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Direct and indirect effects of mass layoffs: Evidence from geo-referenced data

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Evidence from geo-referenced data

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Contents

Abstract

Using a novel data set that contains precise geo-referenced information on the universe of German establishments, we analyse both the direct effects of mass layoffs and any indirect impacts on workers who are employed in the vicinity of an establishment being closed down. In line with the literature, we document economically significant impacts of mass layoffs on the employment and earnings prospects of directly displaced workers. In contrast, neither an individual-level difference-in-difference approach nor an alternative establishment-level approach inspired by the spatial economics literature find evidence of additional adverse economic effects for workers or establishments indirectly exposed to mass layoffs.

Zusammenfassung

Mit Hilfe eines neuen Datensatzes, der Betriebe in Deutschland mit einer exakten Geokoordinate versieht, untersuchen wir sowohl die direkten Effekte von Massenentlassungen, als auch den indirekten Effekt auf Personen, die in der Nähe der schließenden Betriebe beschäftigt sind. Wir bestätigen frühere Ergebnisse, die ökonomisch signifikante Effekte von Massenentlassungen auf Beschäftigungs- und Entlohnungsperspektiven von direkt betroffenen Beschäftigten fanden. Im Gegensatz dazu finden wir weder in einem Differenz-in-Differenzen-Ansatz auf individueller Ebene noch einem alternativen durch die räumliche Ökonomie inspirierten Ansatz auf Betriebsebene zusätzliche adverse Effekte auf Beschäftigte oder Betriebe, die nur indirekt durch eine Massenentlassung betroffen sind.

JEL classification: J64, J65, R12

Keywords: Mass layoffs, local general equilibrium effects, geo-referenced data

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1 Introduction

Starting with Ruhm (1991) and Jacobson, LaLonde and Sullivan (1993), over the last 20 years a sizable literature has documented that mass layoffs have dramatic and long-lasting effects on employment and especially earnings prospects of directly displaced workers (Schoeni/Dardia 2003; von Wachter/Song/Manchester 2008; Couch/Placzek 2010; Schmieder/von Wachter/Bender 2010). Empirical studies have shown that mass layoffs can also have detrimental effects on many other outcome variables such as the consumption (Browning/Crossley 2008), health or mortality (Browning/Heinesen 2012) and fertility (Del Bono/Weber/Winter-Ebmer 2012) of those directly displaced as well as their children's earnings and propensity to receive unemployment insurance or social assistance (Oreopoulos/Page/Huff Stevens 2008). Going even further, it has long been suspected that the losses experienced by directly displaced workers might only be one part of the general equilibrium response to shocks which would also include the labour-market impacts on other workers in the same community (Hamermesh 1989).

In contrast to the sizable and well-established body of literature on mass layoffs' direct effects – with the exception of a small number of very early case studies (Folbre/Leighton/Roderick 1984; Jacobson 1984) – evidence on the impacts on indirectly affected workers is practically nonexistent.[1] This is mostly because the data demands for a clean identification of such "local general equilibrium" effects are extremely high.[2] First, linked employer-employee panel data are needed to document mass layoffs and their effects on indirectly affected workers. Second, these data need to contain detailed individual and firm characteristics including exact geographical information going beyond an identifier for counties, municipalities or similar localities. Third, because the indirect effects of mass layoffs can be conjectured to be of an order of magnitude smaller than the direct ones, the data need to be very reliable (ideally they should be administrative data) and large enough to provide enough power for the identification of even relatively small effects.

The objective of this study is to close the knowledge gap with regard to the "local general equilibrium" effects of mass layoffs with the help of a novel administrative data set that fulfils all three requirements. The data set we use contains precise georeferenced data for the universe of German establishments, allows the identification of all mass layoffs that happened in 2009 – a year marked by recession and rising unemployment – and links employer and employee data in a way that enables us to

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1 In early 2015 we became aware that in independent research Christina Gathmann, Ines Helms and Uta Schönberg were working on a study titled "Spillover Effects in Local Labor Markets: Evidence from Mass Layoffs".

2 We refer here to the "local general equilibrium" effects of mass layoffs as we cannot rule out further general equilibrium effects affecting even workers far removed from a plant closing. Autor, Dorn and Hanson (2013) use a similar concept when they investigate the labour market effects of trade and technology as does Notowidigdo (2011) in his analysis of the impacts of local labour demand shocks on low-skilled workers.

identify not only the direct effects of mass layoffs on employment and earnings but also any indirect impacts on the employment and earnings prospects of workers employed in the vicinity of an establishment being closed down.[3; 4]

Relying on the difference-in-difference approach pioneered by Ruhm (1991) and Jacobson, LaLonde and Sullivan (1993), we confirm that in the two years following a mass layoff, this event has significantly negative effects on the earnings and employment prospects of directly displaced individuals. In contrast, we find no evidence of additional adverse "local general equilibrium" effects on workers employed close by. The latter result is confirmed by an alternative specification inspired by the spatial economics literature that measures whether an establishment's exposure to nearby mass layoffs or the intensity of this exposure have any effect on its subsequent employment growth. This approach again fails to find any adverse "local general equilibrium" effects.

The rest of this paper is structured as follows: Section 3 sketches methodology and results of the individual-level difference-in-difference approach in the tradition of Ruhm (1991) and Jacobson, Lalonde and Sullivan (1993) and Section 3 discusses the alternative establishment-level approach inspired by the spatial economics literature. Section 4 concludes. Details on data sources, sample selection, variable construction etc. are left to the appendix.

2 Individual-level approach

Both the individual-level and the establishment-level analyses are based on a novel administrative data set that contains precise geo-referenced information on the universe of German establishments. It thus allows us to make precise distinctions between workers that are directly affected, indirectly affected and unaffected by mass-layoffs. It is constructed by the linkage of three distinct data bases. The first are the Integrated Employment Biographies (IEB) of the Institute for Employment Research (IAB). The IEB are collected from administrative processes of Germany's Federal Employment Agency and comprise all persons registered with the Federal Employment Agency. Registration is mandatory for individuals that are (1) employed subject to social security, (2) in marginal part-time employment, (3) recipients of unemployment benefits or assistance, (4) looking for a job or (5) participate in an active labour market measure. All German establishments that employ at least one worker are also included in the IEB. Altogether, the data set contains information on about 36 million individuals and circa 2.5 million establishments in 2009.

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[3] Strictly speaking, our data set allows the identification of all mass layoffs that happened between June 30, 2008 and June 30, 2009. For the sake of simplicity, we refer to this period as "2009" (or $k = 0$ in the empirical model), likewise "2008" denotes the period between June 30, 2007 and June 30, 2008 etc.

[4] In many ways our undertaking is similar to those employed in the analysis of the "local general equilibrium" effects of place-based policies (Neumark/Kolko 2010; Busso/Gregory/Kline 2013; Faggio 2014) or the opening of new manufacturing plants (Greenstone/Hornbeck/Moretti 2010).

For the purposes of this study, the IEB are merged with establishment data from the Establishment History Panel (BHP). The BHP is also collected from administrative processes of Germany's Federal Employment Agency. For June 30th of any given year, it encompasses all German establishments that employ at least one worker on this date who is subject to social security contributions. Information contained in the BHP includes an establishment's sector, the number of employees and their median wage as well as its exact address. The different cross sections of the BHP can be combined to form a panel. Because the Federal Employment Agency uses the underlying administrative data to compute social security contributions and unemployment benefits, the IEB and BHP are considered highly reliable.

With the combined IEB/BHP, it is relatively easy to identify those workers who are directly displaced from their jobs due to a mass layoff. However, the identification of indirectly affected – as opposed to unaffected – individuals is not straightforward. To accomplish this task, we make use of a third data set. This data set comes from Germany's Federal Agency for Cartography and Geodesy and contains the exact geographic coordinates of approximately 22 million buildings in Germany. Record linkage techniques based on establishments' addresses enable us to link it with the IEB/BHP.[5]

When distinguishing between workers that are directly affected, indirectly affected and unaffected by mass-layoffs our objectives are to (1) remain as comparable as possible to state-of-the-art studies on the direct effects of job displacement and local general equilibrium, and (2) be able to exploit advantages specific to the data we use. With regard to identifying directly displaced workers, we follow the relevant literature and define a job displacement as the event that a high-tenured worker leaves his main employer in the course of a mass-layoff event. Here, we focus specifically on mass layoffs caused by large establishments being closed down. Large establishments are defined as those with more than 100 employees.[6]

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5 For the data set used here, the reference date combining individual and establishment characteristics as well as establishment's exact geographic location is June 30, 2009. This is the main reason why we focus on mass layoffs happening between June 30, 2008 and June 30, 2009. Cf. the appendix and Scholz et al. (2012) for methodological details related to the linkage of the IEB and the geo-coded address data.

6 The IEB/BHP do not contain direct information on mass layoffs and job displacements. To identify establishment deaths, we make use of a methodology introduced by Hethey-Maier and Schmieder (2013) that relies on worker flows between establishments. More specifically, we focus exclusively on mass layoffs caused by "atomized" or "true" establishment deaths in the parlance of Hethey-Maier and Schmieder (2013). Results for alternative estimations for the direct and indirect effects of job displacements caused by mass layoffs or establishment deaths as defined by Schmieder, von Wachter and Bender (2010) are qualitatively similar and available upon request. The exposition here focuses on atomized deaths because the direct effects of job displacement caused by an atomized death are largest. Thus, any results presented here for the indirect effects of mass layoffs can conjectured to be an upper bound for the indirect effects of alternatively defined mass layoffs or establishment deaths of similar scope.

Concerning the identification of workers that are indirectly affected by mass-layoffs, a large and growing literature shows that "local general equilibrium" or agglomeration effects due to input/output linkages, labour pooling or knowledge spillovers are strongest over very small distances and decay extremely rapidly in space (cf. Arzaghi/Henderson 2008; Ahlfeldt et al. 2014). Against this backdrop, we define workers whose workplace is more than 500 meters away from any plants being closed down in 2009 as unaffected by mass layoffs. Additionally, we distinguish between five groups of workers that could be indirectly affected: the first group contains all those working within a 100 meters range of at least one plant that is being closed down in 2009. The other four encompass all employees working between 100 to 200 meters, 200 to 300 meters, 300 to 400 meters and 400 and 500 meters from at least one such plant, respectively. In the presence of indirect labour market effects of mass layoffs, we would expect these to be strongest for workers in the immediate neighbourhood of one or more plants being closed down.[7]

In terms of statistical specification, we follow Ruhm (1991), Jacobson, Lalonde, and Sullivan (1993) and much of the rest of the literature on job displacement and estimate two specifications of a distributed lag model. However, in contrast to the established literature, this model accounts for both direct and indirect effects of mass layoffs:

$$(1)\ y_{it} = \alpha_i + \gamma_t + \boldsymbol{x_{it}}\boldsymbol{\beta} + \sum_k D_{it}^{k,direct}\delta_k + \sum_k \sum_z D_{it}^{kz}\theta_k^z + \varepsilon_{it} \quad \text{and}$$

$$(2)\ y_{it} = \alpha_i + \omega_i t + \gamma_t + \boldsymbol{x_{it}}\boldsymbol{\beta} + \sum_k D_{it}^{k,direct}\delta_k + \sum_k \sum_z D_{it}^{kz}\theta_k^z + \varepsilon_{it}\ .$$

Here, y_{it} is the outcome variable (which we define as total yearly earnings or days employed per year).[8] α_i and γ_t capture effects specific to the individual or the year and the vector $\boldsymbol{x_{it}}$ contains time-variant individual characteristics. Here, this is a fourth polynomial of a worker's age. The dummy variables $D_{it}^{k,direct}$ take a value of one for directly affected workers in the k^{th} year before, during or after displacement; the D_{it}^{kz} dummies do the same for the five indirectly affected groups $z = \{1, \dots, 5\}$ defined by their distance to a mass layoff. δ_k and θ_k^z are the mass layoffs' effects on the outcome variable *k* years following its occurrence for directly and indirectly af-

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[7] The results of alternative specifications that extent the definition of workers indirectly affected by mass layoffs to those within 1000, 2000, 3000, 4000 or 5000 meters of at least one plant being closed down are available upon request. None of them show any "local general equilibrium" effects.

[8] Our measure of total yearly earnings is comparable to the main outcome variable of von Wachter, Song and Manchester (2008) and includes zero earnings. Results of regressions more closely aligned with that of Schmieder, von Wachter and Bender (2010) – the benchmark study of the direct effects of job displacement for the German labour market – are qualitatively very similar and available upon request. Also available upon request are regressions that use days unemployed per year, days of receipt of unemployment assistance per year or the likelihood of being employed on June 30 in any given year as dependent variables. No matter which outcome variable is used, the overall picture remains the same.

fected workers, respectively. Finally, the error term ε_{it} is assumed to be i.i.d. Following Jacobson, Lalonde and Sullivan (1993), in Equation (2) worker-specific time trends are added. These trends are meant to account for the possibility that workers might have different trend rates of earnings growth and that this might affect whether they are directly or indirectly affected by mass layoffs. For reasons of data availability, we use yearly data, focus on mass layoffs happening in 2009 – a year marked by recession and rising unemployment – and track individuals' employment histories from 2000 and 2010.

— Table 1 around here —

The left-hand side of Table 1 and Figure 1 summarize the results of estimating Equation (1) with the help of our linked employer-employee data set. As noted above, the dependent variables are total yearly earnings and days employed per year. As is evident from the first column of Table 1 and the top panel of Figure 1, even before 2009 the total yearly earnings of individuals employed in an establishment that was being closed down in 2009 had exhibited a slight downward trend as compared to the earnings of individuals that in 2009 were neither directly nor indirectly affected by a plant closing. In 2009 – that is, the year of the plant closing and subsequent job displacement – the earnings of directly affected individuals collapsed. One year later, they recovered somewhat. But they were still much lower than the pre-displacement earnings. This picture is qualitatively very similar to what has been document by the sizable literature on the direct effects of displacements from around the world. In particular, Schmieder, von Wachter and Bender (2010) use the IEB data to document similar effects of mass layoffs during Germany's 1982 recession.

Regressions of days employed per year are documented in the second column of Table 2 and the bottom panel of Figure 1. Again, findings regarding a comparison of individuals directly affected by plant closings with those that are not affected by such an event are again qualitatively very similar to what has been found by the existing literature. Because we restrict the sample to high-tenured workers, the "time trends" for both groups are perfectly parallel for the few years before 2009. In 2009 there is a dramatic drop in the days employed for individuals that are directly affected by a mass layoff. One year later, workers directly displaced by a plant closing still on average work fewer days than those unaffected, but recovery has obviously set. In terms of days employed, this recovery happens much faster than with regard to earnings.

— Figure 1 around here —

The regressions summarized in the left-hand side of Table 1 and Figure 1 confirm the literature's result that mass layoffs have very substantial effects for directly affected workers. At the same time, they fail to find additional indirect or "local general equilibrium" effects. Neither the table nor the figure identifies any discernible pattern in the interactions between years and distance from the location of plant closure in 2009. This is the case no matter whether total yearly earnings or days employed per year are used as dependent variable. For workers employed in the vicinity of a plant that is being closed down, the year 2009 does not signify a significant deterioration in earnings or employment. If anything, workers employed very close to the location of a plant closing experience relatively higher earnings in 2009 and 2010 than in the immediately preceding years. It should be noted, though, that while this group's jump in total yearly earnings between 2009 and 2010 is statistically significant it is economically quite small and practically indistinguishable from fluctuations happening also between "placebo" years (that is, those not characterized by mass layoffs happening close by).

In the regression summarized in the right-hand side of Table 1, Equation (2) is being estimated. That is, worker-specific time trends are added to account for the possibility that different workers might have different trend rates of earnings growth and that this might affect whether they are directly or indirectly affected by mass layoffs. All results are very robust to this alternative specification: Mass layoffs are again shown to have economically significant effects on the earnings and employment prospects of directly affected workers but no additional "local general equilibrium" effects.

3 Establishment-level approach

As noted above, the indirect effects of mass layoffs can be conjectured to be much smaller than the direct ones. Thus, one might argue that even with our large, reliable and detailed administrative micro data set, our failure to find indirect effects of mass layoffs on individuals' earnings and employment prospects might be due not to an absence of such effects but due to a lack of identification power. While it will never be possible to completely rule out this possibility, we can make use of methods recently developed in the spatial economics literature to evaluate whether mass layoffs have effects on establishments that are located close-by. As individuals are only to be impacted by mass layoffs happening nearby their workplace through their job, the presence of effects on establishments would be a necessary condition for the existence of "local general equilibrium" effects on individuals' employment careers. Besides, we would expect indirect effects of mass layoffs on establishments to be an upper bound for effects on individuals. This is because individuals have a plethora of mechanisms to cope with any such effects. For instance, they can move to another location. For an establishment, this is far more difficult (at least in the short run).

Following Faggio (2014), we pursue two approaches to estimate the employment effects of mass layoffs on indirectly exposed establishments. Both are estimated on the establishment level and use establishment-level employment as the dependent

variable. The first approach analyses the effects of indirect exposure to mass layoffs with the help of a "mass layoff dummy" variable that takes the value of one for all establishments within the 500 meter radius of a mass layoff in 2009 (for simplicity, we abstract from distinguishing between different groups of indirectly exposed establishments). The second approach instead uses a "mass layoff size" variable that ranges between zero and one and measures the proportion of jobs present at the beginning of 2009 that are destroyed by mass layoffs during this year 2009 in a 500 meter radius around any given establishment. More specifically:

$$(3)\ y_{it} = \alpha_i + \gamma_t + \sum_k D_{it}^{k,direct}\delta_k + \sum_k D_{it}^{k,indirect}\theta_k + \varepsilon_{it} \quad \text{and}$$

$$(4)\ y_{it} = \alpha_i + \gamma_t + \sum_k D_{it}^{k,direct}\delta_k + \sum_k S_{it}^{k,indirect}\theta_k + \varepsilon_{it}\ .$$

y_{it} again is the outcome variable which is now defined as an establishment's total number of workers. γ_t capture effects specific to the year and α_i are establishment-level fixed effects (which are added in some specifications to account for unobserved time-invariant establishment characteristics). No additional time-variant establishment-level characteristics are included. The dummy variables $D_{it}^{direct,k}$ take a value of one in the k^{th} year before, during or after 2009 for establishments closing down in that year. The $D_{it}^{z,indirect}$ dummies do the same for establishments located within 500 meters of a large establishment closing down in 2009. $S_{it}^{k,indirect}$ measures indirect exposure to a mass layoff not with a dummy variable but with a variable ranging from zero to one that captures the proportion of jobs in a 500 meter radius that are destroyed through mass layoffs in 2009. δ_k and θ_k are the mass layoffs' effects on employment *k* years following its occurrence for directly and indirectly affected establishments, respectively. The error term ε_{it} is again assumed to be i.i.d.

Regression results for Equations (3) and (4) are reported in Table 2. The table's first two columns summarize estimations of Equation (3). In Column (i), only time-specific fixed effects are included. In Column (ii) establishment-level fixed effects are added. Columns (iii) and (iv) turn the attention to Equation (4). Again, results are first presented without and then with establishment-level fixed effects.

All four establishment-level regressions reported in Table 2 show that – by definition – establishments closing down in 2009 experience large employment losses in this particular year from which they do not recover afterwards. In addition to that, the regressions also confirm the basic message of the individual-level approach with regard to the lack of additional "local general equilibrium" effects of mass layoffs. Neither in the "mass layoff dummy" nor the "mass layoff size" regressions and irrespective of whether establishment-level fixed effects are included or not do mass layoffs negatively affect the number of jobs at nearby establishments.

4 Conclusions

Using a novel administrative data set that contains precise geo-referenced information on the universe of German establishments, this study analysed both the direct effects of job displacements and any indirect impacts on workers who are employed in the vicinity of an establishment experiencing a mass layoff. In line with what is found by the existing literature, it documented significant impacts of job displacement on the employment and earnings prospects of directly affected workers. In contrast, neither an individual-level difference-in-difference approach nor an alternative establishment-level approach inspired by the spatial economics literature uncovered evidence of significant adverse effects for workers or establishments indirectly exposed to job displacements.

Given the well-document direct effects of job displacements and the plethora of transmission channels through which job displacements could have local general equilibrium effects (including direct customer supplier-relationships, labour pooling and agglomeration spillovers as documented for instance by Arzaghi/Henderson 2008; Ahlfeldt et al. 2014), what are the implications of the absence of any local general equilibrium effects? This finding might mean that the German labour and/or product markets are more flexible than often surmised. In effect, establishments appear to be able to adapt quickly to nearby mass layoffs of an economically significant magnitude.

Of course, ours is one of the very first studies to document the absence of local general equilibrium effects of mass layoffs and our findings not mean that they do not take place at all. should therefore be taken with a grain of salt. Hamermesh (1989: 55) noted that “involuntary mobility stemming from displacement is a small fraction of total mobility in a local labour market, which in turn implies that the labour-market impacts of displacement may be very hard to quantify.” Especially if these impacts are very small, even with our large, reliable and precise geo-referenced data set we might actually not have enough power to identify them. What is more, in the short run establishments might react to mass layoffs happening in their vicinity through reduced profits or higher prices. Effects felt on the labour market might only set in over time. If this was the case, even the failure to find indirect labour market effects of mass layoffs in the short run might not mean that they do not take place at all.

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Tables

Table 1
Total yearly earning and days employed of workers directly or indirectly affected by plant closings relative to unaffected (with or without worker-specific time trends)

Years rel. to plant closure	(i)			(ii)			(iii)			(iv)		
	Without worker-specific time trends						With worker-specific time trends					
	Total yearly earnings			Days employed			Total yearly earnings			Days employed		
	Est.		S.E.	Est.		S.E.	Est.		S.E.	Est.		S.E.
Permanently separated through plant closing												
-8	-582	**	(290)	6.21	***	(1.84)	833	***	(256)	8.10	***	(1.96)
-7	-1387	***	(274)	5.96	***	(1.95)	348		(282)	14.86	***	(2.58)
-6	-1470	***	(310)	9.81	***	(1.73)	603	*	(348)	23.46	***	(2.99)
-5	-1708	***	(305)	12.41	***	(1.58)	710	*	(385)	30.80	***	(3.25)
-4	-1977	***	(312)	12.35	***	(1.58)	741	*	(438)	35.59	***	(3.56)
-3	-2254	***	(314)	12.35	***	(1.58)	748		(490)	40.44	***	(3.95)
-2	-2320	***	(306)	12.36	***	(1.58)	945	*	(540)	45.27	***	(4.41)
-1	-3041	***	(332)	8.74	***	(1.68)	467		(597)	46.47	***	(4.87)
0	-8989	***	(474)	-50.73	***	(3.55)	-5490	***	(658)	-9.68	*	(5.01)
+1	-6542	***	(445)	-15.45	***	(2.67)	-5105	***	(577)	5.50	*	(2.84)
Within 0-100 meters of plant closing												
-8	148		(175)	-1.95	**	(0.96)	-386	***	(133)	-3.32	***	(1.03)
-7	274		(186)	-0.37		(1.06)	-242		(175)	-3.17	**	(1.44)
-6	316		(202)	-1.10		(0.87)	-234		(196)	-4.65	***	(1.53)
-5	213		(202)	-3.93	***	(0.71)	-290		(216)	-7.80	***	(1.57)
-4	166		(205)	-3.91	***	(0.71)	-291		(232)	-8.23	***	(1.58)
-3	84		(210)	-3.88	***	(0.71)	-324		(254)	-8.69	***	(1.63)
-2	252		(207)	-3.86	***	(0.70)	-105		(271)	-9.16	***	(1.73)
-1	362	*	(209)	-3.23	***	(0.74)	60		(285)	-9.06	***	(1.78)
0	782	***	(240)	3.54	***	(1.12)	510	*	(306)	-2.91	*	(1.61)
+1	858	***	(250)	2.78	**	(1.11)	810	**	(318)	-1.47		(1.08)
Within 100-200 meters of plant closing												
-8	551	**	(231)	-0.72		(1.26)	355	**	(180)	0.41		(1.34)
-7	409	*	(248)	-1.72		(1.38)	301		(237)	-0.45		(1.89)
-6	710	***	(266)	-1.83		(1.18)	708	***	(266)	-0.68		(2.00)
-5	1213	***	(265)	0.23		(0.98)	1210	***	(290)	0.87		(2.02)
-4	1429	***	(271)	0.23		(0.97)	1400	***	(310)	0.48		(2.04)
-3	1615	***	(276)	0.21		(0.97)	1562	***	(339)	0.09		(2.12)
-2	1438	***	(273)	0.19		(0.97)	1360	***	(362)	-0.28		(2.26)
-1	1364	***	(278)	0.51		(1.03)	1262	***	(381)	-0.29		(2.32)
0	1308	***	(318)	-1.85		(1.42)	1219	***	(403)	-2.23		(2.04)
+1	1478	***	(332)	-0.11		(1.52)	1725	***	(419)	0.52		(1.44)

Years rel. to plant closure	(i)			(ii)			(iii)			(iv)		
	Without worker-specific time trends						With worker-specific time trends					
	Total yearly earnings			Days employed			Total yearly earnings			Days employed		
	Est.		S.E.	Est.		S.E.	Est.		S.E.	Est.		S.E.
Within 200-300 meters of plant closing												
-8	-495	**	(214)	4.25	***	(1.17)	-92		(171)	2.66	**	(1.25)
-7	-516	**	(226)	1.65		(1.17)	-235		(221)	0.69		(1.63)
-6	-671	***	(242)	1.58		(1.05)	-448	*	(251)	0.81		(1.76)
-5	-1062	***	(240)	1.94	**	(0.89)	-834	***	(269)	2.33		(1.80)
-4	-1351	***	(245)	1.95	**	(0.89)	-1106	***	(287)	3.35	*	(1.79)
-3	-1241	***	(250)	1.96	**	(0.88)	-980	***	(310)	4.37	**	(1.83)
-2	-1171	***	(249)	1.96	**	(0.88)	-894	***	(330)	5.37	***	(1.93)
-1	-1312	***	(255)	1.56	*	(0.94)	-1021	***	(345)	5.96	***	(1.93)
0	-1905	***	(281)	-1.77		(1.16)	-1514	***	(356)	3.99	**	(1.62)
+1	-2185	***	(293)	-4.34	***	(1.23)	-2217	***	(369)	-0.80		(1.18)
Within 300-400 meters of plant closing												
-8	199		(196)	-1.24		(1.07)	357	**	(159)	1.03		(1.17)
-7	-234		(209)	0.84		(1.04)	34		(208)	3.69	**	(1.49)
-6	-177		(223)	1.47	*	(0.89)	122		(235)	4.27	***	(1.59)
-5	-145		(221)	1.10		(0.75)	177		(250)	3.44	**	(1.64)
-4	-142		(224)	1.00		(0.74)	190		(264)	3.04	*	(1.59)
-3	-9		(228)	0.95		(0.74)	319		(281)	2.74	*	(1.58)
-2	-9		(227)	0.90		(0.74)	303		(297)	2.49		(1.62)
-1	178		(230)	0.40		(0.78)	460		(308)	1.80		(1.59)
0	132		(247)	0.25		(0.98)	233		(318)	0.15		(1.37)
+1	187		(256)	2.01	**	(0.89)	137		(327)	1.08		(0.90)
Within 400-500 meters of plant closing												
-8	-666	***	(126)	-0.53		(0.67)	-357	***	(105)	-1.36	*	(0.74)
-7	-78		(139)	0.25		(0.71)	31		(144)	-1.33		(1.02)
-6	-581	***	(147)	-0.65		(0.59)	-626	***	(159)	-2.13	**	(1.06)
-5	-599	***	(146)	-0.69		(0.47)	-808	***	(168)	-2.44	**	(1.05)
-4	-534	***	(148)	-0.63		(0.47)	-880	***	(176)	-2.65	***	(1.02)
-3	-858	***	(149)	-0.59		(0.47)	-1331	***	(185)	-2.91	***	(1.01)
-2	-881	***	(149)	-0.57		(0.47)	-1472	***	(196)	-3.21	***	(1.03)
-1	-943	***	(149)	-0.37		(0.50)	-1640	***	(203)	-3.35	***	(1.03)
0	-295	*	(162)	1.65	***	(0.63)	-1014	***	(212)	-1.14		(0.91)
+1	-118		(170)	2.65	***	(0.61)	-705	***	(217)	1.02	*	(0.59)
F.E.	All			All			All			All		
Contr.	All			All			All			All		
Obs.	5,812,351			5,812,351			4,767,996			4,767,996		

Notes: (1) Regressions are on the individual level; (2) “All F.E.” indicates that individual- and time-specific fixed effects are included; (3) “All Contr.” denotes a fourth polynomial of a worker’s age; (4) the symbols *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively; (5) for details on the specification, see Section 2.

Sources: IEB, BHP and GAB.

Table 2
Total number of workers of establishments directly or indirectly affected by plant closings relative to unaffected (with or without establishment-specific fixed effects)

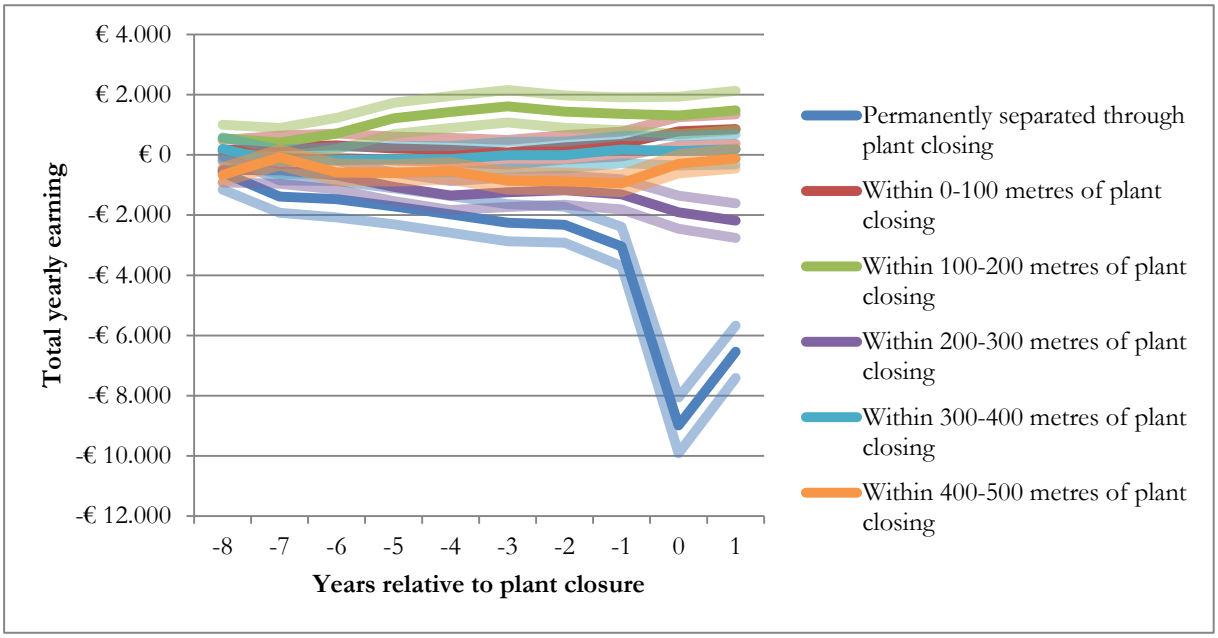
Years rel. to plant closure	(i)			(ii)			(iii)			(iv)		
	Mass layoff dummy variables						Mass layoff size variables					
	Total number of workers			Total number of workers			Total number of workers			Total number of workers		
	Est.		S.E.	Est.		S.E.	Est.		S.E.	Est.		S.E.
Plant closing												
-9	0.596	**	(0.255)				0.58	**	(0.25)			
-8	0.698	***	(0.197)	0.117		(0.194)	0.68	***	(0.19)	0.12		(0.19)
-7	0.654	***	(0.147)	0.083		(0.172)	0.64	***	(0.14)	0.08		(0.17)
-6	0.726	***	(0.101)	0.162		(0.165)	0.71	***	(0.10)	0.17		(0.16)
-5	0.658	***	(0.130)	0.101		(0.170)	0.65	***	(0.13)	0.11		(0.17)
-4	0.693	***	(0.091)	0.146		(0.163)	0.69	***	(0.09)	0.15		(0.16)
-3	0.697	***	(0.099)	0.198		(0.173)	0.69	***	(0.10)	0.21		(0.17)
-2	0.834	***	(0.066)	0.346	**	(0.175)	0.83	***	(0.07)	0.35	**	(0.17)
-1	0.923	***	(0.014)	0.432	**	(0.173)	0.92	***	(0.01)	0.44	**	(0.17)
0	-0.066	***	(0.014)	-0.557	***	(0.172)	-0.07	***	(0.01)	-0.55	***	(0.17)
+1	-0.071	***	(0.013)	-0.562	***	(0.172)	-0.07	***	(0.01)	-0.56	***	(0.17)
Within 0-500 meters of plant closing												
-9	0.032		(0.021)				14.16		(25.46)			
-8	0.030	*	(0.018)	-0.002		(0.008)	12.62		(22.66)	-0.89		(11.13)
-7	0.026	*	(0.015)	-0.002		(0.007)	8.44		(20.38)	-4.03		(10.59)
-6	0.019		(0.012)	-0.007		(0.006)	8.31		(18.85)	-4.77		(9.94)
-5	0.015		(0.011)	-0.009		(0.006)	9.53		(18.60)	-2.41		(9.45)
-4	0.012		(0.010)	-0.010	*	(0.006)	8.58		(17.61)	-1.82		(9.40)
-3	0.008		(0.009)	-0.013	**	(0.006)	4.26		(15.75)	-7.82		(9.75)
-2	0.007		(0.008)	-0.012	**	(0.006)	2.29		(14.08)	-7.88		(9.85)
-1	0.005		(0.008)	-0.013	**	(0.006)	5.17		(14.23)	-7.86		(10.29)
0	0.007		(0.008)	-0.011	*	(0.006)	7.36		(14.07)	-5.67		(10.30)
+1	0.007		(0.008)	-0.011	*	(0.006)	6.80		(13.88)	-6.23		(10.17)
F.E.	Partial			All			Partial			All		
Obs.	224,089			224,089			224,089			224,089		

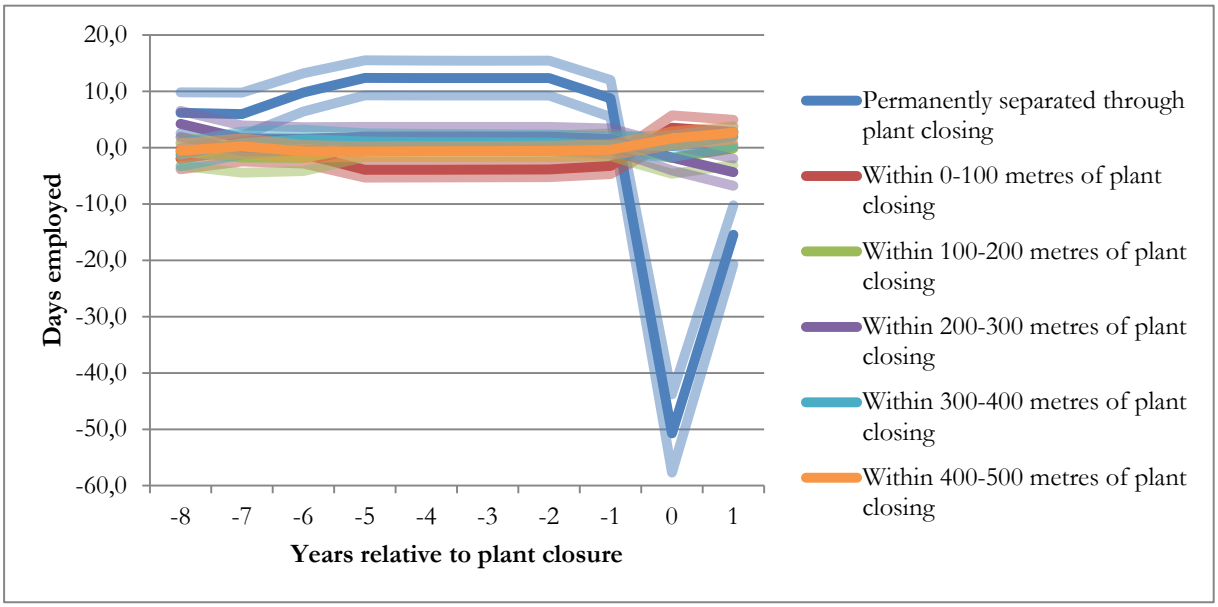
Notes: (1) Regressions are on the establishment level; (2) “Partial F.E.” indicates that time specific fixed effects are included, “All F.E.” means establishment-specific fixed effects are additionally included; (3) the symbols *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively; (4) for details on the specification, see Section 3.

Sources: IEB, BHP and GAB.

Figures

Figure 1
Total yearly earning and days employed of workers directly or indirectly affected by plant closings relative to unaffected (without worker-specific time trends)





Notes: (1) Regressions are on the individual level; individual- and time specific fixed effects are as well as a fourth polynomial of a worker's age are included as additional regressors; (2) for details on the specification, see Section 2.

Sources: IEB, BHP and GAB.

Data Appendix

Both our individual-level and the establishment-level analyses are based on a novel administrative data set that contains precise geo-referenced information on the universe of German establishments. This data is constructed by the linkage of three distinct data bases. The first are the Integrated Employment Biographies (IEB) of the Institute for Employment Research (IAB). The IEB are collected from administrative processes of Germany's Federal Employment Agency and comprise all persons registered with the Federal Employment Agency. Registration is mandatory for individuals that are (1) employed subject to social security, (2) in marginal part-time employment, (3) recipients of unemployment benefits or assistance, (4) looking for a job or (5) participate in an active labour market measure. All German establishments that employ at least one worker are also included in the IEB. Altogether the IEB cover about 80 percent of Germany's total workforce and contains information on about 36 million individuals and circa 2.5 million establishments in 2009. They encompass detailed longitudinal information on individuals' employment status, wages and socio-demographic characteristics to the exact day and basic establishment-level information.

For the purposes of this study, the IEB are merged with establishment data from the Establishment History Panel (BHP). The BHP is also collected from administrative processes of Germany's Federal Employment Agency. For June 30th of any given year, it encompasses all German establishments that employ at least one worker on this date who is subject to social security contributions. Information contained in the BHP includes an establishment's sector, the size of its workforce, its median wage and its exact address. The different cross sections of the BHP can be combined to form a panel.

The establishment identifier (EIDs) used in the BHP is the same one found in the IEB. This makes merging the two data sets straightforward. Because the Federal Employment Agency uses the underlying administrative data to compute social security contributions and unemployment benefits, the IEB and BHP are considered highly reliable. In the context of our study, another important advantage of not relying on survey but on administrative data is that we need not worry about panel mortality or non-response.

With the combined IEB/BHP, it is relatively easy to identify those workers who are directly displaced from their jobs due to a mass layoff. However, the identification of indirectly affected – as opposed to unaffected – individuals is not straightforward. To accomplish this task, we make use of a third data set. These are the *Georeferenzierte Addressdaten Bund (GAB)* from Germany's Federal Agency for Cartography and Geodesy. The GAB contain the addresses and exact geographic coordinates of approximately 22 million buildings in Germany. The GAB data was collected between December 2008 and August 2010. Hence, record linkage techniques based on establishments' addresses enable us to link it with a cross-section drawn from

the IEB/BHP on June 30, 2009. As the BHP contains data for June 30th of any given year and the reference date for combining the IEB/BHP with the GAP is June 30, 2009, we focus on mass layoffs happening between June 30, 2008 and June 30, 2009. For the sake of simplicity, we usually refer to this period as “2009”.

The linkage of the IEB/BHP and GAB is described in Scholz et al. (2012); for methodological details we refer to their paper. The basic idea is to follow a three-step procedure: First, address data contained in the IEB/BHP and GAB are preprocessed by cleaning up and standardizing the names of zip codes, municipalities and street addresses. Second, establishments with the exact same zip codes, municipalities and street addresses in the IEB/BHP and GAB data are merged through deterministic record linkage. Third, distance-based statistical record linkage techniques are used to merge the remaining unmerged records. These record linkage techniques use zip codes as blocking variables and municipalities and street addresses as linkage keys. False-positive assignments are carefully avoided. Overall, the three-step record linkage approach allows us to assign a GPS coordinate to 93.2 percent of all establishments and 94.6 percent of all persons selected from the IEB/BHP.

Once the IEB/BHP and GAB data have been merged, we are able to distinguish whether a worker is directly affected, indirectly affected or not affected by mass layoff. Importantly, the IEB/BHP do not contain direct information on mass layoffs and job displacements. Here, we focus on mass layoffs caused by establishment deaths. To identify such deaths, we make use of a methodology introduced by Hethey-Maier and Schmieder (2013). Hethey-Maier and Schmieder (2013) note that restructuring and relabeling of firms is often poorly measured in administrative data sets like the IEB/BHP and that this can result in large biases. They document that relying solely on the first and last appearance of the IEB/BHP’s EIDs to identify establishment openings and closings does indeed lead to a large extent of misclassification. “Only about 35 to 40 percent of new and disappearing EIDs with more than 3 employees are likely to correspond to real establishment entries and exits.” (Hethey-Maier/Schmieder 2013; Abstract).

Instead of using the disappearance of an EID to measure an establishment’s death, Hethey-Maier and Schmieder (2013) propose a methodology that relies on worker flows between establishments. The methodology divides exiting establishments into four categories: First, exiting establishments with less than four employees are defined as *small establishments deaths*. Second, exiting establishments where less than 30 percent of employees end up together in any single other establishment are defined as *atomized establishment deaths*. Third, exiting establishments where between 30 percent and 80 percent of employees end up together in a single other establishment are defined as *fuzzy establishment deaths*. Finally, exiting establishments where at least 80 percent of employees end up together in a single other establishment are defined as *ID change* or *takeover/restructuring*, depending on whether the establishment where at least 80 percent of employees of the existing

end up is an entrant or not. Hethey-Maier and Schmieder (2013) argue that atomized deaths are the clearest form of "true" establishment deaths. Therefore, we focus exclusively on mass layoffs caused by atomized establishment deaths.[9] In addition to that, we restrict our analysis of the direct and indirect effects of mass layoffs to those situations where large establishments are being closed down. In his context, large establishments are defined as those with more than 100 employees subject to social security contributions or in marginal employment, irrespective of whether they are full-time or part-time workers.

Concerning the identification of workers that are indirectly affected by mass-layoffs due to establishment deaths, a large and growing literature shows that "local general equilibrium" or agglomeration effects due to input/output linkages, labour pooling or knowledge spillovers are strongest over very small distances and decay extremely rapidly in space (cf. Arzaghi/Henderson 2008; Ahlfeldt et al. 2014). Against this backdrop, we define workers whose workplace is more than 500 meters away from any plants being closed down in 2009 as unaffected by mass layoffs. Additionally, we distinguish between five groups of workers that could be indirectly affected: the first group contains all those working within a 100 meters range of at least one plant that is being closed down in 2009. The other four encompass all employees working between 100 to 200 meters, 200 to 300 meters, 300 to 400 meters and 400 and 500 meters from at least one such plant, respectively.[10]

Even though – as explained above – the combination of the IEB/BHP with establishments' GPS coordinates is in principle available for almost the universe of German establishments and their workers, computational restrictions mean that we have to work with a sample of establishments and workers. In order to maximize power, we draw our sample in a way that includes all workers directly affected by atomized deaths (this number is relatively small), oversamples workers indirectly affected by such an event (this group is also relatively small) and only contains a relatively minor proportion of individuals unaffected by atomized deaths. Overall, our final sample contains 495,719 individuals. We track these individuals' employment histories for eleven years, from 2000 and 2010.

Following Schmieder, von Wachter and Bender (2010), our final estimation sample of workers directly, indirectly or not affected by a plant closure in 2009 consists only of employees that on June 30th, 2008, had been continuously employed for at least

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9 Hethey-Maier and Schmieder (2013) not only calculate the proportion of an exiting establishment's employees that end up together in any single other establishment but also what proportion of the workforce of this successor establishment is made up of former employees of the exiting establishment. Here, we disregard establishment deaths where more than 80 percent of a successor's workforce is made up of former employees of the exiting establishment. This situation could more readily be characterized as a *spin-off* than as an atomized death.

10 The results of alternative specifications that extent the definition of workers indirectly affected by mass layoffs to those within 1000, 2000, 3000, 4000 or 5000 meters of at least one plant being closed down are available upon request.

5 years. In robustness checks that are available upon request, we further restrict the groups of workers indirectly or not affected by mass layoffs to those working at an establishment with more than 100 employees. That is, we restrict the overall sample to workers that were actually at risk of being directly affected by a plant closure in 2009.

Also following Schmieder, von Wachter and Bender (2010), our main outcome variables are total yearly earnings and days employed. Total yearly earnings are defined as the sum of all wages during any given year (including zeros) and days employed encompass periods of both full-time and part-time work. Results for regressions that use alternative outcome variables also defined by Schmieder, von Wachter and Bender (2010) – such as days unemployed per year, days of receipt of unemployment assistance per year or the likelihood of being employed on June 30 in any given year – are available upon request. No matter which outcome variable is used, the overall picture remains the same.

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