Displacement Effects in Manufacturing and Structural Change

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This version: November 29, 2025

Abstract

Manufacturing establishments historically 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 gradual disappearance of these well-paid jobs, disproportionately affecting low-wage workers. We show that displacement from manufacturing leads to considerably larger wage losses—and larger declines in establishment premiums—than displacement from services, especially for low-wage workers. Over time, displacement losses in manufacturing have worsened, particularly among low-wage workers who, amid ongoing structural change, are increasingly forced to switch to low-paying, low-knowledge service sector jobs. These patterns are similar for men and women. We then highlight that structural change and the decline in high-paid manufacturing jobs have significantly contributed to job polarization and the rise in assortative matching between workers and firms.

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

JEL Classification: J22, J24, J31, J63

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We thank David Card, Will Dobbie, Arindrajit Dube, Larry Katz, Patrick Kline, Pawel Krolikowski, Attila Lindner, Alex Mas, Suphanit Piyapromdee, Michel Serafinelli, Isaac Sorkin, Till von Wachter, Andrea Weber, Stephen Woodbury, and seminar participants at the AASLE Conference in Seoul, the ASSA Conference in San Diego, the Austrian Labor Economics Workshop, the Berlin Workshop on the Future of Labour, the Bratislava University of Economics and Business, CREI UPF, the DfG Workshop in Cologne, Georgetown University, IFAU, the IFN Research Institute of Industrial Economics, IIES Stockholm, the INEQ Institute, the IZA Workshop on Heterogeneity and the Labor Market, the JK University Linz, the London School of Economics, NORFACE DIAL Workshops in Turku, London and Brussels, Paris Cergy, the SDLM in Marseille, Stockholm University, the Tinbergen Institute, UC Berkeley, Universidad Carlos III de Madrid, University College London, the University of Groningen, the University of Innsbruck, the University of Vienna, the University of Warwick, and the Vienna University of Economics and Business for helpful comments. Alice Kügler acknowledges financial support from ESRC New Investigator grant ES/R011443/1 and Uta Schönberg acknowledges financial support from the NORFACE DIAL program and the European Research Council (grant agreement number 818992).

1. Introduction

Most industrialized countries have experienced substantial changes in the structure of employment over recent decades, marked by significant shifts 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. Germany, the third-largest exporter of manufactured goods, has also experienced a pronounced decline, though manufacturing continues to account for over 20 percent of jobs in the country. Historically, the manufacturing sector has provided high-wage employment opportunities for 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 jobs for which few skills are needed, high-knowledge service industries (e.g., software development, finance, and insurance) are typically well-paid 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 has 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, decarbonization, the transition from the combustion engine to electric vehicles, and export uncertainties are predicted to put up to 400,000 manufacturing jobs in Germany at risk (Financial Times, 2020, 2025).

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 jobs. We focus on mass layoffs, which can be considered exogenous from the workers' viewpoint. We address the following questions: Have the costs of job loss increased over time as manufacturing jobs have become scarcer? Do workers face greater wage losses when displaced from a manufacturing firm compared to a service sector firm?[2] What are the sources of displacement wage losses, do they differ by worker type and sector, and have they changed over time? How has structural change affected job polarization and the wage structure?

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

[2] Our data include establishment (not firm) identifiers. Throughout the paper, we use the terms “firms” and “establishments” interchangeably. For brevity, we often refer to “displacement from a manufacturing (or service sector) firm” as “displacement from manufacturing (the service sector)”.

Our analysis of wage components that drive displacement wage losses combines several factors emphasized by the literature on job displacement. One strand of the literature focuses on losses in workers' human capital following displacement. Displaced workers lose acquired skills that are specific to the firm, as well as occupation- and industry-specific skills if they switch occupations or industries (e.g., Topel, 1990, Jacobson *et al.*, 1993, Neal, 1995, Poletaev and Robinson, 2008, or Huckfeldt, 2022). 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, displaced workers can 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, 2023).

The more recent literature has instead focused on the importance of losses in wage premiums that firms or establishments pay to all their workers (e.g., Lachowska *et al.*, 2020, and Moore and Scott-Clayton, 2025, for the US; Fackler *et al.*, 2021, and Schmieder *et al.*, 2023, for Germany; and Bertheau *et al.*, 2023, in a cross-country analysis). Losses in establishment premiums following displacement can then 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.

Structural change can amplify displacement losses in establishment premiums and general and specific human capital. Workers faced with a shrinking number of manufacturing jobs may be forced into the lower-paying service sector, experience longer job searches and time out of work, and be more likely to switch occupations.

We make three important contributions to the literature. First, we provide a systematic analysis of how the magnitude and sources of displacement wage losses differ across worker types and sectors. We disentangle the sources of displacement wage losses by differentiating between general, occupation-specific, and establishment-specific human capital losses on the one hand, and losses in establishment premiums and match quality on the other hand. Understanding how and why displacement effects differ across workers and sectors is important for designing targeted policy responses. For example, re-training policies are unlikely to remedy lost establishment premiums but can be effective to the extent that displacement costs are due to losses in human capital.

Second, to our knowledge, this paper is the first to investigate general time trends in the cost of job displacement and its sources, and to link these to structural change. In contrast, existing studies, including the work by Schmieder *et al.* (2023), 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).

Third, our paper connects the changing and heterogeneous costs of job displacement to important long-term 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, Haltiwanger *et al.*, 2024).

Specifically, we study trends in wage losses and their sources among displaced workers over two decades, between 1988 and 2007, with a focus on differences across sectors, worker types, and over time. 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 and establishments, allowing us to observe an individual's job and occupational history for at least 15 years prior to a layoff. To disentangle the various sources of displacement wage losses (i.e., losses in general, occupation-specific, and firm-specific human capital, as well as losses in match quality and firm premiums), we estimate the different components using extended regressions based on the Abowd, Kramarz, and Margolis (AKM) model (Abowd *et al.*, 1999).[3]

Our first set of results provides a comprehensive analysis of the sources of wage losses following displacement by worker type and sector. We differentiate between low- and high-wage workers, defined as workers in the bottom and top terciles of the distribution of estimated AKM worker fixed effects. We show that low-wage workers face considerably larger wage losses when displaced from a manufacturing establishment than from a service sector establishment. These differences are primarily driven by larger reductions in establishment premiums, partly reflecting transitions from manufacturing to the low-knowledge service sector, where premiums are substantially lower.

Although high-wage workers, on average, also experience considerable wage losses upon displacement, low-wage workers suffer disproportionately larger reductions in establishment premiums, especially if displaced from manufacturing. This disparity is partially explained by the increased likelihood of low-wage workers switching to the low-knowledge service sector after displacement. Conversely, high-wage workers incur considerably larger losses in match quality following displacement.

These findings are in line with those of Haltiwanger *et al.* (2018) who show that low-wage workers predominantly move to better-paying establishments over the life cycle, whereas high-wage workers move to establishments that offer better matches. Wage losses due to general, occupation-specific, and establishment-specific human capital following displacement do not differ much across worker types and sectors.

In the second part of the paper, we investigate whether structural change that has shifted employment away from manufacturing and into the service sector has increased the cost of

[3] Gulyas and Pytka (2025) and Schmieder *et al.* (2023) 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 decompose wage losses formally based on jointly estimated returns to specific human capital and establishment premiums.

displacement, particularly for low-wage workers. We find that low-wage workers displaced from manufacturing indeed face increasingly severe wage losses over time. Not only are they increasingly less likely to be re-employed after displacement, but they also suffer increasingly large wage losses, both in absolute terms and relative to high-wage workers. Whereas low-wage workers laid off in the late 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, wage losses of high-wage workers have remained more stable. These patterns are unique to the manufacturing sector; trends in employment and wage losses for workers displaced from the service sector are considerably less pronounced.

Losses in establishment premiums are by far the most important driver behind the increasing displacement wage losses of low-wage workers in the manufacturing sector, 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 reflect changes in the composition of displaced workers. Instead, they are 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. Around forty percent of the increased establishment premium losses over time can be explained by such *between*-sector movements. We further show that displacement costs from manufacturing have risen for both production and service occupations, indicating that the increase is not driven solely by domestic outsourcing but broadly affects low-wage manufacturing workers.

Importantly, although manufacturing is a male-dominated sector, the negative effects of structural change are not limited to men. Women employed in manufacturing are disproportionately low-wage workers—the group most exposed to structural change: among low-wage manufacturing workers, 53 percent are women, compared with 11 percent among high-wage workers. Displacement losses have increased over time for both men and women at similar rates, casting doubt on the hypothesis that structural change predominantly harms men.

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. An analysis that leverages variation in the pace of structural change across commuting zones reinforces this conclusion.

In the third part of the paper, we explore the link between the changing and heterogeneous displacement wage losses on the one hand and job polarization and increased wage inequality on the other hand. Our findings suggest that the hollowing out of jobs in the middle of the wage distribution observed in many developed countries (e.g., Autor and Dorn, 2013, Goos *et al.*, 2014) 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 sector jobs with low establishment premiums, complementing the evidence in Bárány and Siegel (2018, 2020). In line with this hypothesis, we document that manufacturing jobs were indeed concentrated in the middle of the occupational wage distribution, in particular among men.[4] In contrast, low-knowledge service sector jobs of low-wage workers and high-knowledge service sector jobs of high-wage workers are overrepresented at the bottom and the top of the occupational wage distribution, respectively.

The decline of the manufacturing sector is also an important driver of the rise in wage inequality and assortative matching between workers and firms observed in Germany and other countries (e.g., Dustmann *et al.*, 2009, Card *et al.*, 2013, Song *et al.*, 2019, Haltiwanger *et al.*, 2024). We find that the increase in wage inequality (measured as the change in the variance of log wages) and in assortative matching (measured as the covariance between worker and establishment fixed effects) between 1988 and 2007 would have been 14 and 21 percent lower if the broad sectoral structure—manufacturing, low-knowledge services, and high-knowledge services—by worker type (low-, medium-, and high-wage) had remained at its 1988 level.

2. Motivating Evidence

Like other developed countries, Germany experienced a marked decline in manufacturing employment over the past few decades. Whereas in 1975, over 40 percent of workers were employed in the manufacturing sector, by 2014, this share had fallen to 25 percent (see Panel A of Figure 1). Over the same period, employment expanded steadily in both the low-knowledge service sector—such as retail, hospitality, and logistics—and the high-knowledge service sector – such as software development, finance, and insurance.[5] These shifts have been comparable across gender

[4] Among women, manufacturing jobs tend to be over-represented at the lower end of the occupational wage distribution. This is because women in the manufacturing sector work in lower-paying firms compared to men.

[5] We use the definitions provided in Grupp *et al.* (2000) to define the low- and high-knowledge service sectors based on NACE 1 three-digit industries. The list of three-digit low- and high-knowledge industries is presented in Table C.1. A small share of industries employing around 10 percent of the workforce can be classified as neither manufacturing nor low- or high-knowledge services.

(see Appendix Figure A.1), even though manufacturing is a male-dominated sector with men accounting for approximately 75 percent of employees.

Panel B of Figure 1 examines these shifts in the employment structure by worker type. To this end, we estimate augmented AKM-style wage regressions, described in more detail in Section 4.2, which include both worker and establishment fixed effects (Abowd *et al.*, 1999). We then differentiate between low-wage and high-wage workers, defining low-wage workers as those in the bottom third of the AKM worker fixed effects distribution and high-wage workers as those in the top third. A remarkable picture emerges. Over our estimation period from 1988 to 2007, the decline in the share of manufacturing employment was considerably more pronounced for low-wage workers than for high-wage workers (a decline of 15 vs. 6 percentage points). At the same time, low-wage workers became increasingly employed in low-knowledge services, while high-wage workers shifted into high-knowledge service jobs. Since low-wage manufacturing workers were predominantly employed in production occupations (about 72 percent) and this share has remained largely stable over time – the decline in low-wage manufacturing employment affected predominantly production jobs (Figure 1, Panel C).[6]

Further distinguishing sectors by the average AKM establishment premiums they pay, manufacturing jobs are characterized by exceptionally high premiums throughout our observation period (Table 1, Panel A). In 1988, the average establishment premium in manufacturing was about 15 percent higher than in the low-knowledge service sector and about 7 percent higher than in high-knowledge services. By 2007, the gap between manufacturing and the low-knowledge service sector had widened to 19 percent.[7] Importantly, establishment premiums in manufacturing are high for both low-wage and high-wage workers. However, with ongoing structural change, it has become increasingly challenging for low-wage workers to secure these high-paying jobs (Figure 1, Panel B). Establishment premiums have also become more dispersed over time in all three sectors and for both types of workers, suggesting that the risk of falling down the establishment premium ladder upon displacement has increased within and across sectors (Table 1, Panel B).[8]

Historically, the manufacturing sector provided good job opportunities for both low- and high-wage workers. In 1988, average worker quality in manufacturing, measured by the worker fixed effect, closely resembled that of the overall workforce. By contrast, the low-knowledge service sector

[6] Our definition of production occupations is broad and includes, for example, craft occupations. Only about 7 percent of low-wage manufacturing workers are employed in what Goldschmidt and Schmieder (2017) define as typical domestic outsourcing occupations—such as food processing, cleaning, security, and logistics.

[7] We interpret establishment fixed effects as premiums paid to all employees, holding worker quality constant. Establishment and worker fixed effects shown in Table 1 are demeaned such that their averages in the economy are zero.

[8] These trends occur even though establishment premiums are constant over time within establishments (see Section 4.2). They are therefore driven by the selective entry and exit of establishments and the differential employment growth of continuing establishments.

was characterized by negative selection, and the high-knowledge sector by positive selection (Panel C of Table 1). Over time, however, workers in manufacturing have become more positively selected, and workers in low-knowledge services more negatively selected, in line with the observed trends in employment shares.

While it is beyond the scope of this study to provide a comprehensive explanation of why establishment premiums are particularly high in the manufacturing sector, Table 2 explores two potential explanations: productivity differences (i.e., higher total job surplus in manufacturing) and rent-sharing (i.e., workers capturing a larger share of the total job surplus). We utilize data from the IAB Establishment Panel, which is available from 1993 onward and provides information on value added per worker (a proxy for productivity) and on union coverage and the presence of works councils (proxies for rent-sharing). We split the data into two periods (1993-1999 and 2000-2007).[9] Consistent with the productivity explanation, value added per worker is substantially higher in the manufacturing and high-knowledge service sectors than in the low-knowledge service sector, and these differences have widened over time. Union coverage rates are similar in manufacturing and in low-knowledge services, but substantially lower in high-knowledge services, where wages are more likely to be negotiated individually. All three sectors experienced strong declines in union coverage rates over time. Furthermore, works councils—representing workers at the establishment level— are consistently more prevalent in manufacturing than in the two service sectors in both periods. The reduction in union influence could also have enhanced firms' monopsony power, consistent with evidence from studies such as Benmelech *et al.* (2022), Dodini *et al.* (2024b), and Prager and Schmitt (2021). It may further have contributed to the observed rise in the dispersion of establishment premiums within sectors, directly or through its impact on monopsony power.

Overall, Table 2 suggests that the higher establishment premiums in manufacturing relative to the low-knowledge service sector may stem from a combination of better worker representation and higher productivity. In contrast, the difference in the establishment premiums between the high- and low-knowledge service sectors appears to be a result of productivity differences.

3. Data and Sample

3.1. Data

Our analysis utilizes data from German Social Security Records (the so-called *Beschäftigtenhistorik*) spanning four decades, from 1975 to 2014. These data include the population of workers and establishments registered with the social security system, comprising roughly 80 percent of the German workforce. Self-employed workers, civil servants, and military personnel are not included.

[9] Union coverage rates are measured as the share of workers covered by either sectoral or firm-wide collective bargaining agreements.

We observe workers' primary 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 East German workers are consistently included in the data from 1992 onwards only, which prevents us from examining longer-run trends in displacement effects in East Germany. Additionally, we exclude all irregular, marginal, and seasonal employment relationships. Since occupation definitions are only consistent until 2010, we discard observations recorded after 2010.

Unique establishment and worker identifiers allow us to match individuals to the establishments where they work and to track workers over time and across establishments. Occupation identifiers allow us to observe occupation switches. We compute establishment and occupation tenure in years and cap both types of tenure at ten years since we do not observe workers' full employment history in the earlier data windows.[10] Increasing the cap to 12 or even 15 years has little impact on our findings but reduces the time window over which we can estimate displacement effects.

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, following the procedure proposed by Card *et al.* (2013). We deflate wages to 1995 prices using the consumer price index.

When examining the employment effects of displacement, we consider both part-time and full-time employment, assigning values of 0 for non-employment, 0.5 for part-time employment, and 1 for full-time employment. Due to the lack of detailed information on hours worked, we focus on full-time employment when analyzing the wage effects of displacement.

3.2. Displacement Definition and Sample

Following the existing literature, we define a worker as displaced if they separate from the establishment due to a mass layoff. Such separations are likely to be involuntary from the worker's perspective and not driven by individual behavior. We define mass layoffs as events where at least 30 percent of the establishment's workforce are separated from one year to the next, and the establishment's employment remains depressed by 30 percent or more for at least two consecutive years. To ensure we capture true mass layoffs and not merely a change in the establishment identifier or a spin-off, we follow Hethey and Schmieder (2010) by excluding cases in which 30 percent or more of those leaving the establishment go to a single other establishment. To prevent

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

misclassification due to fragmentation into multiple establishments, we also require that no more than 70 percent of those leaving go to the same three establishments. Additionally, we restrict our sample to establishments with between 30 and 500 employees in the year prior to the mass layoff event. The minimum size threshold is standard in the literature and reduces the likelihood of misclassifying large employment fluctuations due to general turnover as mass layoffs. The maximum size limit ensures that the event's regional impact is limited and does not unduly influence broader regional employment dynamics (see Gathmann *et al.*, 2020).

Following the existing literature, we restrict our sample of displaced workers to prime-aged, high-tenure workers. Specifically, we require that workers are between 25 and 50 years old and employed full-time at the mass layoff establishment for at least four years. Our sample excludes recalled workers who were laid off but are observed again in the mass layoff establishment within six years of the layoff.

We then construct two samples. In the "pooled" sample, we include workers displaced from an establishment between 1990 and 2004—comprising 132,964 laid-off workers in the manufacturing sector and 94,958 workers in the service sector. This sample allows us to follow workers for at least six years before and after the layoff and to observe their establishment and occupation histories for at least ten years prior to the start of the event study period. 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 layoff. This sample includes mass layoffs that occurred between 1988 and 2007, encompassing 158,264 layoffs in the manufacturing sector and 120,625 layoffs in the service sector.[11]

Our analysis focuses on low- and high-wage workers, defined as those in the bottom and top terciles of the distribution of worker fixed effects estimated in augmented AKM regressions on the entire population of West German full-time workers aged 16 to 65 (see Section 4.2). Our results are qualitatively similar when we instead distinguish between low- and high-educated workers.

4. Estimating Displacement Wage Losses and Their Sources

In this section, we first present a statistical model of wage determination to illustrate the potential 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

[11] Appendix Figure A.2 plots the mass layoff risk over time in manufacturing and services, separately for low- and high-wage workers. Low-wage workers face a higher layoff risk in both sectors. In manufacturing, the mass layoff risk peaked in the early 1990s and declined thereafter. While mass layoffs were more prevalent in manufacturing than in services in the early 1990s, the risk was similar in later years.

(Section 4.2). Finally, we outline our empirical strategy to quantify the cost of job loss and explain how we decompose displacement wage losses into their components (Section 4.3).

4.1. A Statistical Model of Wage Determination

Assume that log wages are determined by the following relationship:

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

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 and characteristics. $ActExp_{it}$, $OccT_{it}$, and $EstT_{it}$ denote general, occupation-specific, and establishment-specific human capital (HC); $m_{iJ(i,t)}$ denotes the quality of the match between the worker and the establishment; ω_t allows for yearly variation in wages; and r_{it} reflects the residual component of wages.

These different components of wage determination capture the potential sources of wage losses following job displacement and therefore determine the severity of these 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 characteristics who was employed in an identical job prior to the layoff.

First, the displaced worker may face losses in the establishment premium ($\psi_{J(i,t)}$). Such losses can be conceptualized as a fall down the "establishment premium ladder". Workers often move from lower- to higher-paying establishments as they gain experience in the labor market. Upon displacement, they are forced to start searching for "good" establishments from scratch (e.g., Burdett *et al.*, 2020; Jarosch, 2023). This fall down the establishment premium ladder may occur either within manufacturing or across sectors, especially if displaced workers transition into the service sector, where establishment premiums are lower (Table 1, Panel A). Consequently, establishment premium losses may partly reflect losses in sectoral wage premiums (as explored in Dickens and Katz, 1987, Krueger and Summers, 1988, Katz and Summers, 1989, and Card *et al.*, 2024, among others), stemming from a higher average productivity and rents in the manufacturing

sector (Table 2).[12] Structural change can further amplify these losses as the availability of high-paying manufacturing jobs declines and sectoral wage premiums widen (Table 1, Panel B).

A second potential reason for displacement wage losses is the reduction in 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 previously acquired skills. This factor may be particularly important for workers displaced from the manufacturing sector, especially if they search longer for a new job in the hope of securing another high-wage manufacturing job.

Third, displaced workers may suffer wage losses due to declines in occupation-specific human capital (e.g., Poletaev and Robinson, 2008, or Kambourov and Manovskii, 2009). When workers switch occupations, they are no longer rewarded for their previously acquired occupation-specific skills and need to start accumulating skills afresh in their new occupation. A switch out of the manufacturing 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, by definition, lose any establishment-specific human capital (Becker, 1964); that is, skills that are valuable only in the particular establishment, such as specialized knowledge of production processes or organizational routines.[13]

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 (e.g., Lachowska *et al.*, 2020).[14]

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 adding occupation and establishment tenure ($OccT_{it}$ and $EstT_{it}$) to the baseline model to capture occupation- and establishment-specific human capital accumulation. The aim of the extension is twofold. First, it

[12] Like Card *et al.* (2024), we define sectoral wage premiums as the average establishment premiums in the sector. This differs from earlier research, which determined sectoral wage premiums by regressing log wages on sector and worker fixed effects. Card *et al.* (2024) demonstrate that this understates the actual sectoral wage premiums.

[13] More generally, the term $f_{3i}(EstT_{it})$ in equation (1) may capture within-establishment wage growth beyond that resulting from general and occupation-specific human capital accumulation. For example, this could reflect the use of optimal contracts, where establishments prefer to pay employees below their marginal product initially and then pay wages above the marginal product over time, as discussed in Lazear (1979).

[14] 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 and hence they cannot differentiate between movements down the firm premium or the match quality ladder.

allows us to quantify the wage losses upon displacement due to losses in establishment- and occupation-specific human capital; and second, since establishment premiums ($\psi_{J(i,t)}$) and occupation and establishment tenure are likely positively correlated, omitting the tenure variables could result in biased establishment premium estimates. To measure the returns to general human capital, we would ideally like to control for actual experience ($ActExp_{it}$) in the augmented AKM regression. However, doing so would significantly restrict the time window available for studying displacement effects, as returns to general human capital tend to be less concave than returns to occupation or establishment tenure and may accumulate over many years after labor market entry. Therefore, we 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 α_i), 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.[15] We allow the returns to potential experience to vary by worker type ($WType_i$), distinguishing between low-, medium-, and high-wage workers. 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 this specification, we allow for a quadratic relationship between log wages and establishment and occupation tenure, and 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. The initial classification of worker types is based on the terciles of worker fixed effects estimated in a standard AKM model not controlling for occupation and establishment tenure. The final classification of worker types, however, is based on the terciles of worker fixed effects estimated in the augmented regression.

We estimate both the standard AKM and 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

[15] Potential experience is 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, instead, we assume that age profiles are flat at age 40 by omitting the linear age term and including a quadratic and cubic in age minus 40, as in Card *et al.* (2018), estimated establishment premiums are strongly correlated with those obtained from our preferred specification.

2010 (i.e., the last year that includes consistent occupation codes), using spells of all West German men and women in full-time employment aged 16 to 65 belonging to the leave-one-out connected set of workers and firms during this period.[16] Since a mass layoff may affect the premiums that establishments pay their employees, our sample excludes post-layoff observations of displacement establishments and displaced workers. We provide descriptive statistics about the AKM estimation sample in Appendix Table A.1.

It should be noted that, unlike the conceptual wage regression given by equation (1), the estimated AKM 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.[17]

It is well known that establishment and worker fixed effects estimated with 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, Bonhomme *et al.*, 2023). The exceptionally long estimation window of 27 years and the sample restriction to the largest leave-one-out connected set as proposed by Kline *et al.* (2020) reduces concerns about limited mobility bias. Moreover, as we describe in greater detail in Section 4.3.3, we use the establishment fixed effects as dependent variables when investigating to which extent wage losses following displacement can be attributed to losses in establishment premiums. Hence, any remaining measurement error in the establishment premium should not systematically bias our estimate.

Although limited mobility bias does not pose a problem in our primary analysis of displacement effects over time, it may affect the decomposition of the wage variance when analyzing the effects of structural change on the wage structure in Section 7. We show that our findings are robust to adopting a k-means clustering algorithm in the spirit of Bonhomme *et al.* (2019).

4.3. Empirical Strategy

Our empirical strategy combines matching with an event study approach and flexibly traces out labor market outcomes of displaced low- and high-wage workers compared to a control group of matched non-displaced workers. We next outline our matching procedure, then explain our baseline estimation

[16] We also estimate augmented AKM regressions over six-year rolling windows to relax the assumption of constant establishment premiums over time (see Appendix A.3.).
[17] The AKM model further assumes additive separability between worker and establishment fixed effects. Card *et al.* (2013) present evidence for Germany supporting this assumption. In addition, in a robustness check, we allow for establishments to pay different establishment premiums for different type of workers (see Appendix A.8).

regression, and finally describe how we decompose overall displacement wage losses into their various components.

4.3.1. Matching

To ensure that we compare displaced workers with their "statistical twins" —individuals who closely resemble displaced workers prior to the layoff—we match each displaced worker to a control worker with similar observed worker and establishment characteristics before the layoff. Our sample of potential control workers consists of all workers who fulfill the same sample restrictions as the displaced workers (see Section 3.2).[18] 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 classification of the workplace (four broad industries in the manufacturing sector and ten broad industries in the service sector). We further match 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 in which displaced and non-displaced workers share identical coarsened characteristics within each cell. For each displaced worker, we then randomly select one non-displaced worker from the corresponding cell. This matching approach 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 prior to the mass layoff to account for the possibility that the imminent job loss may affect the wages of displaced workers even before the actual displacement occurs (similar to Couch and Placzek, 2010). Such pre-displacement losses might, for instance, 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 a large-scale layoff. Alternatively, they may capture reduced investments in general or specific human capital by workers and establishments. Employing a matching procedure that matches on characteristics only one year before the mass layoff or conditions on pre-displacement wage trends—as sometimes done in the literature—would then understate the overall wage loss attributable to displacement.

Tables A.2 and A.3 show that our matching procedure works well in ensuring that displaced and non-displaced workers in both the manufacturing and service sectors are nearly identical in their observed pre-layoff characteristics. While the design of the matching procedure forces displaced and matched non-displaced workers to be in the same skill group, broad sector, and have the same citizenship status, the matched pairs are also similar in terms of continuous characteristics like their

[18] Control group workers are allowed to become non-employed or change employers in any period following the mass layoff event.

pre-displacement wage, worker and establishment fixed effects, age, and establishment and occupation tenure. In contrast, there are considerable differences in pre-layoff characteristics between displaced workers and randomly selected (non-matched) non-displaced workers, highlighting the importance of the matching procedure in controlling for potential confounders (columns (5) and (10) of Table A.2 and Table A.3).

4.3.2. Estimation Regression

We then compare the labor market outcomes of displaced and matched non-displaced workers in the six years before and after displacement, separately for low- and high-wage workers. Specifically, we estimate the following model:

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

where the subscript τ denotes the time period relative to the year of the mass layoff. Displacement occurs between $\tau = -1$ and $\tau = 0$, and 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 $\theta_{c\tau}$.[19] The inclusion of cell-by-period fixed effects ensures that we compare outcomes of displaced and matched control workers within the same cell and in the same period relative to job displacement, thereby accounting for selection into work after job displacement based on matched characteristics. Worker fixed effects account for potential selection into work based on time-invariant worker characteristics within cells.[20] 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 the coefficients β_τ, which measure the difference in the outcome of interest between displaced workers and their matched non-displaced counterparts 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 $Displ_{i,t}^{-4}$ from the regression.

[19] 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.
[20] Since our cells are very narrowly defined and workers barely differ within cells, the inclusion of worker fixed effects in addition to cell-by-period fixed effects has little impact on our estimates.

4.3.3. Decomposition of Displacement Wage Losses

To decompose displacement wage losses into their 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 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). 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) twice with the residualized net log wage as dependent variable: once controlling flexibly for years out 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. This difference captures both the reduced opportunities to accumulate new general skills and the depreciation of existing general skills, representing the overall impact of displacement on general human capital.

Finally, we interpret the worker-firm-specific average of the residual wage loss—the portion of the wage loss not explained by losses in establishment premiums, returns to occupation-specific and establishment-specific tenure, or actual experience—as a loss in match quality. In Appendix A.1, we also explicitly estimate the loss in match quality following the approach of Lachowska *et al.* (2020), which builds on Woodcock (2015). These estimates are qualitatively similar to the residual displacement wage loss we estimate.

5. Displacement Effects by Worker Type

We begin by analyzing the employment and wage effects of job displacement and their underlying sources in a pooled sample of workers displaced between 1990 and 2004. Our focus is on

contrasting the magnitude and sources of displacement effects for low- and high-wage workers, as well as between the manufacturing and service sectors. Section 6 then shifts the focus to changes in the cost of job displacement over time using our larger time series sample for workers displaced between 1988 and 2007.

5.1. Employment and Wage Effects

Employment Effects. Panels A.1 and B.1 of Figure 2 display the employment effects of displacement, differentiated by worker type and displacement sector. 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 virtually identical also five and six years before the mass layoff, confirming that our matching procedure works well.

While employment probabilities fall sharply upon displacement for both low- and high-wage workers, the decrease is more pronounced for low-wage workers in both manufacturing and services －57 vs. 33 percentage points in manufacturing and 42 vs. 29 percentage points in services. Although employment gradually recovers over time and low-wage workers are catching up, the losses remain persistent: six years after displacement, the employment of low-wage workers is still 18 percentage points lower in manufacturing and 15 percentage points lower in services.

Wage Losses. Panels A.2 and B.2 of Figure 2 show the average wage effects of displacement by worker type and displacement sector. The corresponding point estimates and standard errors are reported in Appendix Tables A.4 and A.5. Notably, wage losses following displacement are considerably larger in the manufacturing sector than in the service sector. In the year of the layoff, low-wage workers displaced from manufacturing experience an average wage decline of 8 percent, compared to a smaller decline of 2 percent in the service sector. In both sectors, high-wage workers face larger wage reductions than low-wage workers (11 vs. 8 percent in manufacturing and 6 vs. 2 percent in services). While wages recover somewhat over time for low-wage workers, high-wage workers' wages remain largely stable after displacement.

In both sectors, wages begin to decline before the actual layoff for both low- and high-wage workers (by about 3 percent). Matching on workers' wages one year (instead of four years) before the layoff would therefore understate the true displacement wage loss. There is, however, little evidence of wage differences between laid-off workers and the control group between six and four years prior to displacement, suggesting that our matching procedure successfully removes potential differences between displaced and non-displaced workers.

5.2. Sources of Displacement Wage Losses

Which factors account for the larger wage losses in manufacturing compared to the service sector, and why do high-wage workers experience greater wage losses than low-wage workers? Are these patterns driven by differences in losses in establishment premiums, declines in general human capital, or losses in occupation- or establishment-specific skills? We present evidence on these questions in Figure 3, where we decompose the overall wage loss into its components, as described in Section 4.3.3. We report the corresponding point estimates and standard errors in Appendix Tables A.4 and A.5.

Establishment Premiums. Starting with losses in establishment premiums, two notable findings emerge. First, although overall wage losses after displacement are larger for high-wage workers than for low-wage workers, low-wage workers experience substantially greater losses in establishment premiums—particularly in the manufacturing sector—losing 6.1 percent versus 3.2 percent one year after the layoff.[21] Consequently, low-wage workers face greater difficulties in securing new employment in high-paying establishments after displacement. For both types of workers, losses in establishment premiums remain largely constant over time since displacement. This suggests that workers do not climb back up the establishment premium ladder after being laid off.

Second, losses in establishment premiums are considerably larger in the manufacturing sector compared to the service sector. The difference is particularly pronounced among low-wage workers (6.1 vs. 1.4 percent, compared to 3.2 vs. 0.6 percent for high-wage workers one year after the layoff). This differential decline in establishment premiums largely explains the greater overall displacement wage losses observed in manufacturing.

Specific and General Human Capital. While losses in establishment premiums vary markedly between workers displaced from manufacturing and service establishments, losses attributable to general, occupation-specific, and establishment-specific human capital are more comparable. Losses in occupation-specific human capital are initially substantial. However, due to their concave profiles and the fact that displaced workers gradually rebuild occupation-specific skills, the impact diminishes over time. In contrast, losses from missed general human capital accumulation are initially low but increase over time for both worker types. Six years after the layoff, wage losses due

[21] The larger establishment premium loss for low-wage workers is even more remarkable in light of the finding 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.3). Indeed, when we apply reweighting to make the establishment premium distribution of low-wage workers resemble that of high-wage workers, losses in wages and establishment premiums for low-wage workers increase (see Appendix Figure A.4).

to general human capital are of similar magnitude to those from occupation-specific human capital, while losses in establishment-specific human capital play only a minor role.

Total Wage Loss and Losses in Match Quality. For low-wage workers, losses in establishment premiums, establishment-specific, occupation-specific, and general human capital more than explain the total wage loss in both the manufacturing and service sectors. A different picture emerges for high-wage workers: losses in establishment premiums and human capital account for only about 50 percent of the overall wage loss four years after the layoff. One possible interpretation is that low-wage workers experience an improvement in match quality following displacement, whereas high-wage workers face a decline. When we directly estimate match quality using the approach of Lachowska *et al.* (2020), the results support this view (see Appendix A.1 and Tables A.4 and A.5). This interpretation aligns with findings in Haltiwanger *et al.* (2018), which suggest that moves up the job ladder primarily operate through movements to better-paying establishments for low-wage workers, but through movements to higher-quality matches for high-wage workers.

Reconciling Findings in the Existing Literature. The heterogeneous impacts of displacement across worker types and sectors help reconcile the recent findings on the roles of establishment and firm premiums in the literature. Lachowska *et al.* (2020) found a smaller decline in firm premiums and a larger decline in match quality after displacement than other papers in the literature, such as Bertheau *et al.*, 2023, and Schmieder *et al.*, 2023. In Lachowska *et al.* (2020), the manufacturing sector is underrepresented, while the finance sector—and thereby likely high-wage workers—is strongly overrepresented. Our results indicate that losses in establishment premiums are particularly severe among low-wage workers displaced from manufacturing. In contrast, high-wage workers experience larger declines in match quality than in establishment premiums, which aligns with the findings in Lachowska *et al.* (2020).[22]

5.3. Sectoral Switching and Losses in Establishment Premiums

Why are displacement losses in establishment premiums larger in the manufacturing sector than in the service sector, and why are they larger for low-wage than for high-wage workers? We argue that this is partly due to the higher establishment premiums paid in the manufacturing sector (see Table 1) and a higher propensity of low-wage workers to switch out of manufacturing and into the service sector after displacement.

Table 3 presents findings that support this view. Focusing first on workers displaced from manufacturing establishments, low-wage workers are considerably more likely to leave the

[22] Bertheau *et al.* (2023) also find that the share of wage losses explained by establishment premium losses tends to be larger for countries with a higher share of workers laid off from the manufacturing sector.

manufacturing sector after displacement than high-wage workers (36.7 vs. 29.8 percent four years after the layoff). They are also more likely to move into the low-knowledge service sector (26.1 vs. 15.3 percent), where establishment premiums are particularly low, whereas high-wage workers are more likely to transition into the high-knowledge service sector (9.7 vs. 6.9 percent), where establishment premiums are higher.

Moreover, the destination sector strongly predicts the wage loss following displacement from a manufacturing establishment. Workers who transition to the low-knowledge service sector experience considerably larger wage losses than workers who remain employed in manufacturing (14.9 vs. 4.7 percent among low-wage workers) or transition to the high-knowledge service sector (7.7 percent). These larger losses are almost entirely explained by larger losses in establishment premiums (13.0 percent vs. 3.6 and 5.6 percent, respectively). In contrast, other sources of displacement wage losses, such as losses in general and specific human capital or match quality, barely differ across destination sectors.

A simple back-of-the-envelope calculation suggests that sectoral switching alone can account for about half of the difference in the loss of establishment premiums between low- and high-wage workers in manufacturing. The remainder is explained by low-wage workers facing larger losses in establishment premiums even when staying in the manufacturing sector (see Appendix B.1 for details).

Importantly, conditional on finding re-employment in the service sector after displacement, workers experience much larger losses in establishment premiums when displaced from manufacturing compared to the service sector (for low-wage workers, 13.0 percent when re-employed in low-knowledge services and 5.6 percent in high-knowledge services vs. 2.5 percent among service-sector workers who stay in services). Low-wage and high-wage workers who transition from services to the higher-paying manufacturing sector instead experience an increase in establishment premiums.

A simple back-of-the-envelope calculation suggests that differences in establishment premiums across sectors alone can account for two-thirds of the difference in the establishment premium loss between the manufacturing and service sectors (see Appendix B.2 for details).

5.4. Robustness

In Appendix A and Table A.6, we show that our main conclusions are robust to a number of variations in estimation choices, focusing on workers displaced from manufacturing. For easier exposition, we here present results for the full sample, pooled for low-, medium-, and high-wage workers. Columns (1.1) and (1.2) show our baseline estimates of the displacement effects on wages and establishment premiums. Our findings are robust to estimating establishment premiums according to standard AKM regressions that do not control for establishment and occupation tenure

(column (1.3) and Appendix A.2); estimating establishment premiums using 27 six-year rolling periods rather than a single 27-year period (column (1.4) and Appendix A.3); restricting the sample to workers who were displaced from their firm because of a plant closure (columns (2.1) and (2.2) and Appendix A.4); relaxing the high pre-displacement establishment tenure restriction of four years to two years (columns (3.1) and (3.2) and Appendix A.5); and matching additionally on establishment size and commuting zone (columns (4.1) and (4.2) and Appendix A.6).

6. Trends in Displacement Effects over Time

Our findings thus far indicate that workers displaced from manufacturing experience larger wage losses than workers displaced from the service sector, and that low-wage workers displaced from manufacturing experience larger losses in establishment premiums than high-wage workers, partly because they are less likely to remain employed in the manufacturing sector, where establishment premiums are high. Since structural change has steadily eroded employment opportunities in manufacturing—especially for low-wage workers—transitions out of the manufacturing sector may have become more frequent over time, resulting in increasingly large wage losses upon displacement. To investigate this, we next examine how the cost of job displacement has evolved over time by dividing our time series sample into ten two-year periods, starting with 1988-1989 and ending with 2006-2007. We then estimate equation (3) separately for each two-year period and for low- and high-wage workers, and compare outcomes three years after a mass layoff across time.

6.1. Employment and Wage Effects Over Time

Figure 4 (Panels A.1 and B.1) shows that the costs of displacement from manufacturing have indeed increased over time, particularly among low-wage workers. These workers are increasingly less likely to be re-employed three years after a mass layoff, both in absolute terms and relative to high-wage workers (Panel A.1). While re-employment probabilities exhibit a clear cyclical component, the linear trend lines indicate that the likelihood of working three years after the mass layoff declined by around 10 percentage points from the late 1980s to the mid-2000s for low-wage workers. In contrast, high-wage workers experienced a smaller reduction of about 4 percentage points over the same period.

Not only are low-wage manufacturing workers increasingly less likely to be reemployed after displacement, but they also face increasing wage losses, both in absolute terms and relative to high-wage workers (Panel B.1). Whereas the wage losses of high-wage workers have remained roughly stable over time, at about 10 to 13 percent three years after displacement, the wage losses of low-wage workers increased from about 3 percent in the mid-1980s to 14 percent by the mid-2000s.[23]

[23] While our focus is on trends in displacement wage losses, Panel B of Figure 4 further shows that wage losses appear to be larger in recessions, in line with the findings of Schmieder *et al.* (2023).

Panels A.2 and B.2 of Figure 4 show the evolution of employment and wage effects for workers displaced from service sector establishments. Among high-wage workers, trends in employment and wage losses are relatively similar across the two sectors. In contrast, among low-wage workers, the differences across the two sectors are more pronounced: although displacement costs have also increased somewhat in the service sector, the magnitude of the increase is considerably more pronounced in manufacturing. Given the steeper rise in displacement costs in manufacturing, we focus on manufacturing throughout the remainder of this section.

6.2. Sources of Displacement Wage Losses over Time

Which factors account for the increasing post-displacement wage losses among low-wage workers displaced from the manufacturing sector, both in absolute terms and relative to high-wage workers? We examine the changing sources of displacement wage losses in Figure 5. In Panels A.1 and B.1 of the figure, we show the absolute wage losses attributable to losses in establishment premiums, losses in general and specific human capital, and losses in match quality (i.e., the residual component) three years after displacement over time, separately for low- and high-wage workers. In Panels A.2 and B.2 of the figure, we present the changes in the overall displacement wage losses between the first two and last two two-year periods, along with the contribution of each of the five factors to the overall change.

The figure illustrates that losses in establishment premiums play a key role. Among low-wage workers, these losses are by far the most important driver behind the increasing displacement losses over time, accounting for approximately three-fourth of the increase in overall wage losses. Missed opportunities for general human capital accumulation account for an additional 15 percent, consistent 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 a relatively minor role, indicating that there are no major shifts in the frequency with which displaced workers switch 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.

The increasing losses in establishment premiums among low-wage workers could, in principle, simply reflect changes in the composition of displaced workers or displacing establishments. For example, high-wage establishments may account for an increasingly large share of mass layoff establishments over time, resulting in larger displacement wage losses. In Appendix A.7 and Figure A.5, we show that such compositional changes are small in magnitude and do not drive our findings. We support this conclusion using a reweighting approach that effectively maintains a stable distribution of worker and firm fixed effects over time, as well as an alternative method that models

individual wage losses and controls for composition effects in a unified regression, as suggested by Schmieder *et al.* (2023). In Figure A.6 we further show that the larger increases in displacement losses over time for low-wage workers are not merely an artifact of restricting establishment premiums to be the same across worker types (see also Appendix A.8). Additionally, we observe similar trends when distinguishing between low- and high-skilled workers based on their formal education (Appendix A.9 and Figure A.7).

6.3. Structural Change and Losses in Establishment Premiums over Time

Post-displacement Sectoral Switching. Has structural change and the decline in job opportunities in the manufacturing sector contributed to these increasing establishment premium losses? We present evidence in line with this hypothesis in Panel A of Figure 6. The figure highlights that low-wage workers are increasingly less likely to remain employed in the manufacturing sector and 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 26 percent in the 1988-1989 period to about 40 percent in the 2006-2007 period. Concurrently, the share of low-wage workers moving into the low-knowledge service sector increased by about 14 percentage points, from 16 to about 30 percent. In contrast, sectoral switching patterns among high-wage workers have remained relatively stable over time.

Establishment Premium Losses Within and Between Sectors. In Panel B of Figure 6, we examine how the losses in establishment premiums following displacement from the manufacturing sector have evolved over time, conditional on the destination sector. Three main findings emerge. First, among low-wage workers, losses in establishment premiums have increased over time regardless of the destination sector. Second, this increase has been particularly pronounced among those low-wage workers who transitioned to the low-knowledge service sector; for these workers, losses in establishment premiums almost tripled over our sample period, from about 7 to 20 percent. Third, while high-wage workers also experience increasing losses in establishment premiums when moving to the low-knowledge service sector, the increase is considerably smaller than that observed for low-wage workers.

In order to quantify the extent to which structural change has contributed to the increase in establishment premium losses among low-wage workers over time, we decompose the increase into a within-sector and between-sector component (see Appendix B for details). We display our findings in Table 4. About 40 percent of the increase in establishment premium losses over time occurs between sectors (3.5 of a total increase of 9.2 percent), while losses within the manufacturing sector account for the remaining 60 percent. Further decomposing the between-sector component into a component capturing increased sectoral switching and a component capturing increased sectoral wage

premiums, we find that increased sectoral wage premiums account for around two-thirds of the between-sector increase (2.3 of 3.5 percent), while increased sectoral switching explains the remaining third (1.3 of 3.5 percent).

Structural change has thus shifted low-wage workers away from high-paying jobs in the manufacturing sector into increasingly low-paying jobs in the low-knowledge service sector, thereby significantly contributing to the rise in establishment premium losses following job displacement. However, even among low-wage workers who remain employed in manufacturing after displacement, losses in establishment premiums have increased over time. Several interconnected reasons may have contributed to this trend. First, as shown in Table 1, establishment premiums within manufacturing have become more dispersed over time, which tends to amplify the losses in establishment premiums for workers falling down the establishment premium ladder. Second, union coverage rates have declined substantially in manufacturing (Table 2), potentially leading to a reduction in union wage premiums. Third, a potential increase in firms' monopsony power may have contributed to the rise in establishment premium losses within manufacturing (Dodini *et al.*, 2024a). These factors may also have contributed to the moderate increase in wage losses for low-wage workers displaced from a service sector firm (as shown in Figure 4).

Production Jobs vs. Service Jobs. A recent literature has documented substantial wage losses resulting from declines in firm-specific rents for (primarily low-wage) workers whose jobs have been outsourced, typically from manufacturing firms to firms in the low-knowledge service sector (e.g., Goldschmidt and Schmieder, 2017). It is important to emphasize that the patterns we document—increasingly large displacement wage losses driven by growing losses in establishment premiums—are not limited to low-wage workers at risk of domestic outsourcing. Instead, these patterns affect all low-wage workers in the manufacturing sector. Figure 7 demonstrates that low-wage workers displaced from both production and service occupations experience increasingly large wage losses over time. Moreover, for both groups, a similar share of these growing wage losses can be attributed to losses in establishment premiums.

6.4. Local Variation in Structural Change and Displacement Losses

To provide further evidence on the link between structural change and increasing losses in establishment premiums following displacement, we next leverage variation in structural change across commuting zones. We consider commuting zones to be more affected by structural change if they experienced stronger shifts in their broad industry structure, leading to changes in average establishment premiums in the region. Specifically, we first compute for each year the average sectoral establishment fixed effect at the national level, distinguishing between four broad sectors (manufacturing, low-knowledge services, high-knowledge services, and other sectors). We then

calculate the predicted average establishment fixed effect in the commuting zone in year *t* as a weighted average of the national sector-specific fixed effects, using the commuting zone's employment shares in each broad sector as weights. Commuting zones with larger declines in average establishment premiums between 1988 and year *t* are assumed to experience a higher rate of structural change.

We then apply the method proposed by Schmieder *et al.* (2023). Focusing on low-wage workers in the manufacturing sector, we first obtain an "individual treatment effect" of job loss for each individual by comparing the change in establishment premiums before and after displacement for each displaced worker with that of their matched control worker. We regress these effects on year dummies, both unconditionally to obtain the baseline estimate and conditionally on our local measure of structural change. The findings, presented in Figure 8, are striking: losses in establishment premiums grow significantly less over time once we account for local structural change (solid black line vs short-dashed blue line).

We repeat the exercise using changes in the local unemployment rate as a control variable instead of our local measure of structural change to analyze whether overall deteriorating labor market conditions help explain the increase in establishment premium losses following displacement. However, controlling for local unemployment rates does not have a noticeable impact on the estimated losses from displacement over time (denoted by the long-dashed green line in Figure 8).[24]

Overall, these findings strongly support the hypothesis that structural change has contributed to the rising wage and establishment premium losses experienced by low-wage workers displaced from manufacturing firms.

6.5. Structural Change and Gender

Since manufacturing is a male-dominated sector—nearly three-quarters of workers in the sector are men—researchers and policymakers often argue that structural change has disproportionately affected men (e.g., Autor *et al.*, 2013, 2019, Charles *et al.*, 2019, Gould, 2021, for the US). This perspective, however, overlooks differences in the sector's gender composition by worker type: most women employed in manufacturing are low-wage workers. Put differently, women account for 53 percent of low-wage workers, but only 11 percent of high-wage workers in manufacturing (Table 5, Panel A). Moreover, even within worker type, women exhibit lower average AKM worker fixed effects than men, a disparity that is particularly pronounced among low-wage workers (Panel B).

Our analysis highlights that low-wage workers in manufacturing are particularly affected by structural changes, while high-wage workers tend to be more insulated from these shifts.

[24] We also consider it unlikely that the Hartz Reforms, enacted between 2003 and 2005, play a major role, as most of the increased losses over time take place in the period before (see e.g. Figure 4 and 5).

Consequently, given the near-equal representation of women among low-wage manufacturing workers, women may be as affected as men by the decline of manufacturing. To examine this directly, Figure 9 compares the wage and establishment premium losses of low-wage men and women displaced from manufacturing (represented by the solid black and blue lines). The figure shows that the magnitude of wage and establishment premium losses is similar for both men and women. Additionally, these losses have increased substantially over time for both genders.

Women and men employed in manufacturing differ not only in their worker fixed effects but also in the characteristics of the establishments where they work. Women—particularly low-wage women— are employed in establishments that pay lower premiums (Table 5, Panel C). The dashed lines in Figure 9 display the wage and establishment premium losses for women when we reweight the female sample to match the male distributions of worker fixed effects and establishment premiums. Consistent with Illing *et al.* (2024), we find that women experience larger wage losses than observationally similar men. However, the overall time trends do not differ by gender. Reweighting has little impact on establishment premium losses, which remain similar across genders.[25]

Overall, these findings suggest that men and women are similarly impacted by structural change.

7. Structural Change, the Wage Structure, and Job Polarization

Our findings in Section 6 highlight that, amid ongoing structural change, low-wage men and women experience increasingly severe wage and establishment premium losses when displaced from manufacturing. Next, we explore the role of structural change as one key driver behind the rise in wage inequality and job polarization observed in several developed countries.

7.1. Structural Change and the Wage Structure

Wage inequality has increased across developed countries, and firms have played an important role in this process (e.g., Card *et al.*, 2013; Song *et al.*, 2019). In line with Card et al. (2013), we confirm this trend for Germany in Table 6, Panel A. Over our sample period, the variance of log daily wages among West German workers increased substantially — from 0.200 in 1988 to 0.302 in 2007. Similarly, the variance of establishment premiums rose from 0.033 in 1988 to 0.061 in 2007, while (two times) the covariance between worker and establishment fixed effects — a commonly used measure of the degree of assortative matching of workers to firms — increased from 0.014 in 1988 to 0.031 in 2007. Since worker and establishment fixed effects are constant throughout the sample

[25] We present the corresponding results for high-wage workers in Appendix Figure A.8. While wage losses are somewhat larger for women than men, losses in establishment premiums and trends over time are similar for the two genders.

period, the increase in the dispersion of establishment premiums and the assortative matching of workers to establishments solely reflect selective establishment entry and exit and the reallocation of workers among continuing establishments.[26]

Next, we ask what the increase in wage inequality, the dispersion in establishment premiums, and the covariance between worker and establishment effects would have been if the broad sectoral composition—namely manufacturing, low-knowledge services, and high-knowledge services—by worker type (low-, medium-, and high-wage) had remained at its 1988 levels. To construct the counterfactual wage structure, we adopt the reweighting method proposed by DiNardo *et al.* (1996). The results suggest that shifts in the broad industry structure have played a significant role: they account for about 15.2 percent of the increase in wage dispersion between 1988 and 2007, 13.5 percent of the increase in the dispersion of establishment premiums, and 19.6 percent of the increase in the covariance between worker and establishment fixed effects (see Table 6, Panel A).

Despite our long estimation window and the restriction to the largest leave-one-out connected set, these findings may be affected by limited mobility bias. To address this concern, we repeat the analysis by first classifying firms into 100 groups based on their empirical wage distributions using a k-means clustering algorithm in the spirit of Bonhomme *et al.* (2019). We then estimate the augmented AKM model, including worker fixed effects and establishment groups. The overall patterns that we emphasize remain unchanged (see Table 6, Panel B).

Overall, these findings highlight that shifts in the broad industry structure significantly contributed to the increase in wage inequality, specifically the assortative matching of high-wage workers to high-wage firms observed over our sample period. The effects of structural change on wage dispersion are similar in magnitude to the effects of outsourcing reported by Goldschmidt and Schmieder (2017). They are also consistent with the findings of Haltiwanger *et al.* (2024) who show that 10 percent of four-digit industries account for most of the increase in (between-industry) wage dispersion. These industries include high-paying, high-tech sectors and low-paying retail sectors, which align with the high-knowledge and low-knowledge service sectors analyzed in our paper.

7.2. Structural Change and Job Polarization

Job polarization—whereby employment in occupations situated in the middle of the wage distribution has declined relative to employment in occupations located at the bottom or top—has increased across developed countries (e.g., Autor and Dorn, 2013, and Goos *et al.*, 2014). While the existing literature

[26] This is in contrast to Card *et al.* (2013) who estimate worker and firm fixed effects (unconditional on occupational and establishment tenure) separately for four non-overlapping six-year time periods and compare the components of the variance of log-wages across those periods.

has thus far emphasized the importance of tasks and technological change in explaining this trend, our results highlight the importance of establishment premiums that vary across sectors.

We provide support for this hypothesis in Figure 10 where we rank occupations according to their median wage in 1988 (the "occupational wage percentile") and plot, separately for low- and high-wage workers and men and women, the share of workers employed in manufacturing (in 1988) and in the low- or high-knowledge service sector (in 2007) along the occupational wage distribution. Among low-wage workers, low-knowledge service sector jobs—which pay particularly low establishment premiums and have gained importance over time—are heavily overrepresented at the bottom of the occupational wage distribution (Panels A.1 and A.2). Relatedly, among high-wage workers, high-knowledge service jobs—which have become more significant for high-wage workers—are overrepresented at the top of the occupational wage distribution at the end of our sample period (Panels B.1 and B.2). These trends are of similar magnitude for men and women.

By contrast, the position of manufacturing jobs in the occupational wage distribution—jobs with particularly high establishment premiums that have disproportionately disappeared over time differs between men and women. In particular, among low-wage men, manufacturing jobs tend to be concentrated in the middle of the occupational wage distribution, whereas among low-wage women, they tend to be at the bottom of the distribution.

These findings support the hypothesis that the decline of high-paying manufacturing job opportunities and the growth of the more segmented service sector contributed to job polarization, particularly among men. This complements the work of Bárány and Siegel (2018) by highlighting the importance of lost establishment premiums due to structural change in explaining job polarization.

8. Conclusion

In this paper, we provide novel evidence on the consequences of structural change in employment away from manufacturing and toward the service sector. To this end, we focus on workers who lose their jobs due to a mass layoff. We document that structural change in the labor market has particularly severe consequences for low-wage manufacturing workers. For these workers, the costs of job displacement have 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, but they also suffer increasingly larger wage losses. This increase in wage losses is driven to a large extent by growing establishment premium losses over time, which in part reflect increased sectoral reallocation: 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 growing 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. Importantly, displacement wage losses have increased over time for both low-wage men and women, casting doubt on the hypothesis that structural change has mostly harmed men.

Overall, our findings demonstrate that the decline of manufacturing and the rise of the service sector have had particularly serious repercussions for low-wage workers, men and women alike. 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 observed in several developed countries (Card *et al.*, 2013, Song *et al.*, 2019). Using reweighting methods, we show that structural change can account for around 20 percent of the increase in assortative matching between workers and firms between 1988 and 2007.

Our findings also have important implications for the literature on job polarization (e.g., Autor and Dorn, 2013, Goos *et al.*, 2014). While this literature has thus far emphasized the importance of technological change and tasks, our results point to the importance of firm premiums that vary across sectors. Specifically, our findings are consistent with the notion that the hollowing out of jobs in the middle of the wage distribution is, in part, a consequence of the decline of the manufacturing sector and the rise of the service sector, as emphasized also by Bárány and Siegel (2018). We complement their findings by showing that the disappearance of middle-wage manufacturing jobs often involved low-wage workers employed in high-paying establishments, especially among men.

Currently, one of the most important active labor market policy tools to cushion the adverse effects of displacement in particular and structural change more generally 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 11.2 billion euros in 2019 on such policies (Weber *et al.*, 2020). Our findings, 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.

Recognizing that the manufacturing sector generally provides high-paying jobs for less-skilled workers, and that such jobs are becoming scarcer, some policymakers have pushed to bring back manufacturing jobs, for example, through industrial or trade policy. It is unclear, however, whether such policies can be successful or are even desirable. The challenge is 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 works 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.

References

Abowd, J. M., Kramarz, F., and Margolis, D. N. (1999), "High-Wage Workers and High-Wage Firms", *Econometrica*, 67(2), pp. 251-333.

Andrews, M. J., Gill, L., Schank, T., and Upward, R. (2008), "High Wage Workers and Low Wage Firms: Negative Assortative Matching or Limited Mobility Bias?", *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 171(3), pp. 673-697.

Autor, D. H. and Dorn, D. (2013), "The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market", *American Economic Review*, 103(5), pp. 1553-1597.

Autor, D. H., Dorn, D., and Hanson, G. H. (2013), "The China Syndrome: Local Labor Market Effects of Import Competition", *American Economic Review*, 103(6), pp. 2121-2168.

Autor, D., Dorn, D., and Hanson, G. (2019), "When Work Disappears: Manufacturing Decline and the Falling Marriage-Market Value of Young Men", *American Economic Review: Insights*, 1(2), pp. 161-178.

Bárány, Z. L. and Siegel, C. (2018), "Job Polarization and Structural Change", *American Economic Journal: Macroeconomics*, 10(1), pp. 57-89.

Bárány, Z. L. and Siegel, C. (2020), Biased Technological Change and Employment Reallocation, *Labour Economics*, 67(C), 101930.

Becker, G. S. (1964), *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*, Chicago and London: University of Chicago Press.

Benmelech, E., Bergman N. K., and Kim, H. (2022), "Strong Employers and Weak Employees", *Journal of Human Resources*, 57(S) S200-S250.

Bertheau, A., Acabbi, E., Barceló, C., Gulyas, A., Lombardi, S., and Saggio, R. (2023), "The Unequal Costs of Job Loss Across Countries", *American Economic Review: Insights*, 5(3), pp. 393-408.

Bonhomme, S., Holzheu, K., Lamadon, T., Manresa, E., Mogstad, M., and Setzler, B. (2023). "How Much Should We Trust Estimates of Firm Effects and Worker Sorting?", *Journal of Labor Economics*, 41(2), pp. 291-322.

Bonhomme, S., Lamadon, T., and Manresa, E. (2019), "A Distributional Framework for Matched Employer Employee Data", *Econometrica*, 87(3), pp. 699-739.

Burdett, K., Carrillo-Tudela, C., and Coles, M. (2020), "The Cost of Job Loss", *Review of Economic Studies*, 87(4), pp. 1757-1798.

Card, D., Heining, J., and Kline, P. (2013), "Workplace Heterogeneity and the Rise of West German Wage Inequality", *Quarterly Journal of Economics*, 128(3), pp. 967-1015.

Card, D., Cardoso, A. R., Heining, J., and Kline, P. (2018), "Firms and Labor Market Inequality: Evidence and Some Theory", *Journal of Labor Economics*, 36(S1), pp. S13-S70.

Card, D., Rothstein, J., and Yi, M. (2024), "Industry Wage Differentials: A Firm-Based Approach", *Journal of Labor Economics*, 42(S1), pp. S11-S59.

Charles, K. K., Hurst, E., & Schwartz, M. (2019). The transformation of manufacturing and the decline in US employment. NBER Macroeconomics Annual, 33(1), 307-372.

Couch, K. A. and Placzek, D. W. (2010), "Earnings Losses of Displaced Workers Revisited", *American Economic Review*, 100(1), pp. 572-589.

Davis, S. J. and Von Wachter, T. (2011), "Recessions and the Costs of Job Loss", *Brookings Papers on Economic Activity*, pp. 1-72.

Dickens, W. T. and Katz L. F. (1987), "Inter-Industry Wage Differences and Industry Characteristics", in: Lang K. and Leonard, J., *Unemployment and the Structure of Labor Markets*, Oxford: Blackwell, pp. 48-89.

DiNardo, J., Fortin, N. M., and Lemieux, T. (1996), "Labor Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach", *Econometrica*, 64(5), pp. 1001-1044.

Dodini, S., Lovenheim, M., Salvanes, K., and Willén, A. (2024a), "Monopsony, Job Tasks, and Labor Market Concentration", *Economic Journal*, 134(661), pp. 1914-1949.

Dodini, S., Salvanes, K., and Willén, A. (2024b), "The Dynamics of Power in Labor Markets: Monopolistic Unions versus Monopsonistic Employers", working paper.

Dustmann, C., Ludsteck, J., and Schönberg, U. (2009), "Revisiting the German Wage Structure", *Quarterly Journal of Economics*, 124(2), pp. 843-881.

Fackler, D., Mueller, S., and Stegmaier, J. (2021), "Explaining Wage Losses After Job Displacement: Employer Size and Lost Firm Wage Premiums", *Journal of the European Economic Association*, 19(5), pp. 2695-2736.

Farber, H. S. (2004), "Job Loss in the United States, 1981-2001", *Research in Labor Economics*, 23, pp. 69-117.

Farber, H. S. (2017), "Employment, Hours, and Earnings Consequences of Job Loss: U.S. Evidence from the Displaced Workers Survey", *Journal of Labor Economics*, 35(S1), pp. S235-S272.

Financial Times (2020), "Germany's Shift to Electric Cars Puts 400,000 Jobs at Risk in Next Decade", January 13 2020.

Financial Times (2025), "Can Anything Halt the Decline of German Industry?", November 12 2025.

Fitzenberger, B., Osikominu, A., and Völter, R. (2006), "Imputation Rules to Improve the Education Variable in the IAB Employment Subsample", in *Schmollers Jahrbuch: J. Appl. Soc. Sci. Stud. / Zeitschrift für Wirtschafts- und Sozialwissenschaften*, 126(3), pp. 405-436.

Gathmann, C., Helm, I., und Schönberg, U. (2020), "Spillover Effects of Mass Layoffs", *Journal of the European Economic Association*, 18(1), pp. 427-468.

Goldschmidt, D. and Schmieder, J. F. (2017), "The Rise of Domestic Outsourcing and the Evolution of the German Wage Structure", *Quarterly Journal of Economics*, 132(3), pp. 1165-1217.

Goos, M., Manning, A., and Salomons, A. (2014), "Explaining Job Polarization: Routine-Biased Technological Change and Offshoring", *American Economic Review*, 104(8), pp. 2509-2526.

Gould, E. D. (2021), "Torn Apart? The Impact of Manufacturing Employment Decline on Black and White Americans", *Review of Economics and Statistics*, 103(4), 770-785.

Grupp, H., Jungmittag, A., and Schmoch, U. (2000), "Hochtechnologie 2020: Neudefinition der Hochtechnologie für die Berichterstattung zur technologischen Leistungsfähigkeit Deutschlands", Fraunhofer-Institut für Systemtechnik und Innovationsforschung, report.

Gulyas, A. and Pytka, K. (2025), "Understanding the Sources of Earnings Losses After Job Displacement: A Machine-Learning Approach", working paper.

Haltiwanger, J., Hyatt, H., and McEntarfer, E. (2018), "Who Moves Up the Job Ladder?", *Journal of Labor Economics*, 36(S1), pp. 301-306.

Haltiwanger, J., Hyatt, H. R., and Spletzer, J. R. (2024), "Rising Top, Falling Bottom: Industries and Rising Wage Inequality", *American Economic Review*, 114(10), pp. 3250-3283.

Hethey, T. and Schmieder, J. F. (2010), "Using Worker Flows in the Analysis of Establishment Turnover: Evidence from German Administrative Data", *FDZ Methodenreport*, Institut für Arbeitsmarkt- und Berufsforschung (IAB), Nürnberg [Institute for Employment Research, Nuremberg, Germany].

Hijzen, A., Upward, R., and Wright, P. (2010), "The Income Losses of Displaced Workers", *Journal of Human Resources*, 45(1), pp. 245-271.

Huckfeldt, C. (2022), "Understanding the Scarring Effect of Recessions", *American Economic Review*, 112(4), pp.1273-1310.

Iacus, S., King, G., and Porro, G. (2012), "Causal Inference without Balance Checking: Coarsened Exact Matching", *Political Analysis*, 20(1), pp. 1-24.

Illing, H., Schmieder, J. F., and Trenkle, S. (2024), "The Gender Gap in Earnings Losses after Job Displacement", *Journal of the European Economic Association*, 22(5), pp. 2108-2147.

Jacobson, L. S., LaLonde, R. J., and Sullivan, D. G. (1993), "Earnings Losses of Displaced Workers", *American Economic Review*, 83(4), pp. 685-709.

Jarosch, G. (2023), "Searching for Job Security and the Consequences of Job Loss", *Econometrica*, 91(3), pp. 903-942.

Jung, P. and Kuhn, M. (2019), "Earnings Losses and Labor Mobility Over the Life Cycle", *Journal of the European Economic Association*,17(3), pp. 678-724.

Kambourov, G. and Manovskii, I., (2009), "Occupational Specificity of Human Capital", *International Economic Review*, 50(1), pp. 63-115.

Katz, L. F. and Summers, L. H. (1989), "Industry Rents: Evidence and Implications", *Brookings Papers on Economic Activity: Microeconomics*, pp. 209-290.

Kline, P., Saggio, R., and Sølvsten, M. (2020), "Leave-out Estimation of Variance Components", *Econometrica*, 88(5), pp. 1859-1898.

Krolikowski, P. (2017), "Job Ladders and Earnings of Displaced Workers", *American Economic Journal: Macroeconomics*, 9(2), pp. 1-31.

Krueger, A. B. and Summers, L. H. (1988), "Efficiency Wages and the Inter-Industry Wage Structure", *Econometrica*, 56(2), pp. 259-293.

Lachowska, M., Mas, A., and Woodbury, S. A. (2020), "Sources of Displaced Workers' Long-Term Earnings Losses", *American Economic Review*, 110(10), pp. 3231-3266.

Lazear, E. P. (1979), "Why Is There Mandatory Retirement?", *Journal of Political Economy*, 87(6), pp. 1261-1284.

Mincer, J. (1974), *Schooling, Experience and Earnings*, New York: National Bureau of Economic Research.

Moore, B. and Scott-Clayton, J., (2025), "The Firm's Role in Displaced Workers' Earnings Losses", *ILR Review,* 78(3), pp. 517-542.

Neal, D. (1995), "Industry-specific Human Capital: Evidence from Displaced Workers", *Journal of Labor Economics*, 13(4), pp. 653-677.

Poletaev, M. and Robinson, C. (2008), "Human Capital Specificity: Evidence from the Dictionary of Occupational Titles and Displaced Worker Surveys, 1984-2000", *Journal of Labor Economics*, 26(3), pp. 387-420.

Prager, E. and Schmitt, M. (2021), "Employer Consolidation and Wages: Evidence from Hospitals", *American Economic Review*, 111(2), pp. 397-427.

Schmieder, J. F., von Wachter, T., and Heining, J. (2023), "The Costs of Job Displacement over the Business Cycle and Its Sources: Evidence from Germany*", American Economic Review*, 113 (5), pp. 1208-1254.

Song, J., Price, D. J., Guvenen, F., Bloom, N., and von Wachter, T. (2019), "Firming Up Inequality", *Quarterly Journal of Economics*, 134(1), 1-50.

Topel, R. (1990), "Specific Capital and Unemployment: Measuring the Costs and Consequences of Job Loss", *Carnegie-Rochester Conference Series on Public Policy*, 33, pp. 181-214.

Weber, E., Hausner, K. H., and Engelhard, H. (2020), "Die Kosten der Arbeitslosigkeit sind 2019 leicht gestiegen", in: IAB-Forum 28. Dezember 2020, www.iab-forum.de/die-kosten-der-arbeitslosigkeit-sind-2019-leicht-gestiegen.

Woodcock, S. D. (2015), "Match Effects", *Research in Economics*, 69(1), pp. 100-121.

Tables and Figures

Table 1: Establishment Premiums and Worker Quality by Sector

	Manufacturing		Service Sector			
			Low-knowledge		High-knowledge	
	1988	2007	1988	2007	1988	2007
Panel A: Average Establishment Premium						
All Workers	0.069	0.102	-0.081	-0.086	0.010	0.046
Low-wage Workers	0.035	0.035	-0.114	-0.138	-0.022	-0.027
High-wage Workers	0.094	0.152	-0.062	-0.032	0.036	0.106
Panel B: Dispersion in Establishment Premiums						
All Workers	0.149	0.183	0.187	0.248	0.186	0.247
Low-wage Workers	0.156	0.192	0.203	0.261	0.193	0.250
High-wage Workers	0.145	0.174	0.189	0.245	0.187	0.246
Panel C: Worker Quality						
Worker Fixed Effect	0.006	0.035	-0.023	-0.044	0.030	0.034
Skill Shares (within Sector)						
Low Skilled	0.245	0.130	0.161	0.130	0.091	0.057
Medium Skilled	0.694	0.739	0.774	0.763	0.783	0.722
High Skilled	0.061	0.130	0.065	0.106	0.126	0.222
Panel D: Gender Composition						
Female Share	0.264	0.241	0.448	0.482	0.559	0.570

Notes: The table shows means and standard deviations of establishment premiums (Panels A and B, respectively), measures of worker quality (Panel C) and the female employment share (Panel D) by sector for full-time workers in West Germany for the years 1988 and 2007. Establishment premiums and worker fixed effects 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- 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. 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	
	1993-99	2000-07	1993-99	2000-07	1993-99	2000-07
Union Coverage	0.851	0.727	0.812	0.688	0.669	0.563
Presence of a Works Council	0.692	0.681	0.524	0.482	0.502	0.475
Value Added per Worker	69,607	77,015	70,395	57,236	69,348	71,427

Notes: The table reports average union coverage rates, work council presence, and value added by sector for West German firms, separately for the periods 1993 to 1999 and 2000 to 2007. Data are drawn from the German IAB Establishment Panel, and averages are weighted using survey weights multiplied by the number of workers in the firm, to make findings representative for workers. Union coverage refers to either a firm- or industry-wide collective bargaining agreement. Value added per worker is calculated as revenues minus intermediate inputs in euros.

Table 3: Sectoral Transitions and Displacement Wage Losses by Destination Sector

	Displaced from Manufacturing Sector			*Displaced from Service Sector*	
	New Job: Manufacturing	New Job: Service Sector		New Job: Service Sector	New Job: Manufacturing
		Low-knowl.	High-knowl.		
Panel A: Low-wage Workers					
Transition Likelihood	-0.367	0.261	0.069	-0.154	0.129
Wage Loss	-0.047	-0.149	-0.077	-0.028	0.015
Establishment Premium	-0.036	-0.130	-0.056	-0.025	0.028
Returns to Experience	-0.012	-0.017	-0.015	-0.014	-0.014
Returns to Occup. Tenure	-0.036	-0.044	-0.040	-0.025	-0.029
Returns to Estab. Tenure	-0.008	-0.008	-0.009	-0.008	-0.008
Match Quality	0.045	0.051	0.043	0.045	0.038
Panel B: High-wage Workers					
Transition Likelihood	-0.298	0.153	0.097	-0.132	0.105
Wage Loss	-0.103	-0.187	-0.104	-0.075	-0.067
Establishment Premium	-0.018	-0.077	-0.013	0.001	0.017
Returns to Experience	-0.013	-0.019	-0.014	-0.011	-0.011
Returns to Occup. Tenure	-0.019	-0.023	-0.020	-0.014	-0.017
Returns to Estab. Tenure	-0.012	-0.012	-0.012	-0.010	-0.010
Match Quality	-0.041	-0.056	-0.044	-0.041	-0.045

Notes: The table reports estimates of the effects of job displacement on wages and its sources by displacement sector, destination sector, and worker type, three years after the layoff, conditional on being employed. Panel A reports estimates for low-wage workers and Panel B for high-wage workers. Estimates are based on equation (3). The sample consists of workers displaced between 1990 and 2004, and their matched control workers.

Table 4: Within-Between Decomposition of Establishment Premium Losses over Time

	Absolute	Share
Change in Total Establishment Premium Loss	-0.092	1.000
Within Manufacturing	-0.056	0.614
Between - Total	-0.035	0.386
Between - Sectoral Premium Component	-0.023	0.638
Between - Switching Component	-0.013	0.362

Notes: The table presents the results of a decomposition of changes in establishment premium losses over time into within-sector and between-sector components (three broad sectors), focusing on low-wage workers displaced from the manufacturing sector. Changes are measured as average losses between the first two two-year periods in the estimation sample (1988-1989 and 1990-1991) and the final two two-year periods (2004-2005 and 2006-2007). The decomposition is explained in more detail in Appendix B.3.

Table 5: Summary Statistics on Manufacturing Workers by Gender

	Men	Women
Panel A: Employment Shares		
All Workers	0.74	0.26
Low-wage Workers	0.47	0.53
High-wage Workers	0.89	0.11
Panel B: AKM Worker Fixed Effect		
All Workers	0.070	-0.133
Low-wage Workers	-0.107	-0.247
High-wage Workers	0.211	0.169
Panel C: Establishment Premium		
All Workers	0.099	0.030
Low-wage Workers	0.070	0.001
High-wage Workers	0.117	0.102

Notes: The table reports employment shares (Panel A), establishment premiums (Panel B), and AKM worker fixed effects (Panel C) for the period 1988 to 2007, separately for male and female manufacturing workers and by worker type. Establishment premiums and AKM worker fixed effects correspond to the 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. The sample contains all full-time West German workers aged 16 to 65.

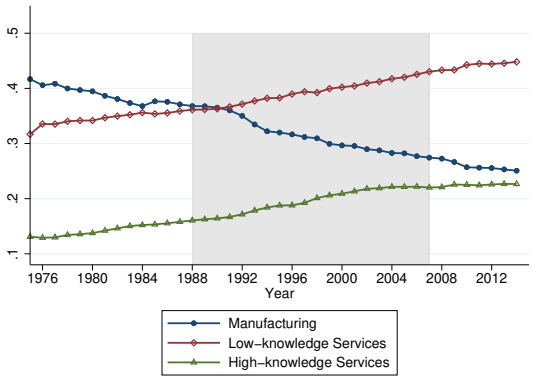
Table 6: Structural Change and Changes in the Wage Structure

	1988	2007	Change from 1988 to 2007	Explained (in %)
Panel A: Extended AKM with Establishment Fixed Effects				
A.1 Observed				
Variance of Wages	0.200	0.302	-0.101	
Variance of Establishment Premiums	0.033	0.061	-0.028	
2 x Cov. (Worker Fixed Effect, Estab. Premium)	0.014	0.031	-0.017	
A.2 DFL-Method, Reweighted to 1988 Sectoral Composition				
Variance of Wages	0.200	0.286	-0.086	0.152
Variance of Establishment Premiums	0.033	0.058	-0.024	0.135
2 x Cov. (Worker Fixed Effect, Estab. Premium)	0.014	0.028	-0.014	0.196
Panel B: Extended AKM with Establishment Group Fixed Effects				
B.1 Observed				
Variance of Wages	0.200	0.302	-0.101	
Variance of Establishment Premiums	0.032	0.049	-0.017	
2 x Cov. (Worker Fixed Effect, Estab. Premium)	0.021	0.040	-0.019	
B.2 DFL-Method, Reweighted to 1988 Sectoral Composition				
Variance of Wages	0.200	0.286	-0.086	0.152
Variance of Establishment Premiums	0.032	0.045	-0.014	0.209
2 x Cov. (Worker Fixed Effect, Estab. Premium)	0.021	0.036	-0.015	0.191

Notes: The table reports wage variance decompositions. Panel A reports decompositions based on our baseline augmented AKM model with establishment fixed effects. To address the potential limited mobility bias, Panel B reports decompositions based on estimated establishment group fixed effects, where, in the spirit of Bonhomme *et al.* (2019), establishments have been grouped into 100 groups based on their wage distribution using a k-means algorithm (see Section 7.1). Panels A.1 and B.1 show the observed variances of (log) wages and establishment fixed effects, as well as the covariance between establishment and worker fixed effects in 1988 and 2007, for the respective model. Panels A.2 and B.2 display the counterfactual variances and covariances based on the DFL reweighting method that would have prevailed if the sectoral composition by worker type (i.e., manufacturing, low-knowledge and high-knowledge services, and other) had remained at its 1988 level, as explained in Section 7.1. The sample contains all West German workers aged 16 to 65.

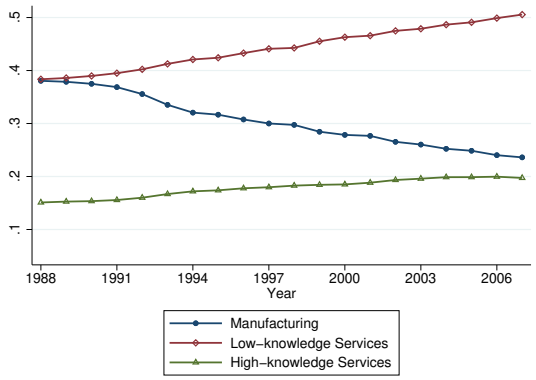
Figure 1: Employment Shares by Sector

Panel A: All Workers

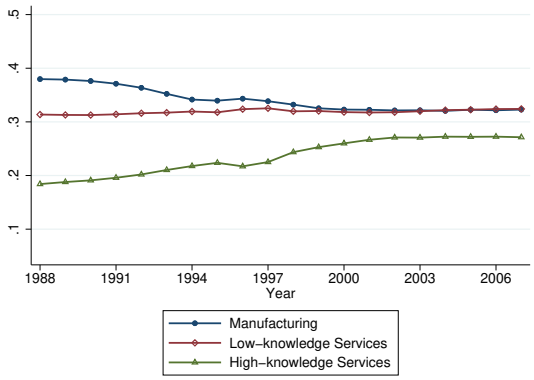


Panel B: By Worker Type

B.1 Low-wage Workers

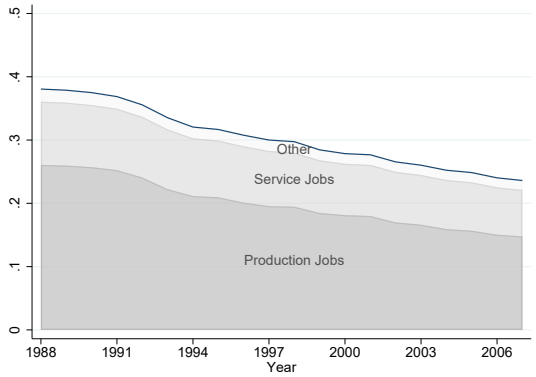


B.2 High-wage Workers

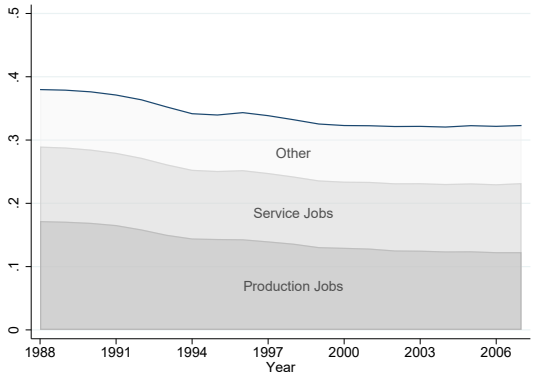


Panel C: Job Types in Manufacturing

C.1 Low-wage Workers



C.2 High-wage Workers

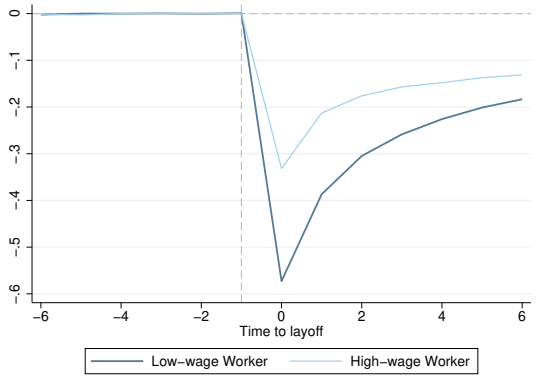


Notes: The figure shows the evolution of employment shares in the manufacturing, the low-knowledge and the high-knowledge service sector for all workers aged 16 to 65 in West Germany in Panel A, and by worker type in Panel B. Panel C shows the evolution of employment shares by job type in the manufacturing sector for low- and high-wage workers. "Other" refers to jobs that cannot be assigned to service or production jobs, most importantly, agricultural and mining jobs. 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.

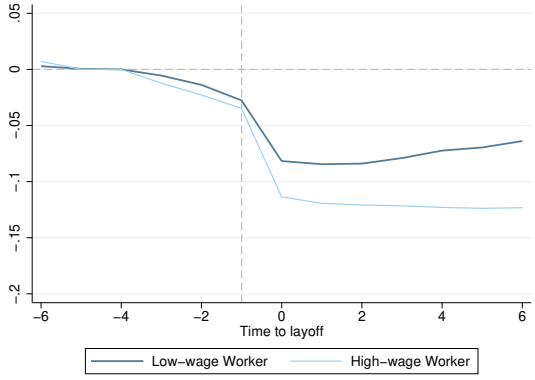
Figure 2: Employment and Wage Effects of Job Displacement by Sector and Worker Type

Panel A: Manufacturing

A.1 Employment Losses

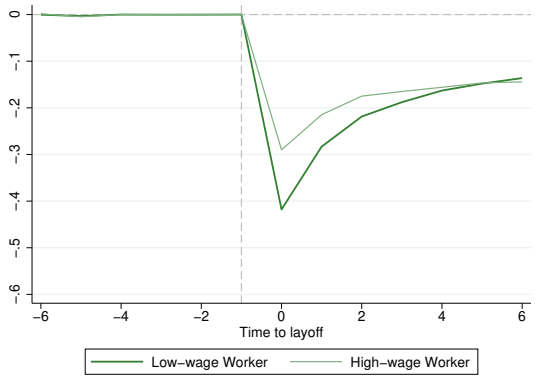


A.2 Wage Losses

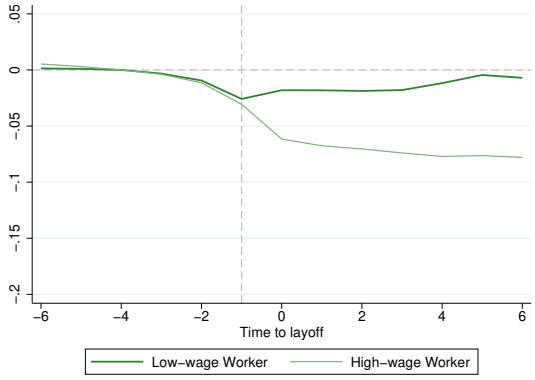


Panel B: Services

B.1 Employment Losses



B.2. Wage Losses

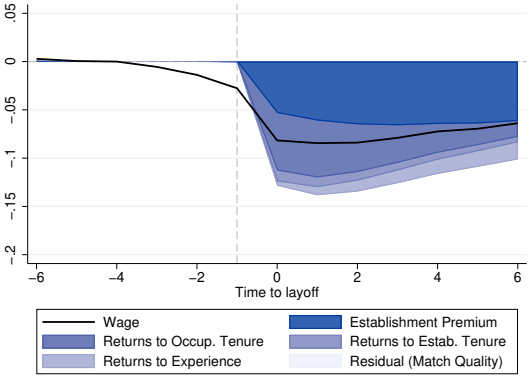


Notes: The figure reports event study estimates of the effects of job displacement of workers displaced from the manufacturing sector (Panel A) and the service sector (Panel B). Panels A.1 and B.1 display the probability of being employed by worker type and Panels A.2 and B.2 display the effect on wages conditional on being employed by worker type, for each sector, respectively. Estimates are based on equation (3). The sample consists of workers displaced between 1990 and 2004, and their matched control workers.

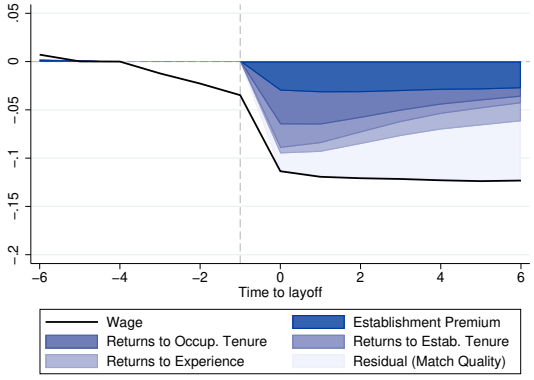
Figure 3: Decomposition of Displacement Wage Losses by Sector and Worker Type

Panel A: Manufacturing

A.1 Low-wage Workers

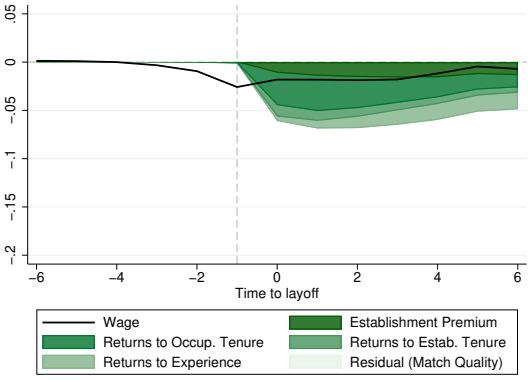


A.2 High-wage Workers

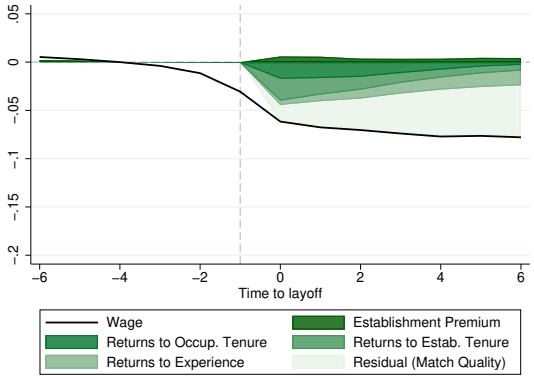


Panel B: Service Sector

B.1 Low-wage Workers



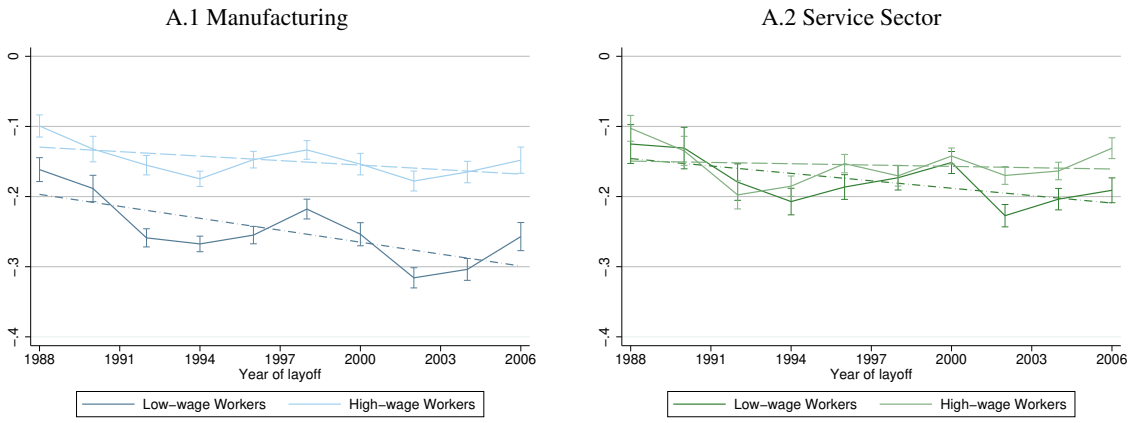
B.2 High-wage Workers



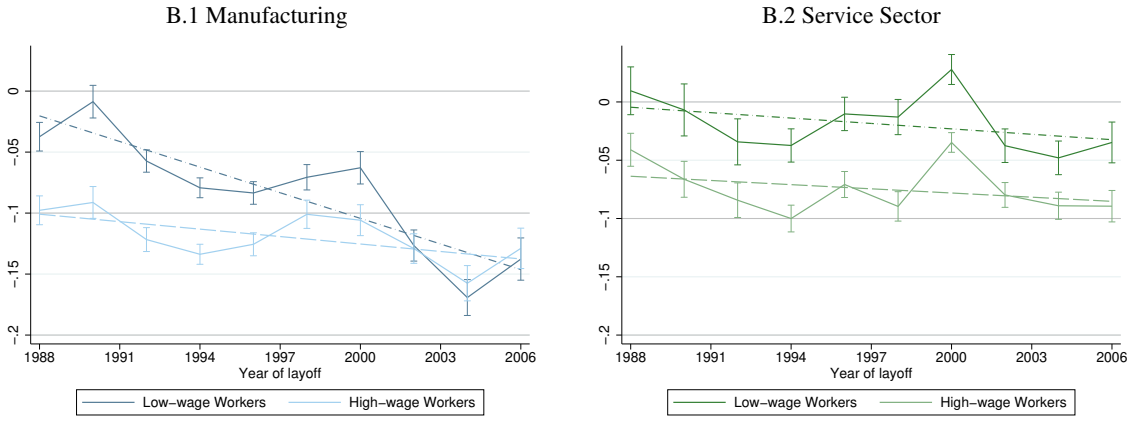
Notes: The figure reports event study estimates of the effects of job displacement on wages, and on five potential sources of wage losses (establishment premiums, returns to establishment and occupation tenure, returns to experience, and match quality (residual) of workers displaced from the manufacturing sector (Panel A) and the service sector (Panel B) and by worker type. Estimates are based on equation (3), with the respective sources of losses as the dependent variable. The sample consists of workers displaced between 1990 and 2004 and their matched control workers.

Figure 4: Displacement Employment and Wage Losses over Time

Panel A: Employment



Panel B: Wages

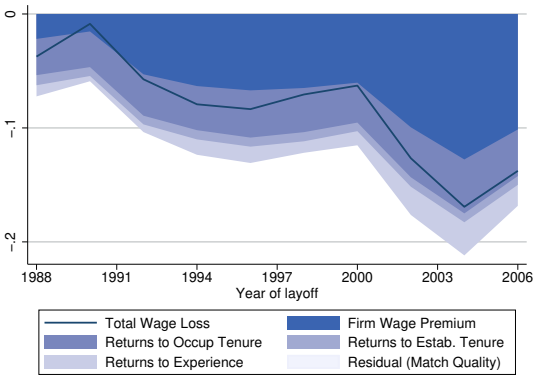


Notes: The figure reports event study estimates of the effects of job displacement by worker type and sector on the probability of being employed in Panel A and on wages in Panel B. Panels A.1 and B.1 present the estimates for the manufacturing sector and Panels A.2 and B.2 for the service sector. Estimates 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. The dashed lines show the linear trends in the estimates for each worker type.

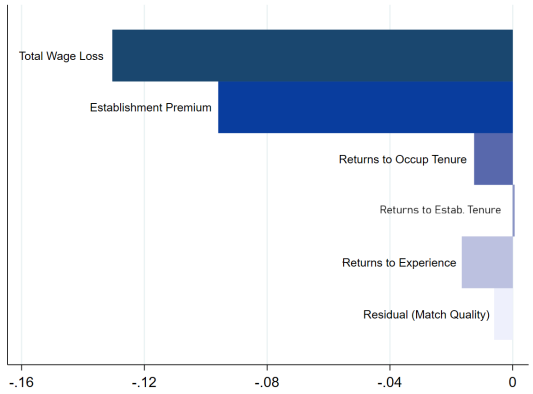
Figure 5: Decomposition of Displacement Wage Losses over Time by Worker Type

Panel A: Low-wage Workers

A.1 Decomposition

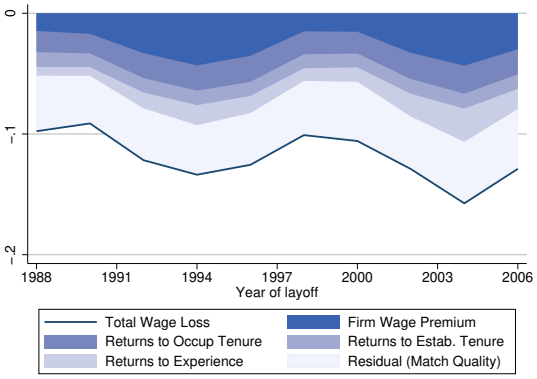


A.2 Change in Wage Loss and its Components

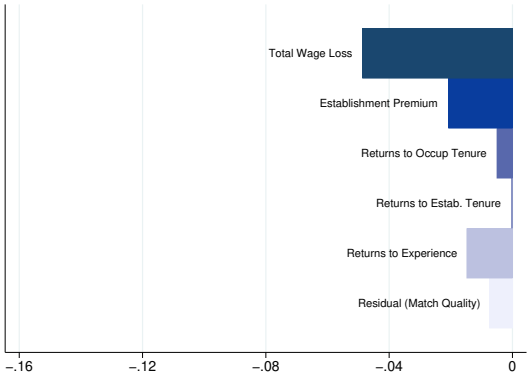


Panel B: High-wage Workers

B.1 Decomposition



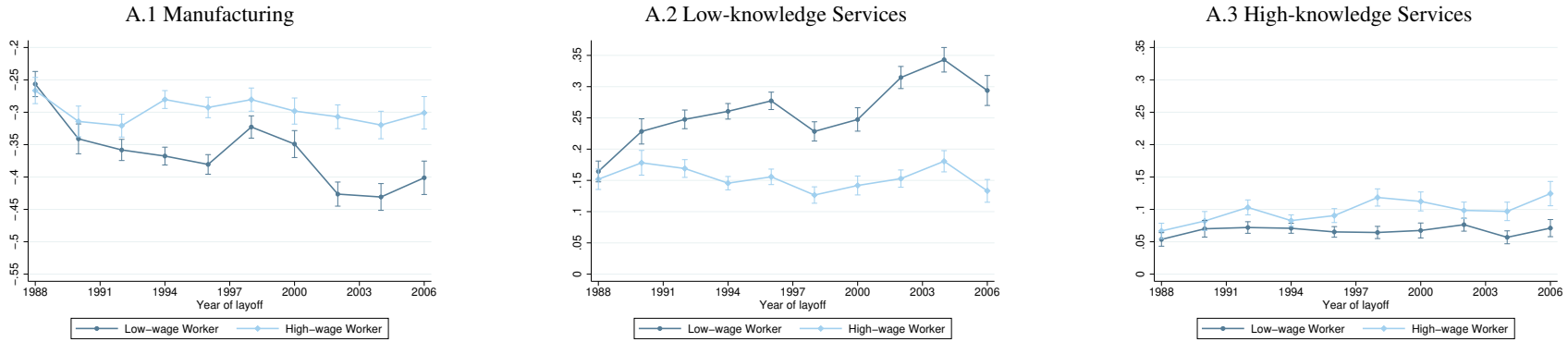
B.2 Change in Wage Loss and its Components



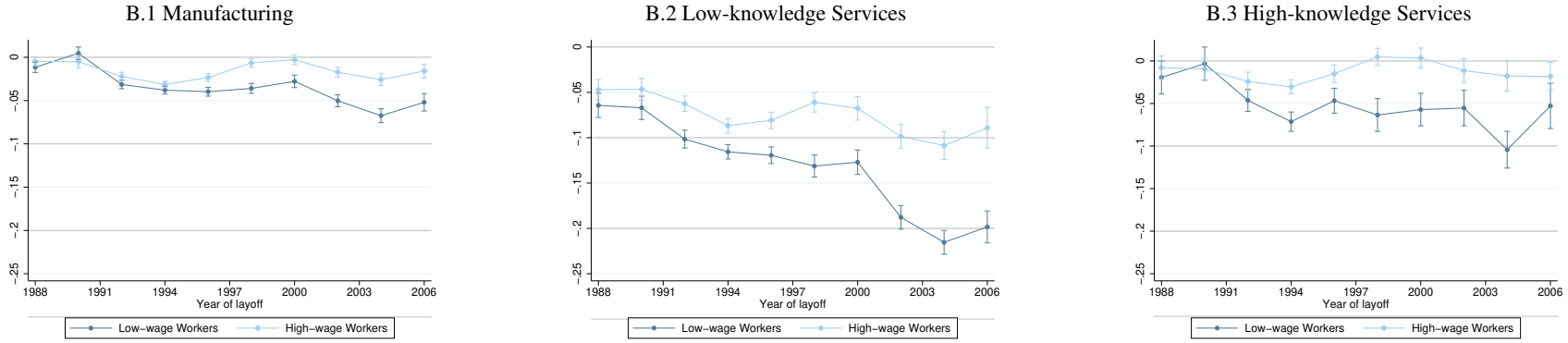
Notes: Panels A.1 and B.1 of the figure show event study estimates of the effects of job displacement on wages, and on five potential sources of wage losses (establishment premiums, returns to establishment and occupation tenure, returns to experience, and match quality) by worker type, estimated separately for each two-year period of layoffs taking place between 1988 and 2007. Estimates are based on equation (3), with the respective source of losses as the dependent variables. Reported coefficients are for the effects three years after displacement. 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 6: Sectoral Switching and Establishment Premium Losses by Destination Sector over Time

Panel A: Employment Probabilities by Destination Sector

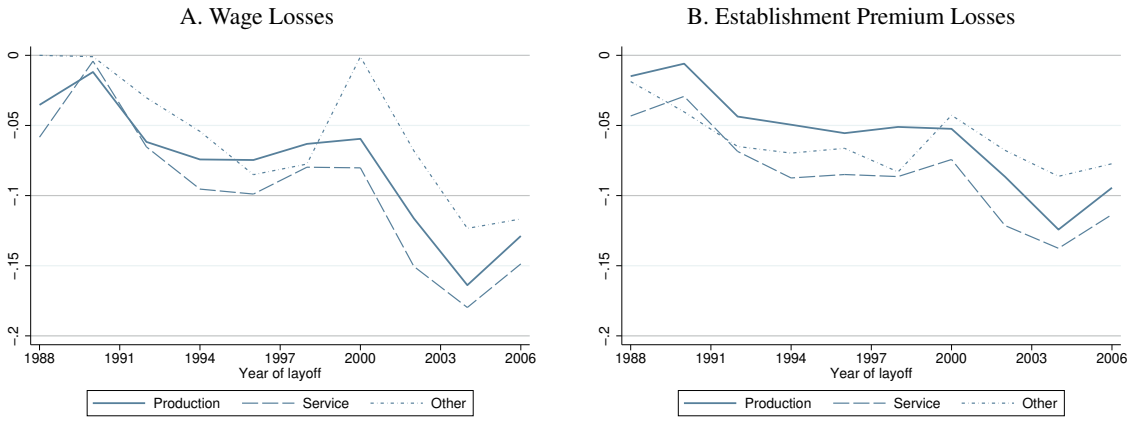


Panel B: Losses in Establishment Premiums by Destination Sector



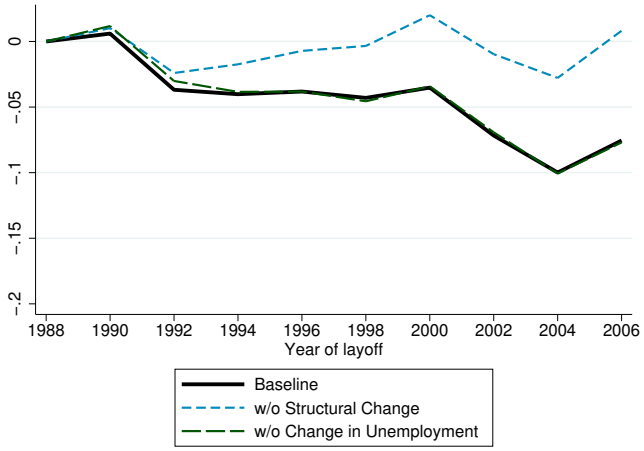
Notes: Panel A reports event study estimates of the likelihood of remaining employed in the manufacturing sector (Panel A.1), and being employed in the low-knowledge (Panel A.2) and the high-knowledge service sector (Panel A.3) three years after displacement from manufacturing, conditional on being employed. Panel B reports event study estimates of the effects of job displacement on establishment premiums by destination sector three years after displacement. Estimates are based on equation (3), estimated separately for each two-year period of layoffs taking place between 1988 and 2007.

Figure 7: Displacement Effects over Time by Job Type - Low-wage Workers



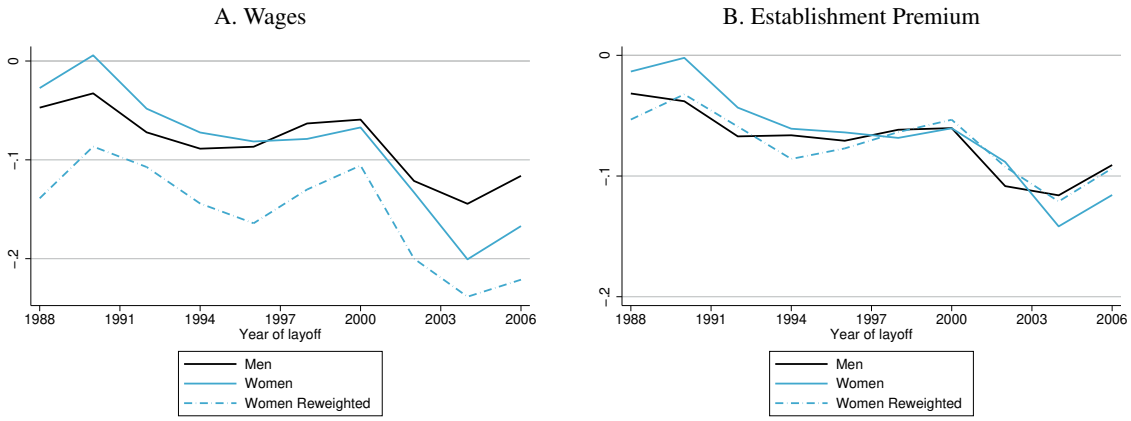
Notes: The figure shows event study estimates of the effects of job displacement on wages in Panel A and on the establishment premium in Panel B for low-wage workers displaced from manufacturing. Estimates are based on equation (3), estimated separately for each two-year period of layoffs taking place between 1988 and 2007. Reported coefficients are for the effects three years after displacement. The solid lines show the effects for workers in production jobs, the long-dashed lines show the effects for workers in service jobs, and the dash-dotted line the effects for workers in other occupations.

Figure 8: Displacement Losses in Establishment Premiums: Leveraging Local Variation in Structural Change - Low-wage Workers



Notes: The figure leverages variation in structural change (short-dashed blue line) and unemployment rates (long-dashed green line) across commuting zones to explore their explanatory power in accounting for the increase in displacement losses in establishment premiums over time, based on the method proposed by Schmieder *et al.* (2023). Local structural change is measured as the predicted change in the commuting zone's average establishment fixed effect based on local shifts in the broad industry structure; see Section 6.4 for details. The figure focuses on low-wage workers displaced from manufacturing. Reported coefficients are for the effects three years after displacement.

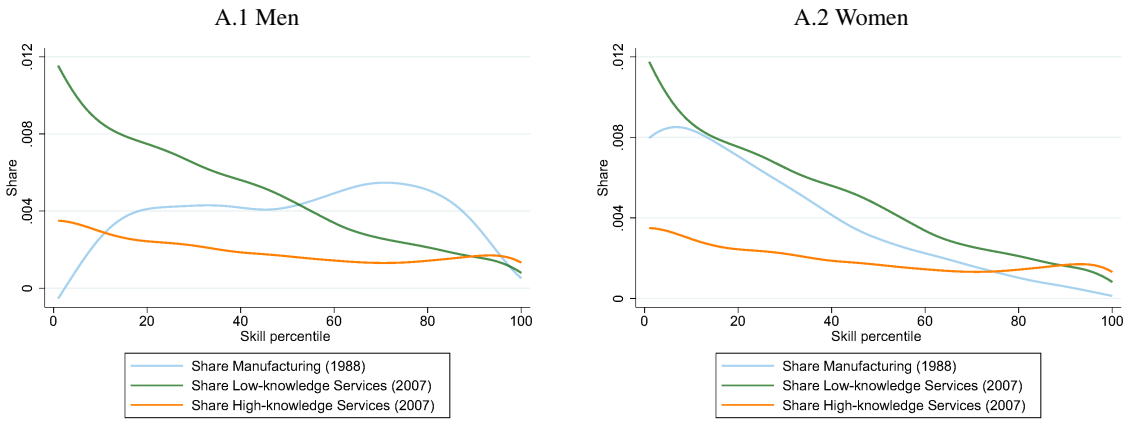
Figure 9: Displacement Losses over Time by Gender - Low-wage Workers



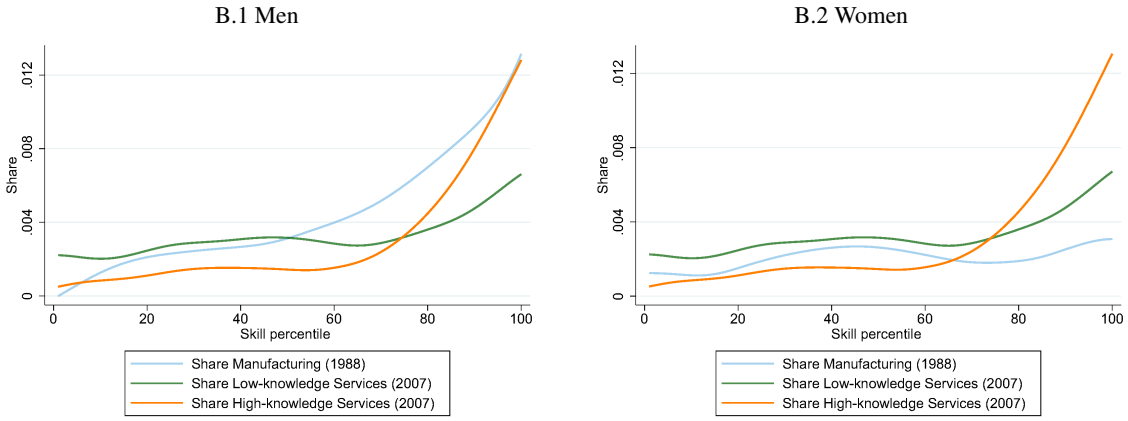
Notes: The figure shows event study estimates of the effects of job displacement in manufacturing on wages in Panel A and on the establishment premium in Panel B for low-wage workers by gender. The dashed lines display the results when the sample of women is reweighted to reflect the male distributions of worker fixed effects and establishment premiums, as described in Section 6.5. Estimates are based on equation (3), estimated separately for men and women and for each two-year period of layoffs taking place between 1988 and 2007. Reported coefficients are for the effects three years after displacement.). The dashed lines display the wage and establishment premium losses for women when we reweight the female sample to match the male distributions of worker fixed effects and establishment premiums.

Figure 10: Job Polarization and the Distribution of Jobs by Sector

Panel A: Low-wage Workers



Panel B: High-wage Workers



Notes: The figure plots, separately for men and women, the share of manufacturing, low-knowledge service sector and high-knowledge service sector employment by the 1988 occupational wage percentile rank for low-wage workers in Panel A and for high-wage workers in Panel B. Panels A.1 and B.1 report the employment shares for men and Panels A.2 and B.2 for women. Occupational wage percentiles are measured as the employment-weighted percentile rank of an occupation's median log wage across all workers in 1988. Each line is smoothed using a locally weighted smoothing regression (bandwidth 0.8 with 100 observations). 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.

ONLINE APPENDIX

Appendix A: 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. For easier exposition, we present the robustness checks in the pooled sample using our full sample, pooled across all worker types. Columns (1.1) and (2.2) of Table A.6 report the baseline results for the full sample.

A.1. Match Quality. In our decompositions, we interpret the residual displacement wage loss that is not explained by losses in establishment premiums or losses in general and specific human capital as being due to valuable match quality. We also 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, and establishment and occupation tenure are averaged within worker-establishment matches and then regressed on establishment and worker fixed effects.[1] 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, occupational tenure, 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. We report results for low- and high-wage workers in Tables A.4 and A.5 (columns (1.7) and (2.7)). Whereas low-wage workers experience an increase in match quality following displacement, losses in match quality amount to 2.1 percent for high-wage workers four years after displacement. Although (absolute) changes in match quality are smaller in magnitude than the residual wage loss displayed in column (1.6), 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.

A.2. Establishment Premiums from a Standard AKM Regression. Table A.6, column (1.3), shows establishment premium losses when using standard AKM establishment fixed effects estimated

[1] 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.

without controls for establishment and occupation tenure. The estimated loss is somewhat larger than in our baseline estimates (Table A.6, column (1.2)). For example, six years after the layoff, losses in establishment premiums result in wage losses of 6.7 percent when using establishment fixed effects from the standard AKM regression, but these shrink to 4.5 percent when occupational and establishment tenure are included in the AKM regression. Thus, omitting controls for establishment and occupation tenure in AKM regressions appears to overstate the importance of establishment premiums in overall displacement wage losses somewhat.

A.3. Establishment Premiums Using Six-Year Rolling Windows. Our baseline specification estimates AKM establishment fixed effects in a single regression using observations over a 27-year period from 1984 to 2010. In Table A.6, column (1.4), we show establishment premium losses when AKM establishment fixed effects are estimated over six-year rolling periods, thus allowing establishment fixed effects to change slowly over time. Estimated displacement losses in establishment premiums are of roughly similar magnitude to our baseline estimates, in line with Lachowska *et al.* (2023) and Engbom *et al.* (2023), who find that establishment fixed effects tend to be stable over time.

A.4. Displacement Effects Due to Plant Closures. 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 because of an establishment closure as a 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.6, column (2.1)) and declines in establishment premiums (Table A.6, column (2.2)) are similar for plant closures and mass layoffs, indicating that there is little within-establishment selection.

A.5. Pre-treatment Establishment Tenure. Our main sample focuses on workers employed full-time at the mass layoff establishment for at least four years. In columns (3.1) and (3.2) of Table A.6, we relax this restriction and include workers with at least two years of tenure in the layoff firm and a total of four years of employment in manufacturing prior to displacement. This has little impact on the wage and establishment premium losses, as the average tenure in the manufacturing sector is high (see Table A.2).

A.6. Alternative Matching Variables. Our main matching strategy applies coarsened exact matching 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), the broad industry of the workplace, and worker and establishment fixed effect terciles. In an extension, we additionally match on the commuting zone and quintiles of establishment size, thus restricting the control worker to be employed in the same local labor market and to work in an establishment of similar size. Table A.6, columns (4.1) and (4.2) report the wage and establishment premium losses. While standard errors are somewhat increasing (this procedure creates many more cells of displaced and control worker characteristics), the estimated effects are similar in magnitude.

A.7. Compositional Changes of Displaced Workers and Layoff Establishments over Time. The increasing wage losses and losses in establishment premiums among low-wage workers after displacement could, in principle, 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 with regard to their worker characteristics. Similarly, the composition of establishments may change over time. For example, high-wage establishments may account for an increasingly large share of mass layoff establishments. Such shifts would result in larger losses in establishment premiums over time.

We apply two approaches to assess the importance of such compositional changes. First, 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 reweighted sample of displaced and control workers in later periods resembles the sample in the first period in terms of the distribution of worker and establishment fixed effects. This approach has advantages as it non-parametrically and thus very flexibly controls for changes in the composition of worker and firm fixed effects in the full sample of displaced workers.

Secondly, we adopt an alternative method proposed by Schmieder *et al.* (2023) to account for multiple dimensions of composition changes. We first obtain an individual "treatment effect" of job loss for each individual by comparing wage (or establishment premium) changes between four years before and three years after the layoff for each displaced worker with that of the matched control worker. In the second step, we regress these individual "treatment effects" on layoff year indicator variables in a single regression over all layoff years and account for compositional changes over time by controlling for worker fixed effects, levels of general experience (age and age squared), establishment- and occupation-specific tenure (linear and squared terms), education, establishment fixed effects, and the industry of the layoff establishment. Each of these controls is measured prior to the layoff. An advantage of this approach is that, in addition to accounting for changes in pre-

displacement characteristics over time, it also accounts for a changing selection into full-time employment (versus part-time employment or not working) after displacement based on observed characteristics.[2]

The results in Figure A.5 demonstrate that the increasing wage losses over time are not driven by compositional changes. The solid lines in Panel A and B of Figure A.5 depict our baseline estimates for the losses in wages and establishment premiums for low-wage workers; the long-dashed and dashed-dotted lines display reweighted losses that hold the composition of displaced workers and mass layoff establishments constant over time, and the short-dashed lines present results based on the method proposed by Schmieder *et al.* (2023). Both wage and establishment premium losses would have been somewhat 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. Moreover, these findings cast strong doubt on the hypothesis that a changing selection of displaced workers into full-time employment is an important driver behind the increasing displacement losses over time.

A.8. 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; hence, there are no complementarities in wages. 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, by construction, constrained to be the same for the two types of workers. To rule out this possibility, we re-estimate the extended AKM model and allow establishment fixed effects to vary by worker type.

In Figure A.6, we focus on the evolution of losses in establishment premiums following the displacement from a manufacturing firm over time, allowing establishment premiums to vary across worker types. The figure clearly demonstrates that establishment premium losses have increased over time, particularly among low-wage workers, aligning closely with our baseline findings.

A.9. Trends in Displacement Effects over Time: Worker Type Definition. In our baseline estimates, we have defined worker types via the estimated worker fixed effects in our augmented AKM regressions and defined low-wage workers as those in the bottom tercile and high-wage

[2] Note that the sample using this approach differs from our baseline sample, as it reduces our sample to pairs where both treated and control workers are employed three years after the layoff, while in the first approach only one displaced and one control worker in each matching cell has to be employed.

workers as those in the top tercile of the distribution of estimated AKM worker fixed effects in the augmented AKM regression, respectively. We show that the trends in displacement effects over time are also present when we distinguish workers based on their formal education. To that end, we divide workers into two groups: workers with a school-leaving degree that entitles them to attend university (*Abitur*) are classified as high-skilled, while workers without such a degree are considered to be low-educated (even if they completed an apprenticeship). Figure A.7 displays the sources of wage losses over time by skill type for workers displaced from a manufacturing establishment. Similar to our baseline results, wage losses and reductions in establishment premiums strongly increase over time among low-skilled workers, while losses are largely stable among high-skilled workers.

Appendix B: Within and Between Sector Decomposition

B.1. Differences between Low-Wage and High-Wage Workers. We can decompose the difference in establishment premium losses following displacement between low- and high-wage workers, $E_L[\Delta\psi_{J(i)}] - E_H[\Delta\psi_{J(i)}]$, into a within and a between-sector component as follows:

$$E_L[\Delta\psi_{J(i)}] - E_H[\Delta\psi_{J(i)}] = \underbrace{E_L[\Delta\psi_{J(i)}|d_i = M] - E_H[\Delta\psi_{J(i)}|d_i = M]}_{\text{within manufacturing}} + \underbrace{\begin{array}{r}\sum_{k\,\in \mathrm{LK,HK}} \Pr_L(d_i = \mathrm{k})\big(E_L\big[[\Delta\psi_{J(i)}|d_i = k\big] - E_L\big[\Delta\psi_{J(i)}|d_i = \mathrm{M}\big]\big) - \\ \Pr_H(d_i = \mathrm{k})\big(E_H\big[[\Delta\psi_{J(i)}|d_i = k\big] - E_H\big[\Delta\psi_{J(i)}|d_i = \mathrm{M}\big]\big).\end{array}}_{\text{between sectors}}$$

Here, $\Pr_L(d_i = \mathrm{k})$ and $\Pr_H(d_i = \mathrm{k})$ correspond to the shares of low- and high-wage workers who are employed in sector k after displacement, with *k=M, LK,* and *HK* (manufacturing, low-knowledge services, and high-knowledge services).

Calculations in Section 5.3.: We estimate an overall loss in establishment premiums of -0.066 for low-wage workers displaced from manufacturing, and of -0.031 for high-wage workers (see Tables A.4 and A.5). In Table 3, the low-wage within-sector component is -0.036 (the loss among those who remain employed in manufacturing) and the between-sector component is -0.026 (0.261×[-0.130-(-0.036)]+0.069×[-0.056-(-0.036)]). For high-wage workers, we obtain a within-sector component of -0.018 and a between-sector component of 0.009. Hence, 49 percent ((0.026-0.009)/(0.066-0.031)) of the overall difference in establishment premium losses between low- and high-wage workers is due to differences in the between-industry component.

B.2 Differences between the Manufacturing and the Service Sector. The difference in establishment premium losses between workers displaced from a manufacturing and service sector firm, $E_M[\Delta\psi_{J(i)}] - E_S[\Delta\psi_{J(i)}]$, can be decomposed in a similar manner:

$$E_M[\Delta\psi_{J(i)}] - E_S[\Delta\psi_{J(i)}] = \underbrace{E_M[\Delta\psi_{J(i)}|d_i = M] - E_S[\Delta\psi_{J(i)}|d_i = S]}_{\text{within sectors}} +$$
$$\underbrace{\begin{aligned}&\Pr_M(d_i = \mathrm{S})\big(E_M\big[[\Delta\psi_{J(i)}|d_i = S\big] - E_M\big[\Delta\psi_{J(i)}|d_i = \mathrm{M}\big]\big) - \\ &\Pr_S(d_i = \mathrm{M})\big(E_S\big[[\Delta\psi_{J(i)}|d_i = M\big] - E_S\big[\Delta\psi_{J(i)}|d_i = S\big]\big).\end{aligned}}_{\text{between sectors}}$$

Here, $\Pr_M(d_i = \mathrm{S})$ refers to the probabilities that a worker displaced from a manufacturing firm is reemployed in a service sector firm, while $\Pr_S(d_i = \mathrm{M})$ denotes the probability that a worker displaced from a service sector firm is reemployed in a manufacturing firm.

Calculations in Section 5.3.: As described above, the overall loss in establishment premiums of -0.066 for low-wage workers displaced from manufacturing can be decomposed into a within-sector component of -0.036 and a between-sector component of -0.026. A similar decomposition in the service sector reveals an overall loss of -0.016, a within-sector component of -0.025, and a between-industry component of 0.008 (0.129×(0.028-(-0.025)). Hence, for low-wage workers, 66 percent ((0.025+0.008)/(0.066-0.016)) of the overall difference in establishment premium losses in the two sectors is due to differences in the between-industry component.

B.3 Changes over Time. Similarly, we can decompose the increase in establishment premium losses following job displacement between the initial displacement period $t = 0$ and the final displacement period $t = 1$, $E_1[\Delta\psi_{J(i)}]$-$E_0[\Delta\psi_{J(i)}]$, into a within-sector and a between-sector component as follows:

$$E_1[\Delta\psi_{J(i)}] - E_0[\Delta\psi_{J(i)}] = \underbrace{E_1[\Delta\psi_{J(i)}|d_i = M] - E_0[\Delta\psi_{J(i)}|d_i = M]}_{\text{within manufacturing}} +$$
$$\underbrace{\begin{aligned}&\textstyle\sum_{k\,\in \mathrm{LK,HK}} \Pr_1(d_i = \mathrm{k})\big(E_1\big[[\Delta\psi_{J(i)}|d_i = k\big] - E_1\big[\Delta\psi_{J(i)}|d_i = \mathrm{M}\big]\big) - \\ &\Pr_0(d_i = \mathrm{k})\big(E_0\big[[\Delta\psi_{J(i)}|d_i = k\big] - E_0\big[\Delta\psi_{J(i)}|d_i = \mathrm{M}\big]\big).\end{aligned}}_{\text{between sectors}}$$

Here, $\Pr_t(d_i = k)$ refers to the probability of being employed in sector k after displacement in period $t = 0.1$ (*k=M, LK,* and *HK*). The between-sector component can be further decomposed into a component due to increased sectoral switching and a component due to increased gaps in establishment premiums across sectors:

$$\text{between} - \text{sector component} = \underbrace{\sum_{k \in LK,HK} \left(\Pr_1(d_i = \text{k}) - \Pr_0(d_i = \text{k})\right) \overline{\text{gap}}_k}_{\text{increased sectoral switching}} +$$

$$\underbrace{\sum_{k \in LK,HK} \overline{\Pr(d_i = \text{k})} \left(E_1\left[[\Delta\psi_{J(i)} | d_i = k\right] - E_1\left[\Delta\psi_{J(i)} | d_i = \text{M}\right]\right) - \left(E_0\left[[\Delta\psi_{J(i)} | d_i = k\right] - E_0\left[\Delta\psi_{J(i)} | d_i = \text{M}\right]\right)}_{\text{increased gaps in sectoral wage premiums}}$$

where

$$\overline{\text{gap}}_k = 0.5 * \left(E_1[\Delta\psi_{J(i)} | d_i = k] - E_1[\Delta\psi_{J(i)} | d_i = \text{M}]\right) + 0.5 * \left(E_0[\Delta\psi_{J(i)} | d_i = k] - E_0[\Delta\psi_{J(i)} | d_i = \text{M}]\right)$$

is the gap in establishment premiums between sector *k* and the manufacturing sector averaged over periods $t = 0$ and $t = 1$ and

$$\overline{\Pr(d_i = \text{k})} = 0.5 * \Pr_0(d_i = \text{k}) + 0.5 * \Pr_1(d_i = \text{k}))$$

is the probability of being re-employed in sector *k* after displacement averaged over periods $t = 0$ and $t = 1$.

We decompose the change in establishment premiums between the first two two-year estimation periods of our "time-series" sample, 1988-1989 and 1990-1991 ($t = 0$) and the final two two-year periods 2004-2005 and 2006-2007 ($t = 1$). The estimated switching probabilities and establishment premium losses in each period that are used to compute the various decomposition components are presented in Table B.1. The estimates are based on equation (3) and the reported coefficients are for the effects three years after displacement.

References

Bonhomme, S., Lamadon, T., and Manresa, E. (2019), "A Distributional Framework for Matched Employer Employee Data", *Econometrica*, 87(3), pp. 699-739.

Engbom, N., Moser, C., and Sauermann, J. (2023), "Firm Pay Dynamics", *Journal of Econometrics*, 233(2), pp. 396-423.

Hethey, T. and Schmieder, J. F. (2010), "Using Worker Flows in the Analysis of Establishment Turnover: Evidence from German Administrative Data", *FDZ Methodenreport*, Institut für Arbeitsmarkt- und Berufsforschung (IAB), Nürnberg [Institute for Employment Research, Nuremberg, Germany].

Lachowska, M., Mas, A., and Woodbury, S. A. (2020), "Sources of Displaced Workers' Long-Term Earnings Losses", *American Economic Review*, 110(10), pp. 3231-3266.

Lachowska, M., Mas, A., Saggio, R., and Woodbury, S. A. (2023), "Do Firm Effects Drift? Evidence from Washington Administrative Data", *Journal of Econometrics*, 233(2), pp. 375-395.

Schmieder, J. F., von Wachter, T., and Heining, J. (2023), "The Costs of Job Displacement over the Business Cycle and Its Sources: Evidence from Germany", *American Economic Review*, 113 (5), pp. 1208-1254.

Woodcock, S. D. (2015), "Match Effects", *Research in Economics*, 69(1), pp. 100-121.

Table A.1: Full Sample vs. Leave-One-Out Connected Set

	Full Sample	Leave-one-out Connected Set
Person/Year Observations	452,245,478	445,084,470
Number of Establishments	4,660,448	3,014,066
Movers	0.67	0.67
Moves	0.12	0.12
Ln Wage (Average)	4.29	4.30
Ln Wage (Std. Dev.)	0.49	0.48

Notes: The table reports summary statistics of the full sample of all full-time workers aged 16 to 65 in the years 1984 to 2010 and the leave-one-out largest connected set used in the AKM estimation.

Table A.2: Displaced vs. Control Workers by Worker Type - Manufacturing

	Low-wage Workers					High-wage Workers				
	Displaced Workers (Treatment)	Non-Displaced (Matched Control)	Non-Displaced (Random Control)	Treatment vs. Matched Control	Treatment vs. Random Control	Displaced Workers (Treatment)	Non-Displaced (Matched Control)	Non-Displaced (Random Control)	Treatment vs. Matched Control	Treatment vs. Random Control
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Worker Characteristics										
Ln Wage	4.040	4.040	4.138	-0.000	-0.099***	4.612	4.614	4.629	-0.002	-0.018***
Worker Fixed Effect	-0.197	-0.195	-0.168	-0.003***	-0.030***	0.156	0.170	0.177	-0.013***	-0.021***
Firm Tenure	7.263	7.207	7.122	0.056*	0.107***	6.758	6.755	7.103	0.002	-0.375***
Occupation Tenure	7.614	7.547	7.398	0.066**	0.196***	7.198	7.190	7.471	0.008	-0.280***
Age	35.443	35.441	35.398	0.003	0.024	35.648	35.636	35.786	0.013	-0.157***
Female	0.623	0.623	0.475	0.000	0.149***	0.073	0.073	0.089	0.000	-0.017***
Low Skilled	0.425	0.425	0.353	0.000	0.072***	0.054	0.054	0.066	0.000	-0.011***
Medium Skilled	0.573	0.573	0.638	0.000	-0.065***	0.780	0.780	0.755	0.000	0.027***
High Skilled	0.002	0.002	0.009	0.000	-0.007***	0.165	0.165	0.179	0.000	-0.015***
Non-German	0.177	0.177	0.148	0.000	0.028***	0.055	0.055	0.059	0.000	-0.005***
Panel B: Firm Characteristics										
Establishment Wage Premium	-0.037	-0.040	-0.024	0.003***	-0.013***	0.021	0.022	0.020	-0.001**	0.001
Sector:										
Food and Beverage	0.084	0.084	0.105	0.000	-0.022***	0.065	0.065	0.075	0.000	-0.010***
Consumer Goods	0.378	0.378	0.234	0.000	0.144***	0.180	0.180	0.167	0.000	0.013***
Producer Goods	0.182	0.182	0.245	0.000	-0.062***	0.199	0.199	0.233	0.000	-0.033***
Investment Goods	0.356	0.356	0.416	0.000	-0.060***	0.556	0.556	0.525	0.000	0.030***
N	60,623	60,623	760,471	121,246	822,756	42,902	42,902	818,229	85,804	862,362

Notes: The table reports, separately by worker type, summary statistics for workers displaced from the manufacturing sector between 1988 and 2007 as well as matched and random control 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. Wages are log average daily wages in euros adjusted to 1995 prices. Establishment premiums and worker fixed effects are demeaned to have zero mean over the sample period. 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 aged 25-50 with at least four years of establishment tenure and employed in establishments with at least 30 and up to 500 employees in West Germany. Levels of significance are * p<0.10, ** p<0.05, *** p<0.01.

Table A.3: Displaced vs. Control Workers by Worker Type - Service Sector

	Low-wage Workers					High-wage Workers				
	Displaced Workers (Treatment)	Non-Displaced (Matched Control)	Non-Displaced (Random Control)	Treatment vs. Matched Control	Treatment vs. Random Control	Displaced Workers (Treatment)	Non-Displaced (Matched Control)	Non-Displaced (Random Control)	Treatment vs. Matched Control	Treatment vs. Random Control
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Worker Characteristics										
Ln Wage	4.004	4.006	4.143	-0.002	-0.140***	4.660	4.662	4.608	-0.001	0.052***
Worker Fixed Effect	-0.210	-0.209	-0.182	-0.001	-0.029***	0.165	0.179	0.165	-0.014***	0.000
Firm Tenure	5.039	5.072	6.277	-0.033	-1.252***	5.090	5.122	6.131	-0.032	-1.052***
Occupation Tenure	6.118	6.124	7.265	-0.005	-1.156***	6.602	6.604	7.412	-0.002	-0.817***
Age	34.363	34.342	34.987	0.020	-0.621***	35.646	35.648	35.823	-0.002	-0.187***
Female	0.567	0.567	0.561	0.000	0.008***	0.172	0.172	0.241	0.000	-0.069***
Low Skilled	0.224	0.224	0.173	0.000	0.051***	0.032	0.032	0.041	0.000	-0.010***
Medium Skilled	0.767	0.767	0.798	0.000	-0.030***	0.701	0.701	0.711	0.000	-0.008***
High Skilled	0.009	0.009	0.029	0.000	-0.020***	0.267	0.267	0.247	0.000	0.018***
Non-German	0.114	0.114	0.079	0.000	0.035***	0.027	0.027	0.037	0.000	-0.009***
Panel B: Firm Characteristics										
Establishment Wage Premium	-0.067	-0.064	-0.027	-0.004***	-0.041***	0.040	0.047	0.029	-0.008***	0.010***
Sector:										
Retail	0.430	0.430	0.279	0.000	0.149***	0.352	0.352	0.266	0.000	0.086***
Transport and Communication	0.132	0.132	0.094	0.000	0.038***	0.137	0.137	0.094	0.000	0.043***
Financial and Insurance Services	0.034	0.034	0.077	0.000	-0.044***	0.069	0.069	0.134	0.000	-0.065***
Hospitality	0.032	0.032	0.029	0.000	0.002**	0.007	0.007	0.012	0.000	-0.006***
Education	0.012	0.012	0.023	0.000	-0.011***	0.016	0.016	0.029	0.000	-0.013***
Health and Social Services	0.051	0.051	0.184	0.000	-0.132***	0.030	0.030	0.115	0.000	-0.084***
Business Services	0.209	0.209	0.107	0.000	0.104***	0.290	0.290	0.165	0.000	0.125***
Other Services	0.028	0.028	0.035	0.000	-0.007***	0.021	0.021	0.032	0.000	-0.011***
Non-Profit Organisations	0.011	0.011	0.023	0.000	-0.012***	0.019	0.019	0.030	0.000	-0.012***
Public Administration	0.061	0.061	0.148	0.000	-0.087***	0.059	0.059	0.124	0.000	-0.064***
N	35,075	35,075	956,645	70,150	992,835	44,953	44,953	1,319,753	89,906	1,365,999

Notes: The table reports, separately by worker type, summary statistics for workers displaced from the service sector between 1988 and 2007 as well as matched and random control 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. Wages are log average daily wages in euros adjusted to 1995 prices. Establishment premiums and worker fixed effects are demeaned to have zero mean over the sample period. Tenure variables are reported in years and are capped at ten years. The random control group is a 10 percent random sample of service-sector workers. Both displaced and control workers are aged 25-50 with at least four years of establishment tenure and employed in establishments with at least 30 and up to 500 employees in West Germany. Levels of significance are * p<0.10, ** p<0.05, *** p<0.01.

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

	Manufacturing							Service Sector						
	Wage	Establishment Premium	Returns to Occupation Tenure	Returns to Establishment Tenure	Returns to Experience	Residual (Match Quality)	Match Quality (Lachowska et al., 2020)	Wage	Establishment Premium	Returns to Occupation Tenure	Returns to Establishment Tenure	Returns to Experience	Residual (Match Quality)	Match Quality (Lachowska et al., 2020)
	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)	(1.7)	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)
τ=-6	0.003	0.001	0.000	0.000	0.000	0.002	-0.001	0.001	0.001	0.000	0.000	0.000	0.000	-0.002
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)
τ=-5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.001	-0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
τ=-4														
τ=-3	-0.006	0.000	0.000	0.000	0.000	-0.005	0.000	-0.003	0.000	0.000	0.000	0.000	-0.003	-0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-2	-0.014	0.000	0.000	0.000	0.000	-0.014	0.000	-0.009	0.000	-0.001	0.000	0.000	-0.009	-0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-1	-0.028	0.000	-0.001	0.000	0.000	-0.027	0.000	-0.026	0.000	-0.001	0.000	0.000	-0.024	-0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
τ=0	-0.082	-0.053	-0.060	-0.011	-0.005	0.047	0.010	-0.018	-0.011	-0.034	-0.012	-0.005	0.043	0.014
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)
τ=1	-0.084	-0.061	-0.059	-0.010	-0.008	0.054	0.009	-0.018	-0.014	-0.037	-0.010	-0.008	0.051	0.017
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.002)
τ=2	-0.084	-0.065	-0.049	-0.009	-0.011	0.051	0.008	-0.019	-0.015	-0.032	-0.009	-0.012	0.050	0.017
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.003)	(0.002)	(0.000)	(0.000)	(0.001)	(0.003)	(0.002)
τ=3	-0.079	-0.066	-0.039	-0.008	-0.013	0.047	0.007	-0.018	-0.016	-0.026	-0.008	-0.015	0.047	0.015
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.003)	(0.002)	(0.000)	(0.000)	(0.001)	(0.003)	(0.002)
τ=4	-0.072	-0.065	-0.030	-0.007	-0.015	0.044	0.006	-0.012	-0.016	-0.021	-0.007	-0.016	0.048	0.014
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.003)	(0.002)	(0.000)	(0.000)	(0.001)	(0.003)	(0.002)
τ=5	-0.070	-0.064	-0.022	-0.006	-0.016	0.039	0.005	-0.004	-0.012	-0.016	-0.006	-0.017	0.047	0.014
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.003)	(0.002)	(0.000)	(0.000)	(0.001)	(0.003)	(0.002)
τ=6	-0.064	-0.062	-0.016	-0.006	-0.018	0.038	0.002	-0.007	-0.014	-0.013	-0.005	-0.017	0.042	0.013
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.004)	(0.002)	(0.000)	(0.000)	(0.001)	(0.004)	(0.002)

Notes: The table reports event study estimates of the effects of job displacement for low-wage workers on wages and its sources (the establishment premium in 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 low-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 of establishment tenure at the time of layoff. Standard errors are in parentheses.

Table A.5: Decomposition of Wage Losses - High-wage Workers

	Manufacturing							Service Sector						
	Wage (1.1)	Establishment Premium (1.2)	Returns to Occupation Tenure (1.3)	Returns to Establishment Tenure (1.4)	Returns to Experience (1.5)	Residual (Match Quality) (1.6)	Match Quality (Lachowska et al., 2020) (1.7)	Wage (2.1)	Establishment Premium (2.2)	Returns to Occupation Tenure (2.3)	Returns to Establishment Tenure (2.4)	Returns to Experience (2.5)	Residual (Match Quality) (2.6)	Match Quality (Lachowska et al., 2020) (2.7)
τ=-6	0.007	0.002	0.000	0.000	0.000	0.005	-0.003	0.005	0.002	0.000	0.000	0.000	0.003	-0.008
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
τ=-5	0.000	0.001	0.000	0.000	0.000	-0.001	-0.001	0.003	0.001	0.000	0.000	0.000	0.002	-0.005
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
τ=-4														
τ=-3	-0.012	0.000	0.000	0.000	0.000	-0.012	0.001	-0.004	0.000	0.000	0.000	0.000	-0.004	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-2	-0.023	0.000	0.000	0.000	0.000	-0.023	0.001	-0.011	0.000	-0.001	0.000	0.000	-0.011	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=-1	-0.035	0.000	0.000	0.000	0.000	-0.035	0.001	-0.031	0.000	-0.001	0.000	0.000	-0.030	-0.001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
τ=0	-0.114	-0.030	-0.035	-0.024	-0.006	-0.018	-0.018	-0.062	0.006	-0.023	-0.023	-0.004	-0.017	-0.024
	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)
τ=1	-0.119	-0.032	-0.033	-0.019	-0.009	-0.026	-0.019	-0.068	0.006	-0.022	-0.017	-0.007	-0.027	-0.023
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)
τ=2	-0.121	-0.032	-0.027	-0.015	-0.012	-0.035	-0.018	-0.070	0.004	-0.019	-0.013	-0.009	-0.033	-0.021
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
τ=3	-0.122	-0.031	-0.020	-0.012	-0.014	-0.045	-0.020	-0.074	0.003	-0.015	-0.010	-0.011	-0.041	-0.021
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
τ=4	-0.123	-0.029	-0.015	-0.010	-0.016	-0.053	-0.021	-0.077	0.004	-0.011	-0.008	-0.013	-0.049	-0.023
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.002)
τ=5	-0.124	-0.029	-0.011	-0.008	-0.018	-0.058	-0.022	-0.076	0.004	-0.009	-0.007	-0.014	-0.051	-0.025
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.002)
τ=6	-0.123	-0.028	-0.009	-0.007	-0.019	-0.061	-0.023	-0.078	0.004	-0.007	-0.006	-0.015	-0.054	-0.026
	(0.002)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.000)	(0.000)	(0.001)	(0.003)	(0.002)

Notes: The table reports event study estimates of the effects of job displacement for high-wage workers on wages and its sources (the establishment premium in 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 workers displaced between 1990 and 2004 and their matched control workers. Standard errors are in parentheses.

Table A.6: Robustness: Displacement from Manufacturing

	Baseline Sample				Plant Closure Sample		2-years Tenure before Layoff		Matching within Commuting Zone and Establishment Size Quintile	
	Wage	Est. Premium Extended AKM	Est. Premium Standard AKM	Est. Premium Six-year Rolling	Wage	Est. Premium	Wage	Est. Premium	Wage	Est. Premium
	(1.1)	(1.2)	(1.3)	(1.4)	(2.1)	(2.2)	(3.1)	(3.2)	(4.1)	(4.2)
τ=-6	0.005	0.001	0.001	0.003	0.006	0.001	0.005	0.001	0.003	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.002)	(0.001)
τ=-5	0.001	0.001	0.001	0.002	0.001	0.001	0.002	0.000	-0.001	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)
τ=-4										
τ=-3	-0.008	0.000	0.000	0.000	-0.008	0.000	-0.007	0.000	-0.009	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
τ=-2	-0.016	0.000	0.000	-0.001	-0.017	0.000	-0.017	-0.001	-0.017	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
τ=-1	-0.028	0.000	0.000	-0.003	-0.027	0.000	-0.029	-0.001	-0.029	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.002)	(0.000)
τ=0	-0.101	-0.047	-0.067	-0.033	-0.098	-0.045	-0.101	-0.048	-0.093	-0.040
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)
τ=1	-0.103	-0.051	-0.072	-0.035	-0.101	-0.050	-0.103	-0.052	-0.096	-0.044
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)
τ=2	-0.102	-0.053	-0.073	-0.037	-0.099	-0.052	-0.102	-0.054	-0.099	-0.046
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)
τ=3	-0.100	-0.053	-0.072	-0.038	-0.098	-0.052	-0.099	-0.053	-0.094	-0.045
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)
τ=4	-0.097	-0.051	-0.071	-0.037	-0.095	-0.051	-0.097	-0.052	-0.096	-0.043
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)
τ=5	-0.095	-0.050	-0.069	-0.038	-0.094	-0.050	-0.094	-0.050	-0.092	-0.041
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)
τ=6	-0.091	-0.049	-0.067	-0.038	-0.090	-0.048	-0.092	-0.049	-0.088	-0.039
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)

Notes: The table reports various event study estimates of the effects of job displacement on wages and the establishment premium. Estimates are based on equation (3). The sample consists of low-, medium-, and high-wage workers. Columns (1.1) and (1.2) present the baseline estimates for wage and establishment premium losses presented in Figure 4, Panel A. Column (1.3) displays coefficients estimated based on the baseline sample but with establishment premiums estimated in a standard AKM model without controls for establishment and occupation tenure as the dependent variable. 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 in columns (3.1) and (3.2) consists workers displaced with at least two years of tenure in the mass layoff firm (and 4 years in manufacturing) prior to the layoff. In columns (4.1) and (4.2), we match on the commuting zone and establishment size quintiles in addition to our baseline matching variables. The sample consists of workers displaced from manufacturing between 1990 and 2004 and their matched control workers.

Table B.1: Within-Between Decomposition over Time: Switching Probabilities and Establishment Premium Losses by Destination Sector

Switching Probabilities		Establishment Premium Losses	
$\Pr_0(d_i = M)$	-0.299	$E_0\left[\Delta\psi_{J(i)} \mid d_i = M\right]$	-0.003
$\Pr_0(d_i = LK)$	0.199	$E_0\left[\Delta\psi_{J(i)} \mid d_i = LK\right]$	-0.066
$\Pr_0(d_i = HK)$	0.062	$E_0\left[\Delta\psi_{J(i)} \mid d_i = HK\right]$	-0.011
$\Pr_1(d_i = M)$	-0.416	$E_1\left[\Delta\psi_{J(i)} \mid d_i = M\right]$	-0.060
$\Pr_1(d_i = LK)$	0.318	$E_1\left[\Delta\psi_{J(i)} \mid d_i = LK\right]$	-0.207
$\Pr_1(d_i = HK)$	0.064	$E_1\left[\Delta\psi_{J(i)} \mid d_i = HK\right]$	-0.079

Notes: The switching probabilities and establishment premium loss estimates are based on equation (3). Reported coefficients are for the effects three years after displacement. *M* denotes the manufacturing sector, *LK* the low-knowledge service sector and *HK* the high-knowledge service sector. Period 0 represents the two two-year periods 1988-1989 and 1990-1991, and period 1 denotes the final two two-year periods 2004-2005 and 2006-2007.

Table C.1: List of Low- and High-knowledge Industries

Panel A: Low-knowledge Service Industries

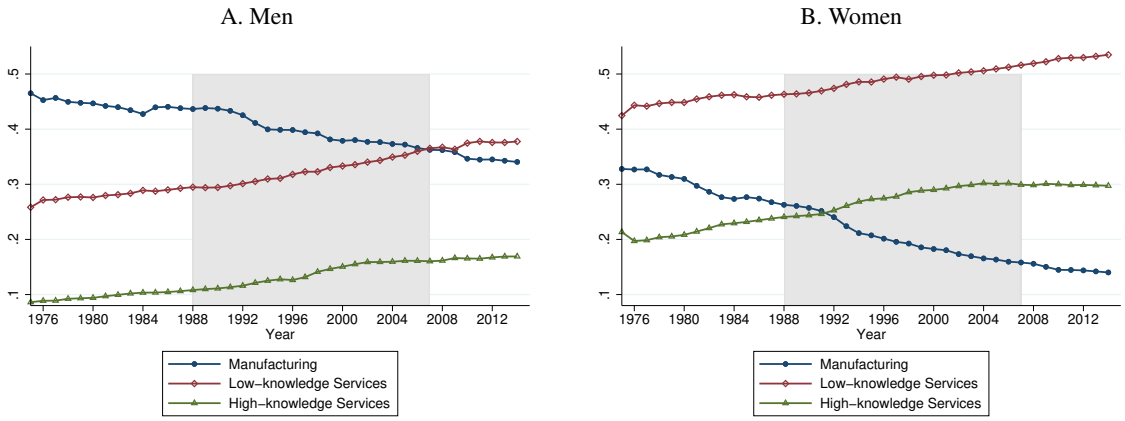
Code	Label	Code	Label
501	Sale of motor vehicles	634	Activities of other transport agencies
502	Maintenance and repair of motor vehicles	641	Post and courier activities
503	Sale of motor vehicle parts and accessories	671	Activities auxiliary to financial intermediation, except insurance and pension funding
504	Sale, maintenance and repair of motorcycles and related parts and accessories	672	Activities auxiliary to insurance and pension funding
505	Retail sale of automotive fuel	711	Renting of automobiles
512	Wholesale of agricultural raw Materials and live animals	712	Renting of other transport equipment
513	Wholesale of food, beverages and tobacco	714	Renting of personal and household goods n.e.c.
514	Wholesale of household goods	745	Labour recruitment and provision of personnel
515	Wholesale of non-agricultural intermediate products, waste and scrap	746	Investigation and security activities
517	Other wholesale	747	Industrial cleaning
521	Retail sale in non-specialized stores	748	Miscellaneous business activities n.e.c.
522	Retail sale of food, beverages and tobacco in specialized stores	751	Administration of the state and the economic and social policy of the community
524	Other retail sale of new goods in specialized stores	752	Provision of services to the community as a whole
525	Retail sale of second-hand goods in stores	753	Compulsory social security activities
526	Retail sale not in stores	801	Primary education
527	Repair of personal and household goods	802	Secondary education
551	Hotels	803	Higher education
552	Camping sites and other provision of short-stay	804	Adult and other education
553	Restaurants	853	Social work activities
554	Bars	900	Sewage and refuse disposal, sanitation and similar activities
555	Canteens and catering	911	Activities of business, employers' and professional organizations
601	Transport via railways	912	Activities of trade unions
602	Other land transport	913	Activities of other membership organizations
611	Sea and coastal water transport	926	Sporting activities
612	Inland water transport	927	Other recreational activities
621	Scheduled air transport	930	Other service activities
622	Non-scheduled air transport	950	Private households with employed persons
631	Cargo handling and storage	953	Rehabilitation centres
632	Other supporting transport activities	954	Sheltered workshops
633	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.	990	Extra-territorial organizations and bodies

Panel B: High-knowledge Service Industries

Code	Label	Code	Label
623	Space transport	726	Other computer related activities
642	Telecommunications	731	Research and experimental development an natural sciences and engineering
651	Monetary intermediation	732	Research and experimental development an social sciences and humanities
652	Other financial intermediation	741	Legal, accounting, book-keeping and auditing activities; tax consultancy; market research and public opinion polling; business and management consultancy; holdings
660	Insurance and pension funding, except compulsory social security	742	Architectural and engineering activities and related technical consultancy
701	Real estate activities with own property	743	Technical testing and analysis
702	Letting of own property	744	Advertising
703	Real estate activities an a fee or contract basis	851	Human health activities
713	Renting of other machinery and equipment	852	Veterinary activities
721	Hardware consultancy	921	Motion picture and video activities
722	Software consultancy and supply	922	Radio and television activities
723	Data processing	923	Other entertainment activities
724	Database activities	924	News agency activities
725	Maintenance and repair of office, accounting and computing machinery	925	Library, archives, museums and other cultural activities

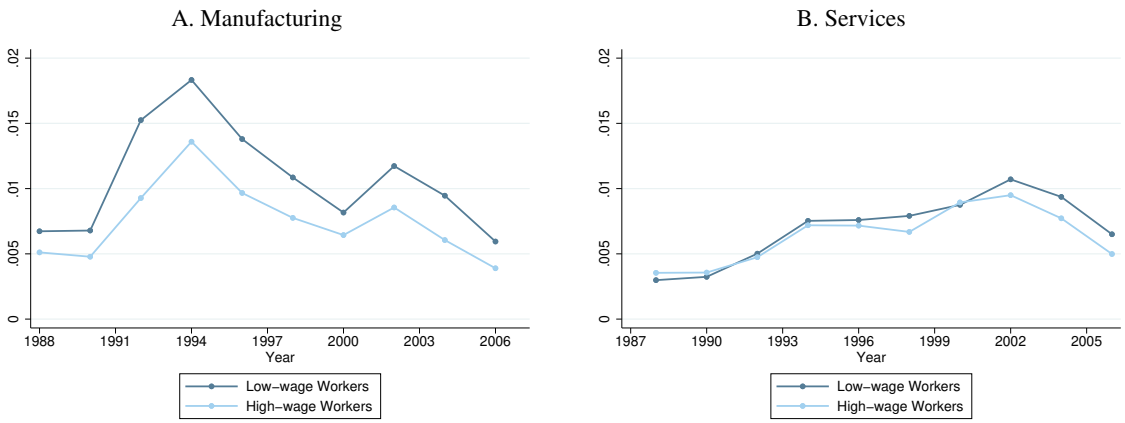
Notes: The table reports three-digit WZ93 industries within the broad sectors low-knowledge services (Panel A) and high-knowledge services (Panel B). We use the definitions provided in Grupp *et al.* (2000) to define the low- and high-knowledge service sectors.

Figure A.1: Employment Shares by Sector and Gender



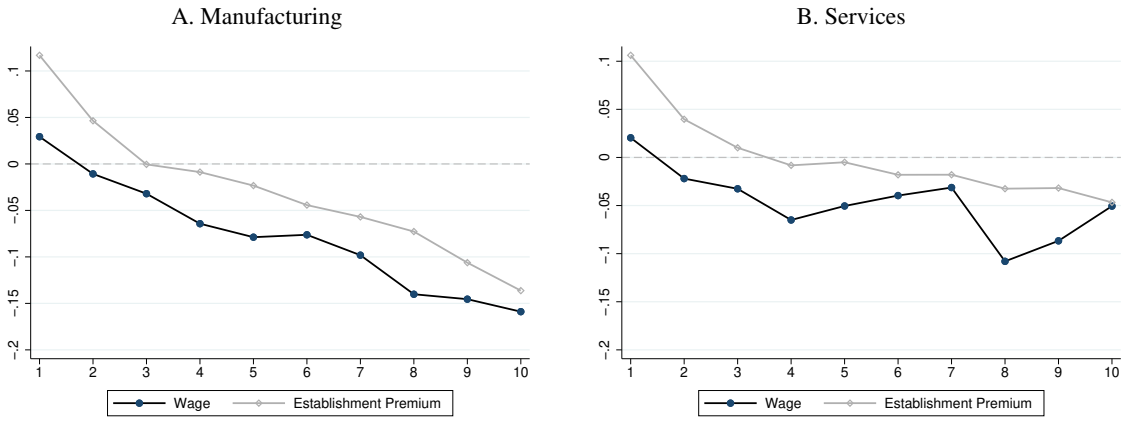
Notes: The figure shows the evolution of employment shares of the manufacturing sector, the low-knowledge sector, and the high-knowledge sector in West Germany by gender.

Figure A.2: Mass Layoff Risk by Sector



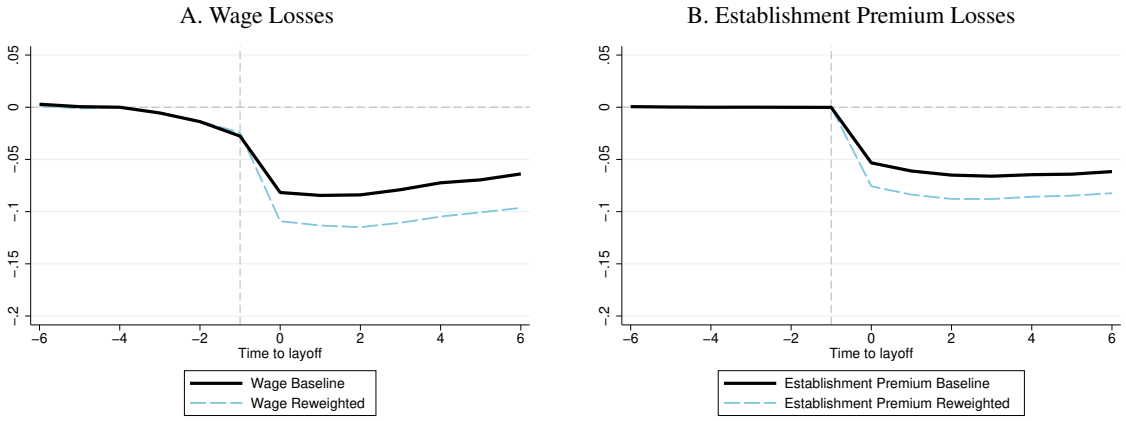
Notes: The figure shows the mass layoff risk in the manufacturing (Panel A) and the service sector (Panel B). The mass layoff risk is measured among workers aged 25-50 with at least four years of establishment tenure and employed in establishments with at least 30 and up to 500 employees in West Germany.

Figure A.3: Displacement Losses by Establishment Premium Decile



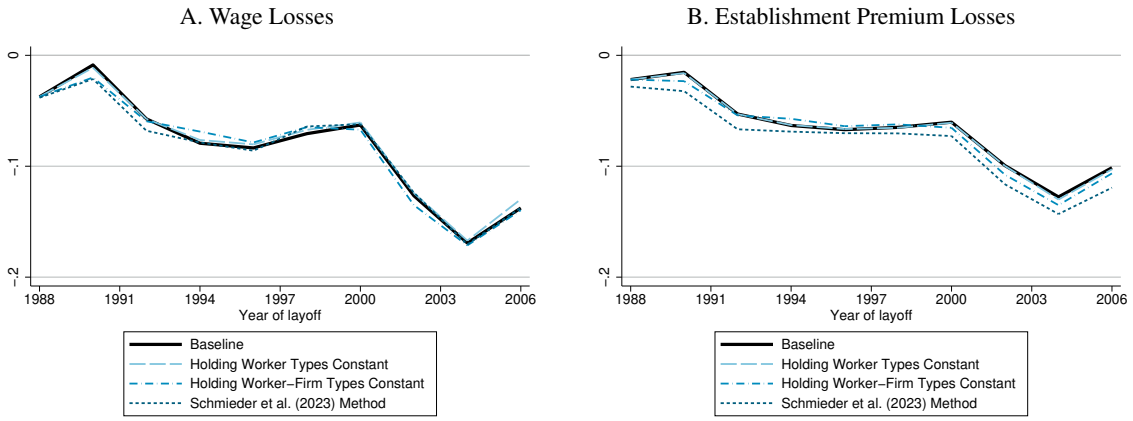
Notes: The figure reports event study estimates of the effects of job displacement on wages and establishment premiums by displacement establishment premium decile and sector. Estimates for the manufacturing sector are reported in Panel A and for the service sector in Panel B. Estimates are based on equation (3). 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. Deciles are defined over the universe of establishments and workers. The sample consists of workers displaced between 1990 and 2004 and their matched control workers.

Figure A.4: Composition-Adjusted Displacement Losses - Low-wage Workers



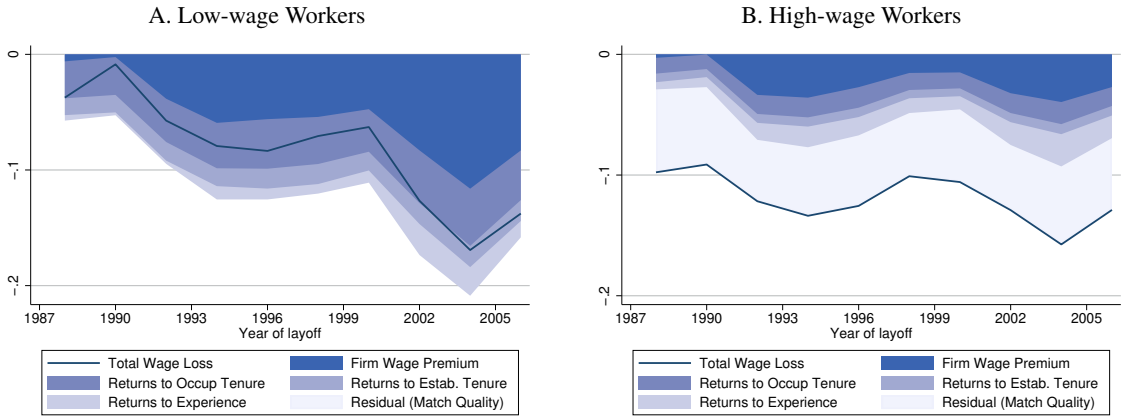
Notes: The figure reports event study estimates of the effects of job displacement on wages in Panel A and on the establishment premium in Panel B for low-wage workers. Estimates are based on equation (3). The solid lines show the baseline wage and establishment premium losses equivalent to those presented in columns (1.1) and (1.2) of Table A.4. 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 workers displaced between 1990 and 2004 and their matched control workers.

Figure A.5: Composition-Adjusted Displacement Losses over Time - Low-wage Workers



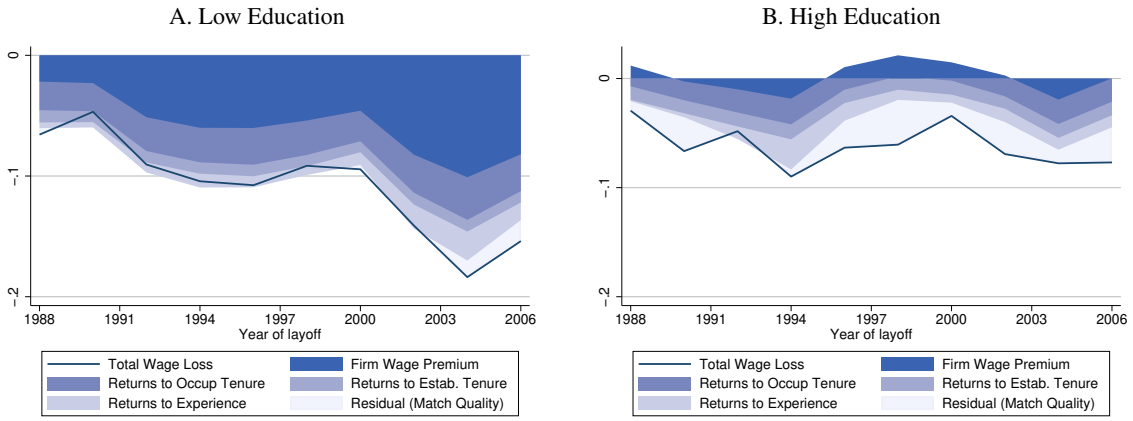
Notes: The figures show event study estimates of the effects of job displacement on wages in Panel A and on the establishment premium in Panel B for low-wage workers. Estimates are based on Equation (3), estimated separately for each two-year period of layoffs taking place between 1988 and 2007. Reported coefficients are for the effects three years after displacement. The solid lines show the baseline wage and establishment premium losses equivalent to those presented in Figure 5. 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. 1988-1989). The dashed-dotted line reweights the composition of workers to reflect the worker and establishment distribution in the first two-year estimation period. The short-dashed line is estimated using the method proposed by Schmieder *et al.* (2023) to account for changes in observable characteristics over time. Both methods are described in more detail in Appendix A.7.

Figure A.6: Displacement Wage Losses over Time When Establishment Premiums Are Allowed to Vary by Worker Type



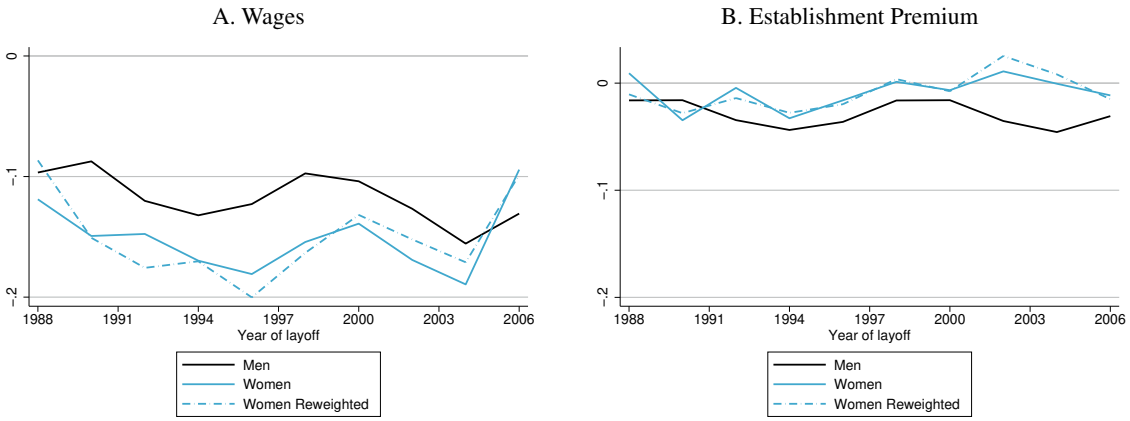
Notes: The figure reports event study estimates of the effects of job displacement on wages and on five potential sources of wage losses (establishment premium, returns to establishment and occupation tenure, returns to experience, and match quality) by worker type. variable. The establishment premium refers to the AKM establishment fixed effect as estimated using a variant of equation (2) that allows the establishment fixed effects to vary by worker type. Estimates are based on equation (3), estimated separately for each two-year period of layoffs taking place between 1988 and 2007, and with the respective source of losses as the dependent variable. Reported coefficients are for the effects three years after displacement. Panel A reports estimates for low-wage workers and Panel B for high-wage workers.

Figure A.7: Displacement Wage Losses over Time by Education



Notes: The figure shows, separately for workers with low and high education, 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). Estimates are based on equation (3), estimated separately for each two-year period of layoffs taking place between 1988 and 2007, and with the respective source of losses as the dependent variable. Reported coefficients are for the effects three years after displacement. Workers without a high school degree (*Abitur*) (including those with a vocational degree but no high school degree) are considered to have low education. Workers with a high-school degree or higher are defined as workers with high education.

Figure A.8: Displacement Losses over Time by Gender - High Wage Workers



Notes: The figure shows event study estimates of the effects of job displacement on wages in Panel A and on the establishment premium in Panel B for high-wage workers by gender. The dashed lines display the results when the sample of women is reweighted to reflect the male distributions of worker fixed effects and establishment premiums, as described in Section 6.5. 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.