounting for selection into work after job displacement based on matched characteristics. Worker fixed effects ensure that we are able to account for within-individual changes in outcomes before and after displacement as well as any potential selection into work after job displacement based on time-invariant worker differences within cells. Since our cells are very narrowly defined and workers barely differ within cells, the inclusion of worker fixed

[11] Controlling for cell-by-period fixed effects is equivalent to controlling for cell-by-calendar year fixed effects, since cells are defined separately for each layoff year.

effects in addition to cell-by-period fixed effects has little impact on our estimates. We cluster standard errors by cell, thus allowing for an arbitrary correlation of error terms within cells over time.

The parameters of interest in regression equation (3) are β_τ, which measure the difference in the outcome of interest between displaced and matched non-displaced workers in period τ relative to the baseline period. Since we match on pre-displacement characteristics four years prior to the mass layoff, we set the baseline period to $\tau = -4$ and exclude $\beta_{-4} Displ_{i,t}^{-4}$ from the regression. The event-study specification further allows us to compare outcomes of displaced and non-displaced workers up to six years prior to displacement to assess whether displaced workers face a wage decline even before job displacement.

4.3.3 Decomposition of Displacement Wage Losses

To decompose overall displacement wage losses into their various components, we proceed as follows. First, to estimate the importance of losses in the establishment premium, we estimate regression equation (3) with the estimated establishment premium $\hat{\psi}_{J(i,t)}$ from the AKM wage regression (2) as the dependent variable.

Second, to investigate the role of losses in occupation and establishment tenure, we predict the returns to establishment and occupation tenure for our sample of displaced and non-displaced workers using the estimates $\hat{\gamma}_{1g}, \hat{\gamma}_{2g}$ and $\hat{\gamma}_{3g}$, as well as $\hat{\delta}_{1g}, \hat{\delta}_{2g}$ and $\hat{\delta}_{3g}$ from the AKM wage regression (2).[12] We then estimate equation (3) using predicted returns to establishment and occupation tenure as dependent variables. Importantly, as establishment premiums and returns to occupation and establishment tenure are pre-estimated, the order in which displacement wage losses from these three sources are computed does not matter.

Since our augmented AKM regression accounts for returns to potential experience but not actual experience, we cannot proceed accordingly to quantify the importance of losses in general human capital. Instead, we first compute residualized wages net of the establishment premium and returns to establishment- and occupation-specific human capital by deducting these returns from an individual's original log wage. We then estimate equation (3) with the residualized net log wage as dependent variable twice: once flexibly, controlling for years out

[12] We display returns to establishment and occupation tenure for low- and high-wage workers based on the AKM regression equation (2) in Appendix Figure A.1. Returns to establishment tenure tend to be low for both worker groups—about 3 percent for high-wage workers and 1 percent for low-wage workers after ten years with the same establishment. Returns to occupation tenure are larger and more concave, about 7.6 percent for high-wage workers and 4.5 percent for low-wage workers after ten years in the same occupation.

of work after job displacement by including dummy variables that indicate how many years an individual has been out of work since displacement and once without controlling for years out of work. We define the difference between the estimated effects of job displacement from these two regressions as the loss in returns to general experience following job displacement, which captures both reduced opportunities to accumulate new general skills and the depreciation of existing general skills.

Finally, we interpret the residual displacement wage loss that is not accounted for by losses in the establishment wage premium, returns to occupation- and establishment-specific tenure or actual experience as a loss in match quality. In Section 5.3, we provide alternative estimates of the loss in match quality by explicitly estimating match quality following the approach of Lachowska et al. (2020), who build on Woodcock (2015), and show that the loss in match quality is quantitatively similar to the residual displacement wage loss.

5. Displacement Effects and their Sources

We start by analyzing the employment and wage effects of job displacement and their sources in the pooled sample for workers who were displaced from the manufacturing sector between 1990 and 2004. We first present average effects for a typical displaced worker (Section 5.1) and then contrast the magnitude and sources of displacement effects for low- and high-wage workers (Section 5.2). In Section 6, we turn to changes in the effects of job displacement over time using our larger time series sample for workers who were displaced between 1988 and 2007.

5.1 Average Displacement Effects

5.1.1 Employment and Wage Effects

Employment Effects. In Panel A of Figure 2, we display the average employment effects of displacement in our sample. By construction, there are no differences in the probability of being employed between displaced workers and their matched counterparts in the four years prior to displacement. The employment probabilities of displaced and non-displaced workers are also virtually identical five and six years before the mass layoff, corroborating that our matching procedure works well. In line with the existing literature, employment effects at layoff are large and persistent. The employment probability of displaced workers decreases by close to 40 percentage points in the first year after the layoff and then slowly recovers. However, even six

years after displacement, displaced workers are still 13 percentage points less likely to be employed than non-displaced workers.

Wage Effects. Panel B of Figure 2 plots the average wage effects of displacement over time. The corresponding point estimates are reported in Table A.1, column (1). Workers displaced in mass layoffs face considerable and long-lasting wage losses: Wages of displaced workers start falling already three years before the actual displacement, amounting to a total pre-displacement wage loss of 2.7 percent.[13] Matching on workers' wages one year (instead of four years) prior to the layoff to select the control group would therefore understate the true displacement wage loss. The wages of displaced workers fall by another 7.5 percent to a total of 10.2 percent in the year of the layoff. There is hardly any recovery over the following years: even six years after the initial layoff, displaced workers' wages are 10 percent lower than those of non-displaced workers.

It should further be noted that there are no differences in wages between laid-off workers and the control group between six and four years prior to displacement, further confirming that our matching procedure removes potential differences between displaced and non-displaced workers.

5.1.2 Decomposition of Displacement Wage Losses

Which factors account for the large displacement wage losses? Do displaced workers suffer losses in establishment premiums? Or do wage losses reflect declines in general or specific human capital, or match quality? In this section, we decompose wage losses into their various components, as described in Section 4.3.3. The results are shown in Figure 2, where we present the absolute contribution of each component of wage loss in Panel A and the relative contribution to the overall wage effect in Panel B. Table A.1 reports the corresponding coefficient estimates.

[13] Wage losses prior to displacement may reflect a decline in establishment premiums in mass layoff establishments that is not picked up in our augmented AKM regression, since we estimate a single establishment premium for the whole period. Alternatively, reduced pre-layoff investment in human capital in mass layoff establishments could account for the pre-displacement wage losses. Such reduced investments are likewise not picked up in our augmented AKM regressions since we assign the same estimated returns to human capital independent of whether a layoff is imminent.

Establishment Premiums. In Panel A of Figure 3, we plot the change in displaced workers' establishment premiums relative to those of non-displaced control workers before and after the mass layoff. Losses in the establishment premium play a key role in accounting for the size of wage losses after displacement. At layoff, displaced workers face a sharp decline in the establishment premium of around 5 percent, which represents around 50 percent of the total wage loss following displacement (see Panel B). Like the wage loss, the loss in the establishment premium is highly persistent.

General and Specific Human Capital. Panel B of Figure 3 further shows that, in the short run, a considerable share of the overall displacement wage loss can be attributed to losses in returns to occupation and establishment tenure. One year after the layoff, losses in occupation- and establishment-specific skills result in a wage loss of about 2.8 and 1.4 percent, respectively, jointly accounting for about 40 percent of the overall wage effect. Due to their concave profiles and because displaced workers rebuild specific human capital, the effects of losses in establishment and occupation tenure become less important over time, contributing only around 5 percent each to the overall wage loss six years after the mass layoff.

While the importance of losses in specific skills declines with time since layoff, wage losses from the depreciation of general human capital accumulation instead build up over time. Six years after the mass layoff, wages of displaced workers have declined by about 1.9 percent due to missed human capital accumulation, contributing 20 percent to the overall wage loss.

Match Quality. Together, losses in establishment premiums and establishment-specific, occupation-specific and general human capital can account for 95 percent of the overall wage loss from job displacement one year after the layoff, and 83 percent after six years. We attribute the remaining "residual" wage loss after displacement to losses in valuable establishment-worker specific matches.

5.1.3 Losses in Establishment Premiums: Manufacturing versus Services

The decomposition exercise highlights that losses in establishment premiums are the most important contributor to the overall wage losses of displaced workers, whereas losses in specific skills play, at least in the medium run, only a relatively minor role. Why, then, do workers displaced from establishments in the manufacturing sector suffer such large establishment premium losses? As shown in Table 1, establishments in the manufacturing sector pay

considerably higher wage premiums than establishments in the service sector. As a consequence, workers displaced from the manufacturing sector are likely to suffer larger losses in establishment premiums than workers displaced from other sectors because they fall down from a higher rung of the establishment premium ladder and because they may be forced to move into the lower-paying service sector.

Panel A of Figure 4 shows that post-displacement transitions out of the manufacturing sector are indeed common. Conditional on being employed, nearly 30 percent of displaced manufacturing workers are re-employed in the service sector. Moreover, movements to the low-knowledge service sector, where establishment premiums are particularly low, are about twice as likely as transitions into the high-knowledge sector. Using the average (scaled) establishment premiums in the three sectors of 0.075, -0.108, and 0.038 (see Table 1), sectoral switching predicts a decline in the establishment premium of about 3.8 percent. Switching from the manufacturing to the service sector alone can therefore account for about 75 percent of the overall loss in establishment premiums. The remainder is due to a fall down the establishment premium ladder within the manufacturing sector.

In Panel B of Figure 4, we further demonstrate that displacement wage losses are indeed considerably larger in the manufacturing sector than in the service sector, as we would expect if manufacturing establishments paid higher premiums and sectoral switching after displacement is common. The differences in post-displacement wage losses across the two sectors are striking. Whereas workers displaced from the manufacturing sector face a wage loss of about 10 percent six years after the layoff, wages of laid-off workers in the service sector decline by only about half as much. This difference is almost entirely explained by larger losses in establishment premiums, which amount to about 5 percent in the manufacturing sector but are largely absent in the service sector.

5.2 Low- versus High-Wage Workers

Our results thus far highlight that, on average, losses in establishment premiums are the main contributor to the considerable wage losses experienced by workers displaced from manufacturing establishments, with losses in human capital and match quality playing a secondary role. Such average effects may, however, mask considerable heterogeneities in the magnitude of overall wage losses and their sources for different types of workers. In this section, we analyze the consequences of displacement separately by worker type, distinguishing

between low- and high-wage workers, defined as workers in the bottom and top terciles of the distribution of worker fixed effects in the population.[14]

5.2.1 Employment and Wage Effects by Worker Type

Employment Effects. Panel A of Figure 5 contrasts the employment effects of displacement for low- and high-wage workers. In the first year after the mass layoff, low-wage workers are considerably less likely to be re-employed than high-wage workers (-47 percentage points vs. -30 percentage points). This gap narrows with time since displacement: six years after the mass-layoff, low-wage displaced workers are 15 percentage points less likely to be employed, compared to 12 percentage points for high-wage workers.

Wage Losses. Panel B of Figure 5 plots the wage effects of displacement by worker type. High-wage workers suffer larger wage losses upon displacement than low-wage workers. Both worker types already experience wage losses prior to the actual layoff (2.4 percent for low-wage workers vs. 3.7 percent for high-wage workers), followed by a sharp decline in the year of the layoff to 9 and 12 percent total wage loss for low- and high-wage workers, respectively. While the post-displacement wages of low-wage workers recover somewhat over time, the wage losses of high-wage workers remain roughly constant at 12 percent.

5.2.2 Decomposition of Wage Losses by Worker Type

To investigate the sources of displacement wage losses by worker type, we decompose wage losses into losses in establishment premiums, general and specific human capital, and match quality, separately for low- and high-wage workers. We display the results in Figure 6, where we present the absolute contribution of each component of wage loss in Panel A and the relative contribution to the overall wage effect in Panel B. Tables A.3 and A.4 report the corresponding coefficient estimates for low- and high-wage workers, respectively.

[14] Table A.2 shows that our matching procedure successfully balances the individual and worker characteristics of displaced and non-displaced control workers for both low- and high-wage workers (compare columns (3) and (6)). The table also shows that high-wage workers are substantially more likely to be to be high-skilled (0.6 vs. 18.3 percent) and less likely to be low-skilled (30.3 vs. 2.6 percent) than low-wage workers (compare columns (1) and (4) of Table A.1). High-wage workers also work in establishments that pay somewhat higher establishment premiums.

Establishment Premiums. Figure 6 shows that displacement losses in establishment premiums differ starkly for low- and high-wage workers. Even though high-wage workers suffer higher overall wage losses upon displacement, low-wage workers experience a much sharper decline in establishment premiums. Whereas low-wage workers see a drop of 7 percent in establishment premiums six years after the layoff, establishment premiums decline by only around 3 percent for high-wage workers. As a consequence, losses in establishment premiums account for a considerably larger share of the overall displacement wage loss for low-wage workers (about 80 percent compared to 25 percent for high-wage workers), indicating that low-wage workers have a harder time finding another job in a "good" high-paying establishment after displacement.

The larger loss in the establishment premium for low-wage workers is even more remarkable in light of the findings that high-wage workers tend to be employed in higher-paying establishments (see Table 1), and workers displaced from higher-paying establishments experience larger wage losses (see Appendix Figure A.2). Indeed, when we apply reweighting to make the establishment premium distribution of low-wage workers resemble that of high-wage workers, losses in establishment premiums for low-wage workers increase (see Appendix Figure A.3).

Specific and General Human Capital. While losses in establishment premiums differ starkly for low- and high-wage workers, losses in establishment- and occupation-specific human capital are largely similar for both types of workers. Such losses are large initially, at 4.1 percent for low-wage workers and 4.6 percent for high-wage workers, thus contributing between 40 and 50 percent to the overall wage loss in the first year after the layoff. Six years after the layoff, however, losses in specific human capital play only a minor role, explaining less than 10 percent of the wage loss for both types of workers.

Losses from missed general human capital accumulation, in contrast, are initially low but increase over time for both worker types. Since low-wage workers have lower re-employment probabilities and thus spend more time out of work after displacement, losses in general human capital contribute a somewhat larger share to the overall wage loss for low-wage workers than for high-wage workers (30 vs. 15 percent six years after the layoff).

Match Quality. As in our initial analysis that pooled all worker types, we attribute the residual wage loss to losses in worker-establishment match quality. For low-wage workers, losses in establishment premiums, establishment- and occupation-specific human capital, and general

human capital more than explain the complete wage loss, indicating that low-wage workers do find jobs with similar (or even improved) match quality after the layoff. A different picture emerges for high-wage workers: losses in establishment premiums and human capital account for about 70 percent of the overall wage loss one year after the layoff and for around 50 percent after six years. Thus, a much larger share of the overall wage loss remains "unexplained", suggesting that losses in valuable establishment-worker matches may play a more important role for high-wage workers. We confirm this conjecture in Section 5.3, where we estimate match quality more directly following the approach suggested in Lachowska et al. (2020). The stark difference in the importance of establishment premiums and match quality losses between low- and high-wage workers suggests that the job ladder predominantly operates through movements to better-paying establishments for low-wage workers, while movements to establishments that offer better matches are more important for high-wage workers, in line with the findings in Haltiwanger et al. (2018).

Post-Displacement Sectoral Switching. A key takeaway from Figure 5 is that low-wage workers suffer larger losses in establishment premiums than high-wage workers and are therefore less able to find well-paying jobs again after displacement. Figure 7 shows that the larger losses are driven in part by low-wage workers being more likely to switch out of the declining manufacturing sector—where establishment premiums are high—and into the expanding low-knowledge service sector, where establishment premiums are particularly low. Six years after displacement, 32 percent of re-employed low-wage workers are no longer employed in manufacturing and 22 percent are employed in the low-knowledge service sector, compared to 28 and 14 percent for high-wage workers. Using the average establishment premiums in the three sectors, sectoral switching predicts a decline in the establishment premium of about 4.8 percent for low-wage workers and 2.7 percent for high-wage workers, compared to actual establishment premium losses of about 7 and 3 percent.[15] Thus, sectoral switching alone explains roughly half of the difference in the loss of the establishment premium between low- and high-wage workers.

Further note that sectoral switching accounts for a larger fraction of the overall loss in the establishment premium for high-wage workers (90 percent compared to 67 percent for low-wage workers). This finding suggests that low-wage workers fall further down the

[15] Average establishment premiums in the manufacturing, low-knowledge service, and high-knowledge service sectors are 0.053, -0.148 and 0.000 for low-wage workers and 0.098, -0.070 and 0.062 for high-wage workers, respectively (see Table 1).

establishment premium ladder than high-wage workers, even when they remain employed in the manufacturing sector after displacement.

5.3 Robustness and Extensions

Our main conclusions are robust to different ways of estimating establishment premiums and match quality, as well as to alternative definitions of displacement.

Establishment Premiums from a Standard AKM Regression. Table A.5, column (1.3), shows establishment premium losses when using the standard AKM establishment fixed effects, estimated without controls for establishment and occupation tenure. The estimated loss is somewhat larger than in our baseline estimates (Table A.5, column (1.2)). For example, six years after the layoff, losses in establishment premiums result in wage losses of 6.1 percent or 67 percent of the overall wage loss when using establishment fixed effects from the standard AKM regression, but these shrink to 5.0 percent or 54 percent of the overall wage loss when occupational and establishment tenure are included in the AKM regression. Thus, omitting controls for establishment and occupation tenure in AKM regressions appears to somewhat overstate the importance of establishment premiums in overall displacement wage losses.

Different Establishment Premiums by Worker Type. A key assumption behind the AKM model is that low- and high-wage workers are paid the same establishment premium. This assumption has been questioned by, for example, Bonhomme et al. (2019), since it does not allow for the possibility that high-wage workers are able to extract higher rents from the establishment than low-wage workers. Differential establishment premiums for low- and high-wage workers could, in principle, contribute to the larger estimated losses in establishment premiums for low-wage workers when these are constrained to be the same for the two types of workers. To rule out this possibility, we re-estimate the extended AKM model with establishment fixed effects allowed to vary by worker type. In Appendix Figure A.4, we show the decomposition of wage losses into their components using the estimates from this model. The losses in establishment premiums are very similar to those estimated in our baseline specification for both worker types. The smaller decline in establishment premiums following job displacement among high-wage workers is therefore not an artifact of restricting establishment premiums to be the same across worker types.

Match Quality. In our decompositions, we have interpreted the residual displacement wage loss not explained by losses in establishment premiums or losses in general and specific human capital as being due to valuable match quality. We now estimate match quality for each worker-establishment pair more directly, closely following Lachowska et al. (2020) and Woodcock (2015). In a nutshell, log-wages net of year effects, returns to potential experience, establishment and occupation tenure are averaged within worker-establishment matches and then regressed on establishment and worker fixed effects.[16] The residuals of this regression are then defined as match quality, capturing variation in (net) average worker-establishment wages after accounting for worker and establishment effects. This procedure continues to assume that match quality is orthogonal to worker and establishment fixed effects. It does, however, allow match quality to be correlated with potential experience, occupation, and establishment tenure.

We then assess the role of losses in match quality in accounting for the overall displacement wage loss by estimating regression equation (3) with estimated match effects as the dependent variable. Using this method, the loss in match quality results in a wage loss of around 2 percent, or 20 percent of the overall wage loss, six years after the layoff (Table A.1, column (7)). Both the magnitude and the pattern in the loss in match quality are similar to the residual displacement wage loss presented in Section 5.1.2 (compare to Table A.1, column (6)). We report separate results for low- and high-wage workers in Table A.3, column (7) and A.4, column (7). Whereas losses in match quality are negligible or even positive for low-wage workers, they amount to 3 percent (or 25 percent of the overall wage loss) for high-wage workers. These findings corroborate the notion that the job ladder operates along the match quality margin for high-wage workers and along the establishment premium margin for low-wage workers.

Displacement Effects due to Plant Closure. Since workers who separated from the establishment in a mass layoff event may differ from workers who continue to work in the establishment, we repeat our baseline analysis for the subset of workers who were displaced

[16] Log wages net of year effects, potential experience, occupation and establishment tenure are estimated in two steps. We first regress log wages on year fixed effects to obtain log wage residuals net of year effects (step 1). We then regress the residual log wages from step 1 on the square and cube of potential experience, the square of (capped) occupation and establishment tenure, indicator variables whether occupation and establishment tenure are capped at ten years, as well as a match-specific fixed effect. We then subtract predicted returns to potential experience and occupation and establishment tenure from individual residual log wages to obtain log wages net of year effects, potential experience, occupation and establishment tenure (step 2). Note that the linear terms of potential experience, occupation and establishment tenure are absorbed by the match-specific fixed effects.

because of an establishment closure as a final robustness check. Following Hethey and Schmieder (2010), we define establishment closures as events where at least 80 percent of the workforce separates from the establishment. Plant closures comprise around 58 percent of our pooled mass layoff sample. Wage losses (Table A.5, column (2.1)) and declines in establishment premiums (Table A.5, column (2.2)) are similar for plant closures and mass layoffs, indicating that there is little such selection.

5.4 Comparison to Other Studies

The finding that losses in establishment premiums are an important factor in explaining wage losses following job displacement is in line with several recent studies on job displacement. Schmieder et al. (2020) and Fackler et al. (2021) show in the German context that workers suffer considerable losses in establishment premiums upon displacement, amounting to about 50 percent of the overall wage loss. Similarly, Gulyas and Pytka (2021) find that the wage premiums paid by displacement firms are the most important predictor for earnings losses after displacement in Austria. Comparing displacement earnings and wage losses across six European countries, Bertheau et al. (2021) show that losses in firm premiums account for a significant share of wage losses in all six countries, ranging from 40 percent in Spain to 90 percent in Portugal.

However, our baseline findings appear to contrast those of Lachowska et al. (2020), who decompose wage losses into firm premiums and match quality in a sample of layoffs that occurred during the Great Recession in the US. They find that losses in employer premiums account for only 17 percent of the overall wage loss after displacement, with the majority explained by losses in the quality of worker-firm specific matches. These findings are broadly echoed by Moore and Scott-Clayton (2019), who conclude that on average 25 percent of displacement earnings losses in the U.S. can be attributed to losses in firm premiums.

Our analysis of the differences in the magnitude and sources of displacement wage losses worker types and sectors helps to reconcile these recent findings on the role of displacement losses in establishment premiums in the literature. The sample of displaced workers used in Lachowska et al. (2020) differs from ours in two important ways. First, only about 30 percent of the layoffs in their sample are from the manufacturing sector, where losses in establishment premiums are particularly pronounced. Indeed, Moore and Scott-Clayton (2019) report that losses in firm premiums account for close to 50 percent of displacement earnings losses if the

sample is restricted to workers laid off from manufacturing firms, a conclusion that is largely in line with our results. Second, high-wage workers are likely overrepresented in the sample used in Lachowska et al. (2020), since close to 40 percent of the layoffs they examine occurred in the high-skilled finance sector. Our results highlight that high-wage workers suffer larger losses in match quality than in establishment premiums, in line with their findings.

6. Trends in Displacement Effects over Time

Our findings thus far show that displaced low-wage workers suffer a larger decline in the establishment premium than high-wage workers, in part because they are less likely to remain employed in the manufacturing sector where establishment premiums are high and more likely to move to the low-knowledge service sector where establishment premiums are low. Have such transitions out of the manufacturing sector following job displacement become more common over time as employment opportunities in the manufacturing sector dwindle? And has structural change resulted in larger displacement wage losses, in particular for low-wage workers? To address these questions, we investigate how the cost of job displacement has changed over time by splitting our time series sample into ten two-year periods, starting with the 1988-1989 and ending with the 2006-2007 period, and estimate equation (3) for each two-year period and separately for low- and high-wage workers. We then compare employment effects, wage effects, and the sources of wage losses three years after the mass layoff across time.

Baseline Results. Figure 8 shows that the cost of displacement from the manufacturing sector has indeed increased over time, particularly for low-wage workers. Low-wage workers are increasingly less likely to be re-employed three years after the mass layoff, both in absolute terms and relative to high-wage workers (Panel A). While there is a clear cyclical component in the probability of re-employment, the linear trend lines indicate that the likelihood of working three years after the mass layoff drops by around 12 percentage points (from 13 to 25 percentage points) from the late 1980s to the mid-2000s, compared to a 3 percentage point reduction for high-wage workers.

Not only are low-wage workers increasingly less likely to be re-employed after displacement, they also face increasing wage losses, both in absolute terms and relative to high-wage workers (Panel B of Figure 8). Whereas the wage losses of high-wage workers have remained largely stable over time, at about 10 to 12 percent three years after displacement, the

wage losses of low-wage workers increased from about 4 percent in the mid-1980s to 14 percent by the mid-2000s.[17]

Sources of Displacement Wage Losses over Time. Which factors explain the increasing post-displacement wage losses among low-wage workers, both in absolute terms and relative to high-wage workers? Panel C of Figure 8 shows that losses in establishment premiums play a key role. The figure displays losses in the establishment premium three years after displacement separately for low- and high-wage workers. According to the linear trend line, low-wage workers displaced from manufacturing establishments in the late 1980s suffered a decline in the establishment premium of only 3 percent, whereas in the mid-2000s, the reduction in the establishment premium exceeds 10 percent. In contrast, losses in the establishment premium increased only slightly for high-wage workers during that period, from about 2 to 3 percent.

We provide a more detailed analysis of the changing sources of displacement wage losses in Figure 9. In Panels A.1 and B.1, we show absolute wage losses over time due to losses in establishment premiums, losses in general and specific human capital, and losses in match quality (i.e., the residual component) by worker type. In Panels A.2 and B.2 of the figure, we instead display the change in the overall displacement wage loss between the first two and last two 2-year periods as well as the changes in wage losses due to each of the five factors that we consider. Among low-wage workers (Panel A), losses in the establishment premium are by far the most important driver behind the increasing displacement losses over time, and account for more than two thirds of the increase in the overall wage loss. Missed opportunities for general human capital accumulation account for an additional 17 percent, in line with our finding that low-wage workers are increasingly less likely to be employed after a mass layoff. In contrast, changes in the returns to occupation and establishment tenure play only a minor role, indicating that there are no changes in the frequency with which displaced workers change occupations or establishments after displacement.

The much smaller increase in the wage losses of high-wage workers can likewise be primarily attributed to losses in establishment premiums and general human capital.

Sector Switching over Time. Why do low-wage workers experience increasingly large losses in the establishment premium after displacement? Has the decline in job opportunities for low-wage manufacturing workers contributed to these increasing establishment losses? We report

[17] While our focus is on trends in displacement wage losses, Panel B of Figure 9 further shows that wages losses appear to be larger in recessions, in line with the findings of Schmieder et al. (2020).

evidence in line with this explanation in Figure 10. While there is a strong cyclical component in the propensity to switch sectors after displacement, especially among low-wage workers, the latter are increasingly less likely to remain employed in the manufacturing sector and increasingly more likely to be re-employed in the low-knowledge service sector after displacement. The share of displaced low-wage workers who transitioned out of manufacturing increased from about 25 percent in the 1988-1989 period to about 37 percent in the 2006-2007 period. In turn, the share of low-wage workers who moved into the low-knowledge service sector increased by about 11 percentage points over that period, from 15 to about 26 percent. In contrast, the sectoral switching patterns of high-wage workers have remained largely constant over time. A simple back-of-the-envelope calculation using worker-specific average establishment premiums in the three sectors suggests that changes in sectoral switching can account for close to 40 percent of the absolute increase in the establishment premium loss over time for low-wage workers, and about 45 percent of the increase relative to high-wage workers.[18] Changes in sectoral switching have thus significantly contributed to increases in the establishment premium losses after displacement. Yet, low-wage workers appear to also be increasingly falling down the establishment premium ladder over time even when they remain employed in the manufacturing sector.

Compositional Changes of Displaced Workers and Displacement Establishments. The increasing wage losses and losses in establishment premiums among low-wage workers after displacement could, in principle, simply reflect changes in the composition of displaced workers or displacing establishments. That is, even among low-wage workers, displaced workers may become increasingly negatively selected as regards to their worker fixed effect; similarly, high-wage establishments may make up an increasingly large share of mass layoff establishments over time. Such shifts would result in larger losses in establishment premiums over time.

To assess the importance of such compositional changes, we categorize workers and establishments by the decile of their respective fixed effects distribution, resulting in a 10 x 10 matrix of cells. We then re-estimate our baseline regression for each two-year period, but we use the ratio between the number of displaced workers in a given worker-establishment cell in the initial 1988-1989 period and the number of workers in that cell in later periods as weights for later periods. This way, the re-weighted sample of displaced and control workers in later

[18] Average establishment premiums in the manufacturing, low-knowledge service, and high-knowledge service sectors are 0.053, -0.148 and 0.000 for low-wage workers, respectively (see Table 1).

periods resembles the sample in the first period in terms of the distribution of worker and establishment fixed effects. We thus hold constant the composition of displaced workers and mass layoff establishments and their controls over time.[19]

The results in Figure 11 demonstrate that the increasing wage losses over time are not driven by compositional changes. The solid lines in Panels A and B depict our baseline estimates for the losses in wages and establishment premiums for low-wage workers (as in Panels B and C of Figure 8), while the short-dashed lines display re-weighted losses that hold the composition of displaced workers and mass layoff establishments constant over time. Both wage losses and losses in the establishment premium would actually have been slightly larger if the composition of displaced workers and displacement establishments had remained constant over time. The increasingly large establishment premium losses therefore reflect lower establishment premiums of post-displacement establishments over time, and not higher establishment premiums of displacement establishments.

7. Conclusion

In this paper, we provide novel evidence on the consequences of structural change in employment away from manufacturing and towards the service sector. To this end, we focus on manufacturing workers who lose their jobs due to a mass layoff. We present two main sets of results. First, we show that the sources of wage loss are markedly different for low- and high-wage workers. Most importantly, displaced low-wage workers suffer substantially larger losses in establishment premiums, which is in part explained by a higher propensity of low-wage workers to move out of the manufacturing sector (where establishment premiums are high) and into the low-knowledge service sector (where establishment premiums are low). For high-wage workers, in contrast, declines in worker-establishment match quality are an important driver of overall wage losses. These findings are consistent with the notion that movements up the job ladder predominantly operate through improvements in match quality for high-wage workers, but through improvements in establishment quality or rents for low-wage workers.

Second, we document that the considerable losses in establishment premiums that we uncover are, at least in part, the result of structural change in the labor market that shifts workers

[19] Schmieder et al. (2020) propose an alternative method to account for composition changes, which in their context occur over the business cycle. They first obtain a measure of the "treatment effect" of job loss for each individual. To assess the importance of compositional changes over the business cycle, they then regress individual treatment effects on the national unemployment rate (their key parameter of interest) with and without controls for individual and establishment characteristics.

away from the manufacturing sector into the service sector, with particularly severe consequences for low-wage workers. For low-wage workers, the cost of job displacement has dramatically increased over time, both in absolute terms and relative to high-wage workers. Not only are low-wage workers increasingly less likely to be re-employed after displacement, they also suffer increasingly larger wage losses. This increase in wage losses is driven to a large extent by greater declines in establishment premiums over time, which partially reflect increases in sectoral switching: low-wage workers are increasingly less likely to remain employed in the manufacturing sector and increasingly more likely to move to the low-paying low-knowledge service sector after displacement. These findings underscore the increasing difficulty encountered by low-wage workers in securing employment in establishments that pay equally high wage premiums as their pre-displacement establishments, in part because of dwindling employment opportunities in the manufacturing sector.

Overall, our findings demonstrate that the decline of the manufacturing and rise of the service sector has had particularly serious repercussions for low-wage workers. As such, our findings are consistent with the idea that structural change may be one driver behind the increased sorting of high-wage workers to high-wage firms and the increased job polarization observed in several developed countries (Autor and Dorn, 2013, Card et al., 2013, Goos et al., 2014, Song et al., 2019). While the polarization literature has thus far emphasized the importance of tasks, our results point to the importance of firms. Specifically, our findings are consistent with the notion that the disappearance of jobs in the middle of the wage distribution is a consequence of the decline of the manufacturing sector, which has historically provided "good" jobs characterized by high establishment premiums for both high- and low-skilled workers.

Currently, one of the most important active labor market policy tools to cushion the adverse effects of structural change are training and retraining programs that are, in part, designed to equip workers with specific skills required in the service sector. Germany, for example, spent EUR 11.2 billion in 2019 on such active labor market policies (Weber et al., 2020). Our finding, however, imply that training programs are not sufficient to buffer the effects of structural change, especially for less skilled workers, as lost establishment premiums account for a considerably larger share of the overall displacement wage loss than losses in specific skills three years after displacement.

Recognizing that the manufacturing sector generally provides high-paying jobs for less skilled workers, and that such jobs are becoming rarer, some policymakers have pushed to bring back manufacturing jobs, for example through industrial policy. It is unclear, however, whether

such policies can be successful or are even desirable. The challenge is thus to turn low-wage jobs, especially in the low-knowledge service sector, into higher-paying jobs. While minimum wage legislation and policies that strengthen unions and work councils, as currently discussed in several countries such as the US and Germany, are likely to play an important role, fostering productivity growth in the low-knowledge service sector is also important.

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Figures and Tables

Table 1: Establishment Premium and Worker Quality by Sector

	Manufacturing	Service Sector	
		Low-knowledge	High-knowledge
Panel A: Establishment Premium			
All Workers	0.077	-0.109	0.034
	(0.139)	(0.210)	(0.191)
Low-wage Workers	0.052	-0.151	-0.008
	(0.139)	(0.226)	(0.201)
High-wage Workers	0.101	-0.068	0.060
	(0.140)	(0.202)	(0.187)
Panel B: Worker Quality			
Worker Fixed Effect	0.002	-0.024	0.085
	(0.165)	(0.180)	(0.223)
Skill Groups			
Low Skilled	0.181	0.171	0.072
	(0.385)	(0.377)	(0.259)
Medium Skilled	0.719	0.742	0.653
	(0.450)	(0.438)	(0.476)
High Skilled	0.100	0.087	0.275
	(0.300)	(0.282)	(0.447)
Panel C: Task Usage			
Routine Tasks	0.478	0.322	0.234
	(0.247)	(0.207)	(0.165)
Manual Tasks	0.208	0.307	0.166
	(0.174)	(0.272)	(0.211)
Abstract Tasks	0.314	0.371	0.600
	(0.282)	(0.277)	(0.264)

Notes: The table shows means and standard deviations of establishment premiums (Panel A), worker quality (Panel B) and task usage (Panel C) by sector for full-time male workers in West Germany over the period 1988 to 2007. Establishment premiums and worker quality correspond to the establishment and worker fixed effects estimated in an AKM-style wage regression (see equation (2) in Section 4.2). Both establishment and worker fixed effects are demeaned by the average fixed effect in the economy. Low-skilled individuals are those without a high school (*Abitur*) or vocational degree, medium-skilled are those with a high school or vocational degree, and high-skilled are those with a college or university degree.

Table 2: Establishment Characteristics by Sector

	Manufacturing	Service Sector	
		Low-knowledge	High-knowledge
Union Coverage	0.798	0.752	0.608
Presence of a Works Council	0.741	0.508	0.529
Value Added per Worker	78,967	71,407	81,472

Notes: The table reports average union coverage rates, work council presence and value added by sector for West German firms over the period 1995-2007. Data are drawn from the German IAB Establishment Panel, and averages are weighted using survey weights multiplied by the number of male workers in the firm, to make results representative for male workers. Union coverage refers to either a firm- or industry-wide collective bargaining agreement. Value added is calculated as revenues minus intermediate inputs in EUR.

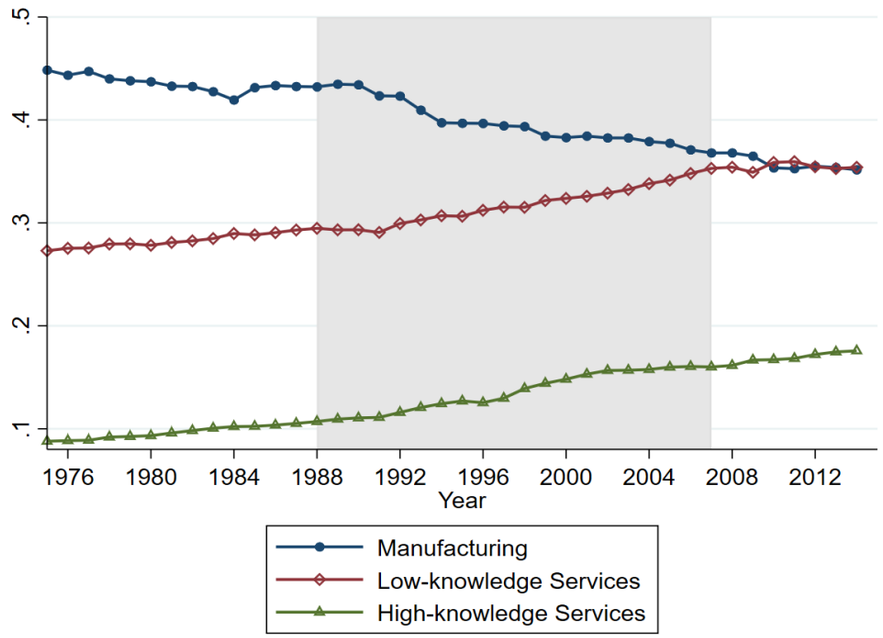
Table 3: Displaced vs. Matched and Random Control Workers

	Displaced Workers (Treatment)	Non-Displaced (Matched Control)	Non-Displaced (Random Control)	Treatment vs. Matched Control	Treatment vs. Random Control
	(1)	(2)	(3)	(4)	(5)
Panel A: Worker Characteristics					
Real Wage (Ln)	4.418	4.419	4.446	-0.001	-0.030***
Worker Fixed Effect	-0.014	-0.011	0.001	-0.003***	-0.016***
Establishment Tenure	7.510	7.481	7.501	0.029	-0.057***
Occupation Tenure	7.902	7.872	7.743	0.029	0.119***
Age	35.64	35.63	35.43	0.013	0.153***
Low Skilled	0.170	0.170	0.165	0.000	0.005***
Medium Skilled	0.777	0.777	0.765	0.000	0.013***
High Skilled	0.053	0.053	0.070	0.000	-0.018***
Non-German	0.121	0.121	0.110	0.000	0.011***
Panel B: Establishment Characteristics					
Establishment Premium	0.005	0.003	-0.000	0.002***	0.005***
Sector:					
Food and Beverage	0.068	0.068	0.082	0.000	-0.014***
Consumer Goods	0.180	0.180	0.163	0.000	0.017***
Producer Goods	0.221	0.221	0.260	0.000	-0.040***
Investment Goods	0.531	0.531	0.495	0.000	0.037***
N	101,557	101,557	1,765,140	203,114	1,873,507

Notes: Columns (1) to (3) of the table reports summary statistics for male workers displaced from the manufacturing sector between 1988 and 2007 as well as matched and random control workers. Columns (4) displays differences in characteristics between displaced and matched control workers, and column (5) differences between displaced and random control workers, respectively. Wages are (log) average daily wages in EUR adjusted to 1995 prices. Establishment premiums and worker fixed effects are demeaned to have zero mean over the sample period (see equation (2) in Section 4.2). Tenure variables are reported in years and are capped at ten years. The random control group represents a 10 percent random sample of manufacturing workers. Both displaced and control workers are males aged 25-50 with at least four years establishment tenure and employed in establishments with at least 30 and a maximum of 500 employees in West Germany. Levels of significance are * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

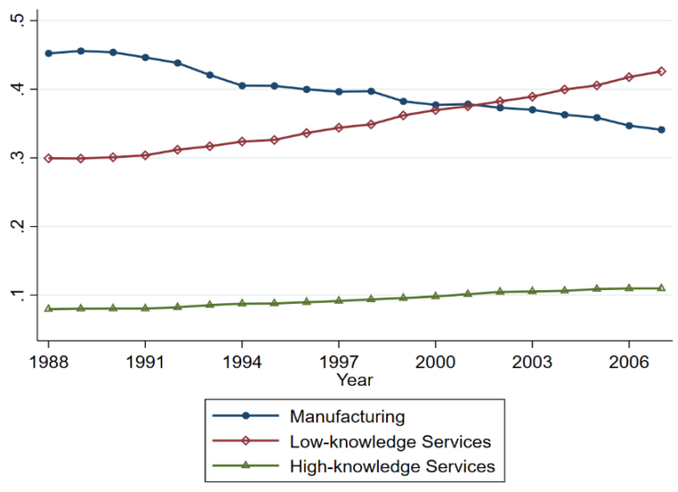
Figure 1: Employment Shares by Sector

Panel A: All Workers

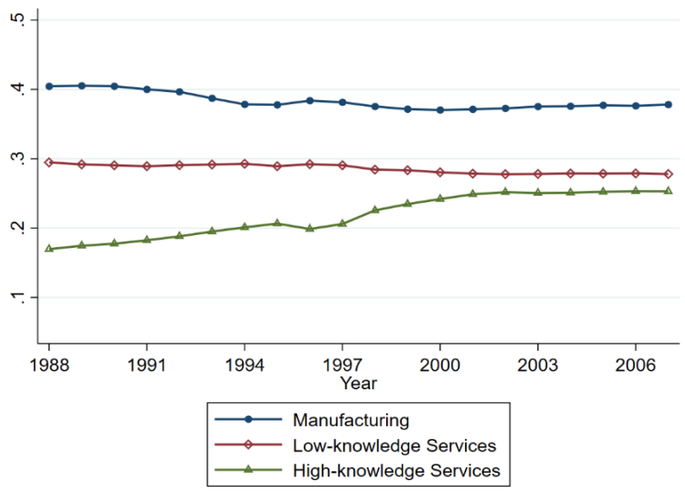


Panel B: By Worker Type

B.1: Low-wage Workers



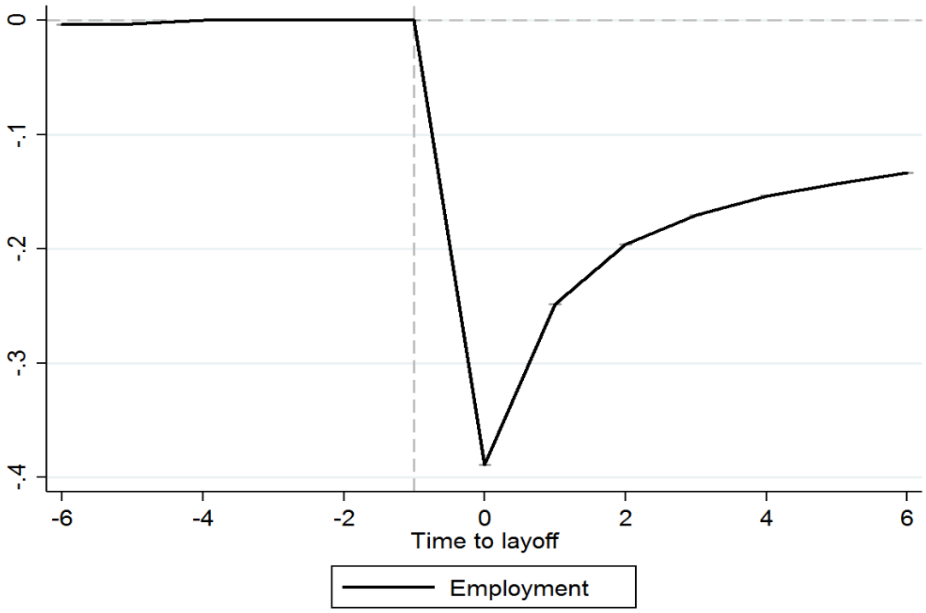
B.2: High-wage Workers



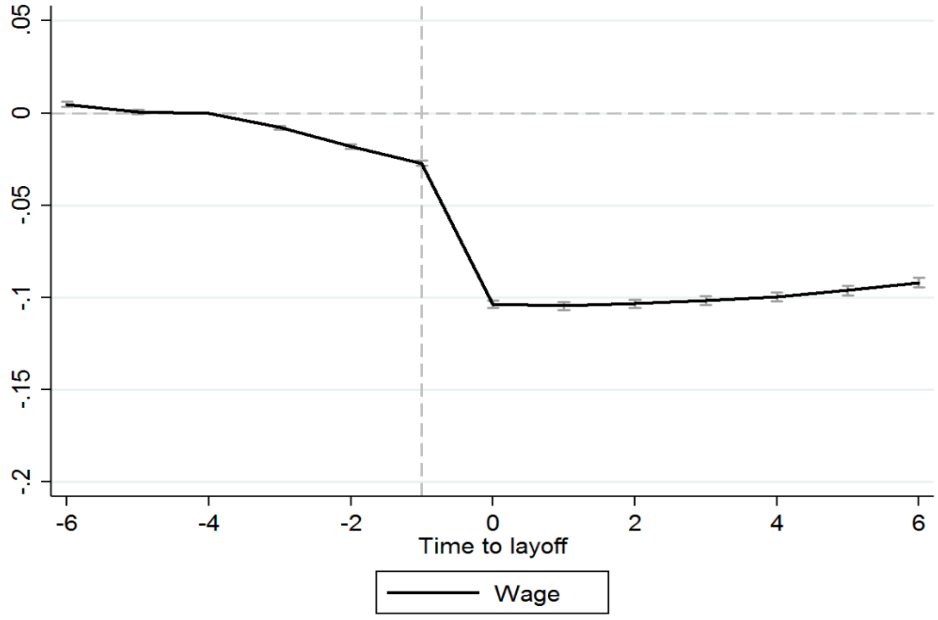
Notes: The figure shows the evolution of employment shares of the manufacturing, the low-knowledge and the high-knowledge sector for male workers in West Germany in Panel A, and by worker type in Panel B. Low-wage workers are defined as workers whose worker fixed effect falls into the bottom tercile and high-wage workers as workers whose worker fixed effects fall into the top tercile of the distribution of worker fixed effects.

Figure 2: Employment and Wage Effects of Job Displacement

Panel A: Employment Losses



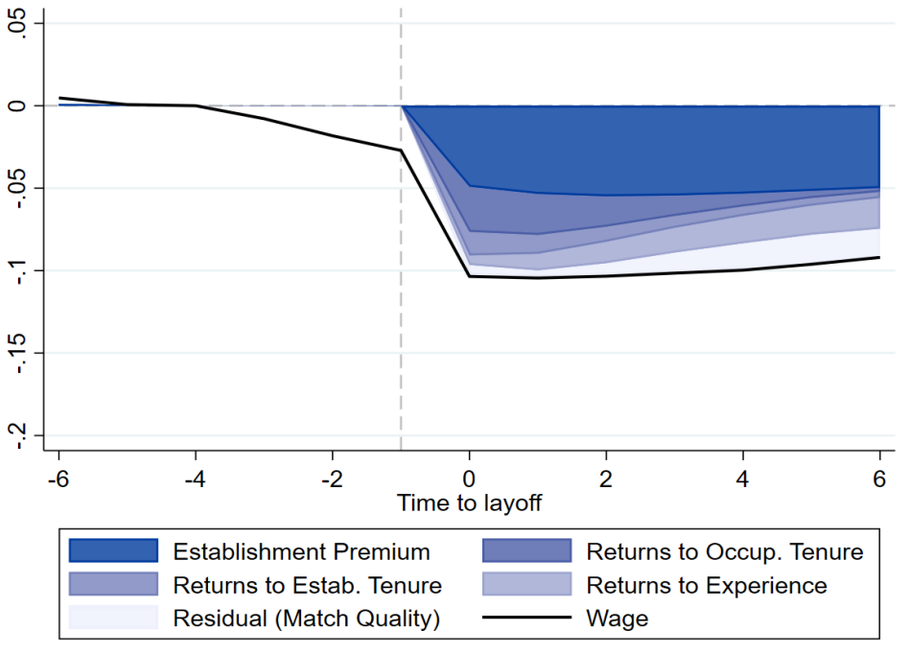
Panel B: Wage Losses



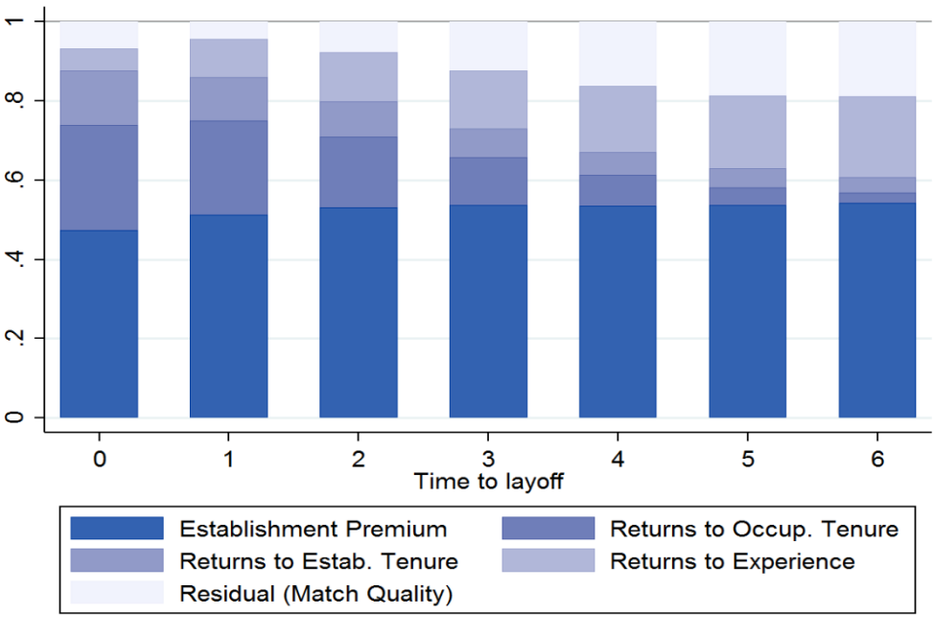
Notes: The figure reports event study estimates of the effects of job displacement on the probability of being employed in Panel A and on wages (conditional on employment) in Panel B. Estimates are based on equation (3). The sample consists of male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff. The horizontal bars show 95 percent confidence intervals clustered at the individual level.

Figure 3: Decomposition of Wage Losses

Panel A: Sources of Wage Losses



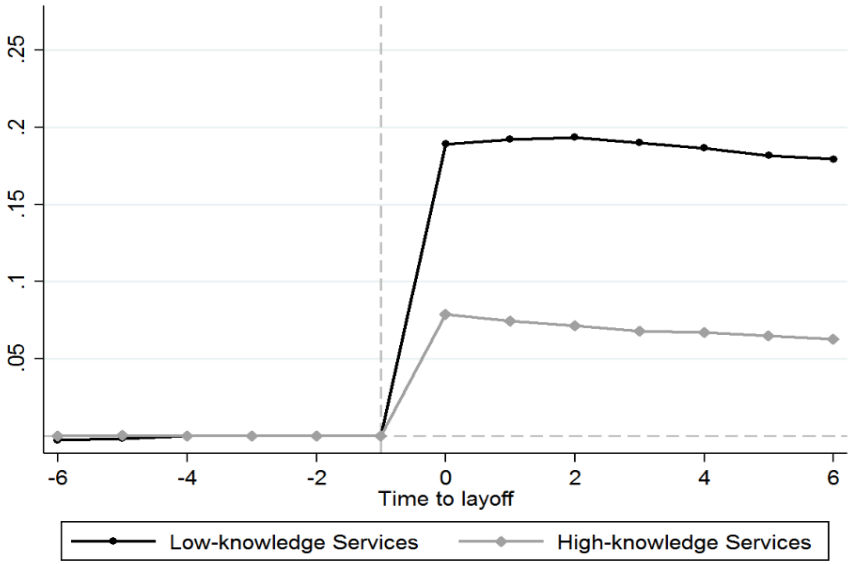
Panel B: Sources of Wage Losses as Share of Total Wage Losses



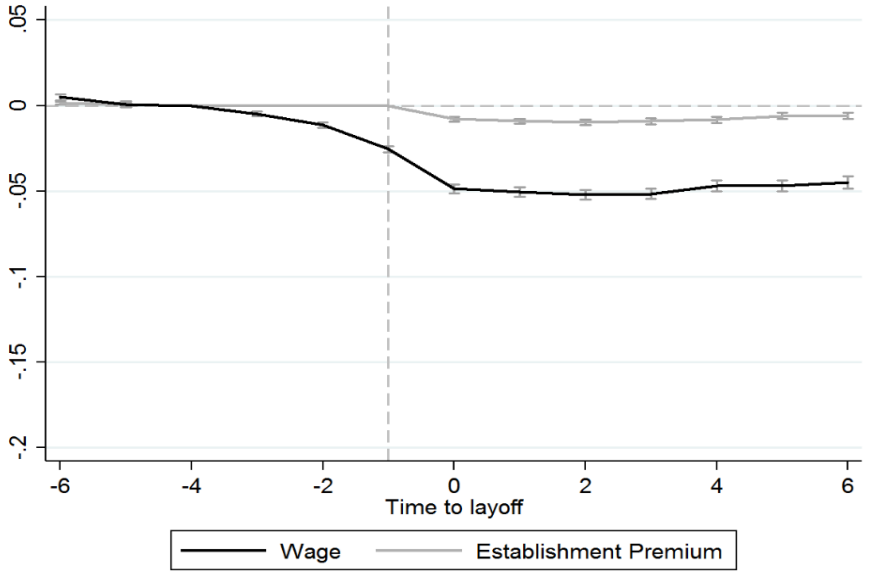
Notes: Panel A reports event study estimates of the effects of job displacement on wages, and on five potential sources of wage losses: the establishment premium, returns to establishment and occupation tenure, returns to experience and match quality. Panel B shows the contribution of each of these sources to the total wage loss. Estimates are based on equation (3), with the respective source as dependent variable. The establishment premium refers to the establishment fixed effect as estimated in an AKM-style regression; see equation (2) in Section 4.2. The returns to establishment and occupation tenure are predicted using the respective estimates from equation (2) and a worker's observed years of tenure. Tenure variables are capped at ten years of tenure. Losses in the returns to experience are estimated as described in Section 4.3.3. Losses in match quality are defined as the residual wage loss. The sample consists of male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff.

Figure 4: Manufacturing vs. Service Sector

Panel A: Probability of Re-employment in Service Sector



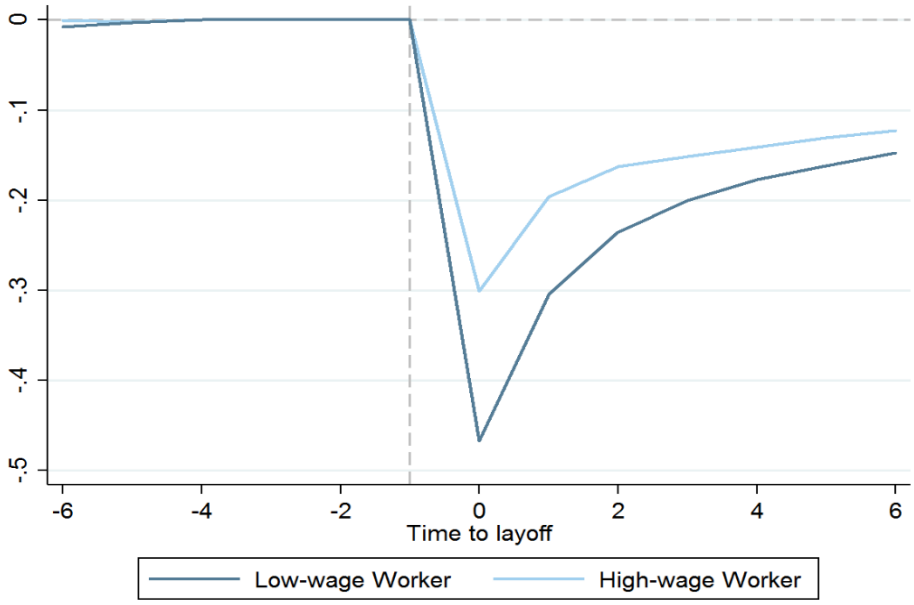
Panel B: Displacement Losses in the Service Sector



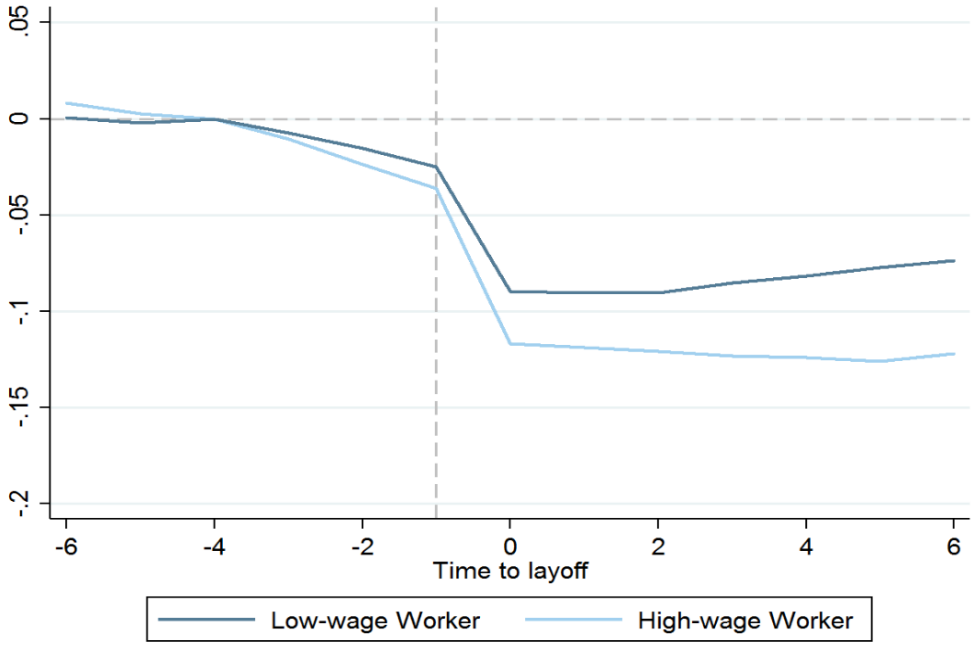
Notes: Panel A reports event study estimates of the likelihood of being re-employed in the low- and high-knowledge service sector after displacement from the manufacturing sector (conditional on employment). Panel B reports event-study estimates of the effects of job displacement on wages and the establishment premium for workers displaced from the service sector. Estimates are based on equation (3). The establishment wage premium refers to the AKM establishment fixed effect as estimated in equation (2) in Section 4.2. The sample consists of male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff. The horizontal bars show 95 percent confidence intervals clustered at the individual level.

Figure 5: The Effects of Job Displacement by Worker Type

Panel A: Employment Losses



Panel B: Wage Losses

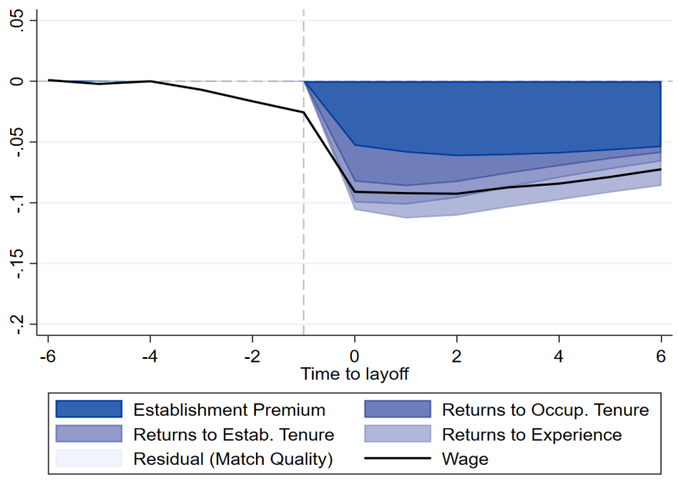


Notes: The figure reports event study estimates of the effects of job displacement by worker type on the probability of being employed in Panel A and on wages conditional on employment in Panel B. Estimates are based on equation (3). Low-wage and high-wage workers are defined as workers with worker fixed effects in the bottom and top terciles of the estimated AKM worker fixed effects distribution, respectively; see equation (2) and Section 4.2. The sample consists of low- and high-wage male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff. The horizontal bars show 95 percent confidence intervals clustered at the individual level.

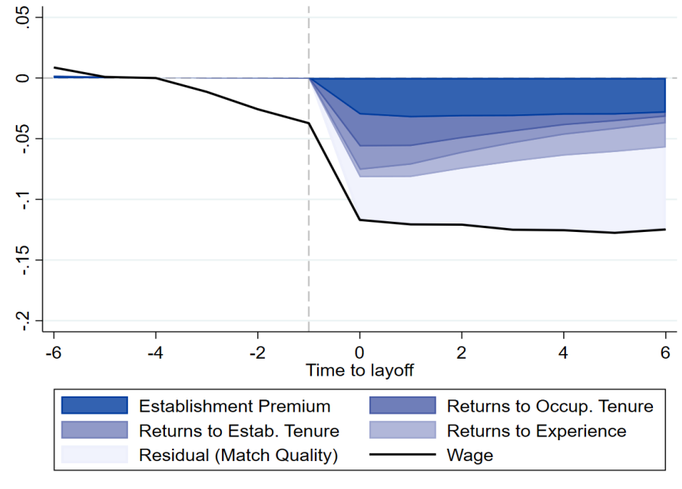
Figure 6: Decomposition by Worker Type

Panel A: Sources of Wage Losses (Stacked)

Panel A.1: Low-wage Workers

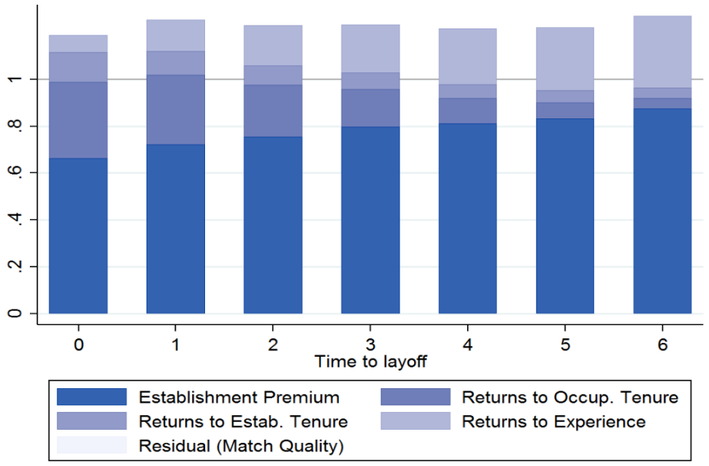


Panel A.2: High-wage Workers

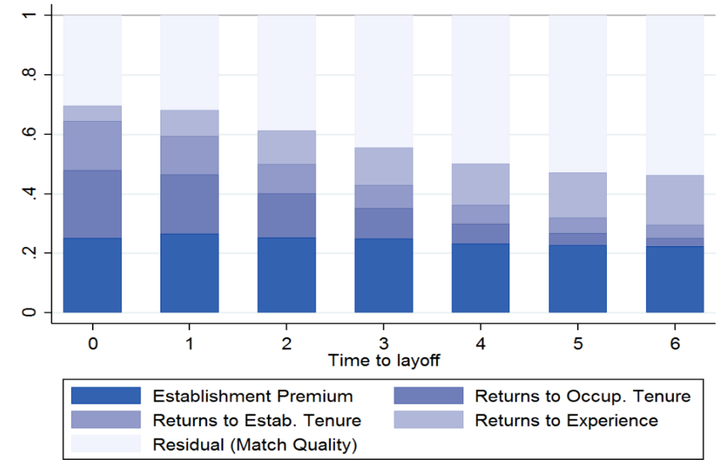


Panel B: Share of Total Wage Loss

Panel B.1: Low-wage Workers



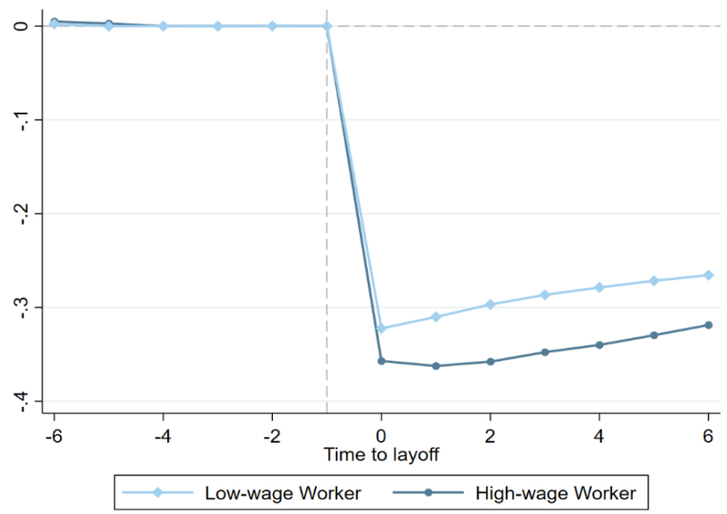
Panel B.2: High-wage Workers



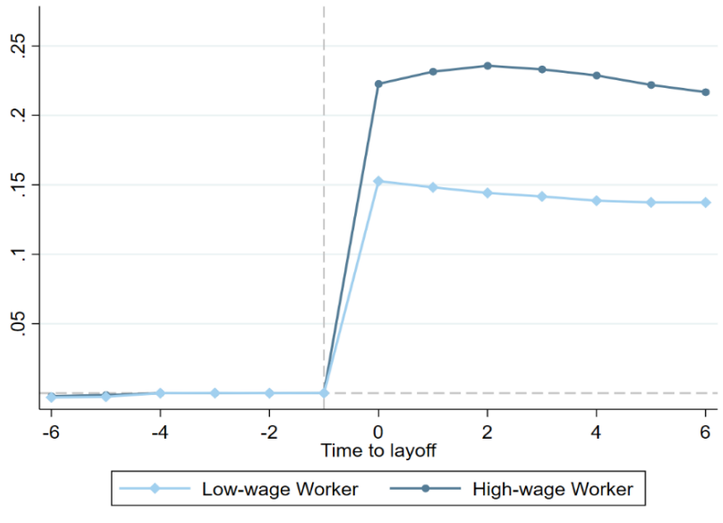
Notes: Panels A.1 and A.2 of the figure report event study estimates of the effects of job displacement on wages, and on five potential sources of wage losses (establishment premium, returns to establishment and occupation tenure, returns to experience, and match quality) by worker type. Estimates are based on equation (3), with the respective source as dependent variable. Panels B.1 and B.2 show the contribution of each of these sources to the total wage loss by worker type. Low- and high-wage workers are defined as workers with worker fixed effects in the bottom and top terciles of the estimated AKM worker fixed effects distribution, respectively. The establishment wage premium refers to the AKM establishment fixed effect as estimated in equation (2) in Section 4.2. The returns to establishment and occupation tenure are predicted using the respective estimates from equation (2) and a worker's observed years of tenure. Tenure variables are capped at ten years of tenure. Losses in the returns to experience are estimated as described in Section 4.3.3. Losses in match quality are defined as the residual wage loss. The sample consists of low- and high-wage male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff.

Figure 7: Sectoral Swtiching after Displacement

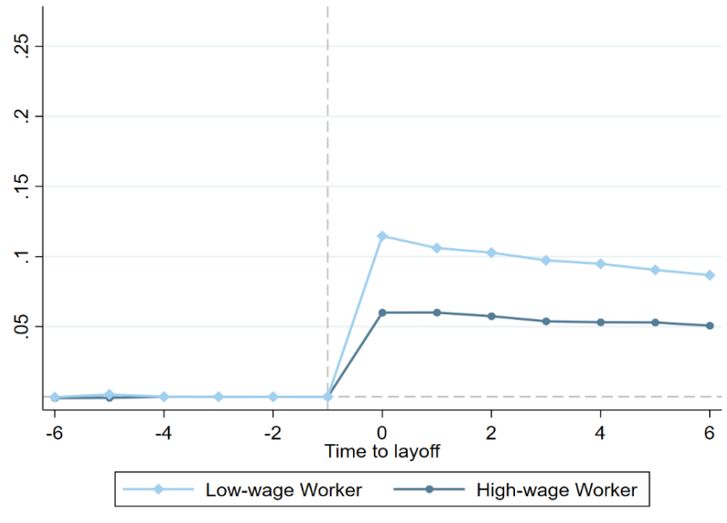
Panel A: Manufacturing Sector



Panel B: Low-knowledge Service Sector



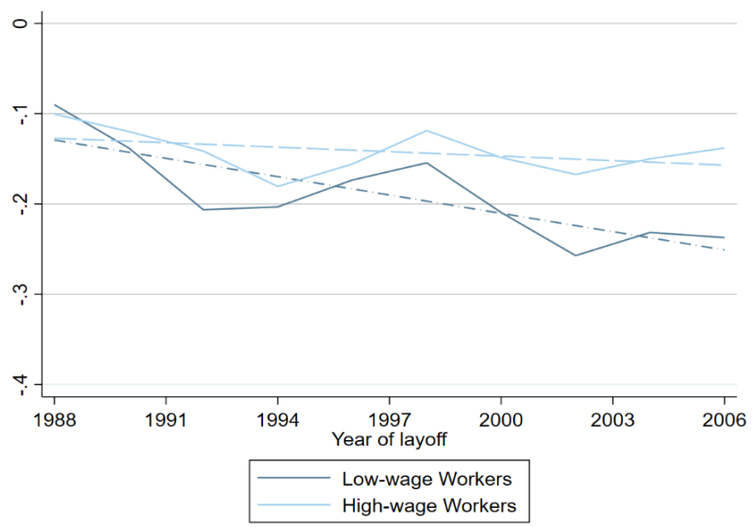
Panel C: High-knowledge Service Sector



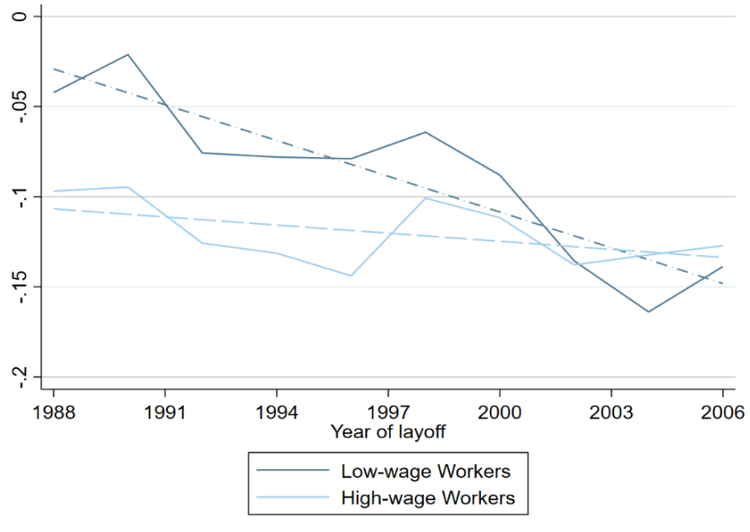
Notes: The figure reports event study estimates of the likelihood of being employed in the manufacturing (Panel A), the low-knowledge service (Panel B) and the high-knowledge service sector (Panel C) after displacement, conditional on being employed. Estimates are based on equation (3). Low- and high-wage workers are defined as workers with worker fixed effects in the bottom and top terciles of the estimated AKM worker fixed effects distribution, respectively. The sample consists of low- and high-wage male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff.

Figure 8: Employment, Wage and Establishment Premium Losses over Time

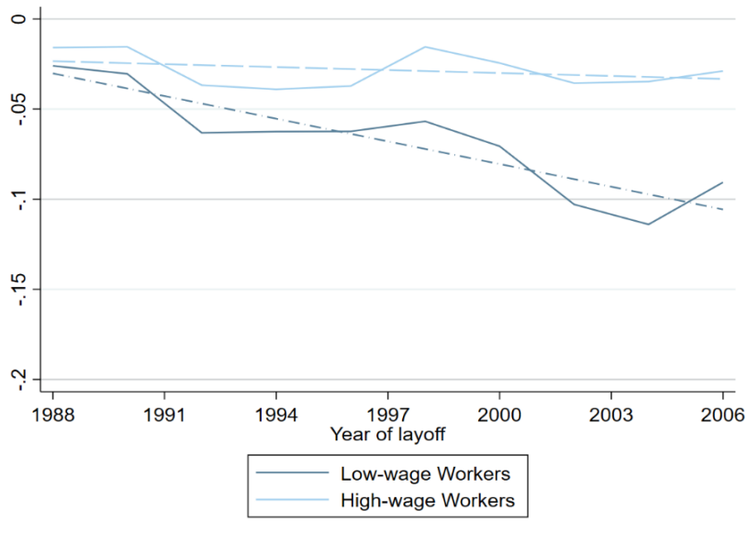
Panel A: Employment



Panel B: Wages



Panel C: Establishment Premiums

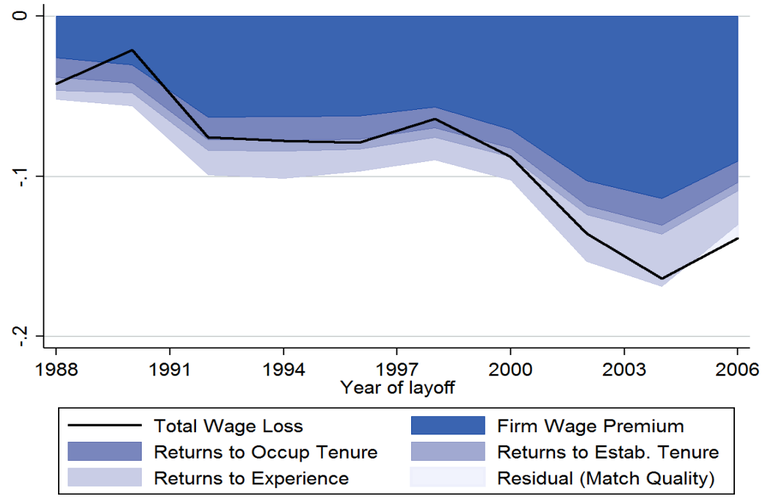


Notes: The figure reports event study estimates of the effects of job displacement by worker type on the probability of being employed in Panel A, on wages in Panel B and on the establishment premium in Panel C. Estimates are based on equation (3) estimated separately for each two-year period of layoffs taking place between 1988 and 2007. Reported coefficients are for the effects three years after displacement. Low- and high-wage workers are defined as workers with worker fixed effects in the bottom and top terciles of the estimated AKM worker fixed effects distribution, respectively. The establishment wage premium refers to the AKM establishment fixed effect as estimated in equation (2) in Section 4.2. The dashed lines present linear trends of the presented estimates for each worker type.

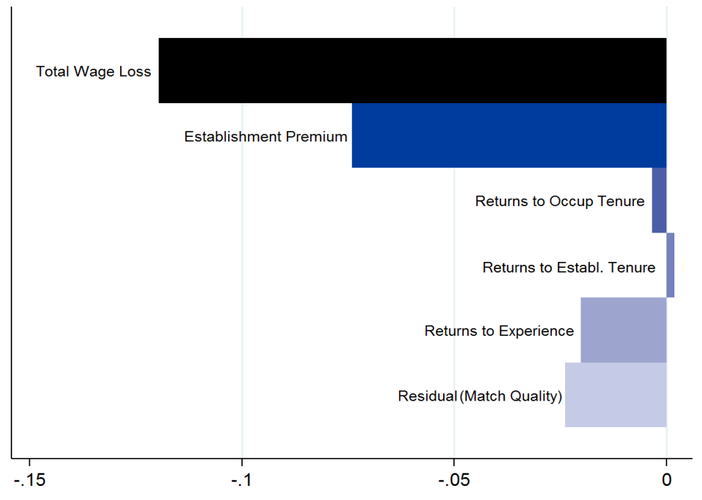
Figure 9: Decomposition of Displacement Wage Losses over Time by Worker Type

Panel A: Low-Wage Workers

Panel A.1: Decomposition

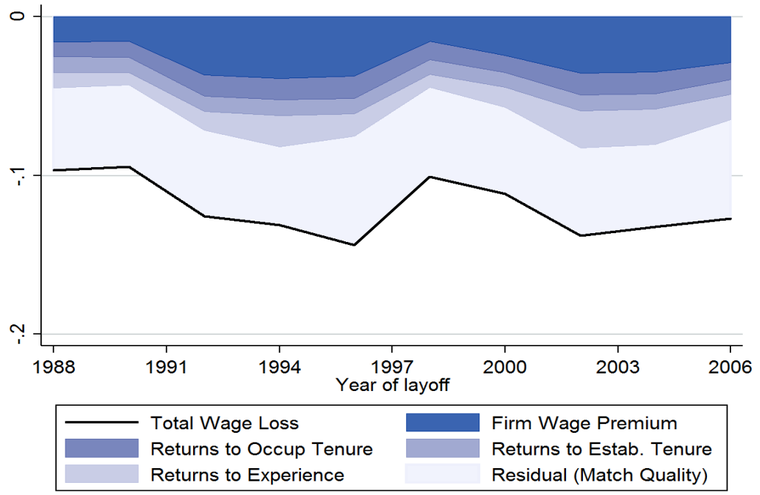


Panel A.2: Change in Wage Loss and its Components

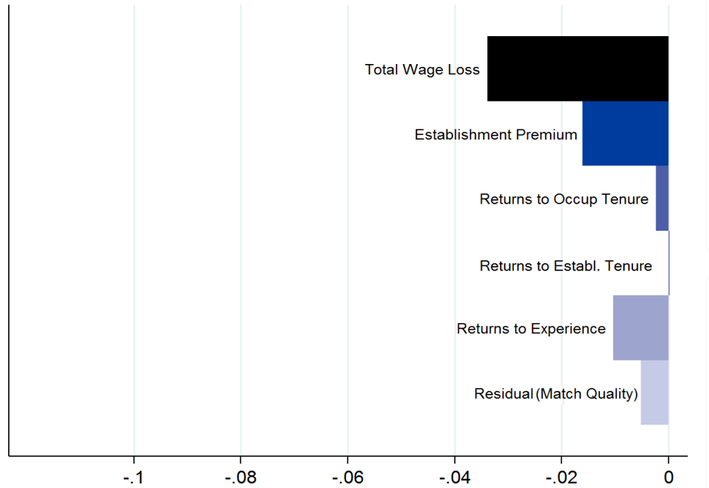


Panel B: High-Wage Workers

Panel B.1: Decomposition



Panel B.2: Change in Wage Loss and its Components

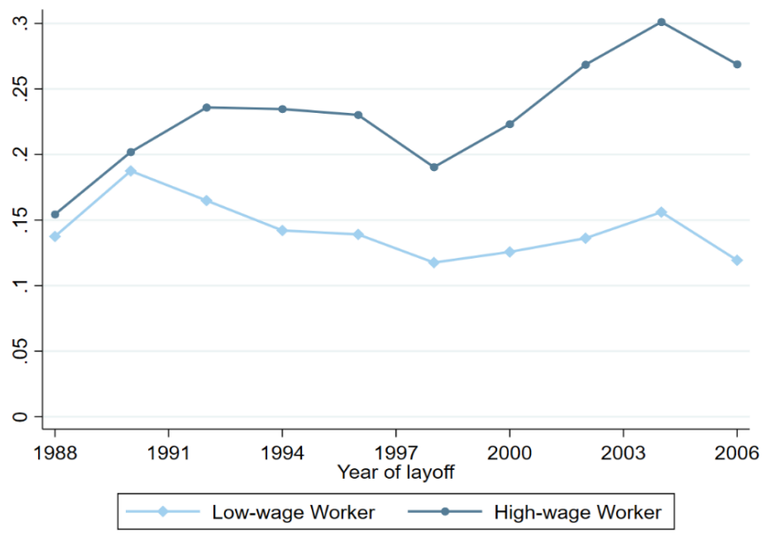


Notes: Panels A.1 and B.1 of the figure show event study estimates of the effects of job displacement on wages, and on five potential sources of wage losses (establishment premium, returns to establishment and occupation tenure, returns to experience and match quality) by worker type estimated separately for each two-year period of layoffs taking place between 1988 and 2007. Estimates are based on equation (3), with the respective source as dependent variable. Reported coefficients are for the effects three years after displacement. Low- and high-wage workers are defined as workers with worker fixed effects in the bottom and top terciles of the estimated AKM worker fixed effects distribution, respectively. The establishment wage premium refers to the AKM establishment fixed effect as estimated in equation (2) in Section 4.2. The returns to establishment and occupation tenure are predicted using the respective estimates from equation (2) and a worker's observed years of tenure. Tenure variables are capped at ten years of tenure. Losses in the returns to experience are estimated as described in Section 4.3.3. Losses in match quality are defined as the residual wage loss. Panels A.2 and B.2 report the change in the wage loss as well as the five sources of wage losses between the first two and the last two two-year periods (i.e., between 1988 to 1991 and 2004 to 2007).

Figure 10: Sectoral Switching after Displacement over Time

Panel A: Manufacturing Sector

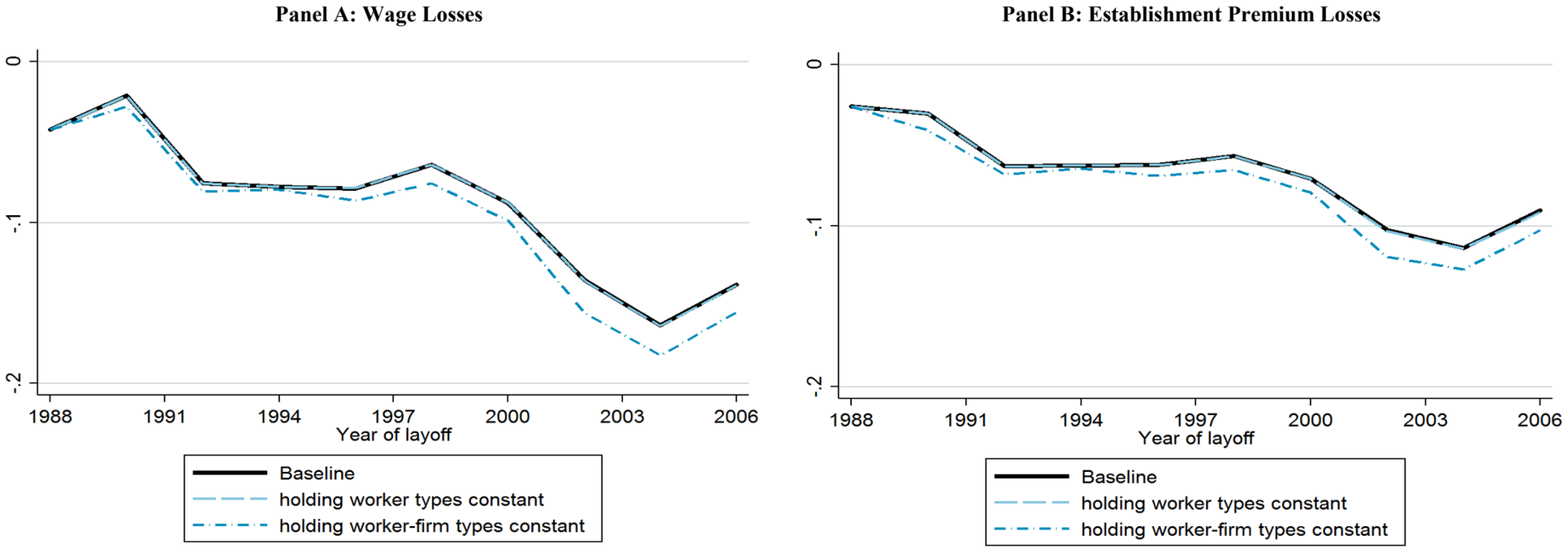
Panel B: Low-knowledge Service Sector



Panel C: High-knowledge Service Sector

The figure reports event study estimates of the likelihood of being employed in the manufacturing, the low-knowledge service (Panel B) and the high-knowledge service sector (Panel C) three years after displacement, conditional on being employed. Estimates are based on equation (3) estimated separately for each two-year period of layoffs taking place between 1988 and 2007. Low- and high-wage workers are defined as workers with worker fixed effects in the bottom and top terciles of the estimated AKM worker fixed effects distribution, respectively.

Figure 11: Composition Adjusted Wage and Establishment Premium Losses Over Time - Low-wage Workers



Notes: The figures show, for low-wage workers, event study estimates of the effects of job displacement on wages in Panel A and on the establishment premium in Panel B. Estimates are based on equation (3) and are estimated separately for each two-year period of layoffs taking place between 1988 and 2007. Reported coefficients are for the effects three years after displacement. The establishment premium refers to the AKM establishment fixed effect as estimated in equation (2) in Section 4.2. Low-wage workers are defined as workers with worker fixed effects in the bottom of the estimated AKM worker fixed effects distribution. The solid lines show the baseline wage and establishment premium losses equivalent to those presented in Figure 8, Panel B and C. The long-dashed lines reweight the composition of workers in each of the two-year periods to reflect the worker-type distribution in the first two-year estimation period (i.e. 1988 and 1989); the short-dashed line instead reweights the composition of workers to reflect the worker and establishment distribution in the first two-year estimation period. The reweighting method is described in more detail in Section 6.3.

APPENDIX

Table A.1: Decomposition of Wage Losses

	Wage (1)	Est. Premium (2)	Returns to Occupation Tenure (3)	Returns to Establishment Tenure (4)	Returns to Experience (5)	Residual (Match Quality) (6)	Match Quality (Lachowska et al., 2020) (7)
τ=-6	0.005	0.001	0.000	0.000	0.000	0.004	-0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-5	0.001	0.001	0.000	0.000	0.000	0.000	-0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-4							
τ=-3	-0.008	0.000	0.000	0.000	0.000	-0.008	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
τ=-2	-0.018	0.000	0.000	0.000	0.000	-0.018	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-1	-0.027	0.000	0.000	0.000	0.000	-0.027	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=0	-0.104	-0.049	-0.027	-0.014	-0.006	-0.007	-0.009
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
τ=1	-0.105	-0.053	-0.025	-0.011	-0.010	-0.005	-0.013
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
τ=2	-0.103	-0.055	-0.018	-0.009	-0.013	-0.008	-0.015
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
τ=3	-0.102	-0.054	-0.012	-0.007	-0.015	-0.012	-0.017
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
τ=4	-0.100	-0.053	-0.008	-0.006	-0.017	-0.016	-0.019
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
τ=5	-0.096	-0.052	-0.004	-0.005	-0.018	-0.018	-0.020
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
τ=6	-0.092	-0.050	-0.002	-0.004	-0.019	-0.017	-0.022
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)

Notes: The table reports event study estimates of the effects of job displacement on wages and its sources (establishment premium column (2); returns to occupation tenure in column (3); returns to establishment tenure in column (4); returns to experience in column (5); the residual (match quality) in column (6); and match quality as estimated in Lachowska et al. (2020) in column (7)). Estimates are based on equation (3). The establishment wage premium refers to the AKM establishment fixed effect as estimated in equation (2) in Section 4.2. For the procedure to estimate wage losses due to occupation and establishment tenure and experience, see Section 4.3.3. The sample consists of male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff. Levels of significance are * p<0.10, ** p<0.05, *** p<0.01.

Table A2: Displaced vs. Control Workers by Worker Type

	Low-wage Workers			High-wage Workers		
	Displaced Workers (Treatment)	Non-Displaced (Matched Control)	Treatment vs. Matched Control	Displaced Workers (Treatment)	Non-Displaced (Matched Control)	Treatment vs. Matched Control
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Worker Characteristics						
Real Wage (Ln)	4.275	4.276	-0.001	4.669	4.672	-0.003
Worker Fixed Effect	-0.125	-0.125	-0.000	0.143	0.155	-0.012***
Firm Tenure	7.452	7.428	0.024	7.168	7.150	0.019
Occupation Tenure	7.710	7.684	0.026	7.696	7.678	0.018
Age	35.957	35.939	0.018	35.567	35.561	0.007
Low Skilled	0.302	0.302	0.000	0.026	0.026	0.000
Medium Skilled	0.692	0.692	0.000	0.791	0.791	0.000
High Skilled	0.006	0.006	0.000	0.183	0.183	0.000
Non-German	0.192	0.192	0.000	0.038	0.038	0.000
Panel B: Firm Characteristics						
Establishment Wage Premium	-0.005	-0.008	0.003***	0.016	0.016	-0.000
Sector:						
Food and Beverage	0.072	0.072	0.000	0.061	0.061	0.000
Consumer Goods	0.207	0.207	0.000	0.157	0.157	0.000
Producer Goods	0.256	0.256	0.000	0.176	0.176	0.000
Investment Goods	0.465	0.465	0.000	0.606	0.606	0.000
N	39083	39083	78166	25927	25927	51854

Notes: The table reports summary statistics for male workers displaced from the manufacturing sector between 1988 and 2007 as well as matched and random control workers separately by worker type. Low- and high-wage workers are defined as workers with worker fixed effects in the bottom and top terciles of the estimated AKM worker fixed effects distribution, respectively. Wages are (log) average daily wages in EUR adjusted to 1995 prices. Establishment premiums and worker fixed effects are demeaned to have zero mean over the sample period (see equation (2) in Section 4.2). Tenure variables are reported in years and are capped at ten years. The random control group represents a 10 percent random sample of manufacturing workers. Both displaced and control workers are males aged 25-50 with at least four years establishment tenure and employed in establishments with at least 30 and a maximum of 500 employees in West Germany. Levels of significance are * p<0.10, ** p<0.05, *** p<0.01.

Table A.3: Decomposition of Wage Losses - Low-wage Workers

	Wage (1)	Est. Premium (2)	Returns to Occupation Tenure (3)	Returns to Establishment Tenure (4)	Returns to Experience (5)	Residual (Match Quality) (6)	Match Quality (Lachowska et al., 2020) (7)
τ=-6	0.001	0.001	0.000	0.000	0.000	0.000	0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-5	-0.002	0.001	0.000	0.000	0.000	-0.003	0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-4							
τ=-3	-0.007	0.000	0.000	0.000	0.000	-0.007	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-2	-0.016	0.000	0.000	0.000	0.000	-0.016	0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-1	-0.026	0.000	0.000	0.000	0.000	-0.025	0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=0	-0.091	-0.060	-0.030	-0.011	-0.007	0.017	0.011
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)
τ=1	-0.092	-0.066	-0.027	-0.009	-0.012	0.023	0.004
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
τ=2	-0.093	-0.070	-0.020	-0.008	-0.016	0.021	0.002
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
τ=3	-0.087	-0.070	-0.014	-0.006	-0.018	0.020	0.000
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
τ=4	-0.084	-0.068	-0.009	-0.005	-0.020	0.018	-0.003
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
τ=5	-0.079	-0.065	-0.005	-0.004	-0.021	0.017	-0.004
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
τ=6	-0.072	-0.063	-0.003	-0.003	-0.022	0.020	-0.005
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)

Notes: The table reports, for low-wage workers, event study estimates of the effects of job displacement on wages and its sources (establishment premium column (2); returns to occupation tenure in column (3); returns to establishment tenure in column (4); returns to experience in column (5); the residual (match quality) in column (6); and match quality as estimated in Lachowska et al. (2020) in column (7)). Estimates are based on equation (3). The establishment wage premium refers to the AKM establishment fixed effect as estimated in equation (2) in Section 4.2. For the procedure to estimate wage losses due to occupation and establishment tenure and experience, see Section 4.3.3. The sample consists of male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff. Levels of significance are * p<0.10, ** p<0.05, *** p<0.01.

Table A.4: Decomposition of Wage Losses - High-wage Workers

	Wage (1)	Est. Premium (2)	Returns to Occupation Tenure (3)	Returns to Establishment Tenure (4)	Returns to Experience (5)	Residual (Match Quality) (6)	Match Quality (Lachowska et al., 2020) (7)
τ=-6	0.009	0.002	0.000	0.000	0.000	0.007	-0.005
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)
τ=-5	0.001	0.001	0.000	0.000	0.000	0.000	-0.004
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)
τ=-4							
τ=-3	-0.011	0.000	0.000	0.000	0.000	-0.011	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-2	-0.026	0.000	0.000	0.000	0.000	-0.025	-0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-1	-0.037	0.000	0.000	0.000	0.000	-0.037	-0.001
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
τ=0	-0.117	-0.030	-0.026	-0.019	-0.006	-0.035	-0.030
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)
τ=1	-0.121	-0.032	-0.024	-0.015	-0.010	-0.039	-0.030
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.002)
τ=2	-0.121	-0.032	-0.018	-0.012	-0.013	-0.046	-0.031
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.002)
τ=3	-0.125	-0.031	-0.013	-0.010	-0.015	-0.056	-0.033
	(0.003)	(0.001)	(0.000)	(0.000)	(0.001)	(0.003)	(0.002)
τ=4	-0.125	-0.030	-0.009	-0.008	-0.017	-0.061	-0.035
	(0.003)	(0.001)	(0.000)	(0.000)	(0.001)	(0.003)	(0.002)
τ=5	-0.128	-0.030	-0.005	-0.007	-0.019	-0.067	-0.036
	(0.003)	(0.001)	(0.000)	(0.000)	(0.001)	(0.003)	(0.002)
τ=6	-0.125	-0.029	-0.003	-0.005	-0.020	-0.068	-0.039
	(0.003)	(0.001)	(0.000)	(0.000)	(0.001)	(0.003)	(0.002)

Notes: The table reports, for high-wage workers, event study estimates of the effects of job displacement on wages and its sources (establishment premium column (2); returns to occupation tenure in column (3); returns to establishment tenure in column (4); returns to experience in column (5); the residual (match quality) in column (6); and match quality as estimated in Lachowska et al. (2020) in column (7)). Estimates are based on equation (3). The establishment wage premium refers to the AKM establishment fixed effect as estimated in equation (2) in Section 4.2. For the procedure to estimate wage losses due to occupation and establishment tenure and experience, see Section 4.3.3. The sample consists of male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff. Levels of significance are * p<0.10, ** p<0.05, *** p<0.01.

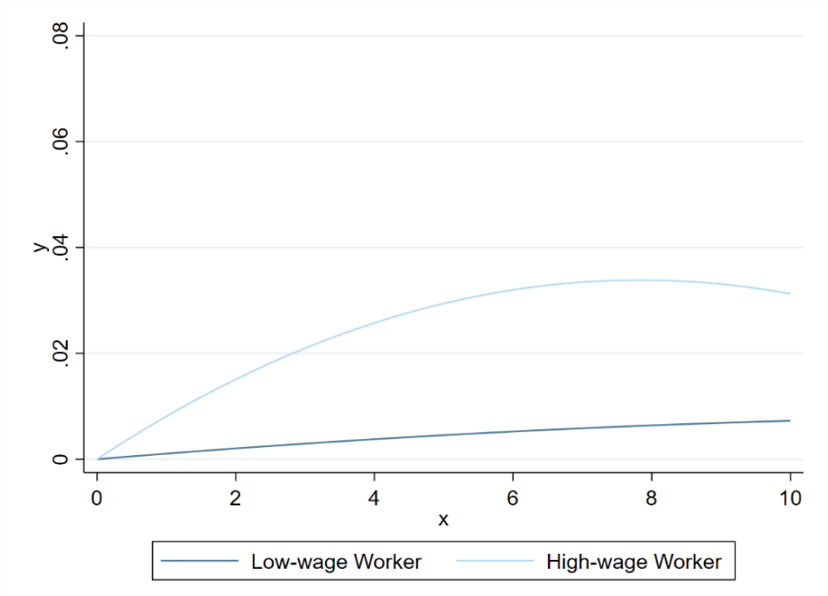
Table A.5: Robustness and Extensions

	Baseline Sample			Plant Closure Sample	
	Wage	Est. Premium Extended AKM	Est. Premium Standard AKM	Wage	Est. Premium
	(1.1)	(1.2)	(1.3)	(2.1)	(2.2)
τ=-6	0.005	0.001	0.001	0.007	0.002
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-5	0.001	0.001	0.001	0.002	0.001
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-4					
τ=-3	-0.008	0.000	0.000	-0.008	0.000
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-2	-0.018	0.000	0.000	-0.019	0.000
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-1	-0.027	0.000	0.000	-0.027	0.000
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
τ=0	-0.104	-0.049	-0.062	-0.104	-0.047
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
τ=1	-0.105	-0.053	-0.066	-0.106	-0.052
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
τ=2	-0.103	-0.055	-0.068	-0.104	-0.054
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
τ=3	-0.102	-0.054	-0.067	-0.101	-0.053
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
τ=4	-0.100	-0.053	-0.065	-0.100	-0.052
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
τ=5	-0.096	-0.052	-0.063	-0.098	-0.051
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
τ=6	-0.092	-0.050	-0.061	-0.093	-0.049
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)

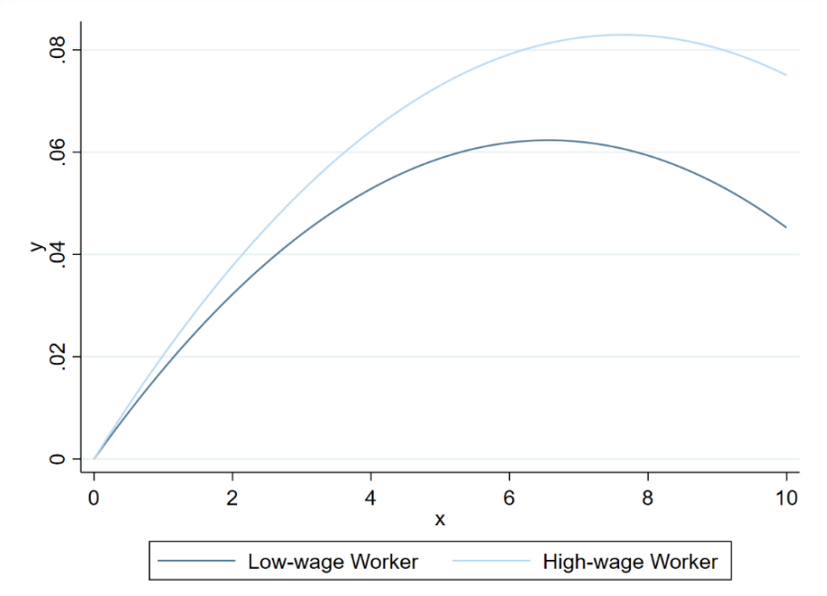
Notes: The table reports event study estimates of the effects of job displacement on wages and the establishment premium. Estimates are based on equation (3). Columns (1.1) and (1.2) present the baseline estimates equivalent to Figure 3, Panel B. Column (1.3) displays coefficients that were estimated based on the baseline sample but using the establishment premium from a standard AKM model estimated without controls for establishment and occupation tenure. The sample in columns (2.1) and (2.2) consists only of plant closures defined as mass layoff establishments in which at least 80 percent of employees left the establishment. The sample consists of male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff. Levels of significance are * p<0.10, ** p<0.05, *** p<0.01.

Figure A.1: Returns to Establishment and Occupational Tenure

Panel A: Returns to Establishment Tenure

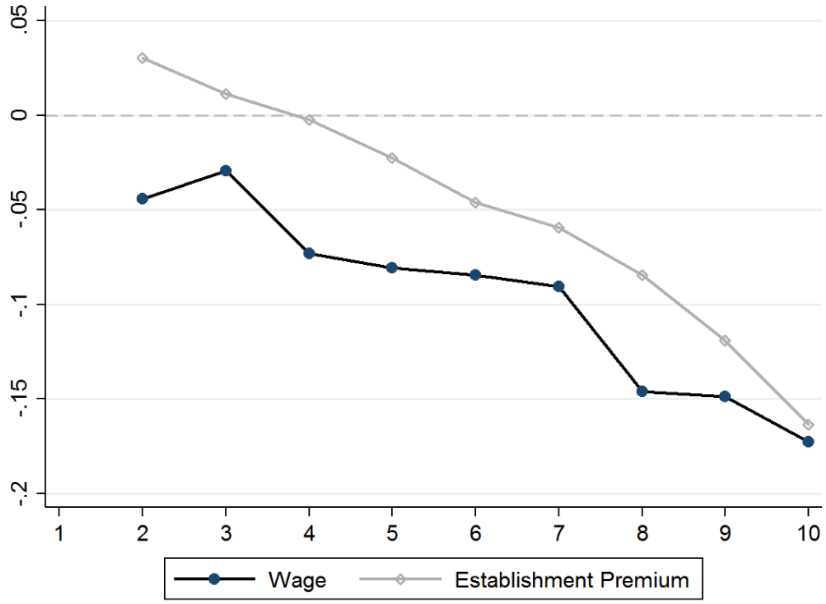


Panel B: Returns to Occupational Tenure



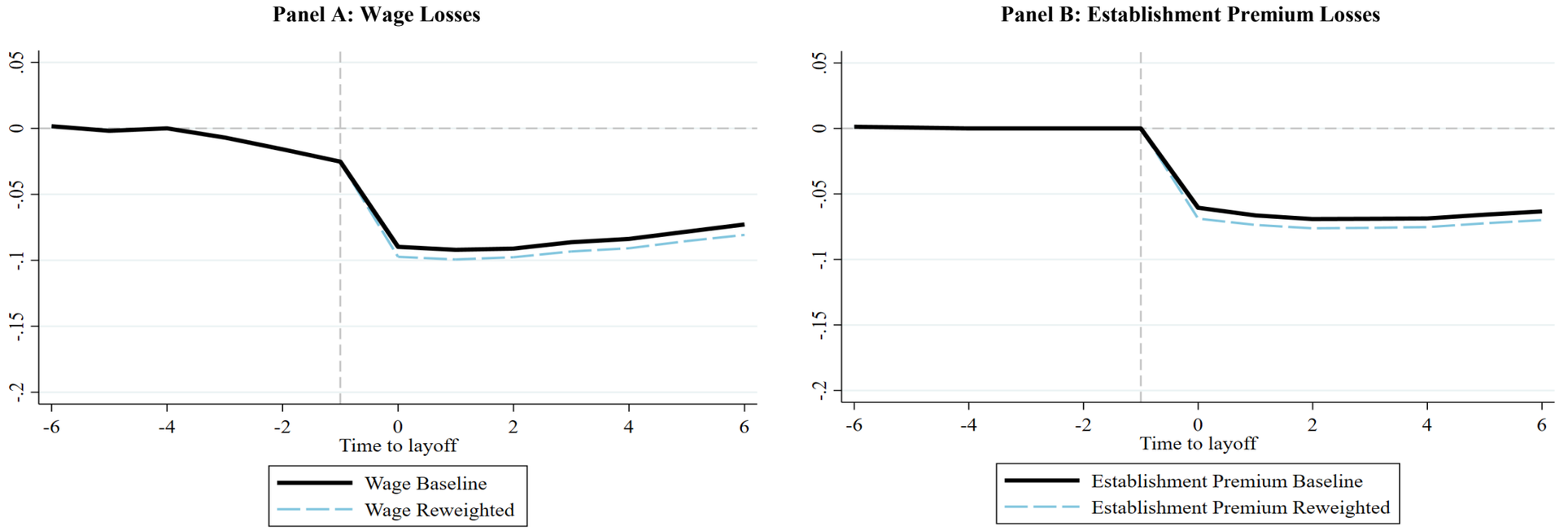
Notes: The figure shows returns to establishment tenure in Panel A and to occupational tenure in Panel B as estimated in the extended AKM model specified in equation (2) in Section 4.2. Low-wage workers are defined as workers whose worker fixed effect falls into the bottom tercile of the distribution of worker fixed effects and high-wage workers as workers whose worker fixed effects fall into the top tercile.

Figure A.2: Displacement Losses by Establishment Premium Decile



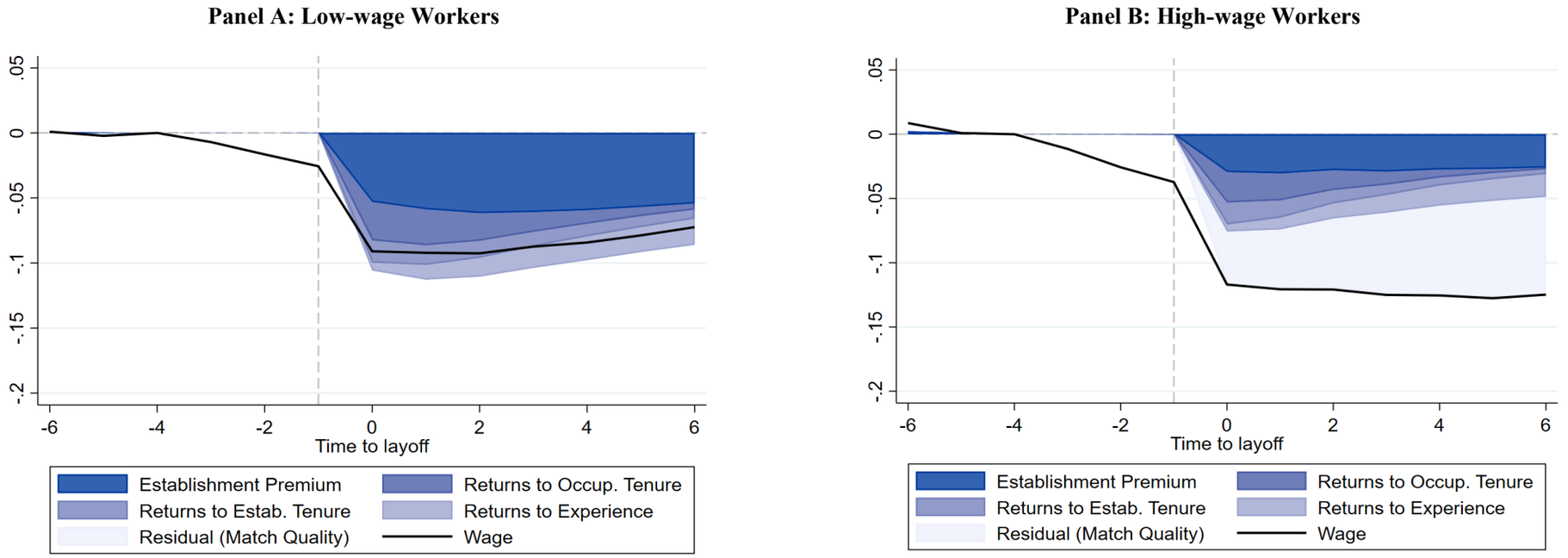
Notes: The figure reports event study estimates of the effects of job displacement on wages and establishment premiums by displacement establishment premium decile. Estimates are based on equation (3) and reported coefficients are for the effects three years after displacement. The establishment wage premium refers to the AKM establishment fixed effect as estimated in equation (2) in Section 4.2. Deciles are defined over the universe of establishments and workers, including establishments in the service sector. There are no establishments in the lowest decile (1) in the manufacturing sector. The sample consists of male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff.

Figure A.3: Composition Adjusted Wage and Establishment Premium Losses - Low-Wage Workers



Notes: The figure reports, for low-wage workers, event study estimates of the effects of job displacement on wages in Panel A and on the establishment premium in Panel B. Estimates are based on equation (3). The establishment wage premium refers to the AKM establishment fixed effect as estimated in equation (2) in Section 4.2. Low-wage workers are defined as workers with worker fixed effects in the bottom of the estimated AKM worker fixed effects distribution. The solid lines show the baseline wage and establishment premium losses equivalent to those presented in columns (1) and (2) of Table A.1. The long-dashed lines reweight the low-wage worker observations to reflect the establishment premium distribution of high-wage workers' displacement establishments. The sample consists of male workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff.

Figure A.4: Decomposition Allowing the Establishment Premium to Vary by Worker Type



Notes: The figure reports event study estimates of the effects of job displacement on wages and on five potential sources of wage losses (establishment premium, returns to establishment and occupation tenure, returns to experience and match quality) by worker type. Panel A reports the estimates for low-wage workers and Panel B for high-wage workers. Low- and high-wage workers are defined as workers with worker fixed effects in the bottom and top terciles of the estimated AKM worker fixed effects distribution, respectively. All estimates are based on equation (3), with the respective source as dependent variable. The establishment premium refers to the AKM establishment fixed effect as estimated using a variant of equation (2) in Section 4.2 that allows the establishment fixed effects to vary by worker type. The returns to establishment and occupation tenure are predicted using the respective estimates from the same AKM model and a worker's observed years of tenure. Tenure variables are capped at ten years of tenure. Losses in the returns to experience are estimated as described in Section 4.3.3. Match Quality is defined as the residual wage loss. The sample consists of male low- and high-wage workers displaced between 1990 and 2004 and their matched control workers. Both displaced and control workers are aged 25-50 with at least four years establishment tenure in the year of layoff.