

Regional employment and productivity effects from mass lay-offs.

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Abstract

This paper uses data from the European Restructuring Monitor database of Eurofound and OECD regional statistics to estimate the average effect of mass lay-offs on the employment and productivity, as measured by industrial GVA per worker, of NUTS3/TL3 regions over the period 2010-18 in seven European countries. Using a staggered difference-in-differences estimator, the paper finds that a mass lay-off reduces regional employment by around 2% to 6%, depending on the threshold of included mass lay-offs. Variation in outcomes depends on the types of regions, and the sector and cause of the mass lay-off. Mass lay-offs in manufacturing due to de-location have the strongest negative employment effects, while mass lay-offs in business services are detrimental to regional productivity.

Keywords: mass lay-offs, local labour markets, regional resilience, economic shocks, productivity

1. Introduction

The size and impact of mass lay-offs on individual workers and local communities, whether at factories, offices or commercial premises, can often result in significant public attention (OECD, 2018). Dismissed workers face income loss and unemployment spells, potentially culminating in further adverse social and health outcomes (Venkataramani et al., 2020; Bertheau et al., 2022). In some cases, affected workers can mobilise the larger community and gain political support to partially reverse mass dismissal decisions (González Begega and Köhler, 2021).

This paper uses data from the European Restructuring Monitor (ERM) database of Eurofound to estimate the average effect of mass lay-offs on the employment and productivity

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of small (NUTS3/TL3) regions over the period 2007 to 2018. The scale-down or closure of a large employer could impact other businesses, both upstream and downstream in the value chain, as well as businesses providing goods and services to affected workers. The immediate impact of a mass lay-off on the local economy, and the adjustment mechanisms and the required capacity to adapt to it, are inevitably more profound than for numerous individual displacements occurring across many employers and spread over time, and so merit particular focus. They are also important to assess as they account for up to 15% of all job displacements (OECD, 2018, p. 131).

Regional measures of productivity can offer insights into the resilience of regions to mass lay-offs. On the one hand, mass lay-offs that occur in under-performing and low productivity firms may result in positive productivity effects over time, especially if affected workers find new jobs in higher productivity firms in the same region. On the other hand, mass lay-offs may also occur in high productivity firms that restructure their business activities across regions or countries. In this case, regional productivity may be affected negatively.

This paper estimates the average effect of mass lay-offs from 2007 to 2018 on the regional (NUTS3/TL3) economies across seven European countries. The existing literature has studied the effect of mass lay-offs on individual workers using data for individual countries. This paper combines a comprehensive database on mass lay-offs with harmonised data on regional employment and productivity. Where other studies gained detail on the timing of mass lay-offs in combination with detailed employer-employee data in a single country, this paper estimates the effect of mass lay-offs across regions in multiple countries simultaneously across years. By pooling cases from multiple countries, further analysis on heterogeneous effect analysis are possible, allowing to gain insights across sectors, the causes of mass lay-offs, ranging from failing business to the relocation of production facilities, and the type of region that mass lay-offs occur in.

This paper finds that mass lay-offs have persistent effects on regional labour markets. A mass lay-off reduces regional employment by around 2% to 6%, depending on the threshold of the size of the lay-off. Employment effects are stronger for mass lay-offs in manufacturing, while intermediate and urban areas tend to see stronger effects relative to rural regions.

Negative regional productivity effects are worst for mass lay-offs occurring in the business services sector and those due to de-location, while mass lay-offs occurring due to failure and restructuring have statistically insignificant or even positive effects.

The remainder of the article is structured as follows. Section 2 presents an overview of the recent empirical literature on the effect of mass lay-offs on workers and regions. Section

3 presents the empirical model, data and results, and Section 4 concludes with implications for policy.

2. Literature review

The empirical literature on mass lay-offs addresses the direct impact on workers and the aggregate effect on regional economies. Some studies combine the two levels of analysis by looking at workers that are not directly affected by the mass lay-off but can be indirectly affected through geographical proximity or business linkages. Most studies use data from a single country. Table 1 summarises the relevant papers, indicating the unit of analysis (e.g., individuals or regions), the geographical and time coverage, the main findings and the main quantitative estimation method.

Table 1: Empirical evidence of mass lay-off events on workers and regions

Study	Object of study	Region, time period, and event characteristic	Main result	Method
Celli et al. (2022)	local labour market-sectors	Italy, 2004-19, shocks of at least 100 jobs in a plant occurring between 2008-11	Employment shocks to a sector in a local labour market cause on average an immediate reduction of employment in the same sector in the local labour market of 22%, which persists over at least eight years.	DiD matching
Vom Berge and Schmillen (2022)	Individual workers	Germany, 2009. Number of events unclear	Attempts to estimate employment and earnings effects on workers not affected by the mass lay-off but geographically working in the same area (within hundreds of meters). The study finds no such effect.	TWFE
Bertheau et al. (2022)	Individual workers	6 European countries, varying time periods approx. 1993-2017, 30% mass dismissal or plant closure	Loss of earnings for workers following job displacement in southern European countries is much larger five year after a mass lay-off than in northern European countries. The differences in spending on active labour market policies can explain these differences to a large extent.	DiD matching
Behrens et al. (2021)	City level population	Canadian urban areas, 1 period of 2003-17	Mass lay-off defined as substantial job loss rate at plants over 14-year period. Document negative effect on population with differentiation across groups, and spill-overs across sectors.	OLS with shift-share instrument

Table 1: Empirical evidence of mass lay-off events on workers and regions
(continued)

Study	Object of study	Region, time period, and event characteristic	Main result	Method
Fallick et al. (2019)	Individual workers	Five US States, Quarters ranging between 1992-2014. Job-to-job transitions	Comparing earnings patterns between job-to-job transitions allowing for different spans of joblessness and differentiating between distressed and non-distressed firms finds little effect of the cause of joblessness, but longer joblessness spells hurt wage growth.	Various TWFE models
Gathmann et al. (2020)	Individual workers and regional aggregates	(West) Germany, 1975-2008, 69 events of at least 500 job losses in a plant	With an average lay-off event of 1700 jobs (1.9% of labour force), regional job losses reach 3000 jobs (3.7% of labour force). Each 1% of job loss may lead to 0.22% in productivity loss in corresponding sector. Only older workers experience a persistent negative effect in income.	TWFE
Foote et al. (2019)	County level	US, 2000-11, following BLS dataset at least 50 job losses in plant	A 1% county LF shock decreases LF by 0.19 percentage points, of which 40% is due to out-migration, and much of the remainder by decrease of participation. During the Great Recession, non-participation channel became more important.	TWFE
Jofre-Monseny et al. (2017)	Municipality-industry	Spain, 2000-08, 45 large manufacturing plant closures, with at least 100 job losses	Plant closures are due to international plant relocations. Analysis at municipality-industry level. For each job lost, between 0.3 and 0.4 are created in other plants. Little response along other margins. Labour market institutions may partly explain the lack of further labour market effects.	DiD Matching
Huttunen et al. (2011)	Individual male workers	Norway, years 1986-2005, manufacturing	Displacement affects earnings negatively and more so for older workers. Transitions between plants (within firm) largely mitigate earnings losses. Between firms (and across sectors) earnings are not fully recuperated after seven years.	TWFE

Table 1: Empirical evidence of mass lay-off events on workers and regions
(continued)

Study	Object of study	Region, time period, and event characteristic	Main result	Method
Eliason and Storrie (2006)	Individual workers	Sweden, 1983-99, plant closures in 1987	Job displacement has long-term effects, which can be aggravated by the economic environment. Workers affected by displacement see worse earnings development during subsequent recessions.	Propensity score matching
Stevens (1997)	Individual workers	US, panel surveys, 1968-88	Workers with a long job tenure who experience displacement may experience further subsequent job-changes. Such repeated events contribute to the persistent negative effect on earnings relative to workers who experience only one displacement over a period.	TWFE
Jacobson et al. (1993)	Individual workers	US (Pennsylvania), 1974-86, matched employee-employer data	Workers experience substantial losses following displacement, up to 25% after five years. This experience is not much differentiated by gender, age and industry, but it is affected by local job market conditions.	TWFE
Ruhm (1991)	Individual workers	US, panel surveys, 1969-82	Differentiating between short- and long-term effects from displacement, finds a reduction in earnings of 10% after four years.	OLS

2.1. Consequences of mass lay-offs for individual workers

Job displacement affects some workers more than others. Specifically, workers that are older or with a lower level of education tend to experience longer negative effects from unemployment and these effects become more important the longer the unemployment spell (OECD, 2018). Moreover, workers without a higher education degree or with a post-secondary technical degree are less likely to move sector relative to people with a higher education degree (Huttunen et al., 2011), which needs to be factored into policy responses.

The literature on mass lay-offs combines plant closures and mass displacements, for which studies often take the threshold of 30% of the workforce of a plant or firm. Mass lay-offs can be argued to be events that are exogenous to workers' individual performance and exclude voluntary separations.

There is little evidence that for individual workers, large lay-off events have substantially different longer-term effects on individual workers relative to lay-offs that do not stem from such events. Generally, workers displaced in a mass lay-off experience a reduction in earnings

growth relative to earnings prior to the event and relative to suitable counterfactual groups (Fallick et al., 2019). Bertheau et al. (2022) use a harmonised sample and estimation approach for seven European countries to estimate the effect of job displacement from mass lay-offs and plant closures. Five years after the event, workers in southern European countries (Portugal, Italy and Spain) experience up to 30% lower earnings. In contrast, workers in Denmark and Sweden see a fall of around 10%. The difference in the likelihood of being re-employed across countries, which is much larger in northern countries, largely explains the earnings difference. The authors argue that the difference in share of spending on active labour market policies of all labour market spending (which ranges as high as 60% in Nordic countries and can be as low as 20% in others) best explains the cross-country variation in re-employment. Moreover, early intervention for affected workers by dismissals, for instance at the moment that lay-offs are announced but not yet executed, potentially increases the effectiveness of any active labour market programme (OECD, 2018).

2.2. Do mass lay-off events affect regional economies?

The evidence on repercussions of mass lay-offs on regional economies focuses mostly on the employment effects, while other regional economic indicators, such as output or productivity are studied less frequently. Studies on the regional employment effects of mass lay-offs aim to understand whether a local labour market is able to absorb a large employment shock through the renewed employment of affected workers. At the same time, a mass lay-off may also have negative consequences for other firms in the same region, for instance if firms have direct business links with the affected firm or the employment shock leads to a reduction in consumption demand. Such economic spill-overs from a large employment shock suggest that a regional economy can be affected beyond employment and measures of regional output and productivity can be analysed too.

Regional employment effects on the firm of the mass lay-off are estimated in several studies. Celli et al. (2022) find that a sector in an Italian local labour market that is affected by a mass lay-off of at least 100 people barely recovers in the following eight years. Gathmann et al. (2020) find that each job lost in a mass lay-off in a German plant may lead to further job losses in other firms, Jofre-Monseny et al. (2017) find for plant closures in Spanish regions that the effect of job losses is mitigated by employment creation in plants of other firms that are active in the same sector that are also located in the same region. Using geo-referenced data on plants in Germany, Vom Berge and Schmillen (2022) find no effects on workers in different but nearby firms in the same industry.

A few studies look at local or regional economic outcomes beyond employment. Foote

et al. (2019) finds that a shock that represents 1% of a US county's labour force leads to a long-term decrease in the labour force of 0.19%, largely due to emigration out of the county. Gathmann et al. (2020) estimated that a mass lay-off in Germany of at least 500 workers on average decreases productivity of the sector by 0.22% in the region where the event occurs. Part of the reason for differences in effects of mass lay-offs on regional economics across the various studies could be due to differences in the selection of events. Relative to small events, larger events, e.g., those above 1000 affected workers or representing more than 1% of the local labour force, are more likely to affect the regional economy directly. However, since such events are also relatively sparse, various studies include more frequent but much smaller events, for which spill-over impacts are likely to be much smaller.

Silva et al. (2019) find that mass lay-offs are not typically driven by technological megatrends, such as automation, but tend to be concentrated in areas that rely on manufacturing employment or that have low employment growth. They use the same data source as this paper, for the period 2002 to 2016 to better understand what drives lay-off events in the first place. Mass lay-offs tend to be more common in some sectors than others, which could be related to business dynamism of specific sectors and to the production structure that favours larger firms over smaller firms, thus increasing the probability of observing mass lay-off events in such sectors.

Using US Bureau of Labour Statistics, Yildiran (2021) documents various time, regional (county level), sectoral and firm level differences of mass lay-off events. The statistics make clear that the events cannot be assumed to be randomly allocated across all regions, but various observed and potentially unobserved factors make the occurrence of an event in specific regions and/or sectors more likely. Therefore, it can be argued that the timing of mass-lay-off events are random to individual regions only once time-constant regional factors and national or international sectoral time dynamics are taken into account.

This paper adds to the literature by combining regional regions from multiple European countries, where previous papers are largely country specific. Using yearly data on mass lay-off across these regions, this paper presents estimates of the effect of mass lay-offs on regional employment and gross value added. The estimates on employment serve to explain the average immediate and medium-to-long term effects of mass lay-offs (Foote et al., 2019). Regional real gross value added per worker, as a measure of regional productivity, provides an indicator for wider economic prosperity (Gathmann et al., 2020).

Finally, this paper contributes to the literature of regional economic resilience. Mass lay-offs represent a local labour market shock, which in many cases is exogenous to the

region because it relates to global factors that affect a particular company. The resilience of a local economy can be shown in the way that the local labour market recovers from an employment shock (Martin and Sunley, 2015; Faggian and Ascani, 2021), for instance, when affected workers can rapidly find new jobs in the same region. In this paper, regions are differentiated through broad characteristics, such as their rural-urban typology. In individual cases, potentially different factors can be relevant in affecting regional resilience, such as industrial diversity, average levels of education and skills, and regional and international linkages. The detailed study of these and other factors lies beyond the scope of this paper.³

3. Empirical Analysis

3.1. Estimating the dynamic effects of shocks that occur across regions and time

The paper uses a panel dataset of regions, where some regions experience a mass lay-off at various points in time and other regions function as the counterfactual. As indicated in Table 1, many papers adopt a linear regression estimation method in a panel dataset summarised as two-way fixed effects (TWFE). The panel dataset consists of units, e.g., workers or regions, that experience a lay-off event. The units are observed prior to the event and followed for a period after. In a standard TWFE specification, indicator variables are specified to track the difference between treated and non-treated units prior to the event (treatment) and following treatment. The information prior to the occurrence of the event serves to assess whether the observations from treated and non-treated units are following similar trends prior to treatment. If this is the case, the estimates provide a valid estimate on the effect of mass lay-offs on regional outcomes.

The standard TWFE estimator can be severely biased if the events are not experienced in the same period (Chaisemartin and D’Haultfoeuille, 2020; Goodman-Bacon, 2021). Under some conditions the TWFE estimator is unable to distinguish within the group of control observations between those that are never treated and those that were treated at an earlier period relative to others. Moreover, if treatment effects are different between units, for instance because some events involve more workers, the issue of estimating the average effect of the shock is biased in the opposite direction of the true effect. In the case of major lay-offs observed in regions, the lay-off dates vary by region, with some regions experiencing such events early in the sample and others later. As the TWFE averages the estimate over all

³The conceptual and empirical literature on regional economic resilience is wide. Further related literature include Simmie and Martin (2010), Hassink (2010), Martin (2012), Boschma (2015), Hynes et al. (2020), Eraydin (2016) and Rizzi et al. (2018).

treated cases, some of such cases would be the estimate of a late “light” treatment against an early “strong” treatment, producing a misspecified estimate of the treatment.

This issue of differential timing of events is something that occurs frequently in cases of lay-offs, especially if lay-off events among multiple firms are pooled into one dataset. For the most appropriate estimate of the effect of a lay-off event on individuals or regions, the outcome variable must be compared to the experience of non-treated observations that are sufficiently similar to the treated observations over the same time-period, or to regions that have not yet experienced a shock.

Recently, various studies highlight the econometric issue of TWFE with differential timing of events and proposed solutions to the identified problems (Callaway and Sant’Anna, 2020; Sant’Anna and Zhao, 2020; Chaisemartin and D’Haultfœuille, 2020; Wooldridge, 2021). This paper follows Wooldridge (2021), who suggests an estimator within the standard linear regression framework. Based on that framework, we estimate

$$y_{i,t} = \sum_{s=5}^{-T} \{\beta_1^s \cdot I(d(w)_{i,t+s})\} + \beta_2^{\text{cause}} \cdot I(d(w)_{i,t}^{\text{cause}}) + \beta_3^{\text{sector}} \cdot I(d(w)_{i,t}^{\text{sector}}) + TL3_i + \mu_t \cdot TL2_i + \varepsilon_{i,t} \quad (1)$$

The indicator variable $(d(w)_{i,t+s})$ tracks the timing of mass lay-offs and is essentially a set of dummy variables that take the value one for the respective lags and leads of the event occurring in year w . The indicator variable $I(d(w)_{i,t}^{\text{cause}})$ takes the value of one from year w and all subsequent years of mass lay-off that corresponds to the cause, and similar for $I(d(w)_{i,t}^{\text{sector}})$ corresponding to the sector. The estimates of β^s give the effect of the mass lay-off of a region relative to the counterfactual. The lead times ($s=1$ to 5), allow to test whether the region experienced differentiating trend prior to the mass lay-off event. The following periods ($s = 0$ to $-T$), provide the dynamic effects of mass lay-offs over T years, where T is determined by sample (e.g., $T = 11$ if the first mass lay-off is in 2007 and the last period is 2018).

The coefficient β_2^{cause} allows for differential level effects of the mass lay-off across lay-off causes, which are de-location, restructuring and failure, where the first is the excluded category. The coefficient β_3^{sector} allows for differential level effects of the mass lay-off across sectors, which are manufacturing, business services, other services, where the first is the excluded category. Hence β_1 provides the dynamic treatment effect of mass lay-offs caused by a de-location of manufacturing plants, while β_2 and β_3 test whether the effect of mass

Table 2: Variable definitions

Variable name	Description
GVA.IND	Gross Value Added of industries (sectors B to N)
EMP.IND	Employment in all industries (B to N)
LF	Labour force of all workers aged 15-64/MAX
UNEM.RA	Unemployment rate (%) of all workers aged 15-64/MAX

lay-offs is substantially different across cases. The underlying assumption is that the dynamic pattern is similar across mass lay-off cases, but that the overall impact can differ across sectors and causes, essentially shifting the impact curve up or down.

Finally, region fixed effects are included ($TL3_i$), where TL3 is the OECD notation for small regions, the cross-sectional unit, i , of the dataset. Time-fixed effects are interacted with $TL2_i$, which is the next geographical level to which region i belongs. Hence, the effect of mass lay-offs in regions are relative to the regions belonging to the same larger regions. Standard errors are clustered by region i since treatment occurs at the level of the region. Newey-White robust standard errors are presented additionally for comparison.

Equation (1) can also be simplified by removing the dynamic effect, essentially assuming a constant impact over time. This is appropriate if the impact is approximately constant with time, which can be investigated based on the estimation of (1). Further interactions can be introduced as well to estimate heterogeneous effects, for instance by allowing different effects across regional types (urban, intermediate, rural). Results of such estimations will be presented below.

3.2. Data

3.2.1. Regions

Regional productivity and employment data are taken from the OECD regional economy database. Specifically, productivity is measured as gross value added per worker with the total business economy. Employment data comes from the same database, counting employment also for the total business economy. Additionally, the paper also presents results on the labour force and the unemployment rate, which are taken from the OECD regional employment database. Table 2 provides detailed descriptions of the outcome variables.

3.2.2. Mass lay-offs

In this paper a mass lay-off is defined as shocks at various thresholds in absolute numbers and as a percentage of the local labour market, approximated by small regions. The mass lay-off events can be identified using the European Restructuring Monitor of Eurofound,

which gathers announcements on ‘large’ employment loss announcements and gains among European Union member states (including the UK up to 2019).⁴ The observations relate to announcements of restructuring at establishments, e.g. plants of manufacturing firms or offices for services oriented firms. For an announcement to be included in the database, it should concern at least 100 jobs or 10% of the work force of more than 250 people. Some of these announcements may be relatively small in terms of absolute numbers and as a percentage of the local labour force. We obtained data up to May 2021, where the dataset has 18,817 separate events, but due to the availability of other data, the chosen thresholds and other limitations, the number of cases that are used in the estimations is much smaller.

While these are lay-off *announcements*, this paper takes them as a measure of actual employment shocks. First, the ERM dataset is aimed to follow real restructuring across European based firms, instead of a database of potential lay-off shocks that may not materialise. Second, even if there is some delay or difference between the announcement and actual lay-offs, this can be understood as measurement error in the treatment indicator. Since the analysis is based on yearly data, issues around timing differences between announcement and mass lay-off are likely to be minor. The effect of the size is mitigated because the analysis uses thresholds. Only if the announcement size is in a different threshold from the real (but unobserved) lay-off size is an error in the measurement of the treatment recorded. In general, the data of the ERM is taken as a reliable indicator of real mass lay-offs, in line with the work of Silva et al. (2019). Vermeulen and Braakmann (2023) presented a detailed picture on the total number of cases in the database, across size, countries and regions.

3.2.3. Descriptive statistics

The regional economic data and the mass lay-off data are combined in one dataset. A region may experience multiple mass lay-offs in one year. The size of the event are then combined, but the characteristics of the events (e.g. from different sectors, or different causes) are separately tracked. Only regions that experience one year with one or more mass-lays through the entire period of observation are included. Except, when two mass lay-offs occur in two subsequent year. Then, the events are also combined with the timing equalised to the first year. Hence, the dataset excludes regions with multiple events that are more than one year apart.

The economic data starts in 2004. To allow for a minimal number of pre-periods without any event, regions with events prior to 2007 are also excluded. Results with different first

⁴see <https://www.eurofound.europa.eu/observatories/emcc/european-restructuring-monitor>. On request, Eurofound provided data with the regional information.

Table 3: Descriptive statistics, first and last year of observation for each variable

Variable	First year	Last year	Unique regions	Observations	Mean	St. Dev	Minimum	Maximum
GVA.IND	2004	2018	352	5270	73 918	12 008	49 604	163 741
EMP.IND	2004	2018	352	5270	112 432	122 992	16 000	2 018 800
LF	2004	2019	351	5328	113 621	114 021	16 100	1 780 760
UNEM.RA	2004	2019	351	5325	7.1	4.9	0.9	34.5
treated	2004	2019	352	5600	0.11	0.31	0.00	1.00

Table 4: Number of cases by threshold

Treatment	N. co	N. reg	Manuf	BusSer	Services	Other	Delocate	Restruct	Failure
250	7	86	66	5	18	1	12	49	35
500	5	29	23	4	6	0	3	10	19
0.50	3	29	24	3	3	0	3	14	13
1.00	1	13	11	0	2	0	2	6	6

Note: The sums represent the number of cases for mass lay-offs from 2007 onwards. The total number of treated regions and the sum across causes and sectors may differ, because regions may be treated by multiple events in the same year.

years of mass lay-offs will be presented below. For instance, including only regions with events from 2010 onwards allows to investigate whether estimated effects are sensitive to the selected period, specifically with regards to the financial crisis of 2008-09.

The paper will use four different thresholds to include mass lay-offs, notably at 250 workers, 500 workers, 0.5% of the regional labour force and 1.0% of the regional labour force. These thresholds are chosen to balance between the size of the mass lay-off and the number of included cases.

Table 3 presents the descriptive statistics for the sample where the mass lay-offs affects at least 250 workers occurring from 2007 onwards. Table 4 presents the number of mass lay-offs by threshold, and across sector and cause and Table 5 lists the countries of the included regions by threshold and year. The total number of treated regions and the sum across causes and sectors may differ, because regions may be treated by multiple events in the same year, as described above. Using mass lay-offs from 2007 onwards, the dataset includes 86 regions with a mass lay-off of at least 250 workers across 7 countries, 29 with at least 500 workers across 5 countries, 29 regions with a shock of at least 0.5% of the labour force across 3 countries and 13 regions with at least 1% of the labour force in 1 country.

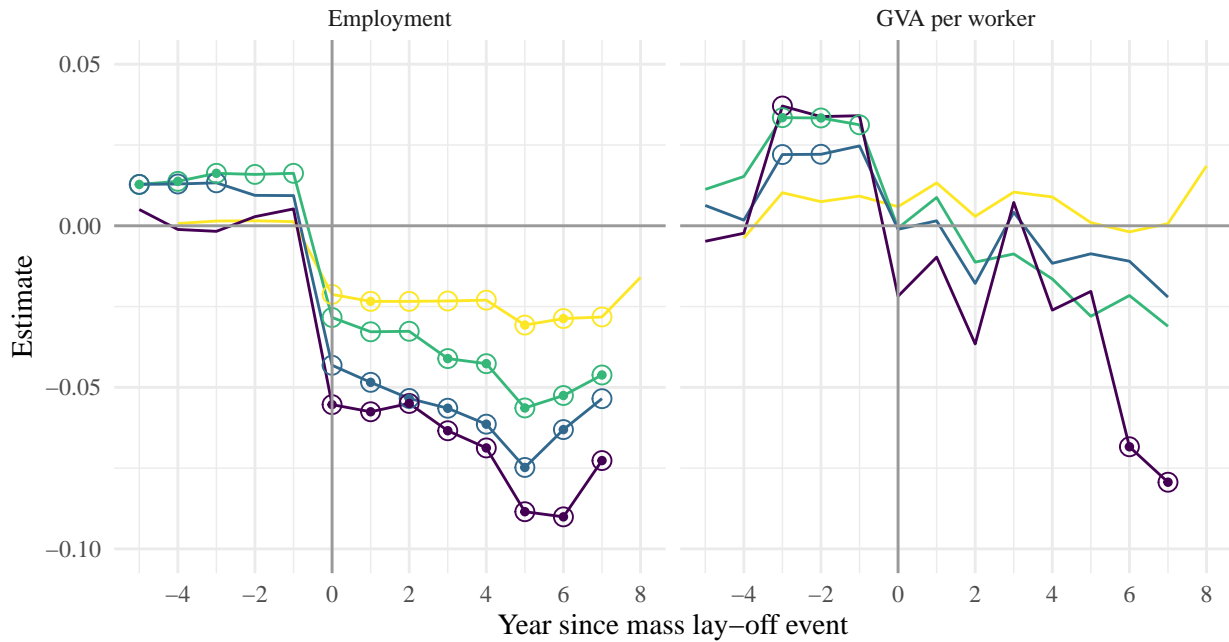
3.3. Do mass lay-offs affect regional economies?

Figure 1 presents the results of (1) using mass lay-offs that occur from 2010 onwards. The lines represent β_1 , which provides provides the effect of lay-offs due to a de-location of

Table 5: Included countries by year and threshold

year	250	500	0.50	1.00
2007	BE,DE,ES,FI,IT,NL,UK	DE,ES,IT,NL,UK	DE,ES,UK	DE
2010	BE,DE,ES,FI,IT,NL,UK	DE,ES,IT,UK	DE,ES	DE
2015	DE,FI,IT,UK	DE,IT,UK	DE	DE

Figure 1: Dynamic effects of mass lay-offs
 Treatment threshold —○— 250 —●— 500 —○— 0.50 —●— 1.00



Note: Estimates following (1) with mass lay-offs from 2010 onwards. The lines represent β_1 , which provides the effect of lay-offs due to a de-location of production in manufacturing. Each threshold is separately estimated. An open dot indicates statistical significance at 95% based on robust standard errors, a filled dot based on clustered standard errors.

production in manufacturing. The dynamic effects are estimated for each threshold separately. An open dot indicates statistical significance at 95% based on robust standard errors, a filled dot based on clustered standard errors.

On average, mass lay-offs have immediate negative effects on employment that are not reversed after at least seven years. The initial effects lies around -2.5% to -5% of employment, with the thresholds defined as a percentage of the labour having larger effects than the threshold based on the absolute number of affected workers. For all threshold except for 250 workers, the employment effect worsens substantially with time, growing from -5.5% to -9% of employment for the mass lay-offs of at least 1% of the regional labour force. The estimates are mostly statistically significant based on the clustered standard errors, although the initial period of the mass lay-off and the shocks with the smallest threshold do not always meet that level of statistical significance. The coefficients for the years prior to the mass lay-off generally confirm that there is no pre-trend. In fact, the regions where a mass lay-off occurs tend to do slight better relative to other regions. Appendix A.1 presents tests on the pre-trends following Rambachan and Roth (2023), indicating that for the results for mass lay-offs of 500 workers and 0.5% of the labour force are not sensitive to reasonable deviation of the common trend assumption.

The effects on productivity suggest a similar pattern, but the effects are smaller and largely not statistically significant. For the threshold of 250 workers the estimates show no effect. For the other threshold a negative trend starting from the year of the mass lay-off is noticeable. Only for the the largest lay-offs, representing at least 1% of the local labour force a long-term negative productivity effect is observed, suggesting a drop in regional productivity of around 8%. This result may be due to a mixture of mass lay-off of different causes and sectors. This will be investigated further below.

Table 6 presents the average effects of mass lay-offs under the assumption that the effect is immediate and permanent. The estimation equation is

$$y_{i,t} = \beta_1 \cdot I(d(w)_{i,t}) + \beta_2^{\text{cause}} \cdot I(d(w)_{i,t}^{\text{cause}}) + \beta_3^{\text{sector}} \cdot I(d(w)_{i,t}^{\text{sector}}) + TL3_i + \mu_t \cdot TL2_i + \varepsilon_{i,t}. \quad (2)$$

As Figure 1 indicates, the employment effects may be worsening over time, so assuming constant effects represents the average across lags, somewhere between the initial and the longer-term effect. The first row presents the treatment effect for the base case which are mass lay-offs in manufacturing due to de-location. The subsequent rows present the additional effects for the sectors business services and other services, and for the mass lay-offs due to

Table 6: Average long-term effects of mass lay-offs

	<i>Dependent variable:</i>							
	GVA pw	Empl.	GVA pw	Empl.	GVA pw	Empl.	GVA pw	Empl.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
treated	0.004 (0.012)	-0.023** (0.011)	-0.020 (0.023)	-0.044** (0.021)	-0.014 (0.017)	-0.057** (0.024)	-0.035 (0.029)	-0.062** (0.028)
i.BusSer	-0.029 (0.036)	0.025** (0.012)	-0.080** (0.038)	0.024 (0.017)	-0.078*** (0.025)	0.037*** (0.013)		
i.Services	0.027 (0.025)	0.010 (0.011)	0.066 (0.049)	0.024 (0.022)	0.071 (0.058)	0.039** (0.020)	0.151*** (0.047)	0.067*** (0.013)
i.Restruct	-0.009 (0.014)	0.013 (0.012)	0.047** (0.024)	0.032* (0.018)	0.026 (0.019)	0.027 (0.022)	0.039 (0.029)	0.032 (0.026)
i.Failure	0.005 (0.015)	0.023* (0.012)	0.012 (0.026)	0.034* (0.019)	0.031* (0.017)	0.045** (0.022)	0.025 (0.029)	0.040 (0.025)
Treatment	250	250	500	500	0.5	0.5	1.0	1.0
White SE	(0.007)	(0.006)***	(0.015)*	(0.012)***	(0.014)	(0.013)***	(0.018)**	(0.015)***
Observations	4 565	4 565	2 866	2 866	2 806	2 806	1 950	1 950

Note:

*p<0.1; **p<0.05; ***p<0.01

restructuring and business failures.

Mass lay-offs decrease employment by 2% to 6% on average for the base case. In comparison, Gathmann et al. (2020) presents estimates of around 1.8% of the local labour force following mass lay-offs in Germany. Productivity effects are never statistically significant and the point estimates are always smaller than the effects on employment. However, if using Newey-White (heteroskedastic robust) standard errors, the effects are statistically significant across both outcome variables and threshold sizes, except for productivity at a threshold of 250 workers and 0.5% of the labour force. The additional effects of sectors indicates that mass lay-offs in business services have much smaller effects, but productivity effects are more negative. Mass lay-offs in other services are statistically indistinguishable from the base case, except for employment with mass lay-off of at least 0.5% of the labour force and productivity following a mass lay-off of at least 1% of the labour force. In the latter case the effects are strongly positive for productivity ($-0.035 + 0.151 = 0.116$). The coefficients for mass lay-offs for restructuring and failures are generally positive, and statistically significant for productivity effects of 500 workers, of for failures affecting 0.5% of the labour force. These results provide some backing that mass lay-offs may have a positive effects on productivity

when badly performing firm close or restructure while firms that relocate can still be highly productive. Appendix A.2 provides results with alternative model specifications relative to (2).

Table 7 presents the treatment effect of the base case with samples that allow for mass lay-offs starting from different year. The coefficient for the year 2010 repeats those presented in Table 6. The estimates are quite stable across the different starting years. A negative effect for productivity is sometimes statistically significant for the starting years of 2007 and 2008, but for no other year. In contrast, the effects on employment are generally statistically significant at the 1% or 5% levels up until the year 2012, where after the estimates tend to decrease in magnitude. This effect for the latest years reflects the reduction in the number of cases and the shorter time-span over which the effect can be estimated. The employment effects tend to be largest for mass lay-offs starting from around 2010.

Table 7: Treatment effects for mass lay-offs due to a de-location in manufacturing

250		500		0.50		1.00	
GVA pw	Empl.	GVA pw	Empl.	GVA pw	Empl.	GVA pw	Empl.
2007							
-0.004	-0.021**	-0.029*	-0.028**	-0.024*	-0.035**	-0.046**	-0.040**
(0.012)	(0.010)	(0.018)	(0.015)	(0.016)	(0.017)	(0.021)	(0.019)
2008							
0.004	-0.024**	-0.024	-0.046**	-0.016	-0.056***	-0.040*	-0.059**
(0.012)	(0.012)	(0.023)	(0.020)	(0.017)	(0.023)	(0.031)	(0.026)
2009							
0.002	-0.024**	-0.020	-0.046**	-0.013	-0.057***	-0.035	-0.062**
(0.012)	(0.011)	(0.023)	(0.021)	(0.016)	(0.023)	(0.029)	(0.028)
2010							
0.004	-0.023**	-0.020	-0.044**	-0.014	-0.057***	-0.035	-0.062**
(0.012)	(0.011)	(0.023)	(0.021)	(0.017)	(0.024)	(0.029)	(0.028)
2011							
0.002	-0.031***	-0.020	-0.044**	-0.014	-0.057***	-0.035	-0.062**
(0.014)	(0.010)	(0.023)	(0.021)	(0.017)	(0.024)	(0.029)	(0.028)
2012							
0.004	-0.027***	-0.010	-0.035**	-0.011	-0.055**	-0.030	-0.055**
(0.014)	(0.010)	(0.024)	(0.018)	(0.017)	(0.024)	(0.030)	(0.025)
2013							
-0.007	-0.024***	0.024	-0.021*	-0.003	-0.056**	-0.009	-0.052**

(0.012)	(0.009)	(0.030)	(0.015)	(0.015)	(0.026)	(0.032)	(0.026)
2014							
-0.006	-0.019**	0.019	-0.014	-0.004	-0.035**	-0.032	-0.044**
(0.015)	(0.010)	(0.029)	(0.015)	(0.018)	(0.018)	(0.034)	(0.024)
2015							
0.011	-0.017**	0.007	-0.020	0.009	-0.022	0.007	-0.020
(0.013)	(0.010)	(0.024)	(0.020)	(0.020)	(0.021)	(0.024)	(0.020)

Note:

Estimates of the base case (de-location in manufacturing), while controlling for mass lay-offs in other sectors and due to other reasons, per (2). Clustered standard errors, *p<0.1; **p<0.05; ***p<0.01

3.4. Heterogeneity across regions, mass lay-off causes and sectors

Regions may have varying ability to cope with mass lay-offs. For instance, the economies of rural and urban regions may respond differently from shocks of mass lay-offs, and these effects may interact with the sector and the cause of the mass lay-off. To investigate the following equation is estimated,

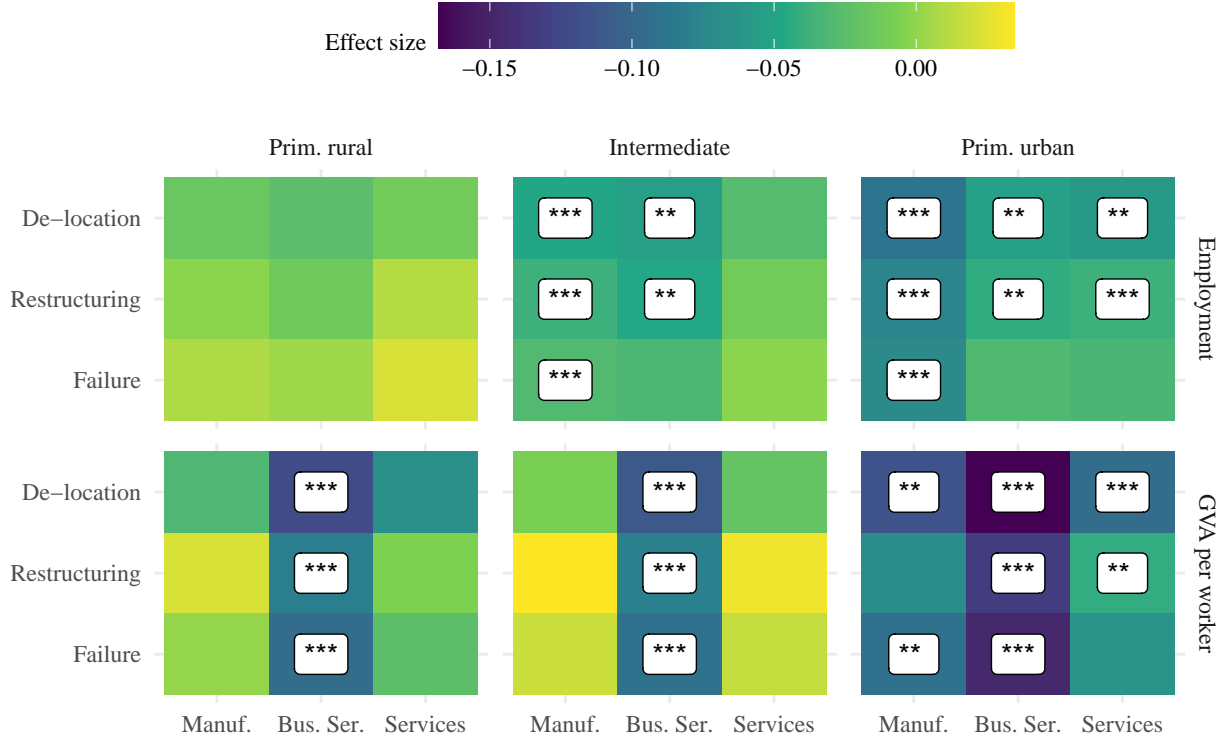
$$y_{i,t} = \beta_1 \cdot I(d(w)_{i,t}) \times I(\text{region type}_i) + \beta_2^{\text{cause}} \cdot I(d(w)_{i,t}^{\text{cause}}) + \beta_3^{\text{sector}} \cdot I(d(w)_{i,t}^{\text{sector}}) + TL3_i + \mu_t \cdot TL2_i + \varepsilon_{i,t}. \quad (3)$$

The interaction between $I(d(w)_{i,t})$ and $I(\text{region type}_i)$ provides differentiated coefficients across regional types, for the base case, while $I(d(w)_{i,t}^{\text{type}})$ and $I(d(w)_{i,t}^{\text{sector}})$ control for the level difference relative to the base case. In order to estimate the effect for the three sectors and three causes, the regressions are run excluding one of the sectors and one of the causes iteratively, such that each combination of sector and cause is captured as the base case.

The results for the threshold size of 0.5% of the labour force are presented in Figure 2. The heat map presents the size of the coefficient for each model (employment and GVA pw), for each combination of cause and sector. The stars indicate statistical significance based on clustered standard errors. Employment effects are stronger in intermediate and urban regions relative to rural regions, where the point estimates tend to closer to zero and there are no statistically significant effects. Within intermediate and urban regions, effects are strongest for manufacturing and weakest for services. De-location and restructuring have relatively stronger effects than mass lay-offs due to business failures.

Negative regional productivity effects are concentrated among business services across all three types of regions. Manufacturing and services only have statistically significant negative effects in urban regions. De-location have stronger productivity effects relative to

Figure 2: Mass lay-off effects differentiated by regional typology



Note: Results following (3) using the mass lay-off threshold of 0.50% of the labour force. The colour bar indicates the size of the point estimate. P-values based on clustered standard errors, *p<0.1; **p<0.05; ***p<0.01

mass lay-off due to business failures or restructuring. This result provides further backing to the hypothesis that mass lay-off due to relocation or off-shoring is more likely to be done by firms that have high levels of productivity.

Figure A-2 in the appendix presents the results taking a threshold of 250 worker instead of 0.5% of the labour force, providing qualitatively similar results, but as the shocks tend to be smaller, statistical significance levels also drop, consistent with the results presented earlier.

3.5. What do mass lay-offs mean for the size of the labour force?

Previous research suggested that regional mobility of workers can be one adjustment factor of lay offs (Foote et al., 2019). Workers may move if other places provide better opportunities for new stable employment. The labour force may also be affected by unemployed workers that stop looking for a job. The results on employment thusfar indicate that there can be long-term negative effects of mass lay-offs. Expanding the outcome to the overall labour

force and the unemployment rate, both of which includes job seekers, provides a way to establish whether these channels are relevant across regions. Table 8 present the results.

While the effect of mass lay-offs on the labour force for the case of de-location in manufacturing tends to be negative, the point estimates are notably smaller than the effects on employment and none of the coefficients are statistically significant. In fact, the additional effects for business services and other services present positive effect on the labour force, suggesting that mass lay-offs attract new workers. The effect on the unemployment rate is positive, but only for the shock of 1% of the labour force the effect is statistically significant, suggesting an increase in the unemployment rate by 0.745 percentage points. However, mass lay-offs in the service sector and those due to a restructuring have strong negative effects on the unemployment rate, reducing these by around one percentage point.

Hence, these estimates suggest that the adjustment in the labour force is relatively minimal for mass lay-offs in manufacturing, independent of the the cause, and may therefore increases the unemployment rate in regions, especially for larger events that are due to a relocation of production.

Table 8: The effect of mass lay-offs on the regional labour force and unemployment rate

	<i>Dependent variable:</i>							
	Log of the labour force				Unemployment rate			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
treated	-0.013 (0.011)	-0.002 (0.016)	-0.010 (0.017)	-0.012 (0.018)	0.124 (0.249)	0.548 (0.350)	0.454 (0.341)	0.745*** (0.265)
i.BusSer	0.016* (0.008)	0.018* (0.010)	0.018* (0.009)		-0.047 (0.563)	0.114 (0.764)	0.415 (0.870)	
i.Services	0.033** (0.016)	0.044 (0.030)	0.047*** (0.013)	0.043*** (0.012)	-0.425 (0.388)	-0.188 (0.534)	-0.806*** (0.281)	-1.084** (0.424)
i.Restrict	0.018 (0.014)	-0.001 (0.018)	0.006 (0.016)	0.015 (0.017)	-0.028 (0.294)	-0.653* (0.344)	-1.029*** (0.332)	-1.193*** (0.279)
i.Failure	0.022 (0.015)	-0.0004 (0.016)	0.008 (0.014)	-0.0002 (0.016)	-0.109 (0.309)	-0.589* (0.325)	-0.487 (0.348)	-0.444 (0.277)
Treatment	250	500	0.5	1.0	250	500	0.5	1.0
White SE	(0.007)**	(0.009)	(0.008)	(0.009)*	(0.154)	(0.269)**	(0.234)**	(0.225)***
Observations	4 710	3 051	2 993	2 080	4 707	3 051	2 993	2 080

Note:

*p<0.1; **p<0.05; ***p<0.01

4. Conclusion

Mass lay-offs occur frequently across regional economies. This paper confirms that large events can have detrimental effects on employment specifically across European countries, confirming results of country cases presented in the existing literature. The advantage of pooling data from across countries and years is that it allows to understand how the experiences of mass lay-offs are shared across places.

The results in this paper indicate that mass lay-offs can have long-term (>5 years) negative effects on employment, ranging from -2% to around -6% for the largest events. The size of the employment effect increases with the size of the mass lay-off. However, not all mass lay-offs are the same. Events occurring in the business services and other services sector tend to be much less detrimental than those in manufacturing. This difference suggest differentiation in the ability of affected workers to find new employment.

This paper also presented results on regional productivity to understand whether mass lay-offs have economic effects beyond employment. The downsizing or closure of a business or branch can have both positive or negative effects on a regions' productivity. The productivity of a region may improve if the mass lay-off occurs in a below average productivity firm and workers find new employment in better performing firms. Productivity may also drop if a well-performing firm decides to locate some of its production elsewhere.

Indeed, average productivity effects tend to be statistically insignificant overall. However, mass lay-offs in business services tend to have large negative productivity effects, which can be explained by business services tending to have generally higher levels of value added per worker (e.g. due to the inclusion of finance and other professional services). Mass lay-offs that are due to de-location of production tend to stronger negative productivity effects than those due to restructuring and business failure.

These results hold relevant insights for national and regional economic policies. Economic policies can address mass lay-off events from two fundamental angles. There are policies that target the firm (in an effort to prevent the mass lay-off), and those that target the affected workers (to facilitate their rapid transition to new jobs). Both present different costs and benefits and, indeed, evidence on effectiveness. National legislation concerning the employee protection from collective dismissals also varies between countries (OECD, 2020)

Policies that target the firm, for instance through some form of emergency credit extension, immediately address the event and prevent a large group of workers being affected, whilst also protecting local suppliers and the wider economy. There are however also risks, notably that such interventions run the risk of merely delaying an eventual business failure, if the

structural issues in the firm that gave rise to initial restructuring are not addressed, which the support itself may often discourage. The support itself may also distort competition and create unfair advantages with competitors, including internationally (which may lead to retaliatory measures). Indirectly, the additional costs are the loss of allocative efficiency, which arises if workers are kept in a potentially suboptimal place of work while better alternatives are available.

Policies that target workers include income support during unemployment, the provision of re-training and help with job searches. Naturally, the success of policies targeting workers with the objective to limit the length of their spell in unemployment depends on the efficiency of the government administration, including at the subnational level where active labour policies are often directly implemented. The success of job transition also depends on the local economic circumstances such as the availability of a sufficient number of relevant vacancies in the same region.

The results in this paper provide a warning that the effects of mass lay-offs on employment and regional productivity should not be underestimated. The recovery from such shocks cannot be assumed, but case-by-case strategies taking into account the regional economic circumstances, the reason for the lay-off and the type of workers may alleviate the repercussions.

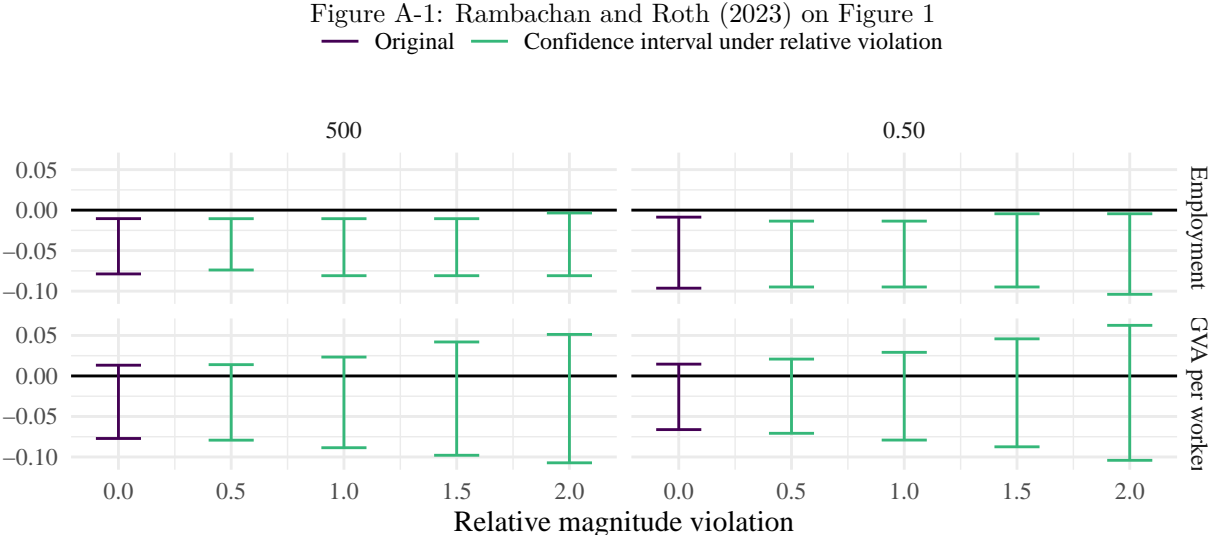
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A. Appendix

A.1. Pre-trend robustness

Rambachan and Roth (2023) propose a methodology to assess the sensitivity of the results from violations in the common trend assumption. The methodology estimates alternative estimates and confidence intervals assuming different underlying trends. The larger the deviation in the trend the more likely is that the results in Figure 1 are not statistically significant. Figure A-1 presents the results. For mass lay-offs of at least 0.5% of the labour force or at least 500 workers, the employment effects for first first period after the shock remain statistically significant even with violations of the common trend assumption that are twice as large as the maximum deviation among the pre-period estimates. For the gross value added results, which are not statistically significant in the baseline results, the tests do not offer further insights.



Note: Results based on the estimates of Figure 1. The estimates were first normalised to the point estimated of period $t - 1$.

A.2. Alternative specifications

This subsection presents alternative specifications relative to (2). Table A-1 presents the results for treatment size of 500 workers and 0.50% of the labour force. The first set of results replicates the baseline results as presented in Table 6. The next set removes the control for sector and mass lay-off cause. This causes the effects on employment to reduce in size and corresponding statistical significance, while the effect on GVA per worker turn positive, with even a marginal statistical significance for one of the mass lay-off thresholds.

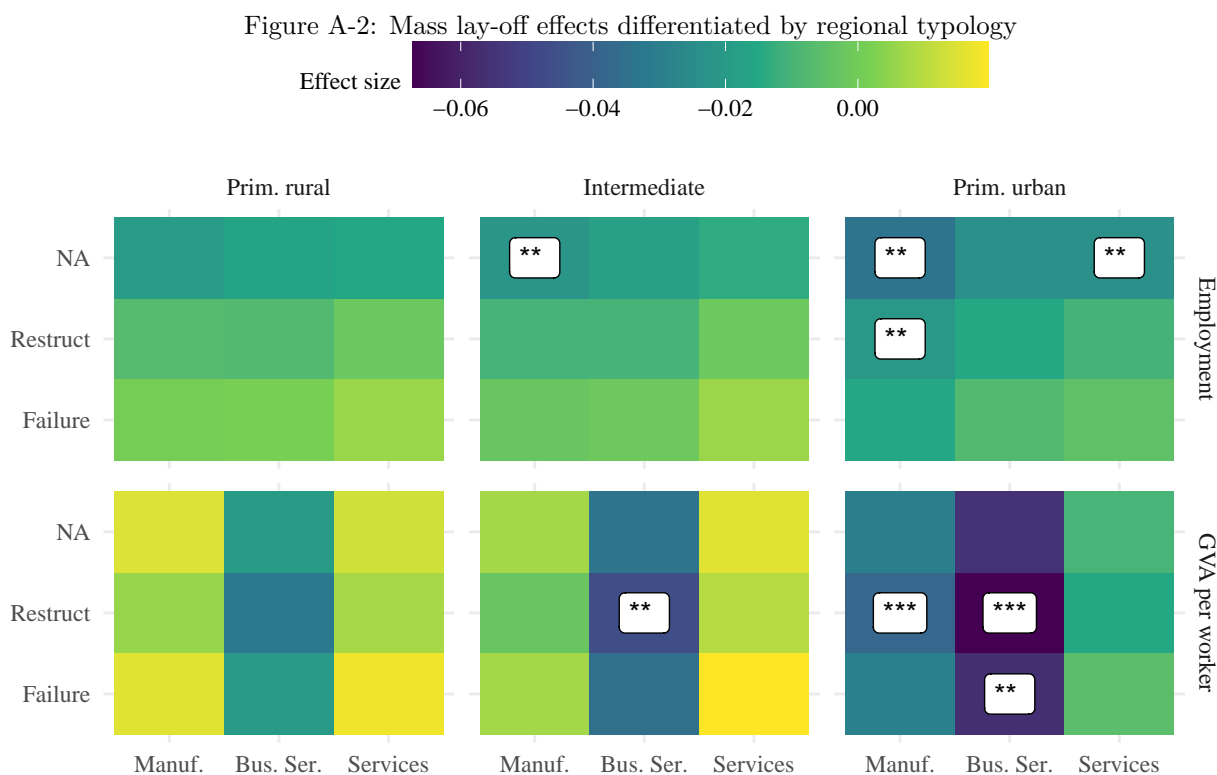
The next set of results control for the sector and mass lay-off cause but vary the specification of fixed effects from the base line. As specified in (2), the base line includes region (TL3) fixed effects and with time-by-large region (TL2) effects. Taking the baseline as controlling for the greatest amount of unobserved heterogeneity, the following three specifications control for progressively less unobserved heterogeneity. The first replaced the baseline fixed effects with region specific linear time-trends and country-by-time fixed effects, the second with region and time fixed effects, and the third with only country and time fixed effects. The results indicate the choice of the fixed effects specification matters for the results and the treatment coefficients vary substantially between the specifications.

Table A-1: Alternative control and fixed effects specifications

Thresh.	Empl					GVA pw				
	Treated	BusSer	Ser	Restruct.	Failure	Treated	BusSer	Ser	Restruct.	Failure
base model										
500	-0.044** (0.021)	0.024* (0.017)	0.024 (0.022)	0.032** (0.018)	0.034** (0.019)	-0.020 (0.023)	-0.080** (0.038)	0.066* (0.049)	0.047** (0.024)	0.012 (0.026)
0.50	-0.057*** (0.024)	0.037*** (0.013)	0.039** (0.020)	0.027 (0.022)	0.045** (0.022)	-0.014 (0.017)	-0.078*** (0.025)	0.071 (0.058)	0.026* (0.019)	0.031** (0.017)
Without sector and cause effects										
500	-0.003 (0.009)					0.012 (0.016)				
0.50	-0.012* (0.009)					0.020* (0.015)				
Region linear trends and country fe										
500	0.015 (0.018)	0.012 (0.017)	0.011 (0.012)	-0.034** (0.018)	-0.032** (0.017)	-0.037* (0.024)	-0.060* (0.040)	-0.017 (0.014)	0.034* (0.024)	0.043** (0.024)
0.50	0.012 (0.015)	0.014 (0.015)	0.018* (0.012)	-0.035** (0.015)	-0.031** (0.015)	-0.031* (0.020)	-0.066* (0.043)	-0.005 (0.018)	0.037** (0.020)	0.039** (0.020)
Region + time fe										
500	-0.021* (0.016)	0.032** (0.019)	0.060** (0.027)	0.028** (0.015)	-0.026** (0.013)	-0.073* (0.046)	-0.085** (0.044)	0.044 (0.061)	0.108*** (0.041)	0.062* (0.044)
0.50	-0.041*** (0.015)	0.054*** (0.014)	0.083*** (0.034)	0.002 (0.011)	0.018* (0.012)	-0.032 (0.029)	-0.121*** (0.028)	0.031 (0.075)	0.054** (0.030)	0.060** (0.030)
Country + time fe										
500	0.060 (0.416)	1.018*** (0.390)	0.903*** (0.301)	-0.183 (0.331)	-0.136 (0.373)	0.142** (0.085)	0.133** (0.061)	0.176 (0.142)	0.067 (0.084)	-0.198*** (0.082)
0.50	-0.505*** (0.207)	1.536*** (0.253)	0.376 (0.316)	0.084 (0.158)	0.201 (0.175)	0.058 (0.065)	0.242*** (0.082)	0.267** (0.154)	0.020 (0.065)	-0.087* (0.061)

A.3. Heterogeneity analysis at threshold of 250 workers

Figure A-2 replicates Figure 2 using a threshold of 250 workers instead of 0.5% of the labour force. The results are qualitatively similar, but as the shocks tend to be smaller, statistical significance levels also drop.



Note: Results following (3) using the mass lay-off threshold of 250 workers. The colour bar indicates the size of the point estimate. P-values based on clustered standard errors, * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

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