

Gathmann, Christina; Helm, Ines; Schönberg, Uta

**Conference Paper**

## Spillover Effects in Local Labor Markets: Evidence from Mass Layoffs

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2014: Evidenzbasierte Wirtschaftspolitik  
- Session: Local Labour Markets, No. A13-V4

**Provided in Cooperation with:**

Verein für Socialpolitik / German Economic Association

*Suggested Citation:* Gathmann, Christina; Helm, Ines; Schönberg, Uta (2014) : Spillover Effects in Local Labor Markets: Evidence from Mass Layoffs, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2014: Evidenzbasierte Wirtschaftspolitik - Session: Local Labour Markets, No. A13-V4, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft, Kiel und Hamburg

This Version is available at:

<https://hdl.handle.net/10419/100378>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# SPILOVER EFFECTS IN LOCAL LABOR MARKETS: EVIDENCE FROM MASS LAYOFFS

Christina Gathmann\*  
University of Heidelberg

Ines Helm†  
University College London

Uta Schönberg‡  
University College London and Institute for Employment Research

First version: March 1, 2014

## Abstract

Governments are often willing to subsidize firms on the verge of bankruptcy. The main economic rationale behind these interventions is that a plant closure would not only harm the workers employed in that plant, but create a domino effect on the regional economy as a whole. Yet, little is still known empirically how important these spillover effects are for economic development in the region. In this paper, we use administrative data of all workers and firms in Germany to quantify the spillover effects of mass layoffs. For the empirical analysis, we combine a difference-in-differences estimator with an event-study approach. We find sizeable negative spillover effects on the regional economy: regions, and especially firms producing in the same sector as the firm hit by a mass layoff, lose many more jobs than in the initial layoff. In contrast, we find few negative effects for workers employed (but not directly affected by the layoff) in the region. As such, mass layoffs seem to have negative spillovers locally, but not nationally.

**Keywords:** Spillover Effects, Regional Economy, Displacement, Germany  
**JEL Classification:** J21, J31, J61, J64, R12

---

\*Christina Gathmann is a Professor at the University of Heidelberg and Research Fellow at the CESifo, IZA and ZEW Mannheim, email: christina.gathmann@awi.uni-heidelberg.de.

†Ines Helm is a doctoral student at University College London, email: ines.helm.10@ucl.ac.uk.

‡Uta Schönberg is an Associate Professor at University College London, email: u.schoenberg@ucl.ac.uk.

# 1 Introduction

Governments are often willing to subsidize or bail out firms on the verge of bankruptcy. In 2008 and 2009, the Bush as well as the Obama administration provided in total over US\$50 billion to General Motors and Chrysler to prevent the shut-down of plants. In Europe, both the British and German governments tried to ensure that a new Opel/Vauxhall model would be produced in their country thus preventing plant closings in 2012.<sup>1</sup> These examples raise the question whether such state interventions can be justified on economic efficiency grounds. The main economic rationale behind these government actions is that a plant closure or a bankruptcy would not only harm workers in the particular plant, but create a domino effect on other plants and workers in the region, thereby multiplying job losses. In the absence of such spillover effects on the region as a whole, it is not obvious how to justify the use of taxpayer's money for subsidizing these companies.

The goal of this project is to test for and quantify spillover effects in local labor markets. The existence and exact magnitude of agglomeration spillovers are still considered open questions in regional and urban economics, despite their enormous theoretical and practical relevance. The identification of spillover effects in the labor market also provides new insights into a series of other important questions in economics. Why are firms that produce nationally traded goods often clustered in dense areas with extraordinarily high production costs? Why do cities exist, and what explains their historical development? And why do incomes and productivity vary so much across countries?

To find answers to these important questions, we assess how regional economies adjust to the occurrence of a mass layoff in a local firm. Specifically, we analyze how employment and wages in other plants in the same region respond to the mass layoff. We further shed light on the possible mechanisms by investigating whether the magnitude of the spillovers depends on economic density in the region or economic linkages between the plant hit by a mass layoff and other plants. Even if massive job destruction leads to a large decline in employment and wages

---

<sup>1</sup>Similarly, local jurisdictions in many countries compete for the headquarters of large companies by offering substantial subsidies or tax breaks to those companies. One prominent example was the up to \$60 million package, a combination of property tax breaks and subsidies, by the state of Illinois and the City of Chicago to lure Boeing's World Headquarters from Seattle to Chicago in 2001.

locally, this does not necessarily justify government interventions at the national level. Spillover effects might be small in the aggregate as one region's loss may be another region's gain. To investigate the potential spillover effects at the national level, we shift the analysis from the local labor market (in which the mass layoff occurred) to the individual worker who was employed in the region but not directly affected by the mass layoff.

Spillover effects at the individual level may differ from those at the regional level for two reasons. First, workers can adjust to a negative employment shock in the region by finding a job in another local labor market. Second, workers who at the time of the mass layoff were employed in another local labor market may no longer move to the region hit by a mass layoff thus reducing worker inflows in the affected region. As workers can search for jobs in many different local labor markets, their employment prospects are unlikely to be hampered much by massive job destruction in one particular region.

For the empirical analysis, we use administrative data from Germany spanning the years from 1975 to 2008 which contain the population of workers and firms covered by the social security system. In addition to detailed individual characteristics including wages and employment status, we also observe unemployment rates in the local labor market. The plant identifier allows us to identify plant closures and mass layoffs as well as plants located in the same local labor market as the plant hit by a mass layoff. A unique employee identifier allows us to follow workers over time, even if they leave their current job or move out of the region. We define a mass layoff either through the disappearance of a plant identifier or through a substantial reduction in plant size. We take great care to make sure that our mass layoffs do not reflect firm spin-offs, break-ups or takeovers, for example, by excluding mass layoffs in which a significant share of displaced workers are found in another plant a year later. We further restrict our analysis to regions, in which no other mass layoff took place in the time before the layoff. To study the consequences of a mass layoff, we combine a difference-in-difference with an event-study approach. We first match for each region hit by a mass layoff to a control region that in years prior to the mass job destruction was similar to the treatment region in terms of population density, demographic and industry structure, wages and employment, but that was not hit by a negative employment shock. To identify the causal impact of mass job destruction on wages

and employment in the region, or on workers residing in the region at the time of the layoff, we flexibly trace outcomes in treatment and control districts in the years after the mass layoff took place. Our identifying assumption is that plants and workers in the control region form a valid counterfactual for the plants and workers in the region experiencing the mass layoff conditioning on our control variables. A comparison between the region hit by a mass layoff and its control region prior to the mass layoff allows us to assess the plausibility of the identifying assumption. If our identification strategy is valid, treatment and control regions should experience similar trends in our outcome variables before the mass layoff.

Our findings suggest that mass layoffs have sizeable negative spillover effects on the regional economy. Four years after a mass layoff (displacing on average 1800 workers), the region has lost almost 3,000 jobs - or about 3.6% of its total employment. Job losses are even larger, about 6% four years after the event, in firms producing in the same sector as the firm hit by the mass layoff. At the same time, we find basically no effect on regional wages suggesting that labor supply is highly elastic. Regions mainly adjust to the negative employment shock through reduced inflows of workers from outside the region and from workers first entering the labor market. We find little evidence however, that workers who were employed in the region, but not displaced by the mass layoff, suffer negative consequences. The main reason is that workers in the affect region can look for and find jobs in other regions at higher frequency than prior to the mass layoff. Hence, spillover effects seem to be confined to the local labor market with few aggregate effects - casting doubt on arguments that interventions by the national government can be justified on economic efficiency grounds.

The proposed research here is important for several reasons. First, our findings will add to the literature on displacement effects by not only analysing whether mass layoffs harm those directly affected by it, but also whether there are negative spillover effects on other workers and firms in the region. If so, the social costs of displacement may be substantially larger than the private costs of displacement suggest. Second, our research project will provide novel evidence on the existence, magnitude, and reasons behind agglomeration effects. As such, our proposed research contributes to long-standing questions such as: why do cities and industrial clusters exist? And can mass layoffs lead to a long-term decline of a region? Third, our findings have

important policy implications. In particular, by contrasting spillover effects at the local labour market level with those at the individual level, our research will provide novel evidence whether state subsidies to particular firms can be justified not only from the viewpoint of the affected region, but also from the viewpoint of the economy as a whole.

The paper is structured as follows. The next section discusses the related literature on displacement, agglomeration and local multiplier effects. Section 3 sets out theoretical mechanisms through which a mass layoff affects the regional economy and the individuals in the local labor market. Section 4 describes the data and our empirical strategy to quantify the effects of mass layoffs. Section 5 reports the main results, while Section 6 discusses additional dimensions and several robustness checks. Finally, Section 7 discusses the policy implications of our analysis and concludes.

## 2 Related Literature

Our article is related to three strands of the literatures: the economic consequences of job displacements; the sources and effects of agglomeration forces in the economy; and the existence and size of local multiplier effects.

### 2.1 Effects of Job Displacement

A long line of research has documented that workers who lose their job for reasons that are beyond their control (i.e. because their plant shuts down or lays off a significant share of its workforce) suffer long-lasting earnings losses (see e.g. Ruhm (1991a); Ruhm (1991b); and Jacobson et al. (1993) for early contributions for the US; Eliason and Storie (2006) for Sweden; Huttunen et al. (2011) for Norway; and Schmieder et al. (2009) for a recent study of Germany, focusing on displacements during the 1982 recession).<sup>2</sup> Schmieder et al. (2009) further demonstrate that in Germany, the persistent earnings losses are mostly due to a decline in wages - which could reflect a loss in specific skills, a loss in search capital, or a loss in firm-wide rents. More recently, the literature analyses the effects of displacement on a wide variety of additional

---

<sup>2</sup>Earlier contributions found only modest displacement effects for Germany (see Burda and Mertens (8); or Bender et al. (2002)).

outcomes, such as divorce (e.g. Charles and Stephens (2004)), fertility (e.g. Del Bono et al. (2012)), mortality (e.g. Sullivan and von Wachter (2009)), or children’s performance in school (e.g. Rege et al. (2011)). All existing studies have focused on the consequences for those directly affected by the displacement. Yet, a plant closure or mass layoff may not only affect the individuals who get displaced, but may spill over to other firms and workers in the local labor market. For instance, the closure of a car manufacturer may trigger additional job losses in nearby plants that provide intermediate goods to the car manufacturer. Our study investigates for the first time these spillover effects for the regional labor market. Our paper therefore provides a novel and complementary view on the economic consequences of job displacement.

## 2.2 Agglomeration Effects

In most countries, economic activity is spatially concentrated. One explanation for this concentration is the presence of a natural cost advantage or shared amenities. However, Ellison and Glaeser (1999) and others argue that natural advantage alone, even if broadly defined, cannot account for the observed degree of agglomeration. At the same time, areas that are economically concentrated are often characterized by high costs of labour and land so firms in these areas typically face particularly large production costs.<sup>3</sup> Why then are firms willing to locate in these high-cost areas?

As first hypothesized by Marshall (1920), a locational advantage may be explained by cost or productivity advantages enjoyed by firms when they locate near other firms. A first reason for locational advantages is input-output relations: firms may benefit from locating in denser areas because of the cheaper and faster delivery of local services and intermediate goods. A second reason why firms prefer to locate near each other is knowledge spillovers and human capital externalities. Knowledge spillovers could arise because the formal and informal interaction of individuals at work or in the neighborhood leads to a sharing of knowledge and skills, which may generate positive production externalities across workers (see, e.g., Marshall (1890); Lucas (1988); Jovanovic and Rob (1989); Glaeser (1999)).<sup>4</sup> A third reason why economic concentration

---

<sup>3</sup>For the United States, Baum-Snow and Pavan (2012) report, for example, that in the 2000 census hourly wages of white prime-age men working full-time and full-year were 32 percent higher in metropolitan areas of over 1.5 million people than in rural areas and metropolitan areas of less than 250 thousand people.

<sup>4</sup>Acemoglu (1996) provides an alternative explanation for human capital externalities, where the underlying

may be beneficial to firms is the size of the market. In a labor market characterized by search frictions and heterogeneous firms and workers, the worker-firm match may be more productive in markets where many firms offer jobs and many workers look for jobs. Further, large labor markets may provide insurance against idiosyncratic shocks, either on the firm side or on the worker side (e.g. Krugman (1991)). Thicker labor markets (with more workers and firms) reduce the likelihood that a firm cannot fill a vacancy or that a worker remains unemployed when firms are hit by idiosyncratic negative demand shocks, and hiring is costly for firms. All three reasons for agglomeration effects imply that a mass layoff leads to productivity declines in other firms in the local labor markets, and may therefore cause a domino effect triggering additional job losses in nearby firms.

Despite their enormous relevance, empirical evidence on the existence of agglomeration effects is, although growing, scarce. The primary approach in testing for agglomeration spillovers is indirect, and tests for an unequal geographic distribution of firms. This approach infers agglomeration spillovers from the equilibrium location decision of firms which may not only be driven by agglomeration effects, but also by natural advantage or shared amenities (see e.g. Audretsch and Feldman (2004) for a good survey). Ellison and Glaeser (1997, 1999) provide convincing evidence that natural advantage alone, even if broadly defined, cannot account for the observed degree of agglomeration. Ellison et al. (2010) go a step further and show that co-agglomeration patterns are stronger between industries that are economically similar which points to spillovers as partly responsible for the geographical clustering of firms. While these patterns are suggestive, this approach does not provide a direct measure of agglomeration effects.

An alternative approach studies whether firms' total factor productivity is affected by the size of the city or industry (see e.g. Rosenthal and Strange (2004) for a survey; Henderson (2003) and Martin et al. (2011) provide recent evidence using plant-level data). In a similar vein, several studies attempt to test for human capital externalities by comparing wages of otherwise similar individuals who work in cities (e.g. Ciccone and Peri (2006); Moretti (2004a) or

---

mechanism is a pecuniary, and not a technological, externality. Suppose that a group of high-skilled workers moves to the local labor market. If physical and human capital are complements, firms will start to invest more in physical capital. Moreover, with costly search, some incumbent workers will end up working with more physical capital, which will increase their wage.



states (e.g. Acemoglu and Angrist (2000)) with varying shares of college graduates in the labor force.<sup>5</sup> The key challenge here is to isolate the causal effect of agglomeration economies from confounding factors, like unobserved heterogeneity (some factors unobserved to the econometrician are correlated with both plant productivity and city or industry size) and simultaneity (an economic shock in the region affects all firms in that region alike). While these studies carefully deal with these issues, they are unable to fully resolve them.

A very recent study employs exogenous shocks to population density to identify agglomeration forces (Ahlfeldt et al. (2013)). Using sudden changes in city density that occurred with separation of East and West Berlin after World War II, the authors show that population declines and reductions in land prices were more pronounced in West Berlin areas close to densely populated areas in East Berlin than districts further away. Our research project also uses exogenous shocks for identification. We rely however, on mass layoffs in plants and a different methodology to identify spillover effects for the regional economy. A second difference is that we study spillover effects for rural as well as urban areas over recent decades. The strength and type of agglomeration effects might be very different in a large metropolitan area like Berlin than in less densely populated areas.

Finally, several recent papers evaluate the effects of place-based policies, such as the federal urban Empowerment Zone programme (Busso et al. (2013)), the Tennessee Valley Authority program (Kline and Moretti (2014a), or the EU structural funds (Becker et al. (2010); Becker et al. (2013)) - all of which have been motivated by the existence of agglomeration spillovers. The general consensus that seems to emerge is that these policies have been successful at fostering local growth and employment, although the gains at the national level are still debated (see Glaeser (2008); and Kline and Moretti (2014b) for recent surveys).

The study that to date provides the most direct evidence on agglomeration effects, and is closest to this paper, is Greenstone et al. (2010). The authors analyze how the arrival of a large plant affects total factor productivity of incumbent plants within the same local labor market. To identify causal effects, Greenstone et al. (2010) compare counties that attracted a large

---

<sup>5</sup>Rather than focusing on wages, Moretti (2004a) investigates whether plants in cities with high levels of human capital have higher productivity, i.e. produce more output with the same inputs, than otherwise similar plants located in cities with low levels of human capital.

manufacturing plant (the "winning" counties) with counties that were the runner-up locational choice (the "losing" counties). They find that 5 years after the opening, total factor productivity of incumbent plants in the manufacturing sector is 12% higher in winning than in losing counties. Productivity spillover effects are even larger in industries that are economically similar to the new plant.

Rather than analyzing the (positive) spillover effects of plant openings, we investigate the potentially (negative) spillover effects of massive job destruction. The spillover effects from job creations and job destructions need not be symmetric. A plant opening may bring new knowledge to the local labor market, for example, that is not necessarily lost when a plant closes down (as other plants could absorb the workers fired from the closing plant). Another important difference to our paper is that we focus is on employment, worker flows and wages which are at the heart of the policy debate.

### **2.3 Local Multiplier Effects**

Local multiplier effects provide a reason other than agglomeration effects why a plant closure or a mass layoff may cause additional job losses in the local economy. The idea here is that laid off workers will have less money available and may even move out of the area. Hence, demand for local non-tradable services (such as hairdressing, restaurant visits, household helpers etc.) may decline, which in turn might lead to job losses in this sector. This effect may be particularly strong if mostly high-skilled workers are affected by the mass layoff. Autor and Dorn (2013) argue that such spillovers contributed to the growing polarization of the US labor market whereby workers at the top of the wage distribution (the main demanders of local non-tradable services) as well as workers at the bottom of the wage distribution (the main providers of local non-tradable services) have gained relative to workers in the middle of the wage distribution.

The importance and magnitude of local multiplier effects is still debated. For instance, Moretti (2010) finds relatively large local multiplier effects in the United States. For every job created in the manufacturing sector, 1.6 additional jobs are created in the non-tradable service sector. Creation of high-skilled jobs or jobs in the high-tech industry seem to generate even larger multiplier effects. Aus dem Moore and Spitz-Oener (2012) corroborate these findings for

Germany, exploiting a local negative demand shock caused by the withdrawal of the US military from Germany since the end of the Cold War. In contrast, other studies find little effect of military base closures on the surrounding economy suggesting that local multiplier effects might be small (see Andersson et al. (2007) for Sweden; Hooker and Knetter (2001) for the United States; and Paloyo et al. (2010) for Germany). We will add to this literature by analyzing whether a mass layoff in the tradeable sector generates additional layoffs in the non-tradeable service sector within the same local labor market.

### 3 Theoretical Considerations

In the empirical analysis, we want to explore how mass layoffs affect the regional economy and the workers who were employed in that region. Our starting point is a standard spatial equilibrium model (Rosen (1979); Roback (1982); Moretti (2010) provides a good summary) where firm productivity depends on economic density in the region. Here, we outline the main arguments and empirical predictions derived from such a model.

Suppose that a plant is hit by an idiosyncratic productivity shock that forces the plant to lay off workers. As long as labor supply is not perfectly elastic, i.e. not all displaced workers leave either the labor market or region immediately, the mass layoff will increase labor supply in the region. Unless capital is fully flexible in the short-run, the additional labor supply puts a downward pressure on regional wages which in turn would induce other plants in the region to hire more workers. Underlying this direct effect is the standard assumption in spatial equilibrium models that wages are determined locally because workers' locational preferences limit geographic mobility.<sup>6</sup> In the absence of agglomeration economies, we would then expect that regions hit by a mass layoff pay lower wages, and that employment in non-affected plants increases.

However, if agglomeration effects are present, the mass layoff, caused by the idiosyncratic negative shock to plant productivity, leads to negative spillover effects in other firms in the region. For the following discussion, we distinguish between firms in the non-tradeable sector

---

<sup>6</sup>Similarly, housing prices should also fall as long as housing supply is upward sloping.

whose products are sold in the region and the tradeable sector whose products are sold in the national market.

Consider first potential spillover effects in the tradeable sector. With agglomeration effects, a mass layoff affects other plants who are linked economically, technologically or through knowledge or worker flows with the plant experiencing the negative productivity shock. If the productivity of other firms depends on regional employment, through thick labor markets or knowledge spillover for example, a mass layoff reduces productivity in other firms as well. If in contrast, firm productivity only depends on the number of firms (irrespective of employment), a mass layoff may have little effect as long as there are no plant closures. Agglomeration effects then reduce labor demand in these other firms as well and puts more downward pressure on regional wages.<sup>7</sup>

Consider next potential local multiplier effects in the non-tradeable sector. A mass layoff reduces the demand for local goods and services because displaced workers have less income available and because some of the displaced workers might leave the region to look for a job elsewhere. This decline in demand in the non-tradeable sector will be more pronounced the more workers get laid off and the higher the income of the displaced workers. Effects on the local service industry will also depend on how much production costs decrease because of declining land prices and local wages.

In sum, we get the following empirical predictions: the mass layoff results in an immediate decline in regional employment through displaced workers. In the presence of agglomeration or local multiplier effects, employment declines even further over time because additional jobs are lost in the regional economy. If spillover effects are mostly driven by agglomeration forces in the tradeable sector, the employment decline in the region would be stronger for firms that are economically closer to the firm hit by a layoff. If spillovers are rooted in local multiplier effects, we should see a stronger employment decline in the non-tradeable sector producing for the local market. Finally, wages in the region decline if regional labor supply is not perfectly elastic.

---

<sup>7</sup>Firms in the region might also use this decline in labor demand to restructure their workforce in order to reduce production costs. In that case, we would see a decline in employment but not necessarily in productivity.

## 4 Data Sources and Empirical Strategy

### 4.1 Data Sources

To study the spillover effects from mass layoffs, we use unique administrative data in Germany from 1975 to 2008. The data cover the whole population of workers covered by the social security system. Overall, the data include information of 75% to 80% of all employed individuals in Germany each year.<sup>8</sup> We drop East Germany from the analysis as district boundaries changed in East Germany over our time period. Furthermore, employment and wage structures still differ substantially between East and West Germany.

The data contain unique identifiers for the employees and the plants they are working at. Using the employee identifier, we are able to track the individuals' labor market careers over time, even if they leave the region or plant. The data comprise detailed characteristics of the individual worker (like education and occupation) and the plant (like sector of employment and municipality of the workplace). We can also merge information on individual unemployment (if an individual draws unemployment benefits) and unemployment rates in the local labor market to the main data. We define three skills groups: the low-skilled without a highschool or vocational training, the medium-skilled with a high school degree or vocational training and the high-skilled with a college degree. Wages are measured as daily wages and deflated to 1995 prices using the consumer price index. As in many administrative datasets, wages are right-censored at the highest level of earnings that are subject to social security contributions. Top-coding is negligible for unskilled workers and those with an apprenticeship but reaches up to 30% for university graduates.

Most importantly, we observe unique identifiers for the plant a worker is employed at. Based on the plant identifier, we define mass layoffs and can also identify all workers who lost their job in a mass layoff. To examine the consequences of a mass layoff for the regional economy, we study its effects within the same administrative district ("Kreis" equivalent to NUTS-3 regions).

German districts are self-contained administrative units with about 70,000 jobs observed in our

---

<sup>8</sup>Note that civil servants, the self employed and military personnel are not covered by the general social security system and are therefore not part of this dataset. We further exclude all plants from the following industries: education, health and social work as well as private households.

data (Lange and Zischek (2004)).<sup>9</sup> In the robustness section, we check for spillover effects above and beyond the district in larger commuting zones which also include the neighboring districts.

## 4.2 Identification of a Mass Layoff

We define a mass layoff as a reduction in plant size of at least 500 individuals for a minimum of two consecutive years. One question that arises is how to distinguish mass layoffs from mere changes in plant identifiers or from a breakup into multiple plants. We define a reduction in plant size as a mass layoff only if less than 30% of the individuals leaving a plant go to one other plant (following Hethey and Schmieder (2010)). To rule out breakup of plants into multiple plants, we further require that at most 70% of individuals leaving the plant go to the same three plants in the dataset. To isolate the effect of the mass layoff, we further require (a) that no other layoffs with more than 200 individuals or more than 50% of the original layoff take place in the year of the mass layoff or the preceeding two years; (b) that no other layoff with more than 500 employees takes place in the four years before the mass layoff studied. And (c) that no increase in employment bigger than the mass layoff takes place in the first two years after the mass layoff. Finally, if there are two mass layoffs in the same region in consecutive years, we combine them into a single event.

Because we trace regional development four years prior to the mass layoff and for at least four years afterwards, we only include mass layoffs that occur between 1981 and 2004. Furthermore, we restrict attention to mass layoffs in the tradeable sector (which include agriculture, mining, food industry, construction sector, producer goods, investment and durable goods as well as consumer goods) where we think that agglomeration forces are most important. Table 1 shows some descriptive statistics about our sample of mass layoffs. Most layoffs occur in the manufacturing sector and more than half the events occur in the years surrounding the 1993 recession. A mass layoff destroys on average 1,500 jobs reducing regional employment by a sizeable 2.3% in the displacement year. Treatment districts are more likely to be urban since there are basically no mass layoffs in rural areas.<sup>10</sup>

---

<sup>9</sup> Altogether there are 326 districts in West Germany.

<sup>10</sup> Our sample of mass layoff districts also excludes the large urban centers because they often experience multiple mass layoffs or because no good match could be found for the affected urban center.

Our mass layoffs occur in relatively large plants which also pay higher wages than the average plant in Germany.<sup>11</sup> The individuals who lose their job because of the mass layoff are older and more likely to be low-skilled than the average individual in the affected district or the average employee in Germany (see Table A1 in the appendix).

### 4.3 Matching Treatment and Control Regions

The key econometric challenge of analyzing the consequences of a mass layoff is that districts experiencing a mass layoff may be systematically different from other West German districts. Districts experiencing a mass layoff might have lower productivity or less favorable workforce characteristics, for example, than other regions even before the mass layoff. Table A2 in the appendix indeed shows that districts with a mass layoff differ substantially from the average West German district along many observable dimensions like industry structure, employment or wage growth. Therefore, we cannot simply compare districts experiencing a mass layoff with districts that do not experience a negative employment shock.

A credible identification strategy requires to find a region that is similar to the mass layoff region in terms of its determinants of wages and employment dynamics. To identify proper counterfactuals for the districts with a mass layoff, we use a matching procedure. Our basic approach is very similar to the identification strategy used in the job displacement literature (Jacobson et al. (1993); Schmieder et al. (2009), among others). The main difference is that we match at the district level in order to analyze the spillover effects of displacement for the region as a whole.

For the main empirical analysis, we match on employment shares in 17 broad industries, three age (ages 16-25, 26-50 and 51-65) and education groups (low-, medium- and high-skilled) of the workforce as well as the real wage for each of the four years prior to the mass layoff (by including a complete set of interactions between the basic matching variables and each year from 4 to 1 years prior to the event). We use a mahalanobis matching algorithm minimizing the standardized Euclidean distance for treatment and control region.<sup>12</sup>

---

<sup>11</sup>Note that employment in a mass layoff firm is defined as all employees in the plant experiencing a mass layoff plus additional employees in potential break-up (possibly spinoff) plants. A plant is a break-up if at least 200 displaced individuals find a job there and make up at least 50% of the worker inflow in that plant.

<sup>12</sup>Specifically, we minimize the sum of all squared distances of the matching variables in the treatment and

We impose further restrictions on the matched region to rule out confounding factors. We exclude districts that are from the same spatial planning region as the district experiencing the mass layoff to avoid any indirect effect of the mass layoff on the control group (e.g. through regional spillover effects).<sup>13</sup> We also impose on control regions the same restrictions as for treatment regions (see conditions (a) to (c) in the last subsection) to rule out other shocks to the control region. Further, we only keep control districts in which regional employment is not more than 15% above or below the treatment district in the year prior to the layoff. This restriction ensures that control and treatment district are similar in size. To increase the comparability of control and treatment regions further, we also drop all matches with the highest distance in the matching variables (using a 5% trimming margin). We also restrict our analysis to mass layoffs in the tradeable sector because we think that agglomeration forces are more important here. Our final sample consists of 65 districts pairs in which both treatment and control satisfy all restrictions.<sup>14</sup>

Table 2 shows that the matching procedure generates a balanced sample of treatment and control regions in terms of observable characteristics. All variables are measured in the period prior to the mass layoff. The only exception is the share of consumer goods which is slightly higher in control regions; yet the difference is only borderline statistically significant and well within the margin of statistical error. Overall, a comparison of Table 2 and Table A2 in the appendix reveals that our matching procedure works well in eliminating observable differences between treatment and control districts.

## 5 Econometric Strategy

To analyze the effects of a mass layoff, we then combine a difference-in-difference approach with an event-study approach. Specifically, we compare labor market outcomes of workers in the

---

possible control regions, normalized by their variance. The distance equation for all treatment regions  $i$  and control regions  $j$  is given by  $\text{distance}_{ij} = \sum_n \sum_\tau \frac{(x_{in}\gamma_\tau - x_{jn}\gamma_\tau)^2}{s_{nj}^2}$ , where  $s_{nj}$  is the standard deviation of variable  $n$  in the control regions  $j$  and the  $\gamma_\tau$  are indicators for each of the four years prior to the layoff. See Stuart and Rubin (2008), for example, for additional details.

<sup>13</sup>The 326 districts in West Germany are combined into 78 spatial planning regions ("Raumordnungsregionen"), which contain an economic center and the surrounding commuting areas.

<sup>14</sup>We perform extensive sensitivity checks using alternative values for the maximum difference in regional employment, alternative trimming margins or using only the variance of the treatment regions to scale the distance (see the robustness section and the online appendix).



treatment district to those in the control district in the periods after the mass layoff. Using the sample of paired treatment and control regions, we then estimate variants of the following model:

$$Y_{rt} = \alpha_r + \sum_{\tau=-4}^{k-1} \beta_{\tau} Event_{r,t}^{\tau} + \sum_{\tau=k+1}^4 \gamma_{\tau} Event_{r,t}^{\tau} + \delta_t + \theta_{\tau} + \epsilon_{rt}, \quad (1)$$

where the mass layoff occurs between  $\tau = -1$  and  $\tau = 0$ .  $Y_{rt}$  denotes the outcome variable of interest like employment or wages of displaced workers or worker flows in the affected region. We control for level differences using district fixed effects ( $\alpha_r$ ) and aggregate shocks through year fixed effects. ( $\delta_t$ ). The event fixed effects  $\theta_{\tau}$  are measured relative to the period in which the mass layoff occurred. The coefficient  $\theta_4$ , for example, represents the common effect in treatment and control regions four years after the event. Including both event and year fixed effects ensures that we only compare outcomes in the same year and in the same point in time relative to the layoff.

The parameters of interest are the  $\gamma$ s which trace flexibly the economic consequences of a mass layoff on the displaced workers and the affected region over time. The coefficients reflect the percentage change in the outcome variables between the post- and pre-event periods relative to the control region. In the main analysis, we focus on four years prior to and four years after the mass layoff ( $-4 \leq \tau \leq 4$ ). We return to the question of long-run effects of the mass layoff after we present our main results.

Our identifying assumption is that plants and workers in the control regions form a valid counterfactual for the plants and workers in the region experiencing a mass layoff. Most importantly, this assumption rules out diverging trends in wages and employment in treatment and control regions conditional on the covariates included. A comparison between the two types of regions in years prior to the mass layoff allows us to assess the plausibility of this assumption: If our identification strategy is valid, treatment and control regions should experience similar trends in economic variables prior to the mass layoff (and hence the  $\beta$  coefficients in equation (1) should be close to zero and statistically insignificant prior to the event, i.e. for  $\tau \leq 0$ ).

## 6 Empirical Results

### 6.1 Direct Effects on Displaced Workers

We start out with examining the direct effect of a mass layoff on workers who got displaced in the layoff event. These direct effects are not only interesting in their own right, but also aid in interpreting the spillover effects on other plants and workers in the region. We would expect strong local multiplier effects, for example, if displaced workers move away from the region, or suffer particularly large earnings losses.

Descriptive statistics show that only 40% of the workers displaced by a mass layoff actually find a new job within five years. Figure 1 shows that workers who got displaced in a mass layoff between  $t-1$  and  $t$  have much lower employment rates and wages in the following years. Employment rates initially decline by almost 60% compared to the control region. Though there is some recovery over time, employment is still about 40% lower even four years after the mass layoff. The bottom panel further shows that displaced workers also suffer sustained wage losses. Wages conditional on employment are 20% lower than in the control region and there is little evidence that wages of displaced workers catch up over time to those in the control region.

The wage effects we find for Germany are large compared to those found in the displacement literature (e.g. Schmieder et al. (2009) report wage losses following job displacement in Germany during the 1982 recession of between 10-15%). As noted above, the plants experiencing a mass layoff in our data are larger and pay higher wages than the average firm in Germany; and the workers which get displaced are somewhat older than the workforce in the average West German plant.<sup>15</sup> Our sample restrictions also differ from samples of displaced workers typically analyzed in the displacement literature. We include both men and women who are between 16 and 65 years-old while most of the literature focuses on men aged 20 to 55 with strong labor force attachment.<sup>16</sup> As such, it is not surprising that we find large wage losses for displaced workers.

---

<sup>15</sup>In addition, our sample of displaced workers is somewhat more attached to the labor market and the region as well as less likely to be unemployed prior to the mass layoff than the average worker in the control region. These differences are not surprising given that we match at the regional level (and not the individual displaced worker as in the displacement literature).

<sup>16</sup>Earnings losses are typically higher among workers with strong labor force attachment. Yet, our sample also includes older workers above 50 who might have more difficulties finding a new job; as such, they might suffer higher earnings losses than workers under 50. Del Bono et al. (2012), for example, provide evidence that employment and earnings losses of young women are smaller than for men. In addition, our estimation is at the

Table 3 provides additional evidence that displaced workers suffer negative consequences in the labor market. Mirroring the large decline in employment, displaced workers are much more likely to be unemployed than workers in the control region. The share of unemployed declines from 40% shortly after the layoff to about 4% four years later, in part because unemployment benefits might have been exhausted.<sup>17</sup> Over the same period, the share of displaced workers who are no longer observed in the social security system increases from 21% to 33% four years after the layoff.<sup>18</sup>

Not only do many displaced workers stay unemployed or leave the social security system, they are also more likely to leave the region as a whole. Employment in the local labor market declines even more than overall employment. The reason is that displaced workers are about 8% more likely to find employment in a different district four years after the displacement. Of those, the vast majority (7%) leave the broader labor market region (defined by commuting zones). Hence, displaced workers do probably not remain and commute to a new job in the broader region, but move out of the district altogether.

We now turn to the question how mass layoffs affect the regional economy as a whole above and beyond the displaced workers.

## 6.2 Spillover Effects in the Region

The large and persistent negative consequences for displaced workers documented in the last section suggest that mass layoffs may have an impact on the regional economy as well. Lower employment and earnings losses of displaced workers reduce the demand for goods and services in the non-tradeable sector generating local multiplier effects. In addition, the mass layoff may also affect other plants in the region through labor supply or additional labor demand shifts.

---

district level, while the displacement literature focuses on the individual worker level. If we impose the same sample restrictions and use individual-level data instead, we find very similar effects than the previous literature. The results are available upon request.

<sup>17</sup>Note that a person is defined as unemployed in our sample if she draws unemployment benefits. A person receives unemployment benefits if she is registered as unemployed and eligible for unemployment benefits. Since 2005, the duration of unemployment benefits varies from six months to two years depending on how long a person was employed (and hence, paid its unemployment insurance contribution) within the last five years preceeding the unemployment spell. In general, a person who has worked for the one (two) out of the five years, for example, is eligible for six (twelve) months of unemployment benefits. Workers older than 50 (58) years are eligible for 15 (24) months independent of the length of employment prior to the unemployment spell.

<sup>18</sup>Individuals are not observed in our data set either because they are out of the labor force (non-employed), move abroad, enter the military, become a civil servant or self-employed

Displaced workers looking for a job in other plants in the region shift labor supply outward and put a downward pressure on local wages (unless labor supply is perfectly elastic). In the presence of spillover effects due to agglomeration forces or local multipliers, the mass layoff may also induce negative labor demand shocks in other plants. Hence, a negative effect on employment in other plants in the same region is evidence for spillover effects.

Table 4 investigates how employment and wages in the region change relative to the control region after a mass layoff. The left-hand side studies the overall effect on the region relative to the period prior to the event ( $\tau = -1$ ). The right-hand side shows the indirect effect on the region by excluding employment in the plant experiencing the mass layoff; to allow some time for spillovers to unfold, estimates are relative to the year of the mass layoff ( $\tau = 0$ ). The overall effect suggest a decline in regional employment by 1.6% in the year after the mass layoff.<sup>19</sup> The employment decline is highly persistent and more than doubles over time. Four years after the mass layoff, the region has lost 3.6% of its employment, or almost 3,000 jobs.

Yet, how much does a mass layoff in the region affect other plants and workers in the region? Excluding employment in the event firm shows that the region as a whole suffers substantial negative consequences as well. Employment in the region declines by 0.6% more than doubling to 1.3% over the next four years. This evidence suggests that spillover effects are important as the affected region loses almost as many jobs through spillovers than through the initial layoff. Only a small share of the employment decline is reflected in higher unemployment rates which suggests that most of the adjustments to the mass layoff occurs through other channels. We investigate those channels in more detail in the next section.

Figure 2 further illustrates the loss in employment for the regional economy. The top panel shows the evolution of overall employment in the event and control region (predicted from the estimates in Table 4, column (1))). The figure shows that employment declines in both treatment and control - as most layoffs occur during economic recessions. Yet, the decline is much more pronounced in the region experiencing the mass layoff. The bottom panel shows that a mass

---

<sup>19</sup>The decline is smaller than the 2.3% decline in the descriptive statistics (see Table 1) because here, employment effects are measured relative to the control region. Since employment in the control region also declines between the pre-event period and the post-event period, the difference-in-difference estimates are smaller than the simple before-after comparison in the descriptive statistics.

layoff creates a substantial and persistent employment decline in the region as a whole and the spillover effect (excluding event firm employment).

In contrast, we find little evidence for a persistent downward pressure on wages in the regions with the mass layoff compared to the control regions. The absence of wage effects suggests that the labor supply curve is very elastic. A negative demand shock induced by the layoff and additional spillover effects on other plants in the region is then absorbed either through worker leaving the region (outmigration) or the labor market covered by the social security system (especially non-employment) altogether.

So far, our evidence points to substantial negative spillovers which manifest through higher unemployment and fewer employment opportunities. Yet, in which sectors or industries are negative spillover effects most prominent? Are spillover effects stronger for firms within the same industry or broad sector than the plant experiencing the mass layoff? Or, do mass job destructions cause additional job losses mostly in the non-tradable service sector, as we would expect in the presence of local multiplier effects?

Table 5a suggests that spillover effects are much larger for plants producing in the same industry or broad sector than the plant experiencing the mass layoff. The results for the broad sector suggest that there is a 3% employment decline in the same sector which grows to over 6% four years after the layoff. Results for the same industry are initially smaller than for the same sector. A possible explanation is that more displaced workers look for jobs in the same industry and region; this positive labor supply effect would work against finding an overall negative employment effect within the same industry. While the same industry effects also become larger over time, they are typically statistically not significant. The reduced precision of our estimates emerges because treatment regions often have few (if any) plants within the same two-digit industry than the event plant.

Local multiplier effects could be an additional channel how mass layoffs in the tradeable create negative spillover effects in the local labor market. Local multiplier effects mostly affect the non-tradeable sector and should be most pronounced if displaced workers have less income available or leave the region altogether. The evidence (on the right-hand side of Table 5a) suggest however, that local multiplier effects through declining consumer demand are not the

primary source of spillover effects.

In sharp contrast, there are sizeable spillovers to the tradeable sector, especially if compared to the initial size of the mass layoff. Employment declines by almost 3% in plants (other than the event plant) within the tradeable sector, which is, in percentage terms, more than twice as large as the indirect effect on the region as a whole. Hence, spillover effects seem to work mostly through agglomeration forces within the same sector and industry, and among firms producing for the national and international market.

Table 5a also helps to address concerns that the estimates in Table 4 merely reflect a region-specific demand shock where the mass layoff we study is just one event among others occurring in the region. There are several reasons why a district-specific shock does not explain our results. First, we restrict our sample to mass layoffs in the tradable sector in which firms produce goods for the national or international market. Hence, firms should not depend on local demand conditions. Furthermore, Table 5a shows that spillover effects are much larger for firms producing in the same industry and broad sector. This result seems inconsistent with a regional labor demand shocks, such as a natural disaster or a sudden change in regional in- or outflows of workers, that affect all firms in the region in a similar way.

Spillover effects might not only be larger in neighboring industries and sectors; they might also depend on the thickness of the local labor market or degree of urbanization more generally. Here, we use a differences-in-differences approach by collapsing the post-event period into a single coefficient. The first specification in Table 5b shows the baseline result for the overall spillover effect on employment in the post-event period. We then measure economic density in two ways: the first one uses (log) employment density; the second measure defines a district as urban if it contains a city with a population above 100,000 or has a population density over 300,000 per square kilometer.<sup>20</sup> Both measures tell a very similar story: spillover effects on regional employment are stronger in dense or urban areas.<sup>21</sup> Table 5b provides some first

---

<sup>20</sup>The results are not specific to these particular measures. We find very similar results if we distinguish between agglomeration centers (population above 300,000 or population density of 300,000 per square kilometer), urban centers (population above 100,000 or population density of 100,000 per square kilometer) and rural districts; or, if we allow for separate effects by quartiles of employment density. In all cases, negative employment spillovers are more pronounced in economically dense areas.

<sup>21</sup>One might be worried that some unobserved factor correlated both with employment and employment density accounts for these results. Note however, that omitted factors, like natural advantages, shared amenities or other productivity-enhancing factors are likely to be higher in dense areas and also increase regional employment (see,

support for the idea that the negative spillover effects we find cannot be explained by thick labor markets alone. Since urban or denser areas have thicker labor markets, employment declines should be less pronounced because displaced workers have more options available for finding a new job in densely populated areas; and firms have more options to fill a vacancy there.<sup>22</sup>

### 6.3 Regional Effect or Worker Effect?

Even if mass job destructions lead to a substantial decline in employment in the local economy, spillover effects may be small at the national level. The reason is that one region's losses may be another region's gains. If the overall decline in regional employment following a mass layoff is fully compensated by outflows of workers looking for a job elsewhere, for example, the loss of the treatment region is offset by employment gains in other regions. The economy as a whole would then adjust to the mass layoff simply by reallocating labor across regions. In that case, there would be little reason for the national government to intervene in the adjustment process.<sup>23</sup>

Table 6 studies more closely how regional economies adjust to a mass layoff. The dependent variables are inflows and outflows relative to regional employment (including the displaced workers) just prior to the mass layoff (in  $\tau = -1$ ). The job flows suggest that outflows play a minor role in adjusting to the employment shock. There is no evidence of increased outflows into other districts though outflows into unemployment and non-employment/unobserved are

---

for example, Ciccone and Hall (1996)). Therefore, omitted factors would bias us in the direction of finding a positive effect, not a negative effect as in Table 5b.

<sup>22</sup>To shed more light on the precise nature of these spillover effects, we are currently investigating whether spillovers are stronger for firms that are "closer" to the industry of the plant experiencing the mass layoff. Here, there are potentially two opposing effects. On the one hand, the negative agglomeration effect should be larger for close than for distant industries (the "demand effect"). On the other hand, workers who were displaced by the mass layoff may first seek employment in close industries (for instance because the loss in specific skills is smaller in these industries). As a result, close industries should experience a larger positive labor supply shock after the mass layoff than other, more distant industries in the local labor market (the "supply effect"). For the empirical analysis, we use three alternative measures of closeness (see Greenstone et al. (2010) for a similar approach). The first one defines two industries as close if they draw on the same labor pool, for example, because both industries require or train workers in similar skills. Specifically, we use the share of workers moving from or to the industry of the event plant to any other industry (defined at the 2-digit level) in the years prior to the mass layoff in our data. As a second measure, we look at vertical relationships between industries (input-output linkages). Our third measure investigates whether industries draw on the same knowledge in the production process (using patent citation patterns between industries). So far, we find little evidence that industries with a joint labor pool or stronger input-output linkages are more negatively affected by the mass layoff than other industries.

<sup>23</sup>In principle, a similar argument would apply to wages. With an upward sloping labor supply curve, wage declines in the affected region would be offset by wage increases in regions receiving displaced workers from the event region. However, we find few indirect wage effects neither in the region experiencing the layoff nor in other regions. Therefore, government interventions also cannot be justified based on arguments of declining wages or regional equity considerations.

somewhat higher in the first couple of years after the layoff.

In contrast, most of the adjustment comes from reduced inflows into regions experiencing a mass layoff. The biggest adjustment occurs through reduced flows from other districts into the event district; in addition, there are also reduced outflows from unemployment and unobserved state (which includes non-employment) as well as fewer labor market entrants working in the affected region. Overall, these results suggest that mass layoffs disrupt worker flows - especially reducing the arrival of new workers in the region experiencing the layoff.

Does the disruption of regional job flows also imply that workers who were employed in the event region around the time of the mass layoff suffer negative consequences? Spillover effects at the individual level may differ from those at the local labor market level for two reasons. First, workers may move away from the local labor market and find comparable jobs in other regions. Second, job opportunities could improve again for workers in the event region if workers from other local labor markets no longer move into the region hit by a mass layoff. To answer this question, we shift the analysis from the local labor market to the individual level. Here, we sample all workers who at the time of the mass layoff were employed or looking for a job in the region of the layoff. We restrict attention to attached workers who were employed in the region in the three years prior to the layoff. We then follow these workers throughout their career, even if they leave the labor force or no longer reside in the event region.

Table 7 shows results for attached workers (who have been employed in the region in the three years prior to the mass layoff). Workers with a strong attachment to the labor force are less likely to be employed in the event district (by 1.4%, see column (7)) after the mass layoff. Instead, they are more likely to be unemployed (by 0.6%, see column (6)) and more likely to work in a different district (by 0.8%, see column (8)). Hence, workers in the region seem to adjust to negative spillover effects primarily by moving out of the event region and finding a job elsewhere.

Since workers can search for jobs in many different local labor markets (or even a national labor market), their employment prospects are unlikely to be hampered much by the events in one particular local labor market. Hence, workers employed in the region (but not the event firm) are harmed much less by a mass layoff than the regional economy as a whole. As such,



the consequences of massive job destruction are geographically bounded and, due to geographic mobility, have small aggregate effects on workers not directly affected by the layoff.

## 7 Additional Results and Robustness Checks

### 7.1 Longer-Run Effects of Mass Layoffs

Our results indicate substantial spillover effects: regions hit by a mass layoff in terms have lower employment, higher unemployment and lower inflows from other regions. To evaluate the potential consequences for regional economic development and arguments for regional government interventions, it is important to know whether these spillover effects are transitory and hence die out after a few years; or, whether a mass layoff may threaten a region's economic welfare in the long-run as well. To study these long-run effects, we reestimate equation (1) including separate coefficients for up to ten years after the mass layoff. The sample now consists of 55 events and their respective control region as we have to drop mass layoffs after 1998. The identifying assumption is that there are no differential employment trends in the treatment and control region conditional on our covariates in the ten years following the mass layoff.

Table 9 shows the long-run effects of a mass layoff on the regional economy. As before, the dependent variable is log employment in the region. Overall, we find that the spillover effects are highly persistent and even accumulate over time. A decade after the mass layoff, the region has lost 5.8% of its employment or about 4,700 jobs - much more than the initial mass layoff. Spillover effects on other firms in the region are around 2% though estimates become increasingly noisy over time. Focusing on differences across firms, we find the largest negative spillovers in the tradeable sector (a decline of almost 6.8%) and especially for firms producing in the same sector as the event plant (a decline of almost 13.5% over a ten years period). The longer time period further reveals that spillover effects also lower employment (by about 5.6%) in firms producing in a different sector than the event plant.<sup>24</sup>

Figure 5 further illustrates the a mass layoff has long-term employment consequences for the regional economy, especially for firms in the tradeable sector and above all, firms in the same

---

<sup>24</sup>The effect on plants in a different sector becomes statistically significant seven years after the layoff.

sector than the plant experiencing the mass layoff.

## 7.2 Heterogeneity of Regional Effects by Worker Skill and Age

The size and permanent nature of spillover effects on the regional economy raise the question whether certain groups of workers are more negatively affected than others. In particular, are less-skilled workers or older workers more likely to suffer from the negative spillovers of a mass layoff? Table A3 in the appendix shows regional employment spillovers (employment excluding the event firm) by skill and age groups. Effects seem to be similar to the overall effect (in Table 4) for low- and medium-skilled workers. Spillover effects are somewhat larger for the high-skilled but, due to relatively small shares in each region, also noisier. Interestingly, negative spillovers are also stronger for very young workers (below age 25) but basically absent for older workers (above age 50).<sup>25</sup>

We see a very similar pattern if we study job flows into and out of the region (see Table A4). A region hit by a mass layoff receives fewer high-skilled and young workers (see Table A4, columns (6) and (8)). A region then not only suffers permanent job losses but also attracts fewer young workers and less human capital. If we follow attached workers who were employed in the region prior to the layoff however, the picture is more nuanced. It is mostly the low-skilled workers who respond to worse job opportunities by finding employment outside the region (see Table A5). The medium-skilled adjust either by moving into unemployment or by finding a job elsewhere. The high-skilled seem to adjust to negative spillover effects through unemployment (though the coefficients are not statistically significant). Both young and prime-aged workers respond to the worsening job opportunities in the region by looking (and finding) jobs elsewhere. As before, we find basically no effect for older workers (see Table A6).

## 7.3 Further Robustness Checks

Lastly, we probe the validity of our estimation approach to alternative specifications. Our main analysis matches events and control regions at the district level (see Figure A1 for a map of

---

<sup>25</sup>There are several explanations for the absence of an effect on older workers. If firm- or job-specific human capital is important, firms prefer to fire young workers with low tenure in the job or firm ("last in, first out"). It is also likely that job protection legislation protects older worker with high tenure from being fired.

West German districts). Yet, if many workers commute across district boundaries on a daily basis, a district might be too small a unit to define the appropriate local labor market. To check whether our results are robust to the spatial definition of a local labor market, we rerun the analysis using commuting zones instead. Commuting zones combine districts that are connected via commuting flows. After applying the same restrictions as in the main analysis, we are left with 43 commuting zones with a mass layoff and their respective control regions.

Overall, the estimates in Table 9 are similar to the district level; if anything, the spillover effects are actually somewhat stronger than on the district level. Employment (net of the event firm) in the commuting zone declines by a sizeable 4.2% four years after the initial mass layoff. Employment within the same sector is even 10% lower and there is also a small effect (of 2.1%) in the non-tradeable sector suggesting a multiplier effect for the broader region (beyond the affected district). Table 9 also tests whether districts adjacent to the broader local labor market (defined by the larger commuting zone) are affected by a mass layoff. If mass layoffs have spillover effects due to agglomeration forces and commuting areas are self-contained local labor markets, most adjustment should occur within the affected commuting zone. As a consequence, we should see few if any negative effects on neighboring districts outside the commuting zone. Columns (2) and (3) confirm that there are few employment effects in districts bordering on the commuting zone hit by a mass layoff. Again, this supports the view that negative spillover effects of mass layoff are constrained to the local labor market but have little negative effects on the economy as a whole.

Finally, we test whether our results are robust to alternative choices for matching regions. As outlined above, our matching approach imposes that control districts cannot have employment more than 15% above or below the treatment district in the year prior to the layoff. We also drop all matches with the highest distance in the matching variables (using a 5% trimming margin). Further, we use the variance of both event and control regions to scale the distance between treatment and control. Finally, our matching variables are industry, age and skill shares as well as the wage, all interacted with year dummies. Table A7 reports results for regional spillover effects (employment excluding the event firm) for alternative choices for each variable.

The first column repeats the baseline result from Table 4, column (4). Column (2) and

(3) allow a difference of 10% and 20% in event and control region employment prior to the mass layoff. The results for a more restrictive deviation of 10% are very similar to the baseline. Allowing for larger deviations in employment results in smaller effects possibly because of some differential trend already prior to the mass layoff. We next restrict the sample further by dropping the 10% worst matches. Column (4) shows that this has little effect on the spillover effect. Using the variance of the treatment region (rather than both the treatment and control region) also yields very similar effects (column (5)). In the last column, we match on industry shares interacted with year dummies only; again, we find similar results than in the baseline. Overall, our results are very robust to alternative definitions of a local labor market and to modelling choices for finding a proper match for the mass layoff regions.

## 8 Discussion and Conclusion

... to come ... Lessons: Our results are also informative for the literature on the individual effects of job displacement on earnings and future employment. The event study approach in this literature compares the outcomes of exogenously displaced workers to the outcomes of a group of non-displaced workers, often within the same region (as geographical areas are often used as a matching variable). In the case of spillover effects of job displacements on other workers in the region, the identifying assumption that the control group is unaffected by the treatment (displacement) would be invalid. Our analysis suggests instead that workers in the region are not much affected - while the regional economy indeed suffers from a mass layoff.

## References

- Acemoglu, D. and Angrist, J. (2000). How large are human-capital externalities? evidence from compulsory schooling laws. *NBER Macroeconomics Annual*, 15:9–59.
- Ahlfeldt, G., Redding, S., Sturm, D., and Wolf, N. (2013). The economics of density: Evidence from the berlin wall. Technical report, London School of Economics.
- Andersson, L., Lundberg, J., and Sjöström, M. (2007). Regional effects of military base closures: The case of sweden. *Defence and Peace Economics*, 18(1):87–97.
- Audretsch, D. B. and Feldman, M. P. (2004). *Knowledge spillovers and the geography of innovation*, pages 2713–2739. North Holland: Elsevier Science.

- Aus dem Moore, J. P. and Spitz-Oener, A. (2012). Bye bye, G.I. - The impact of the U.S. military drawdown on local german labor markets. Sfb 649 discussion papers, Humboldt University of Berlin.
- 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):1553–1597.
- Becker, S., Egger, P., and Ehrlich, M. V. (2013). Absorptive capacity and the growth effects of regional transfers: A regression discontinuity design with heterogeneous treatment effects. *American Economic Journal: Applied Economics*, forthcoming.
- Becker, S. O., Egger, P. H., and von Ehrlich, M. (2010). Going nuts: The effect of eu structural funds on regional performance. *Journal of Public Economics*, 94(9-10):578 – 590.
- Bender, S., Dustmann, C., Margolis, D., and Meghir, C. (2002). *Worker displacement in France and in Germany*, pages 375–471. Upjohn Institute, Kalamazoo, Michigan.
- Burda, M. and Mertens, A. (8). Estimating wage losses of displaced workers in germany. *Labour Economics*, 1:15–34.
- Busso, M., Gregory, J., and Kline, P. (2013). Assessing the incidence and efficiency of a prominent place based policy. *American Economic Review*, 103:897–947.
- Charles, K. and Stephens, M. (2004). Disability, job displacement and divorce. *Journal of Labor Economics*, 22:489–522.
- Ciccone, A. and Hall, R. E. (1996). Productivity and the density of economic activity. *American Economic Review*, 86:54–70.
- Ciccone, A. and Peri, G. (2006). Identifying human-capital externalities: Theory with applications. *Review of Economic Studies*, 73:381–412.
- Del Bono, E., Weber, A., and Winter-Ebmer, R. (2012). Clash of career and family: Fertility decisions after job displacement. *Journal of the European Economic Association*, 10(4):659 – 683.
- Eliason, M. and Storie, D. (2006). Lasting or latent scars? Swedish evidence on the long-term effects of job displacement. *Journal of Labor Economics*, 24(4):831–856.
- Ellison, G. and Glaeser, E. L. (1997). Geographic concentration in U.S. manufacturing industries: A dartboard approach. *Journal of Political Economy*, 105(5):889–927.
- Ellison, G. and Glaeser, E. L. (1999). The geographic concentration of industry: Does natural advantage explain agglomeration? *American Economic Review, Papers and Proceedings*, 89(2):311–316.
- Ellison, G., Glaeser, E. L., and Kerr, W. R. (2010). What causes industry agglomeration? Evidence from coagglomeration patterns. *American Economic Review*, 100(3):1195–1213.
- Glaeser, E. L. (1999). Learning in cities. *Journal of Urban Economics*, 46(2):254–277.
- Glaeser, E. L. (2008). *Cities, agglomeration and spatial equilibrium*. Oxford University Press.
- Greenstone, M., Hornbeck, R., and Moretti, E. (2010). Identifying agglomeration spillovers: Evidence from winners and losers of large plant openings. *Journal of Political Economy*, 118(3):536–598.
- Henderson, V. (2003). Marshall’s scale economies. *Journal of Urban Economics*, 55:1–28.

- 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].
- Hooker, M. A. and Knetter, M. M. (2001). Measuring the economic effects of military base closures. *Economic Inquiry*, 39(4):583 – 598.
- Huttunen, K., Moen, J., and Salvanes, K. (2011). How destructive is creative destruction? Effects of job loss on job mobility, withdrawal and income. *Journal of the European Economic Association*, 9(5):840–870.
- Jacobson, L. S., LaLonde, R. J., and Sullivan, D. G. (1993). Earnings losses of displaced workers. *American Economic Review*, 83(4):685–709.
- Jovanovic, B. and Rob, R. (1989). The growth and diffusion of knowledge. *Review of Economic Studies*, 56(4):569 – 582.
- Kline, P. and Moretti, E. (2014a). Local economic development, agglomeration economies, and the big push: 100 years of evidence from the Tennessee Valley Authority. *Quarterly Journal of Economics*, 129:275–331.
- Kline, P. and Moretti, E. (2014b). People, places and public policy: Some simple welfare economics of local economic development programs. *Annual Review of Economics*, forthcoming.
- Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, 99:483–499.
- Lange, K. and Zischek, C. (2004). Zur Messung und Aussagekraft regionalstatistischer Daten. *Jahrbücher für Nationalökonomie und Statistik*, 224(1-2):103–114.
- Lucas, R. J. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(1):3–42.
- Marshall, A. (1890). *Principles of economics*. Macmillan: New York.
- Martin, P., Mayer, T., and Mayneris, F. (2011). Spatial concentration and plant-level productivity in france. *Journal of Urban Economics*, 69(2):182 – 195.
- Moretti, E. (2004a). Estimating the social return to higher education: Evidence from longitudinal and repeated cross-sectional data. *Journal of Econometrics*, 121(1-2):175–212.
- Moretti, E. (2004b). Workers’ education, spillovers, and productivity: Evidence from plant-level production functions. *American Economic Review*, 94(3):656–690.
- Moretti, E. (2010). Local multipliers. *American Economic Review, Papers and Proceedings*, 100(2):373–377.
- Paloyo, A. R., Vance, C., and Vorell, M. (2010). The regional economic effects of military base realignments and closures in germany. *Defence and Peace Economics*, 21(5-6):567–579.
- Rege, M., Telle, K., and Votruba, M. (2011). Parental job loss and children’s school performance. *Review of Economic Studies*, 78(4):1462–1489.
- Roback, J. (1982). Wages, rents, and the quality of life. *Journal of Political Economy*, 90(6):1257–1278.

- Rosen, S. (1979). *Wage-based indexes of urban quality of life*, pages 74–104. John Hopkins University Press.
- Rosenthal, S. S. and Strange, W. C. (2004). Evidence on the nature and sources of agglomeration economies. In *Handbook of regional and urban economics. Volume 4. Cities and geography*, pages 2119 – 2171. Elsevier, Syracuse U.
- Ruhm, C. J. (1991a). Are workers permanently scarred by job displacements? *American Economic Review*, 81(1):319–324.
- Ruhm, C. J. (1991b). Displacement induced joblessness. *Review of Economics and Statistics*, 73(3):517–522.
- Schmieder, J. F., von Wachter, T., and Bender, S. (2009). The long-term impact of job displacement in Germany during the 1982 recession on earnings, income, and employment. Discussion papers, Columbia University, Department of Economics.
- Stuart, E. A. and Rubin, D. B. (2008). *Best practices in quasi-experimental designs*, chapter 11, pages 155–176. Best Practices in Quantitative Methods. Sage Publications.
- Sullivan, D. and von Wachter, T. (2009). Job displacement and mortality: An analysis using administrative data. *Quarterly Journal of Economics*, 124(3):1265–1306.

**Table 1: Characteristics of Mass Layoff Sample**

Total Number of Events (by Plant)		70	Total Number of Events (by District)		62
<u>Number of Events by Industry (of plant):</u>			<u>Characteristics of Event Regions:</u>		
Manufacturing of capital/consumer goods	43		Average Employment in Region		81,421
Manufacturing of industrial goods	12		Unemployment Rate		0.061
Energy and Mining	10		Share of Urban Regions		0.600
Manufacturing of consumer products	4		Share of Low Skilled in Region		0.212
Construction	1		Share of Medium Skilled in Region		0.719
			Share of High Skilled in Region		0.070
<u>Layoffs:</u>			Share Aged 16-25 in Region		0.207
Average Size of Layoff	1,545		Share Aged 26-50 in Region		0.618
Average Share of Total Employment	0.023		Share Aged 50-65 in Region		0.175
			Average Daily Wage in Region Prior to Displacement		72.38
<u>Characteristics of Affected Firms:</u>			<u>Number of Events by Period:</u>		
Firm Size	7,596		1981-1988		17
Average Wage	93.54		1989-1996		36
			1997-2004		9
<u>Characteristics of Laid-Off Workers:</u>					
Low Skilled Worker	0.249				
Medium Skilled Worker	0.692				
High Skilled Worker	0.059				
Age 16-25	0.208				
Age 26-50	0.394				
Age 50-65	0.398				
Average Daily Wage Prior to Displacement	84.49				

*Notes* : A mass layoff is defined as a reduction in firm size of at least 500 individuals and lasting at least two consecutive years accounting for changes in firm id and spin-offs. We impose a number of additional restrictions to make sure no other sizeable event occurred prior to the actual layoff (see main text for details). The number of events by district is smaller than the number of events by plant because multiple events in different plants might occur within the same district (which we count as a single event in that district). Urban districts are districts with a population above 100,000 or a population density above 300,000 per square kilometer. Wages are daily wages in EUR adjusted to 1995 prices. Low-skilled individuals are those without a high school or vocational degree, the medium-skilled are those with high school degree or vocational degree and the high-skilled are those with a college degree.



**Table 2: Summary Statistics of Mass Layoff and Control Regions**

	Mass Layoff Region	Control Region	Difference
Employment	81,421.092*** (5,785.735)	78,652.077*** (5,906.579)	-2,769.015 (8,268.156)
Employment Growth (over last 5 years)	0.039*** (0.008)	0.055*** (0.010)	0.016 (0.013)
Unemployment	0.061*** (0.004)	0.056*** (0.005)	-0.005 (0.007)
Unemployment Growth (over last 5 years)	0.012*** (0.003)	0.012*** (0.003)	0.000 (0.004)
Share Urban Regions	0.597*** (0.070)	0.581*** (0.084)	-0.016 (0.110)
Wage	72.380*** (1.418)	69.569*** (1.262)	-2.811 (1.898)
Wage Growth (over last 5 years)	0.075*** (0.005)	0.077*** (0.006)	0.002 (0.007)
Low Skilled	0.212*** (0.008)	0.221*** (0.009)	0.010 (0.012)
Medium Skilled	0.719*** (0.006)	0.715*** (0.007)	-0.004 (0.009)
High Skilled	0.070*** (0.004)	0.064*** (0.004)	-0.005 (0.006)
Age 16-25	0.207*** (0.006)	0.214*** (0.007)	0.007 (0.009)
Age 26-50	0.618*** (0.005)	0.613*** (0.007)	-0.006 (0.009)
Age 50-65	0.175*** (0.003)	0.173*** (0.003)	-0.001 (0.004)
[1] Agriculture and Fishing	0.006*** (0.000)	0.006*** (0.001)	0.001 (0.001)
[2] Energy and Mining	0.033*** (0.007)	0.023*** (0.007)	-0.010 (0.010)
[3] Food	0.028*** (0.001)	0.031*** (0.003)	0.004 (0.003)
[4] Consumer Goods	0.050*** (0.006)	0.066*** (0.006)	0.016* (0.008)
[5] Producer Goods	0.095*** (0.012)	0.095*** (0.008)	-0.000 (0.014)
[6] Investment Goods	0.243*** (0.018)	0.229*** (0.016)	-0.015 (0.024)
[7] Construction	0.065*** (0.003)	0.068*** (0.003)	0.003 (0.004)
[8] Retail Trade	0.145*** (0.005)	0.145*** (0.005)	-0.000 (0.007)
[9] Transport and Communications	0.043*** (0.003)	0.043*** (0.003)	0.000 (0.004)
[10] Finance and Insurance	0.031*** (0.003)	0.031*** (0.002)	0.000 (0.004)
[11] Hotel and Restaurant Industry	0.016*** (0.001)	0.018*** (0.001)	0.002 (0.001)
[12] Educational Services	0.026*** (0.003)	0.029*** (0.004)	0.003 (0.005)
[13] Health, Veterinary and Social Services	0.068*** (0.003)	0.068*** (0.004)	0.000 (0.005)
[14] Corporate Services	0.046*** (0.004)	0.042*** (0.003)	-0.004 (0.005)
[15] Other Services	0.029*** (0.002)	0.029*** (0.002)	-0.000 (0.003)
Observations	62	62	124

*Notes:* Column (1) reports means in event districts, column (2) means in the control districts. All level variables are measured in the pre-event period (t-1) while growth variables are measured from t-6 to t-1. Observations are weighted by district employment in the pre-event period (t-1). Low-skilled individuals are those without a high school or vocational degree, the medium-skilled have either a high school degree or vocational training and the high-skilled have a college degree. Wages are real daily wages in EUR (at 1995 prices). Standard errors are clustered at the district level. Column (3) reports the difference between the event and control region and whether a t-test of differences in means is significant. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

**Table 3: Direct Effect of Mass Layoff on Displaced Workers**

	Employment (1)	Unemployment (2)	Unobserved (incl. Nonemployed) (3)	Employment in Same District (4)	Employment in Different District (5)	Daily Wages (in logs) (6)
Event Region (t-4)	0.063*** (0.017)	-0.016*** (0.003)	-0.063*** (0.016)	0.080*** (0.025)	-0.017 (0.012)	0.008 (0.014)
Event Region (t-3)	0.055*** (0.011)	-0.015*** (0.003)	-0.053*** (0.010)	0.064*** (0.019)	-0.009 (0.010)	-0.006 (0.010)
Event Region (t-2)	0.027*** (0.006)	-0.012*** (0.003)	-0.024*** (0.004)	0.028** (0.013)	-0.001 (0.009)	0.005 (0.007)
Event Region (t-1)						
Event Region (event year)	-0.606*** (0.033)	0.394*** (0.042)	0.210*** (0.030)	-0.714*** (0.012)	0.109*** (0.026)	-0.133*** (0.034)
Event Region (t+1)	-0.515*** (0.034)	0.322*** (0.040)	0.188*** (0.028)	-0.621*** (0.014)	0.106*** (0.027)	-0.197*** (0.040)
Event Region (t+2)	-0.455*** (0.033)	0.220*** (0.032)	0.226*** (0.027)	-0.552*** (0.013)	0.097*** (0.027)	-0.201*** (0.038)
Event Region (t+3)	-0.417*** (0.032)	0.112*** (0.015)	0.293*** (0.030)	-0.506*** (0.013)	0.088*** (0.026)	-0.197*** (0.039)
Event Region (t+4)	-0.384*** (0.031)	0.042*** (0.010)	0.330*** (0.033)	-0.464*** (0.013)	0.080*** (0.026)	-0.194*** (0.039)
Time since/to Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R Squared	0.97	0.89	0.95	0.98	0.90	0.98
Observations	1,116	1,116	1,116	1,116	1,116	1,116

*Notes :* The table reports estimates of equation (1) with the mass layoff taking place between t-1 and t, the event year. All observations are measured at the district level. The dependent variables in columns (1) to (5) are shares engaged in the activity shown in the top row relative to the number of displaced workers in event districts and relative to employment in (t-1) in control districts; the dependent variable in column (6) is the average log daily wage (base year 1995). Event regions are weighted by displaced individuals in the pre-event period, control regions by district employment in the pre-event period. We exclude displaced workers who work in the same firm two periods after the layoff (to account for recalls); or, if at least 100 workers move together to another firm (to account for spin-offs). Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

**Table 4: Effects of Mass Layoff on Local Labor Markets**

	<u>Local Labor Market</u>			<u>Local Labor Market (excluding event firm)</u>		
	Employment (1)	Unemployment (2)	Daily Wages (3)	Employment (4)	Unemployment (5)	Daily Wages (6)
Event Region (t-4)	0.004 (0.005)	0.002* (0.001)	0.001 (0.002)	0.001 (0.008)	0.003 (0.002)	-0.001 (0.003)
Event Region (t-3)	0.000 (0.004)	0.002 (0.001)	0.001 (0.002)	-0.003 (0.007)	0.002 (0.002)	-0.001 (0.002)
Event Region (t-2)	0.001 (0.003)	0.000 (0.001)	0.001 (0.001)	-0.002 (0.005)	0.000 (0.002)	0.000 (0.002)
Event Region (t-1)				-0.002 (0.004)	0.000 (0.001)	-0.001 (0.002)
Event Region (event year)	-0.016*** (0.004)	0.004*** (0.001)	-0.005** (0.002)			
Event Region (t+1)	-0.024*** (0.005)	0.006*** (0.002)	-0.005 (0.003)	-0.006* (0.003)	0.002** (0.001)	0.000 (0.001)
Event Region (t+2)	-0.029*** (0.006)	0.005*** (0.002)	-0.003 (0.003)	-0.008* (0.004)	0.003** (0.001)	0.001 (0.002)
Event Region (t+3)	-0.033*** (0.007)	0.005** (0.002)	-0.003 (0.003)	-0.010** (0.005)	0.003* (0.002)	0.001 (0.002)
Event Region (t+4)	-0.037*** (0.008)	0.005** (0.002)	-0.001 (0.004)	-0.013** (0.006)	0.005** (0.002)	0.001 (0.003)
Time since/to Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R Squared	0.998	0.968	0.991	0.936	0.969	0.993
Observations	1,116	1,116	1,116	1,116	1,116	1,116

*Notes :* The table reports estimates of equation (1) with the mass layoff taking place between t-1 and t. All observations are measured at the district level. Columns (1)-(3) show results for the region as a whole, while columns (4)-(6) focus on the spillover effects by excluding the event firm. The dependent variables are log employment in columns (1) and (4), unemployment rates in columns (2) and (5) and average log daily wages (in EUR at 1995 prices) in columns (3) and (6). Observations are weighted by district employment in the pre-event period. For columns (1)-(3), the base period is t-1; for columns (4)-(6) t, the event year. Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

**Table 5a: Spillover Effects in Local Labor Markets by Industries**

	Same Industry (2-digit level)	Same Sector (7 broad sectors in tradeables)	Different Sector	Tradeable Goods	Nontradeable Goods
Log Employment	(1)	(2)		(3)	(4)
Event Region (t-4)	0.042 (0.056)	0.023 (0.025)	0 (0.012)	0.008 (0.012)	0.001 (0.008)
Event Region (t-3)	-0.005 (0.034)	0.006 (0.024)	0.002 (0.011)	0.004 (0.010)	-0.003 (0.007)
Event Region (t-2)	-0.016 (0.030)	0.005 (0.022)	0.002 (0.009)	0.000 (0.008)	0.005 (0.006)
Event Region (t-1)	-0.015 (0.024)	0.004 (0.019)	0 (0.006)	-0.002 (0.006)	0.003 (0.004)
Event Region (event year)					
Event Region (t+1)	-0.019 (0.022)	-0.030** (0.015)	-0.004 (0.005)	-0.011** (0.006)	-0.005* (0.003)
Event Region (t+2)	-0.033 (0.026)	-0.040** (0.018)	-0.006 (0.007)	-0.016** (0.007)	-0.007 (0.005)
Event Region (t+3)	-0.049 (0.036)	-0.049** (0.019)	-0.009 (0.009)	-0.020*** (0.008)	-0.011* (0.006)
Event Region (t+4)	-0.087* (0.046)	-0.064*** (0.021)	-0.014 (0.011)	-0.029*** (0.010)	-0.012 (0.007)
Time since/to Event FE	Yes		Yes	Yes	Yes
Same Industry x Time FE	Yes		No	No	No
Same Sector x Time FE	No		Yes	No	No
Event Region x Time FE	Yes		Yes	No	No
Region FE	No		No	Yes	Yes
Region x Industry FE	Yes		Yes	No	No
Year FE	Yes		Yes	Yes	Yes
R Squared	0.988		0.988	0.34	0.318
Observations	25,722		25,722	7,812	10,044

Notes : The table reports estimates of equation (1) with the mass layoff taking place between t-1 and t. Estimation is at the industry (two-digit) x district level in columns (1) and (2) and on sector (17 broad sectors) x district level in columns (3) and (4). In columns (1) and (2), we restrict attention to industries (sectors) producing tradeable goods (agriculture, mining, food industry, construction sector, producer goods, investment and durable goods as well as consumer goods). Non-tradeables in column (4) in contrast include service industries such as transportation, telecommunications, hotel and restaurant industry, education, health and social services. Dependent variables are log employment of the respective estimation level. Observations are weighted by employment of the respective estimation level in the pre-event period. The event region x time fixed effect is excluded for the industry (sector) in which the event takes place to avoid collinearity. Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

**Table 5b: Spillover Effects in Local Labor Markets by Density**

	<u>Overall Effect</u>	<u>Area Density</u>	<u>Urban vs. Rural Districts</u>
	(1)	(2)	(3)
Overall Post-Event Effect	-0.008 (0.007)		
Post-Event Effect*Log Employment Density		-0.002** (0.001)	
Post-Event Effect in Urban Districts			-0.016** (0.008)
Post-Event Effect in Rural Districts			0.014 (0.011)
Time since/to Event FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R Squared	0.998	0.998	0.998
Observations	1,116	1,116	1,116

*Notes:* The table reports estimates of equation (2) with the mass layoff taking place between t-1 and t. The coefficient of interest in column (1) is the interaction effect between the event region and the post-event period (t+1 to t+4); in column (2) a triple interaction between the event region, the post-event period and a measure of area density. In column (3), separate estimates of the interaction effect between event region and post-event period (t+1 to t+4) are reported for urban districts (defined as cities with a population above 100,000 or districts with a population density above 300,000 per square kilometer) and rural districts (all other districts). Observations are at the district level. The dependent variable is log employment (excluding employment in the event firm). Observations are weighted by district employment in the pre-event period. Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

**Table 6: Effect of Mass Layoff on Job and Employment Flows**

	<u>Total Outflows</u>	<u>Outflows to</u>		<u>Total Inflows</u>	<u>Inflows from</u>		<u>Labor Market</u>
		Other Districts	Unemp./ Unobs.		Other Districts	Unemp./ Unobs.	<u>Entry</u>
	(1)	(2)	(3)	(3)	(4)	(5)	(6)
Event Region (t-4)	0.005 (0.005)	0.002 (0.002)	0.003 (0.003)	0.003 (0.007)	-0.005 (0.003)	0.001 (0.002)	0.000 (0.001)
Event Region (t-3)	0.001 (0.004)	0.001 (0.002)	0.001 (0.002)	0.000 (0.004)	-0.003 (0.002)	0.001 (0.001)	0.000 (0.001)
Event Region (t-2)	-0.001 (0.002)	0.000 (0.001)	0.000 (0.001)	0.002 (0.002)	0.000 (0.001)	0.000 (0.000)	0.000 (0.000)
Event Region (t-1)							
Event Region (event year)	0.008 (0.007)	0.003 (0.002)	0.005** (0.002)	-0.007 (0.006)	-0.004 (0.002)	-0.001* (0.001)	0.000 (0.000)
Event Region (t+1)	0.009 (0.007)	0.003 (0.003)	0.007** (0.003)	-0.013** (0.006)	-0.008*** (0.003)	-0.003*** (0.001)	0.000 (0.001)
Event Region (t+2)	0.009 (0.007)	0.003 (0.003)	0.007** (0.003)	-0.018*** (0.006)	-0.011*** (0.004)	-0.004*** (0.002)	-0.001 (0.001)
Event Region (t+3)	0.007 (0.008)	0.002 (0.003)	0.006 (0.004)	-0.022*** (0.008)	-0.014*** (0.004)	-0.006*** (0.002)	-0.002* (0.001)
Event Region (t+4)	0.005 (0.010)	0.001 (0.004)	0.006 (0.005)	-0.028*** (0.009)	-0.017*** (0.005)	-0.008*** (0.002)	-0.003** (0.001)
Time since/to Event FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Squared	0.751	0.818	0.759	0.697	0.841	0.914	0.975
Observations	1,116	1,116	1,116	1,116	1,116	1,116	1,116

Notes : The table reports estimates of equation (1) with the mass layoff taking place between t-1 and t. All observations are measured at the district level. The dependent variables in all columns are shares of the flows reported in the top row relative to district employment in t-1. Observations are weighted by district employment in the pre-event period (t-1). Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

**Table 7: Effect of Mass Layoff on Attached Workers in the Region**

	<u>All Attached Workers in Region</u>				<u>Attached Workers (excluding workers at event firm in t-1)</u>			
	Employment	Unemployment	Employment Same District	Employment Different District	Employment	Unemployment	Employment Same District	Employment Different District
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Event Region (t-4)	0.003 (0.002)	0.001 (0.002)	0.002 (0.003)	0.000 (0.003)	-0.002 (0.003)	0.001 (0.002)	-0.001 (0.004)	-0.001 (0.002)
Event Region (t-3)	0.000 (0.002)	0.000 (0.002)	0.000 (0.002)	0.000 (0.001)	0.000 (0.003)	-0.001 (0.002)	0.003 (0.004)	-0.003* (0.002)
Event Region (t-2)	0.001 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	0.000 (0.002)	-0.001 (0.002)	0.004 (0.003)	-0.003** (0.002)
Event Region (t-1)					0.000 (0.002)	-0.001 (0.002)	0.004 (0.003)	-0.004** (0.002)
Event Region (event year)	-0.004 (0.003)	0.007*** (0.002)	-0.007** (0.004)	0.003 (0.002)				
Event Region (t+1)	-0.006** (0.003)	0.009*** (0.003)	-0.011** (0.004)	0.004 (0.003)	-0.003 (0.002)	0.002* (0.001)	-0.006** (0.002)	0.002** (0.001)
Event Region (t+2)	-0.006** (0.003)	0.009*** (0.003)	-0.011** (0.005)	0.005 (0.003)	-0.004* (0.002)	0.003* (0.002)	-0.008** (0.003)	0.004** (0.002)
Event Region (t+3)	-0.005* (0.003)	0.009*** (0.003)	-0.011** (0.005)	0.006 (0.004)	-0.005* (0.003)	0.005** (0.002)	-0.011*** (0.004)	0.006** (0.002)
Event Region (t+4)	-0.005 (0.003)	0.009*** (0.003)	-0.012* (0.006)	0.007* (0.004)	-0.006** (0.003)	0.006** (0.002)	-0.014*** (0.004)	0.008*** (0.003)
Time since/to Event FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Squared	0.994	0.949	0.99	0.934	0.994	0.959	0.992	0.951
Observations	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116

*Notes:* The table reports estimates of equation (1) with the mass layoff taking place between t-1 and t. All observations are at the district level. The estimation is restricted to attached workers, i.e. those working in the event or control districts from at least (t-3) to (t-1). Columns (1)-(4) include all attached workers, while columns (5)-(8) focus on the spillover effect by excluding all attached workers from the event firm. The dependent variables in columns (1) to (5) are shares in the activity reported in the top row scaled by district employment of attached workers in (t-1); the dependent variable in column (6) is average log daily wages (in EUR at 1995 prices). Observations are weighted by district employment of attached workers in the pre-event period. Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

Table 8: Spillover Effects of Mass Layoffs on Employment and Wages in the Long-Run

	<u>District Level</u>		<u>Same Industry</u>	<u>Same Sector</u>	<u>Different Sector</u>	<u>Tradeable</u>	<u>Nontradeable</u>
	<u>overall</u>	<u>excl. event firm</u>	(2-digit level)	(7 broad sectors in tradeables)		<u>Goods</u>	<u>Goods</u>
Employment	(1)	(2)	(3)	(4)		(5)	(6)
Event Region (t-4)	0.004 (0.006)	0.001 (0.009)	0.016 (0.056)	0.013 (0.026)	-0.001 (0.013)	0.005 (0.012)	0.002 (0.009)
Event Region (t-3)	0.000 (0.004)	-0.004 (0.007)	-0.026 (0.033)	-0.003 (0.024)	0.002 (0.011)	0.002 (0.011)	-0.003 (0.008)
Event Region (t-2)	0.000 (0.003)	-0.003 (0.005)	-0.035 (0.030)	-0.002 (0.023)	0.002 (0.009)	-0.002 (0.009)	0.005 (0.006)
Event Region (t-1)		-0.002 (0.004)	-0.030 (0.024)	-0.001 (0.020)	0.001 (0.006)	-0.003 (0.007)	0.003 (0.005)
Event Region (event year)	-0.016*** (0.004)						
Event Region (t+1)	-0.024*** (0.006)	-0.006* (0.003)	-0.021 (0.021)	-0.033** (0.016)	-0.004 (0.006)	-0.012* (0.006)	-0.004 (0.003)
Event Region (t+2)	-0.028*** (0.007)	-0.007 (0.004)	-0.032 (0.027)	-0.042** (0.019)	-0.006 (0.008)	-0.017** (0.007)	-0.005 (0.005)
Event Region (t+3)	-0.031*** (0.008)	-0.009* (0.005)	-0.041 (0.038)	-0.050** (0.020)	-0.008 (0.010)	-0.020** (0.008)	-0.009 (0.006)
Event Region (t+4)	-0.035*** (0.008)	-0.012* (0.007)	-0.080* (0.048)	-0.064*** (0.022)	-0.012 (0.012)	-0.028** (0.011)	-0.01 (0.008)
Event Region (t+5)	-0.039*** (0.010)	-0.012 (0.008)	-0.073 (0.052)	-0.063** (0.024)	-0.013 (0.013)	-0.030** (0.013)	-0.012 (0.010)
Event Region (t+6)	-0.044*** (0.012)	-0.016 (0.010)	-0.076 (0.057)	-0.066** (0.032)	-0.035 (0.022)	-0.043** (0.018)	-0.01 (0.012)
Event Region (t+7)	-0.048*** (0.013)	-0.017 (0.012)	-0.064 (0.065)	-0.072* (0.037)	-0.046* (0.025)	-0.048** (0.021)	-0.012 (0.013)
Event Region (t+8)	-0.053*** (0.014)	-0.019 (0.013)	-0.072 (0.068)	-0.084** (0.040)	-0.053* (0.028)	-0.052** (0.023)	-0.014 (0.015)
Event Region (t+9)	-0.053*** (0.016)	-0.017 (0.014)	-0.078 (0.097)	-0.090** (0.043)	-0.048* (0.029)	-0.056** (0.025)	-0.014 (0.017)
Event Region (t+10)	-0.058*** (0.017)	-0.02 (0.016)	-0.256 (0.243)	-0.135* (0.070)	-0.056* (0.033)	-0.068** (0.028)	-0.017 (0.018)
Time since/to Event FE	Yes	Yes	Yes	Yes		Yes	Yes
Same Industry x Time FE	No	No	Yes	No		No	No
Same Sector x Time FE	No	No	No	Yes		No	No
Event Region x Time FE	No	No	Yes	Yes		No	No
Region FE	Yes	Yes	No	No		Yes	Yes
Region x Industry FE	No	No	Yes	Yes		No	No
Year FE	Yes	Yes	Yes	Yes		Yes	Yes
R Squared	0.994	0.994	0.971	0.971		0.346	0.306
Observations	1,650	1,650	37897	37897		11,550	14,850

Notes : The table reports estimates of equation (1) for an extended post-event period (up to t+10) with the mass layoff taking place between t-1 and t. Estimation is on district level in columns (1) and (2), on the industry (two digit) x district level in columns (3) and (4), on sector (17 broad sectors) x district level in columns (5)-(7). Estimations in columns (3) to (5) include observations in industries or sectors producing tradeable goods only (excluding all service industries, such as transportation, telecommunications, hotel and restaurant industry, education, health and social services). The dependent variable is log employment at the respective estimation level. Column (1) estimates the employment effect for the district as a whole, while columns (2) -(6) focus on the spillover effect (excluding employment in the event firm). Observations are weighted by employment at the respective estimation level in the pre-event period. The event region x time fixed effect is excluded for the industry (sector) in which the event takes place to avoid collinearity. Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

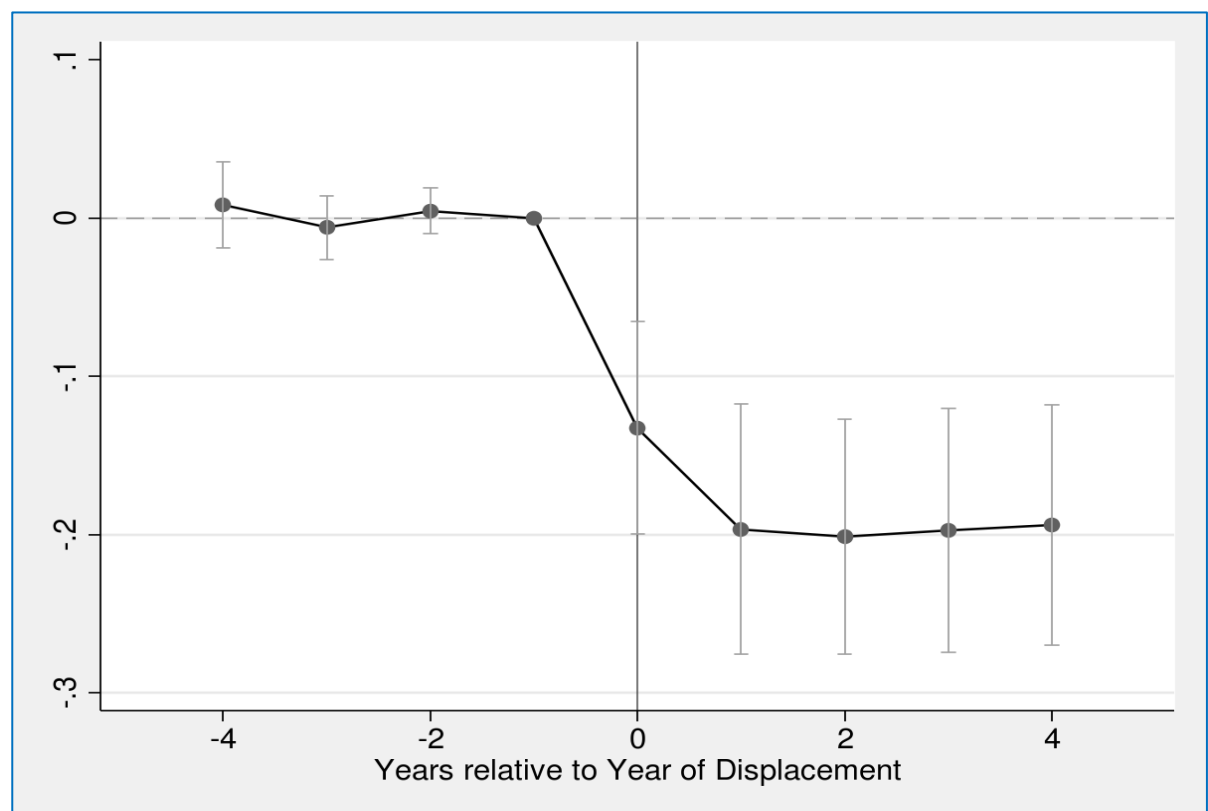
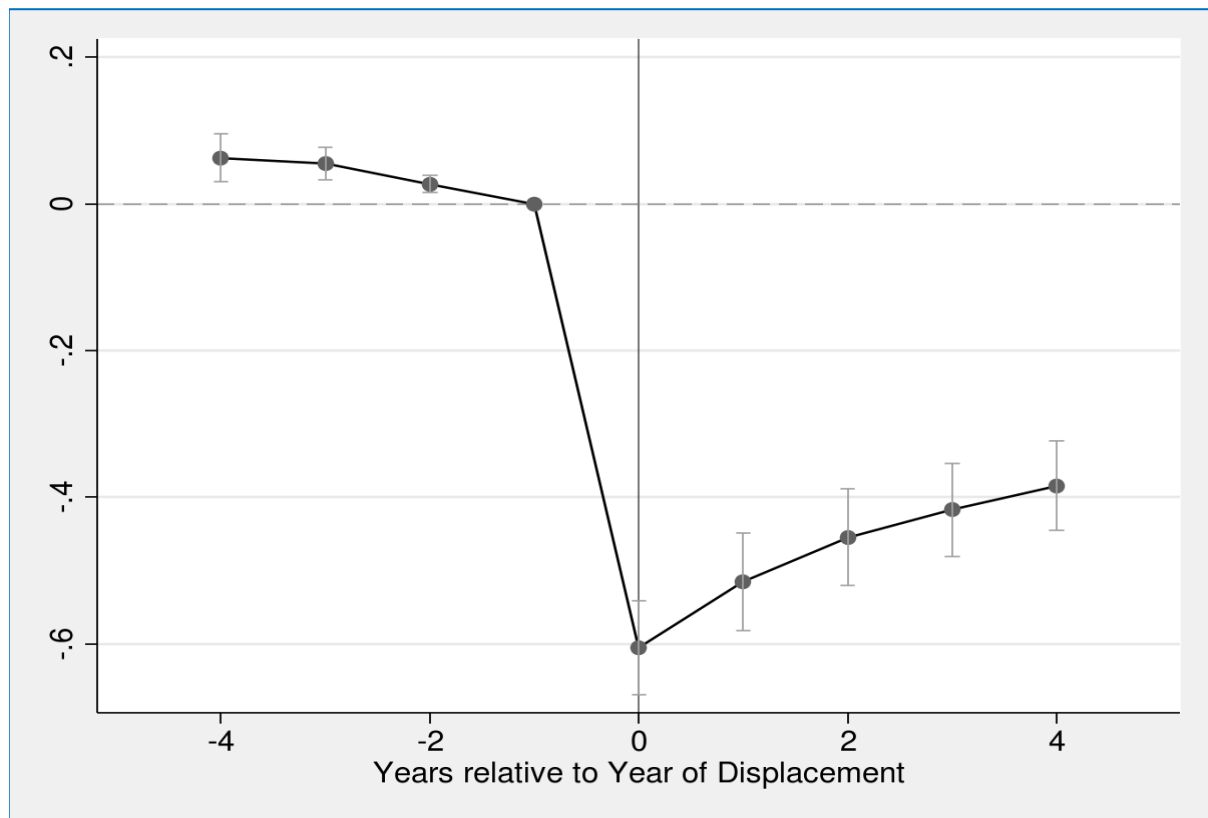


Table 9: Effects of Mass Layoffs on Local Labor Markets Defined by Commuting Zones

	<u>Overall Effect</u> (including event firm) (1)	<u>Spillover Effect</u> (excluding event firm) (2)	<u>Neighbouring Districts (excl. event firm)</u> Same Commuting Zone Other Commuting Zone (3)		<u>Same Industry</u> (2-digit level) (4)	<u>Same Sector</u> (7 broad sectors in tradeables) (5)	<u>Different Sector</u> (6)	<u>Tradeable Goods</u> (6)	<u>Nontradeable Goods</u> (7)
Event Region (t-4)	0.008 (0.005)	0.009 (0.008)	0.012 (0.008)	-0.003 (0.007)	0.044 (0.072)	0.041* (0.022)	-0.011 (0.013)	0.01 (0.011)	0.007 (0.008)
Event Region (t-3)	0.006 (0.004)	0.006 (0.007)	0.009 (0.007)	0.000 (0.006)	0.011 (0.048)	0.028 (0.019)	-0.006 (0.011)	0.009 (0.009)	0.006 (0.007)
Event Region (t-2)	0.005** (0.002)	0.004 (0.005)	0.007 (0.006)	0.000 (0.004)	0.014 (0.037)	0.025 (0.016)	-0.010 (0.009)	0.000 (0.007)	0.011* (0.006)
Event Region (t-1)		0.001 (0.004)	0.003 (0.004)	-0.001 (0.003)	0.011 (0.026)	0.012 (0.011)	-0.009 (0.006)	-0.003 (0.004)	0.007 (0.005)
Event Region (event year)	-0.013*** (0.004)								
Event Region (t+1)	-0.021*** (0.006)	-0.005** (0.003)	-0.005** (0.003)	-0.002 (0.002)	-0.019 (0.013)	-0.028*** (0.008)	-0.001 (0.005)	-0.009** (0.004)	-0.003 (0.003)
Event Region (t+2)	-0.030*** (0.007)	-0.012*** (0.004)	-0.013*** (0.004)	-0.006* (0.003)	-0.032 (0.025)	-0.047*** (0.014)	0.001 (0.008)	-0.013** (0.006)	-0.012** (0.005)
Event Region (t+3)	-0.035*** (0.008)	-0.017*** (0.005)	-0.018*** (0.006)	-0.006 (0.004)	-0.055 (0.036)	-0.070*** (0.020)	0.001 (0.011)	-0.020** (0.008)	-0.017*** (0.006)
Event Region (t+4)	-0.042*** (0.009)	-0.024*** (0.007)	-0.025*** (0.007)	-0.009* (0.005)	-0.081 (0.055)	-0.100*** (0.024)	-0.004 (0.011)	-0.031*** (0.009)	-0.021*** (0.007)
Time since/to Event FE	Yes	Yes		Yes	Yes	Yes		Yes	Yes
Same Industry x Time FE	No	No		No	Yes	No		No	No
Same Sector x Time FE	No	No		No	No	Yes		No	No
Event Region x Time FE	No	No		No	Yes	Yes		No	No
Region FE	Yes	Yes		Yes	Yes	No		Yes	Yes
Region x Industry FE	No	No		No	Yes	Yes		No	No
Year FE	Yes	Yes		Yes	Yes	Yes		Yes	Yes
R Squared	0.999	0.999		0.999	0.989	0.989		0.271	0.468
Observations	774	774		5,787	18,648	18,648		5,418	6,966

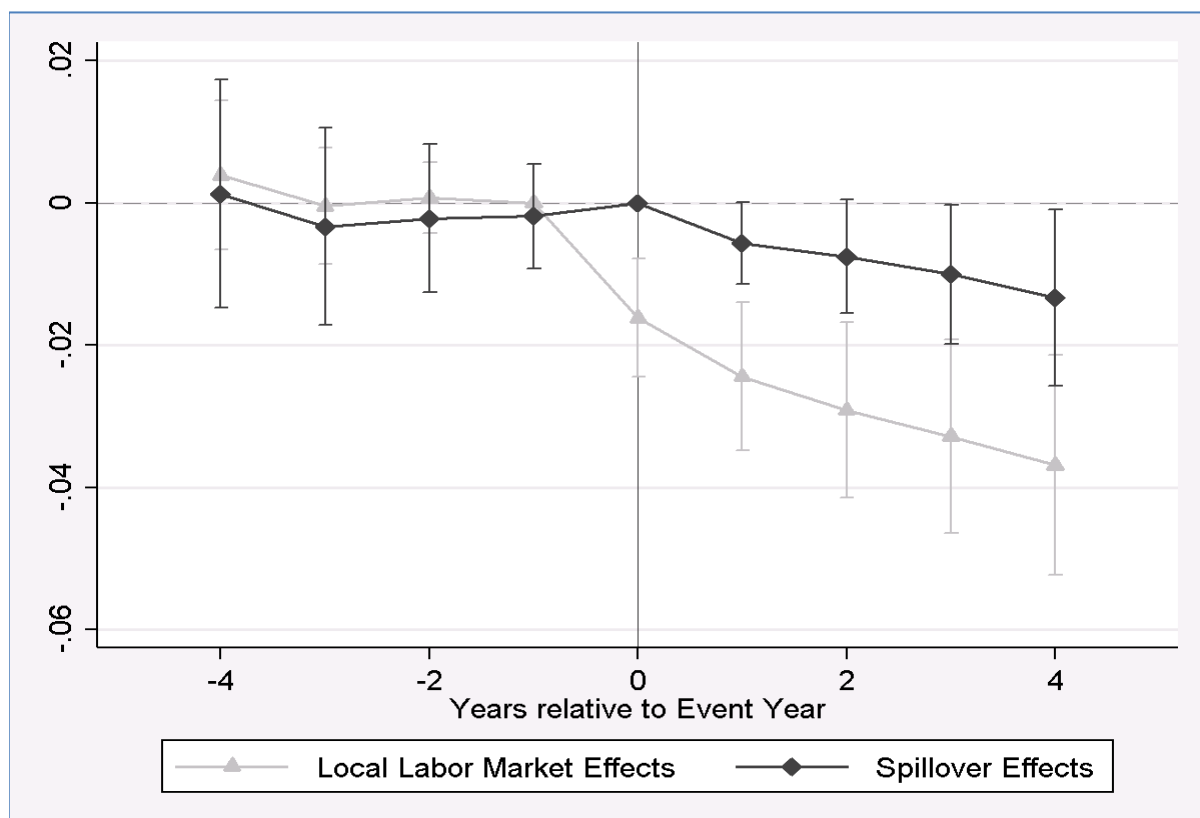
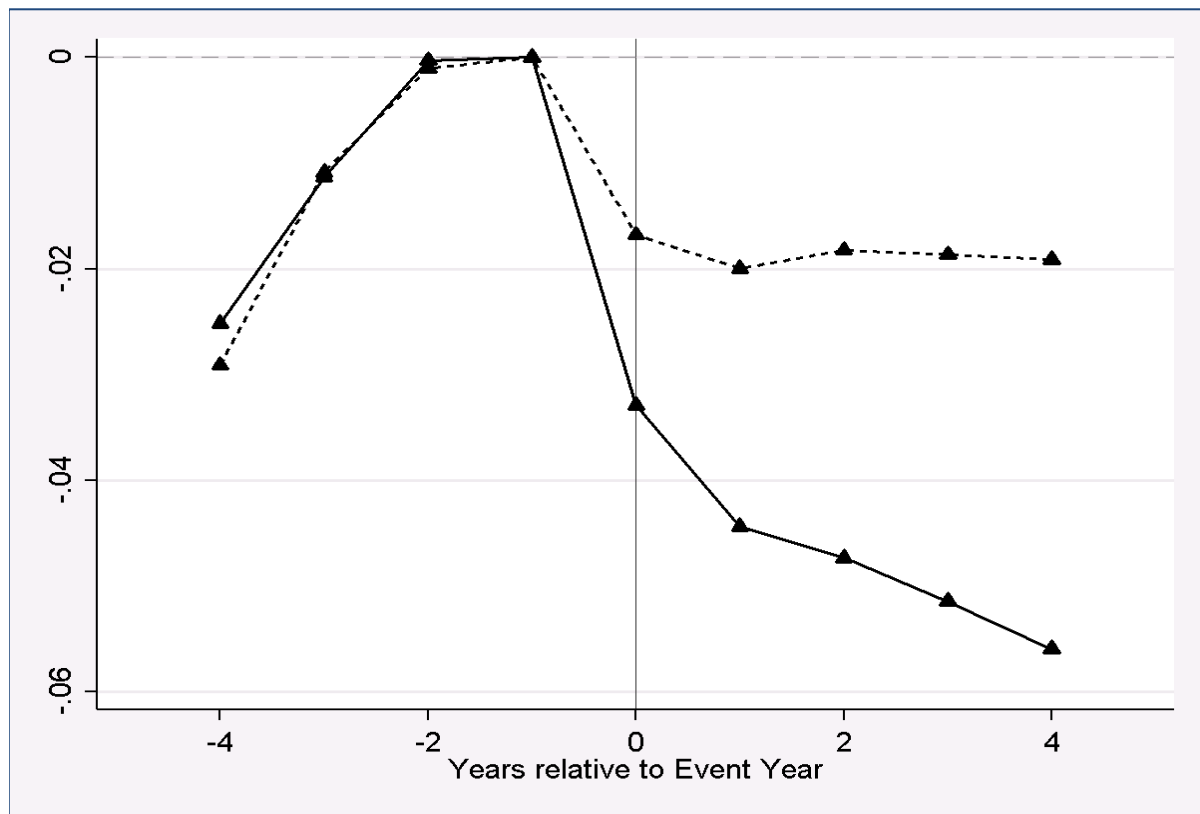
Notes : The table reports estimates of equation (1) where event and control region are now commuting zones (except for column (3) which is at the smaller district level). As before, the mass layoff takes place between t-1 and t. Estimations in columns (4) to (6) include observations in industries or sectors producing tradeable goods only (excluding all service industries, such as transportation, telecommunications, hotel and restaurant industry, education, health and social services). The dependent variable in all columns is log employment at the respective estimation level. In column (1), the overall effect on employment (including displaced workers) is estimated; in columns (2)-(6), the spillover effect is estimated (by excluding employment in the event firm). Neighboring districts share a border with the commuting zone in which the event took place (or the matched commuting zone respectively). Observations are weighted by employment at the respective estimation level in the pre-event period. The omitted category in the event region x time fixed effect is the industry (sector) in which the event takes place. Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

**Figure 1: Employment (top) and Wages (bottom) for Displaced Workers**



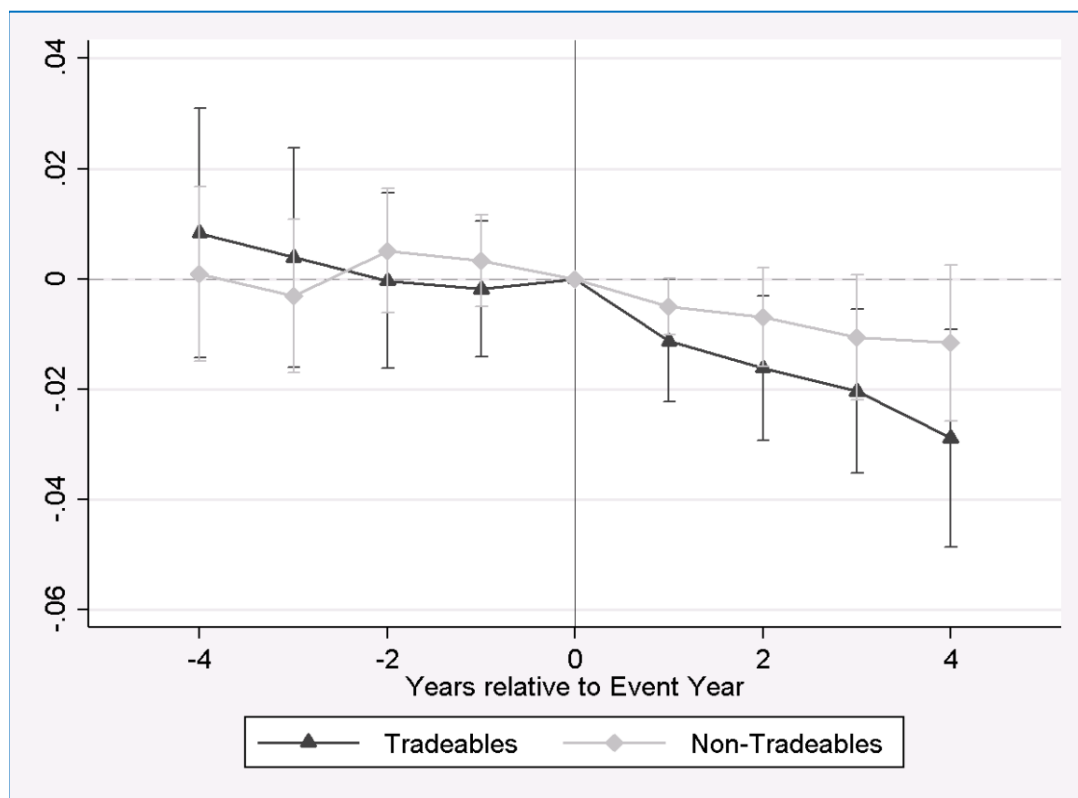
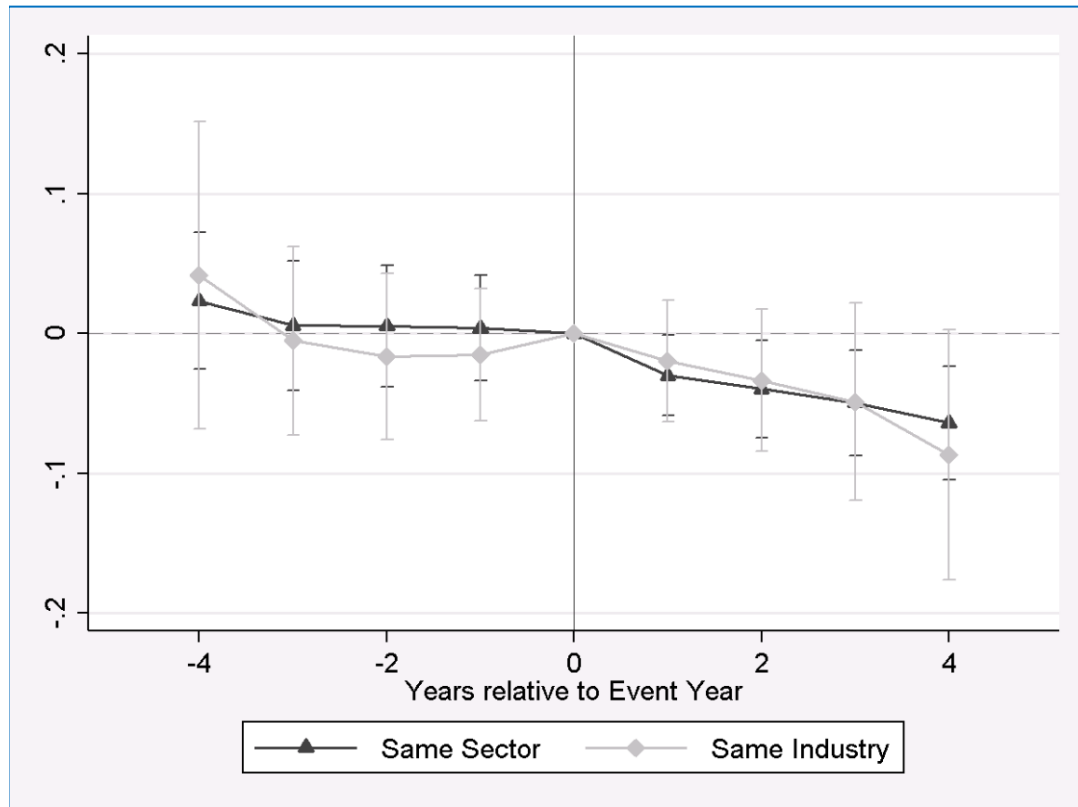
*Notes :* The top panel shows employment effects of displaced workers relative to the control region, the bottom panel shows effects on log daily wages. The x-axis denotes the period before (negative) or after (positive) the layoff event, where the mass layoff occurs between period -1 and 0. All variables are defined at the district level. See notes to Table 3 for further details.

**Figure 2: Employment and Spillover Effects in the Regional Economy**



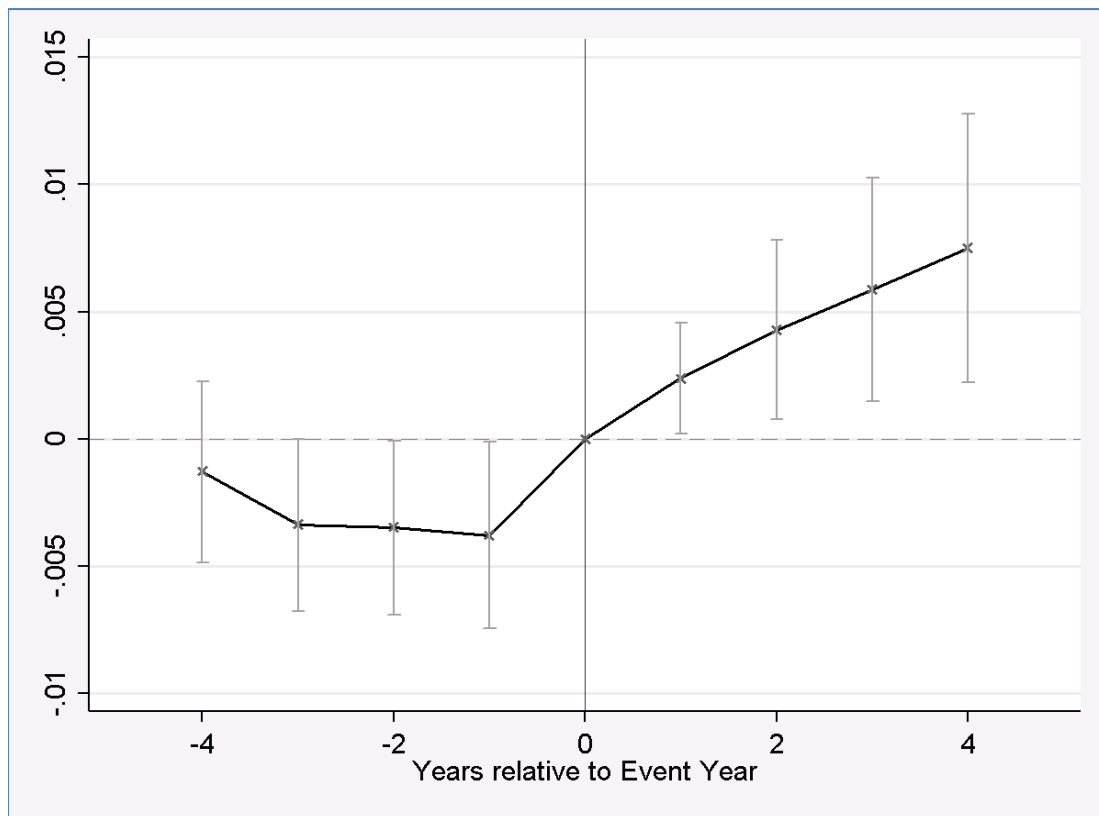
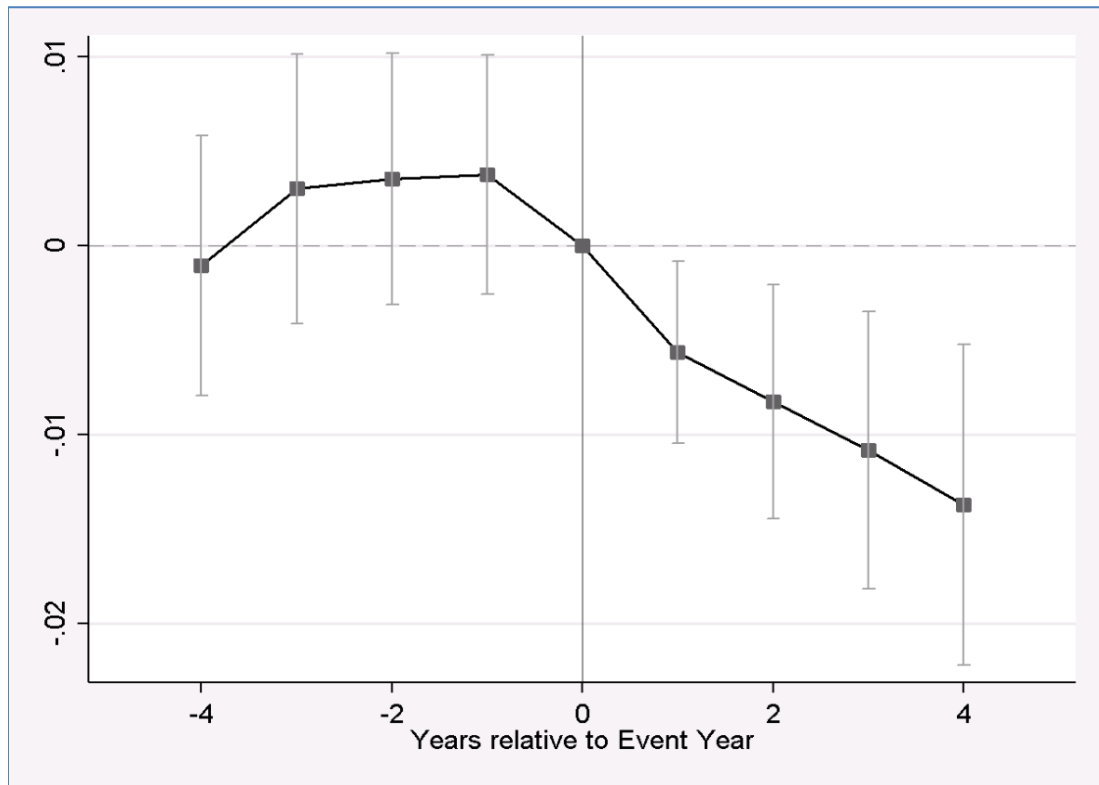
*Notes:* The top panel shows predicted employment in the event and control regions relative to the period before the layoff (based on results from Table 4, column (1)). The bottom panel plots the overall (black line) and spillover effect (grey line) of the mass layoff on the regional economy (from Table 4, columns (1) and (4)).

**Figure 3: Heterogeneity of Spillover Effects by Industry and Sector**



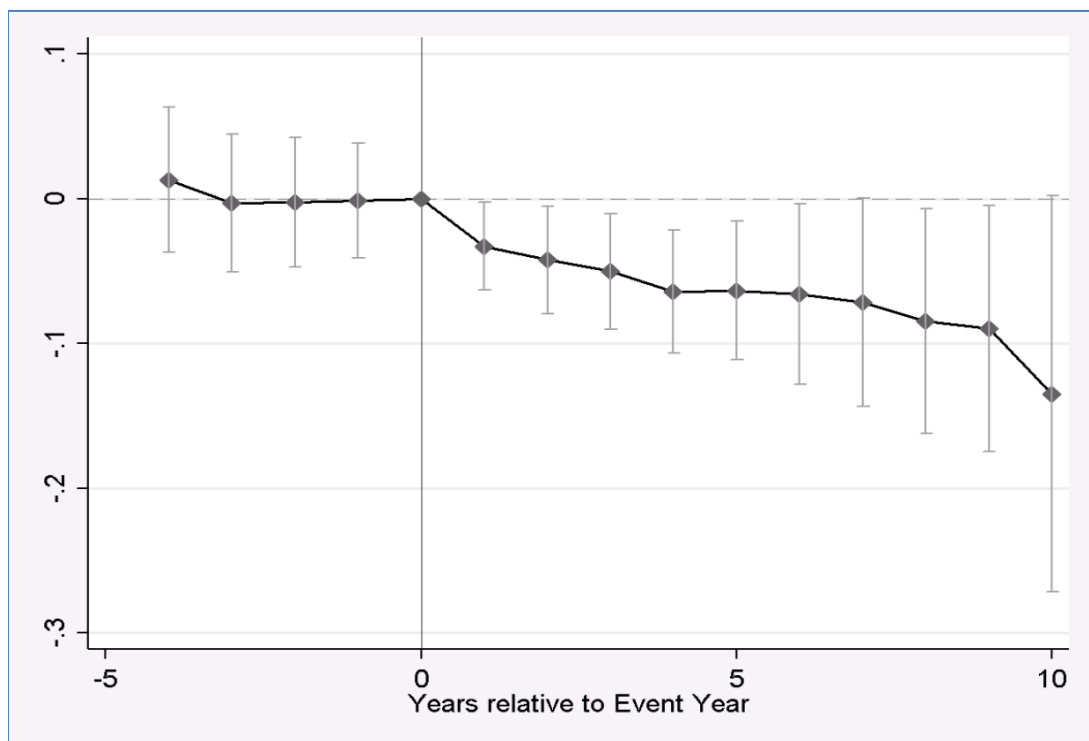
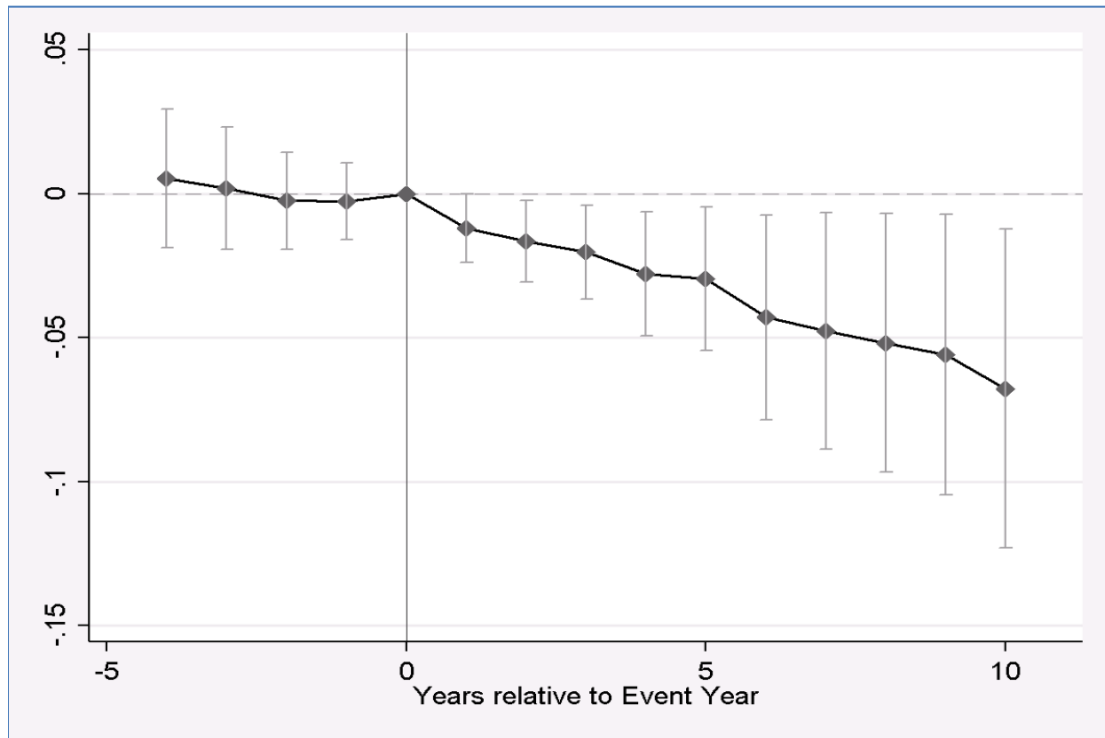
*Notes:* The top panel shows spillover effects for the same two-digit industry (black line) and the same broad sector (grey line). The bottom panel shows spillover effects for the tradeable (black line) and non-tradeable sector (grey line). In all cases, the dependent variable is log employment (excluding the event firm). The x-axis denotes the period before (negative) or after (positive) the layoff event, where the mass layoff occurs between period -1 and 0. All variables are defined at the district level. See notes to Table 5a for further details.

**Figure 4: Employment of Attached Workers**



*Notes:* The top panel shows employment of attached workers who were employed in the event region in the three years prior to the mass layoff. The bottom panel shows employment in a different district for attached workers. See also notes to Table 7.

**Figure 5: Long-run Effects on Regional Employment**



*Notes :* The table reports the long-run effects of a mass layoff (taking place between  $t=-1$  and  $t=0$ ) on regional employment in the tradeable sector (top panel) and regional employment in the same sector as the event firm (bottom panel). See Table 8 for details of the estimation.

**Table A1: Summary Statistics of Individual Characteristics**

	Displaced Workers	Firms with Mass Layoff	Mass Layoff Districts	West German Districts
Low Skilled	0.249	0.216	0.212	0.201
Medium Skilled	0.692	0.712	0.719	0.723
High Skilled	0.059	0.072	0.070	0.076
Age 16-25	0.208	0.150	0.207	0.217
Age 26-50	0.394	0.648	0.618	0.611
Age 50-65	0.398	0.202	0.175	0.172
Average Log Daily Wage	84.49	93.54	72.38	70.96

*Notes :* The table shows descriptive statistics for the workers displaced by the event (column (1)), all workers in the firm experiencing the event (column (2)), all individuals in the district in which the event takes place (column (3)) and all individuals in a West German district (including event and control districts). Low-skilled are those without a high school or vocational degree, medium-skilled those with a high school or vocational degree and high-skilled those with a college degree. Log daily wages are reported in EUR at 1995 prices.

Table A2: Comparison of Districts with Mass Layoffs and Rest of West Germany

	Mass Layoff Region	West German Regions	Difference
Employment	81,421.092*** (5,785.735)	60,302.722*** (4,102.236)	-21,118.370*** (6,502.379)
Employment Growth (over last 5 years)	0.039*** (0.008)	0.059*** (0.002)	0.020** -0.008
Unemployment	0.061*** (0.004)	0.059*** (0.001)	-0.001 (0.003)
Unemployment Growth (over last 5 years)	0.012*** (0.003)	0.010*** (0.000)	-0.001 (0.003)
Share Urban Regions	0.597*** (0.070)	0.302*** (0.025)	-0.295*** (0.065)
Wage	72.380*** (1.418)	70.963*** (0.940)	-1.417 (1.612)
Wage Growth (over last 5 years)	0.075*** (0.005)	0.080*** (0.001)	0.006 -0.005
Low Skilled	0.212*** (0.008)	0.207*** (0.004)	-0.005 (0.008)
Medium Skilled	0.719*** (0.006)	0.720*** (0.002)	0.001 (0.006)
High Skilled	0.070*** (0.004)	0.074*** (0.004)	0.004 (0.006)
Age 16-25	0.207*** (0.006)	0.217*** (0.003)	0.010 (0.007)
Age 26-50	0.618*** (0.005)	0.611*** (0.002)	-0.007 (0.005)
Age 50-65	0.175*** (0.003)	0.172*** (0.002)	-0.003 (0.003)
[1] Agriculture and Fishing	0.006*** (0.000)	0.007*** (0.000)	0.001*** (0.001)
[2] Energy and Mining	0.033*** (0.007)	0.020*** (0.002)	-0.013** (0.006)
[3] Food	0.028*** (0.001)	0.033*** (0.001)	0.005*** (0.002)
[4] Consumer Goods	0.050*** (0.006)	0.058*** (0.003)	0.007 (0.006)
[5] Producer Goods	0.095*** (0.012)	0.084*** (0.005)	-0.011 (0.010)
[6] Investment Goods	0.243*** (0.018)	0.194*** (0.007)	-0.050*** (0.016)
[7] Construction	0.065*** (0.003)	0.072*** (0.002)	0.007** (0.003)
[8] Retail Trade	0.145*** (0.005)	0.151*** (0.002)	0.006 (0.005)
[9] Transport and Communications	0.043*** (0.003)	0.050*** (0.004)	0.006 (0.004)
[10] Finance and Insurance	0.031*** (0.003)	0.041*** (0.003)	0.010** (0.004)
[11] Hotel and Restaurant Industry	0.016*** (0.001)	0.023*** (0.001)	0.006*** (0.001)
[12] Educational Services	0.026*** (0.003)	0.027*** (0.001)	0.001 (0.002)
[13] Health, Veterinary and Social Services	0.068*** (0.003)	0.072*** (0.002)	0.003 (0.003)
[14] Corporate Services	0.046*** (0.004)	0.053*** (0.003)	0.007 (0.005)
[15] Other Services	0.029*** (0.002)	0.033*** (0.002)	0.004* (0.002)
Observations	62	6784 (326)	6846

Notes: Column (1) reports means in event districts, column (2) means in all West German districts. All level variables are measured in the pre-event period (t-1) while growth variables are measured from t-6 to t-1. Observations are weighted by district employment in the pre-event period (t-1). West German district observations are further reweighted to represent the same weights per year as the event districts. Low-skilled individuals are those without a high school or vocational degree, the medium-skilled have either a high school degree or vocational training and the high-skilled have a college degree. Wages are real daily wages in EUR (at 1995 prices). Standard errors are clustered at the district level. Column (3) reports the difference between the event and control region and whether a t-test of differences in means is significant. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.



**Table A3: Employment Spillovers on the Region by Worker Skill and Age Groups**

	<u>Skill Groups</u>			<u>Age Groups</u>		
	Low-Skilled Workers (1)	Medium-Skilled Workers (2)	High-Skilled Workers (3)	Young Workers (Ages 16-25) (4)	Prime-Age Workers (Aged 26-50) (5)	Older Workers (Aged 51-65) (6)
Event Region (t-4)	-0.001 (0.010)	0.002 (0.009)	0.031** (0.016)	-0.005 (0.011)	0.004 (0.009)	-0.001 (0.012)
Event Region (t-3)	-0.006 (0.009)	-0.002 (0.007)	0.021 (0.013)	-0.009 (0.010)	-0.001 (0.008)	-0.006 (0.009)
Event Region (t-2)	-0.005 (0.007)	-0.001 (0.005)	0.011 (0.011)	-0.005 (0.008)	0.000 (0.006)	-0.009 (0.007)
Event Region (t-1)	-0.005 (0.005)	-0.001 (0.004)	0.01 (0.007)	-0.003 (0.005)	0.000 (0.004)	-0.006 (0.005)
Event Region (event year)						
Event Region (t+1)	-0.005 (0.004)	-0.006* (0.003)	-0.014* (0.007)	-0.007** (0.004)	-0.006* (0.003)	-0.001 (0.004)
Event Region (t+2)	-0.006 (0.005)	-0.008* (0.004)	-0.014 (0.010)	-0.012** (0.006)	-0.007 (0.005)	0.000 (0.006)
Event Region (t+3)	-0.011* (0.006)	-0.010** (0.005)	-0.012 (0.014)	-0.016** (0.007)	-0.010* (0.006)	-0.001 (0.008)
Event Region (t+4)	-0.013* (0.008)	-0.014** (0.006)	-0.022 (0.016)	-0.023** (0.009)	-0.012* (0.007)	-0.004 (0.009)
Time since/to Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R Squared	0.997	0.997	0.996	0.995	0.997	0.995
Observations	1,116	1,116	1,116	1,116	1,116	1,116

*Notes:* The table reports estimates of equation (1) with the mass layoff taking place between t-1 and t by skill and age groups. Low-skilled workers have no highschool or vocational degree, medium-skilled workers have a highschool or vocational degree; and high-skilled workers have a college degree. Young workers are aged 16-25, prime-age workers 26-50 and older workers aged 51-65. All observations are measured at the district level. All columns show results of the employment spillovers by excluding event firm employment. The dependent variable in all columns is log employment. Observations are weighted by district employment in the pre-event period. The base period in all columns is t, the event year. Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

Table A4: Heterogeneities in Employment Flows by Worker Skill and Age Groups

	Skill Groups						Age Groups					
	Low-Skilled Workers		Medium-Skilled Workers		High-Skilled Workers		Young Workers		Prime-Aged Workers		Older Workers	
	Outflows (1)	Inflows (2)	Outflows (3)	Inflows (4)	Outflows (5)	Inflows (6)	Outflows (7)	Inflows (8)	Outflows (9)	Inflows (10)	Outflows (11)	Inflows (12)
Event Region (t-4)	0.012 (0.008)	0.011 (0.011)	0.003 (0.005)	0.001 (0.006)	0.004 (0.012)	-0.004 (0.013)	0.007 (0.008)	0.008 (0.011)	0.002 (0.005)	0.002 (0.007)	0.013 (0.009)	-0.001 (0.005)
Event Region (t-3)	0.004 (0.006)	0.007 (0.007)	0.001 (0.003)	-0.002 (0.004)	0.004 (0.009)	-0.005 (0.008)	0.003 (0.005)	0.007 (0.007)	0.000 (0.004)	-0.001 (0.004)	0.006 (0.006)	-0.003 (0.003)
Event Region (t-2)	0.000 (0.003)	0.004 (0.003)	-0.001 (0.002)	0.001 (0.002)	0.001 (0.004)	-0.001 (0.004)	0.000 (0.003)	0.005 (0.003)	-0.002 (0.002)	0.001 (0.002)	0.002 (0.004)	-0.001 (0.002)
Event Region (t-1)												
Event Region (event year)	0.009 (0.009)	-0.003 (0.008)	0.009 (0.006)	-0.007 (0.005)	0.008 (0.009)	-0.017 (0.010)	0.004 (0.009)	-0.009 (0.010)	0.005 (0.005)	-0.008 (0.005)	0.027* (0.014)	-0.002 (0.002)
Event Region (t+1)	0.012 (0.009)	-0.007 (0.008)	0.010 (0.006)	-0.014*** (0.005)	0.006 (0.012)	-0.032*** (0.011)	0.005 (0.008)	-0.017* (0.009)	0.005 (0.005)	-0.014** (0.006)	0.031** (0.015)	-0.005 (0.003)
Event Region (t+2)	0.012 (0.011)	-0.011 (0.010)	0.010 (0.006)	-0.018*** (0.006)	-0.006 (0.015)	-0.040*** (0.014)	0.005 (0.009)	-0.027*** (0.010)	0.003 (0.006)	-0.018*** (0.007)	0.034** (0.016)	-0.006 (0.004)
Event Region (t+3)	0.013 (0.013)	-0.015 (0.012)	0.008 (0.007)	-0.023*** (0.007)	-0.017 (0.019)	-0.046** (0.018)	0.004 (0.012)	-0.036*** (0.012)	0.001 (0.008)	-0.023*** (0.008)	0.028 (0.018)	-0.009 (0.005)
Event Region (t+4)	0.012 (0.016)	-0.021 (0.016)	0.005 (0.009)	-0.028*** (0.008)	-0.023 (0.023)	-0.062*** (0.023)	0.004 (0.015)	-0.044*** (0.016)	-0.001 (0.010)	-0.028*** (0.010)	0.023 (0.021)	-0.012* (0.006)
Time since/to Event FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Squared	0.755	0.783	0.755	0.725	0.751	0.758	0.816	0.818	0.828	0.770	0.695	0.65
Observations	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116

Notes: The table reports estimates of equation (1) with the mass layoff taking place between t-1 and t by skill and age groups. Low-skilled workers have no highschool or vocational degree, medium-skilled workers have a highschool or vocational degree; and high-skilled workers have a college degree. Young workers are aged 16-25, prime-age workers 26-50 and older workers aged 51-65. All observations are measured at the district level. The dependent variables in all columns are shares of the flows reported in the top row relative to district employment in t-1. Observations are weighted by district employment in the pre-event period (t-1). Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

Table A5: Heterogeneities in Spillover Effects on Attached Workers in the Region by Skill Group

	<u>Low-Skilled Workers</u>				<u>Medium-Skilled Workers</u>				<u>High-Skilled Workers</u>			
	Employment	Unemployment	Employment Same District	Employment Other District	Employment	Unemployment	Employment Same District	Employment Other District	Employment	Unemployment	Employment Same District	Employment Other District
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Event Region (t-4)	-0.012** (0.006)	-0.001 (0.003)	-0.009 (0.006)	-0.002 (0.002)	-0.001 (0.003)	0.001 (0.002)	0.001 (0.003)	-0.001 (0.002)	0.005 (0.004)	0.000 (0.002)	0.006 (0.006)	-0.001 (0.004)
Event Region (t-3)	0.001 (0.005)	-0.003 (0.003)	0.006 (0.006)	-0.004*** (0.002)	0.000 (0.003)	-0.001 (0.002)	0.003 (0.004)	-0.003* (0.002)	0.002 (0.004)	0.001 (0.002)	-0.001 (0.006)	0.003 (0.004)
Event Region (t-2)	0.003 (0.004)	-0.004 (0.003)	0.008 (0.005)	-0.004*** (0.002)	0.000 (0.002)	-0.001 (0.002)	0.003 (0.003)	-0.003* (0.002)	0.000 (0.004)	0.001 (0.002)	-0.002 (0.005)	0.002 (0.004)
Event Region (t-1)	0.005 (0.004)	-0.005 (0.004)	0.009* (0.005)	-0.005** (0.002)	0.000 (0.002)	-0.001 (0.002)	0.004 (0.003)	-0.004* (0.002)	0.000 (0.004)	0.001 (0.002)	-0.003 (0.005)	0.002 (0.004)
Event Region (event year)												
Event Region (t+1)	-0.002 (0.003)	0.002 (0.002)	-0.005 (0.003)	0.003** (0.001)	-0.003 (0.002)	0.002* (0.001)	-0.006** (0.003)	0.002** (0.001)	-0.006* (0.003)	0.003 (0.002)	-0.005 (0.004)	-0.001 (0.003)
Event Region (t+2)	-0.001 (0.003)	0.002 (0.003)	-0.006 (0.004)	0.005** (0.002)	-0.004* (0.002)	0.003** (0.002)	-0.009*** (0.003)	0.004** (0.002)	-0.005 (0.004)	0.004 (0.003)	-0.003 (0.005)	-0.001 (0.003)
Event Region (t+3)	-0.002 (0.004)	0.004 (0.003)	-0.009* (0.005)	0.007*** (0.002)	-0.006** (0.003)	0.005** (0.002)	-0.012*** (0.004)	0.006** (0.002)	-0.003 (0.004)	0.005* (0.003)	-0.002 (0.006)	-0.001 (0.005)
Event Region (t+4)	-0.001 (0.004)	0.004 (0.004)	-0.010* (0.005)	0.009*** (0.003)	-0.008*** (0.003)	0.006*** (0.002)	-0.015*** (0.005)	0.007*** (0.003)	-0.007 (0.004)	0.005** (0.002)	-0.006 (0.006)	-0.001 (0.005)
Time since/to Event FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Squared	0.988	0.952	0.988	0.922	0.994	0.959	0.991	0.949	0.980	0.910	0.984	0.943
Observations	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116

Notes: The table reports estimates of equation (1) with the mass layoff taking place between t-1 and t by skill groups. Low-skilled workers have no highschool or vocational degree, medium-skilled workers have a highschool or vocational degree; and high-skilled workers have a college degree. All observations are at the district level. The estimation is restricted to attached workers, i.e. those working in the event or control districts from at least (t-3) to (t-1). All columns focus on the spillover effect by excluding all attached workers from the event firm. The dependent variables in all columns are shares in the activity reported in the top row scaled by district employment of attached workers in (t-1); . Observations are weighted by district employment of attached workers in the pre-event period. Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

Table A6: Heterogeneities in Spillover Effects on Attached Workers in the Region by Age Group

	<u>Young Workers</u>				<u>Prime-Age Workers</u>				<u>Older Workers</u>			
	Employment	Unemployment	Employment Same District	Employment Other District	Employment	Unemployment	Employment Same District	Employment Other District	Employment	Unemployment	Employment Same District	Employment Other District
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Event Region (t-4)	-0.005 (0.004)	0 (0.002)	-0.001 (0.005)	-0.004 (0.003)	-0.002 (0.003)	0.001 (0.001)	-0.001 (0.004)	-0.001 (0.002)	0 (0.006)	-0.001 (0.006)	0 (0.006)	0 (0.001)
Event Region (t-3)	0.004 (0.004)	-0.001 (0.003)	0.010* (0.005)	-0.007** (0.003)	-0.001 (0.003)	-0.001 (0.001)	0.002 (0.004)	-0.003 (0.002)	0 (0.005)	-0.001 (0.005)	0.002 (0.005)	-0.002* (0.001)
Event Region (t-2)	0.004 (0.004)	-0.001 (0.003)	0.010** (0.005)	-0.006** (0.003)	0 (0.003)	-0.001 (0.001)	0.003 (0.004)	-0.003* (0.002)	0 (0.005)	-0.002 (0.005)	0.002 (0.005)	-0.002* (0.001)
Event Region (t-1)	0.002 (0.004)	-0.002 (0.003)	0.009* (0.005)	-0.007** (0.004)	0 (0.002)	-0.001 (0.001)	0.003 (0.004)	-0.004* (0.002)	0.001 (0.005)	-0.002 (0.005)	0.003 (0.005)	-0.002* (0.001)
Event Region (event year)												
Event Region (t+1)	-0.003 (0.003)	0 (0.002)	-0.008** (0.003)	0.004** (0.002)	-0.004 (0.002)	0.001** (0.001)	-0.006** (0.003)	0.002* (0.001)	-0.003 (0.003)	0.006* (0.003)	-0.003 (0.003)	0.001 (0.001)
Event Region (t+2)	-0.003 (0.003)	0 (0.002)	-0.010** (0.004)	0.006** (0.003)	-0.004 (0.003)	0.002** (0.001)	-0.009** (0.004)	0.005** (0.002)	-0.004 (0.004)	0.009* (0.005)	-0.005 (0.004)	0.001 (0.001)
Event Region (t+3)	-0.005 (0.003)	0.002 (0.002)	-0.012** (0.005)	0.007* (0.004)	-0.005* (0.003)	0.004** (0.001)	-0.012*** (0.004)	0.007*** (0.003)	-0.005 (0.005)	0.011* (0.006)	-0.006 (0.005)	0.001 (0.001)
Event Region (t+4)	-0.007* (0.004)	0.003 (0.003)	-0.015** (0.006)	0.008** (0.004)	-0.007** (0.003)	0.005*** (0.002)	-0.016*** (0.005)	0.009*** (0.003)	-0.005 (0.006)	0.01 (0.007)	-0.006 (0.006)	0.001 (0.001)
Time since/to Event FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Squared	0.987	0.948	0.987	0.949	0.985	0.958	0.982	0.946	0.995	0.931	0.995	0.878
Observations	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116	1,116

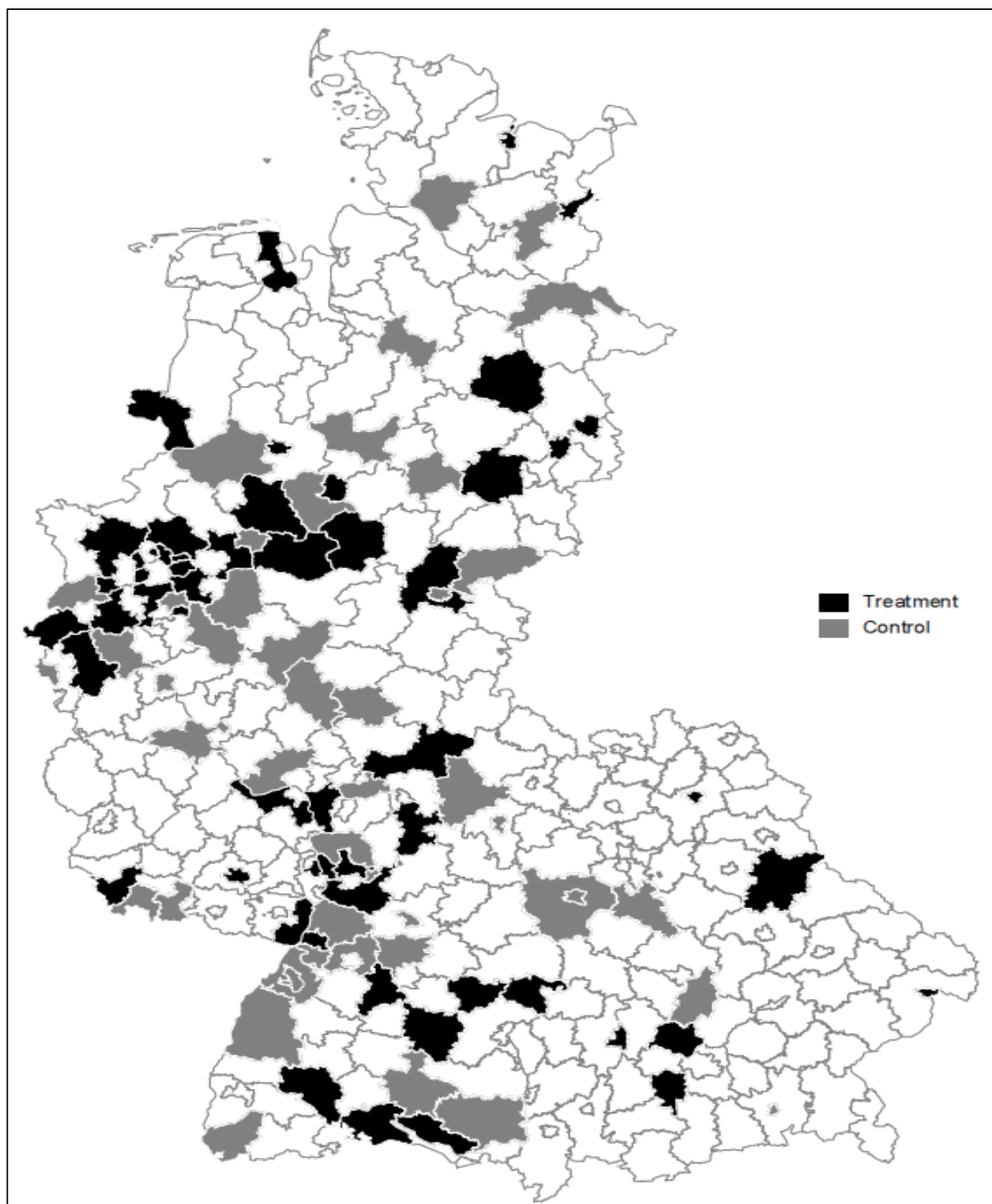
Notes: The table reports estimates of equation (1) with the mass layoff taking place between t-1 and t by age groups. All observations are at the district level. Young workers are aged 16-25, prime-age workers 26-50 and older workers aged 51-65. The estimation is restricted to attached workers, i.e. those working in the event or control districts from at least (t-3) to (t-1). All columns focus on the spillover effect by excluding attached workers from the event firm. The dependent variables in all columns are shares in the activity reported in the top row scaled by district employment of attached workers in (t-1). Observations are weighted by district employment of attached workers in the pre-event period. Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

Table A7: Alternative Matching Assumptions

	<u>Spillover Effects on Regional Employment (excluding the event firm)</u>					
	Baseline (1)	Maximum Distance (10%, 20%) (2)	(3)	Trim 10% (4)	Variance (5)	Match Vars. (6)
Event Region (t-4)	0.001 (0.008)	0.004 (0.008)	-0.001 (0.008)	0.002 (0.008)	-0.002 (0.008)	-0.001 (0.008)
Event Region (t-3)	-0.003 (0.007)	-0.002 (0.007)	-0.006 (0.007)	-0.004 (0.007)	-0.006 (0.007)	-0.007 (0.007)
Event Region (t-2)	-0.002 (0.005)	-0.002 (0.005)	-0.004 (0.005)	-0.004 (0.005)	-0.003 (0.005)	-0.005 (0.006)
Event Region (t-1)	-0.002 (0.004)	-0.003 (0.004)	-0.004 (0.004)	-0.003 (0.004)	-0.003 (0.004)	-0.004 (0.004)
Event Region (event year)						
Event Region (t+1)	-0.006* (0.003)	-0.007** (0.003)	-0.004 (0.003)	-0.006** (0.003)	-0.007** (0.003)	-0.005* (0.003)
Event Region (t+2)	-0.008* (0.004)	-0.008* (0.004)	-0.004 (0.004)	-0.009** (0.004)	-0.007* (0.004)	-0.007 (0.004)
Event Region (t+3)	-0.010** (0.005)	-0.011** (0.005)	-0.005 (0.005)	-0.011** (0.005)	-0.009* (0.005)	-0.011** (0.005)
Event Region (t+4)	-0.013** (0.006)	-0.013** (0.006)	-0.008 (0.007)	-0.014** (0.007)	-0.014** (0.006)	-0.015** (0.007)
Time since/to Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R Squared	0.936	0.998	0.997	0.997	0.998	0.997
Observations	1,116	1,080	1,116	1,062	1,116	1,116

*Notes :* The table reports estimates of equation (1) with the mass layoff taking place between t-1 and t. All observations are measured at the district level. All columns show spillover effects of mass layoffs where the dependent variable is log employment excluding the event firm. Column (1) shows the baseline results reported in Table 4, column (4) using the following matching specifications: 15% maximum difference in regional employment between event and control region, a trimming margin of 5%, using the variance over both treatment and control regions to scale the distance; matching on industry shares, age groups, education groups and real wage and those variables interacted with year dummies. In columns (2)-(6), we sequentially change one of these specifications. In columns (2) and (3), we allow a maximum difference in regional employment of 10% and 20% respectively. In column (4), we use a trimming level of 10%. In column (5), we use only the variance of treatment regions to scale the distance. In column (6), we only match on industry shares interacted with year dummies. Observations are weighted by district employment in the pre-event period. The base period in all columns is t, the event year. Standard errors are clustered at the district level. Significance levels: 1% \*\*\*, 5% \*\* and 10% \*.

**Figure A1: Matched Event and Control Districts in Germany**



*Notes :* The table shows the geographic distribution of event regions (in black) and control regions (in grey). Event districts experience a mass layoff of between 1981 and 2004 and satisfy all other restrictions described in Section 4. The control regions are matched to the event regions using the matching algorithm described in Section 4.3. We also impose that event and control region cannot be located in the same spatial planning area in the year of the mass layoff. Neighboring event and control regions therefore refer to different mass layoff events.