Big plant closures and agglomeration economies*

Jordi Jofre-Monseny†

Maria Sánchez-Vidal‡

Elisabet Viladecans-Marsal†

Abstract

This paper analyses the effects of large manufacturing plant closures on local employment. Specifically, we estimate the net employment effects of the closure of 45 large manufacturing plants in Spain, which relocated abroad between 2001 and 2006. We run differences-in-differences specifications in which locations that experience a closure are matched to locations with similar pre-treatment employment levels and trends. The results show that when a plant closes, for each job directly lost in the plant closure, between 0.3 and 0.6 jobs are actually lost in the local economy. The adjustment is concentrated in incumbent firms in the industry that suffered the closure, providing indirect evidence of labor market pooling effects. We find no employment effects in the rest of manufacturing industries or in the services sectors. These findings suggest that traditional input-output analyses tend to overstate the net employment losses of large plant closures.

JEL classification: R12, R23, R58, J23

Keywords: local employment, plant closures, input-output, agglomeration economies

* We gratefully acknowledge helpful comments from Henry Overman, Olmo Silva, Giulia Faggio, Rosa Sanchís-Guarner, Ioulia Ossokina and participants at the SERC work in progress seminar, IEB PhD seminar, 2014 SERC Annual Conference, INFER Workshop (Reus) and UEA Meeting (Washington DC). We acknowledge financial support from Ministerio de Economía y Competitividad (ECO2013-41310) and Generalitat de Catalunya (2014SGR420)

† Universitat de Barcelona and Institut d'Economia de Barcelona. Emails: jordi.jofre@ub.edu, eviladecans@ub.edu

‡ Spatial Economic Research Centre (London School of Economics) & Institut d'Economia de Barcelona. Corresponding author. Email: M.Sanchez-Vidal@lse.ac.uk

1. Introduction

Local and regional governments around the world provide large plants with generous subsidies, often in the form of tax breaks. According to the *New York Times*, each year US local and State governments spend more than $80 billion on incentives targeted to individual firms[1]. In Europe, although government aid to firms is generally forbidden by EU legislation, national and regional governments do subsidize large plants by exploiting certain exemptions, including funds used to promote research and development, environmental protection and economic activities in lagging regions. Subsidies are frequently offered to attract new plants. For instance, Tesla Motors recently decided to locate an electric-car battery ‘gigafactory’ in Nevada (partly) because of a $1.25 billion tax deal. However, once a plant is operational, subsidies to avoid its relocation (or that of some of its activities) are also common. In fact, the $8.7 billion tax break that Boeing was recently offered to produce a new jet in Seattle is the largest incentive received by an individual firm in US history. In Spain, the Seat and Ford plants in Barcelona and Valencia have regularly held regional governments to ‘ransom’ under the threat of relocating production.

The welfare effects of subsidies targeted to individual firms are unclear (Wilson, 1999). Subsidies might cause inefficiencies if they shift plant locations to low productivity areas. However, as emphasized by Glaeser (2001) and Greenstone and Moretti (2004), subsidies can also be welfare enhancing. If the local labor supply curve slopes upward, inframarginal resident workers will gain by the presence of a large plant. In this context, subsidies can be seen as bids offered by different locations reflecting local welfare gains. A similar argument applies if large plants create significant (positive) local production externalities. Then, a subsidy will be efficient if it induces a plant to locate in an area in which the resulting local externality is especially large.

In the policy arena, the desirability of subsidies targeted to individual firms is often evaluated on a cost per job basis. An argument often made in justification of such subsidies is that large plants create employment in local supplier firms. In fact, input-output models predict (large) net employment effects of big plant openings/closures. However, the opening of a large plant might also tighten the local labor market and, thus, reduce employment in the rest of the local economy. The objective of this paper is to estimate empirically the net employment

[1] http://www.nytimes.com/interactive/2012/12/01/us/government-incentives.html

effects of large manufacturing plants. To the best of our knowledge, this is the first study to address this empirical question directly.

Specifically, we estimate the net local employment effects in Spain of the closure of 45 large manufacturing plants (median layoff of 264 jobs), which relocated abroad between 2001 and 2006. We match each municipality experiencing a closure to a small set of municipalities (four in the baseline analysis) that are very similar in terms of their 2000 employment levels. We also find that treatments and the selected controls do not differ in their pre-treatment employment trends, either. This lends empirical support to the hypothesis that the plant relocations examined here were the result of international strategies adopted by parent companies and did not respond to declining, area-specific employment trends. We run differences-in-differences specifications in which each treatment is matched to its controls by including case-specific fixed effects. The results show that when a plant closes, for each job directly lost in the plant closure, between 0.3 and 0.6 jobs are actually lost in the local economy. This is explained by local incumbent plant expansions in the industry that suffered the plant closure. We find no employment effects in the rest of manufacturing industries or in the services sectors. One implication of these findings is that they suggest traditional input-output analyses tend to overstate the net local employment losses of large plant closures. In fact, for our sample of closures, the input-output framework predicts that, for each job directly lost in the plant closure, one additional job will be lost in the local economy. Thus, in our application, the input-output prediction overestimates the negative employment consequences by an order of three. The fact that some fired workers are reemployed in local incumbent firms in the industry that suffered the closure provides indirect evidence of labor market pooling hypothesis, which states that industry concentration arises because of scale economies in the labor market[2]. Specifically, our results suggest that the presence of same industry firms allow workers to change employers when firm specific shocks occur[3].

Fox and Murray (2004) and Edmiston (2004) study the employment effects of large plant openings in the US. Both studies conclude that such openings largely fail to create indirect jobs in the local economy. Here, our study seeks to complement these earlier reports by quantifying the effects of large plant closures. Note that the effects of openings and closures

---

[2] Ellison *et al.* (2010), Jofre-Monseny *et al.* (2011) and Faggio *et al.* (2015) test the relative importance of labor market pooling vis-à-vis other agglomeration economies' mechanisms.

[3] Krugman (1991) formalizes this argument while Overman and Puga (2010) show that, in the UK, industries with more idiosyncratic volatility tend to be more geographically concentrated.

need not necessarily coincide if, for instance, a closure provides an opportunity for local incumbents to hire trained workers that have recently been laid off. Our study shows that plant closures do not, in fact, destroy indirect jobs and, moreover, that they actually generate jobs in local incumbent firms. As a consequence, the net employment effects of closures are smaller than the initial layoff itself. Greenstone *et al.* (2010) also study large plant openings in the US but focus on the impact on local productivity. In a unique empirical design, the authors use data on the subsidies offered to new plants by different local and State governments to define 'winning' counties (those attracting a plant) and 'losing' counties (those left as runners-up in the choice process). They find that the opening of a large plant increases the productivity of incumbent plants in the winning county relative to that of plants in the losing county. In line with our study, Hooker and Knetter (2001) and Poppert and Herzog (2003) estimate the local employment effects of closures but focus their attention on US military bases as opposed to manufacturing plants. They report that net employment effects are very similar to the number of jobs directly destroyed by the closure. Finally, Moretti (2010) develops a framework to estimate empirically the local impact of creating an additional job in a tradable industry on employment levels in the rest of local industries[4]. His estimates indicate that additional jobs in one part of the tradable sector have a negligible impact on jobs in other parts of the tradable sector but a large positive effect on those in the non-tradable sector, especially if these newly created positions are for skilled occupations that command higher wages. Our results can (partly) be reconciled with those reported in Moretti (2010) as net employment effects in the industry directly affected by the closure are much smaller than the closure layoffs themselves.

Following on from this introduction, the rest of the paper is organized as follows. Section 2 describes the data used throughout the paper with particular emphasis on individual plant closures. In Section 3 we explain how we select the control locations to match the areas experiencing a plant closure in terms of their respective pre-treatment employment levels. Section 4 introduces the empirical specifications used and presents the results. Finally, section 5 concludes.

[4] Using this same framework, Faggio and Overman (2014) estimate the local labor market effects of public sector employment.

2. Data

Our study examines the impact of 45 large plant closures in the manufacturing sector resulting from international relocations. In this section we first describe the characteristics and circumstances of these closures. Then, we turn our attention to the employment data sources that constitute our outcome of interest.

2.1 (International relocation) plant closures

Information on plant closures (and their corresponding job losses) is obtained by combining various data sources. Thus, we draw on information from the firms' international relocation dataset built by Myro and Fernández-Otheo (2008) and combine this with balance sheet data extracted from the *Sistema de Análisis de Balances Ibéricos* (SABI) and information obtained from newspapers and the trade unions. We restrict our attention to the 45 plant closures resulting from international relocations that occurred between 2001 and 2006 and which involved, at least, 100 job losses[5]. We exclude closures in the five largest Spanish municipalities (Madrid, Barcelona, Valencia, Seville and Zaragoza) as layoffs here are unlikely to represent a relevant shock to local employment. However, by so doing, only three closures are excluded.

For each closure, we collected the following information: firm's name, year of closure, number of workers laid off, activity (3-digit CNAE-93 classification), municipality of origin and the new country of destination[6]. Table A1, deferred to the Appendix, reports these plant-level data. Most of the closures in our dataset (49%) correspond to what the OECD classifies as medium-technology industries. The number of workers laid off ranges between 105 and 1,600, with a median of 264. In terms of their impact on the local economy, the layoffs represent, on average, 30 percent of local employment in the industry suffering the plant closure. In Spain, firms are among the smallest in OECD countries[7]. In fact, the average

[5] Greenstone *et al.* (2010) examine evidence from 47 large plant openings in the US.
[6] CNAE-93 is the Spanish equivalent to the NACE classification.
[7] Entrepreneurship at a Glance 2012 (OECD).

manufacturing plant employs 14 workers and, therefore, all the closures in our sample can be considered as being big[8].

The plant closures we analyze form part of international relocation processes. As Table A1 shows, most plants relocated to China or Eastern Europe. Using international relocation closures to estimate the effect of large layoffs on the local economy is helpful in terms of identification to the extent that these closures can be attributed directly to the parent companies' international strategy rather than the effects of declining local employment. As is shown below, we find no evidence that the areas experiencing closures present differential employment trends prior to the closure. Two other factors need to be borne in mind when interpreting the effects of these plant closures. First, the study period was characterized by economic growth. Between 2000 and 2008, the Spanish economy experienced an average annual growth rate of 3.1 percent; however, in the manufacturing sector, growth was much less vigorous with employment rising at an annual rate of 0.77 percent. Second, among the countries of the OECD, Spain's employment protection regulations represent some of the strictest. This holds also for collective dismissals[9]. In Spain, plant closures are accompanied by a bargaining process between the firm and trade unions mediated by the (regional) government. Anecdotal evidence suggests that deals generally involve severance payments above the (already very high) statutory level, early retirement packages and attempts by local and regional governments to re-locate workers within the local economy.

2.2 Employment outcomes

The outcome we examine is local employment at the industry level. We draw primarily on Social Security employment counts by industry and municipality. The data covers the universe of employees in Spanish municipalities at the 2-digit industry level. One caveat of this dataset is that it does not cover self-employed workers[10]. We follow employment outcomes in the period 2000 to 2008. Since we will study the impact of plant closures taking place between 2001 and 2006, this gives us a minimum of one pre-treatment year (2000) and two post-treatment years (2007 and 2008). Additionally, we use employment data from the 1990 Census

[8] Spanish Social Security for the year 2000.
[9] OECD Employment Outcome 2004.
[10] The data, in fact, exclude all workers in specific social security regimes which, in addition to the self-employed, include agricultural workers, and civil servants.

of Establishments, which enables us to measure (and control for) local (pre-treatment) employment trends. We end the period of analysis in 2008 for two reasons. First, in 2009 the industry classification underwent a major overhaul and, second, 2008 was the last year of economic growth in Spain with output growing at 0.9 percent[11,12].

3. Matching procedure

Most of the 8,122 municipalities in Spain are quite small, which suggests the impact of a plant closure might extend beyond a municipality's borders. Therefore, we construct a 10-km ring around each municipality in order to capture a municipality's immediate neighbors. This ring is built by calculating air distances between municipality centroids and the resulting area serves as our baseline geographical unit. We define a treated area as one suffering a plant closure between 2001 and 2006 and we select four appropriate controls using a matching procedure based on employment characteristics measured in 2000. Each treatment and its corresponding controls constitute what we label here as a case. Figure 1 illustrates the case of *La Cellophane Española*, a rubber and plastics plant in Burgos that closed in 2001. Panel (a) shows the geographical location of treatment and controls (*Llinars del Vallès*, *Logroño*, *Alcalá de Henares* and *Silla*). Panel (b) zooms in to show that the five areas are in fact the sum of the municipality itself (dark gray) and its neighbors lying within a 10-km ring (light gray).

[Figure 1 here]

The matching procedure applied operates in two steps[13]. First, for each municipality in Spain, we compute its total level of employment in 2000 by adding to its own employment

[11] From 2009, the industry classification adopted was CNAE-2009.
[12] In 2009 there was a sharp drop in output of 3.8 percent (EUROSTAT).
[13] We do not use propensity score matching because our sample only contains plants that eventually closed due to an international relocation strategy. As such, we cannot predict where these plant closures might occur. An alternative matching procedure, and one that is more similar to the one used here, is the synthetic control algorithm, which matches pre-treatment trends in the dependent variable (see Abadie and Gardeazabal, 2003). However, this method is more appropriate for cases in which the

level that of its neighbors. Then, we rank the 8,122 Spanish municipalities and create six categories (<5, 5-10, 10-20, 20-50, 50-100 and >100 thousand employees). We restrict the matching procedure to municipalities within the same total employment category. Thus in the case illustrated in Figure 1, *Burgos*, *Llinars del Vallès*, *Logroño*, *Alcalá de Henares* and *Silla* have an employment level of between 50 and 100 thousand jobs, if we consider number of jobs in the municipality itself (dark gray) together with the number of jobs in the neighboring municipalities (light gray). In the second step, the target is to make treated and control areas similar in terms of employment levels in 2000 in the specific industry affected by the closure. To do so, we compute the distance for this industry between the level of employment in each potential control and each treated area. This is done in two dimensions: first, we only consider employment at the level of the municipality and, second, we add to this figure the jobs in the neighboring municipalities. Then, we compute the following Euclidean distance $\sqrt{(I_m)^2+(I_a)^2}$, where I_m and I_a are the employment deviations in the industry affected by the plant closure at the municipality and area (municipality and neighbors) levels, respectively. Among the control municipalities whose employment level in this industry is higher than that of the treated municipality, i.e. $I_m > 0$, we select the two controls with the smallest Euclidean distance. We apply the same procedure to the control municipalities whose employment level in the affected industry is lower, i.e. $I_m < 0$. In the case illustrated in Figure 1, *Llinars del Vallès* and *Silla* are the two closest matches having higher levels of employment than Burgos in the rubber and plastics industry in 2000. Analogously, *Logroño* and *Alcalá de Henares* are the two closest matches with lower levels of employment in this industry. While we allow municipalities to be the controls for more than one treatment, we do not always find four controls for all cases. As a result, we have 217 (as opposed to 225) case-municipality observations.

In order to validate this matching procedure, we regress predetermined employment variables on a treatment indicator variable, while controlling for case fixed-effects. The results are reported in Table 1.

[Table 1 here]

---

treatment affects a large aggregate, such as a region or a country. In our case, we are able to choose our counterfactuals from a pool of more than 8,000 municipalities and so building a synthetic control is unnecessary.

The dependent variables in columns 2, 4 and 6 are the employment outcomes for the year 2000 that are directly used in the matching procedure. These results validate the matching insofar as the treated and control areas do not present statistically significant differences for any of the variables used to perform the matching. In columns 1, 3 and 5 we measure the same employment outcomes in 1990, namely, the level of employment in the affected industry at the municipality and area levels, and total employment at the area level[14]. The results indicate that employment levels in 1990 in treatments and controls were also similar, suggesting common pre-treatment employment trends. Figure 2 illustrates this point by plotting the evolution in employment in the industry suffering a plant closure for the treatment and control groups, where both time and employment levels have been normalized for the year of plant closure.

[Figure 2 here]

4. Results

Using this matched sample, we use differences-in-differences specifications to estimate the effects of big plant closures on local employment. We focus our attention primarily on the employment changes that occurred between 2000 and 2008.

4.1. Local employment effects in the industry affected by the plant closure

In this section we seek to estimate the impact of a plant closure on the employment in the industry suffering that closure. We estimate variants of the following equation:

$$\Delta employment_{ij} = \alpha_c + \beta\, job\ losses_{ij} + X_{ij}^{'}\delta + u_{ij} \qquad (1)$$

where $\Delta employment_{ij}$ is the job change in area *i* and industry *j* between 2000 and 2008 and, thus, u_{ij} denotes shocks in employment changes. The key explanatory variable is *job losses*,

[14] The 1990 employment outcomes are drawn from *Censo de Locales del INE 1990*.

which is defined as the layoff count associated with the particular plant closure. If $|\beta|$ equals 1, then each job lost as a result of the closure translates simply as one job lost in the local industry affected by that closure. We label $|\beta|$equal to unity as 'the mechanical effect', as this is the expected outcome if the closure had zero impact on the rest of the firms in the affected industry. However, if $|\beta|> 1$, then each job lost as a result of the closure generates additional job losses in the affected industry and area. A possible mechanism accounting for such an outcome is the one often used to justify subsidies, namely, that large plants create indirect jobs through the purchase of inputs from local suppliers[15]. Alternatively, if $|\beta|< 1$, then each job lost as a result of the closure creates jobs in the local industry affected by the closure. In the presence of workers that are imperfectly mobile across locations and industries, a significant collective dismissal would reduce labor market tightness and increase employment in all other local firms. In terms of control variables, case fixed-effects (α_c) are included to account for case industry employment trends while, in some specifications, the 1990 and 2000 (pre-treatment) employment outcomes used in the matching procedure are further included ($X_{ij}^{'}$) as controls. The baseline results are reported in the first two columns of Table 2.

[Table 2 here]

The first column shows the estimates of a specification that only includes case fixed-effects. The results imply that a job lost as a result of a large plant closure reduces employment in the affected industry and area by -0.521, implying that the closure spurs employment growth in local firms operating in the same industry and area as the closing plant. In the second column, we add the pre-treatment employment levels ($X_{ij}^{'}$) to the case fixed-effects. Specifically, we include the 2000 and 1990 industry and overall employment levels. As expected, the main estimate of interest, β, is not greatly affected by the inclusion of these pre-treatment outcomes (the point estimate is -0.628) as these controls are orthogonal to treatment status as shown in Table 1. In the third column of Table 2, we estimate a slightly different model by pooling all manufacturing industries so as to account for (possible) area specific trends in employment. Here, the specifications include case industry fixed-effects and area fixed-effects. The results

[15] The presence of agglomeration economies would also be consistent with $|\beta|> 1$ as the productivity of local firms (and labor demand) would depend positively on local employment size.

yield a point estimate of -0.556, confirming that when a large plant closes, employment in the rest of the firms within the local area and sector increases rather than decreases. This finding provides indirect evidence of labor market pooling effects. As first put forward by Marshall (1890), industry concentration creates scale economies by allowing workers to move between firms when idiosyncratic shocks at the firm level occur.

As discussed above, input-output analyses have often been used to predict the net employment effects of large plant openings/closures. For our sample of plant closures, a traditional input-output analysis predicts that for each job directly lost in the closure, another (indirect) job is lost in the local economy[16]. As such, our results seem to suggest that input-output analysis performs very poorly in predicting local employment responses to plant closures. Specifically, the traditional input-output analysis predicts a reduction in net employment that is three times greater (in absolute terms) than that observed.

We check the robustness of our results to the specific matching procedure adopted in two ways. First, we re-run the baseline specification selecting only the two closest controls (as opposed to four). The results, reported in columns 1 to 3 in Table A2 (deferred to the Appendix), are largely unchanged, suggesting that our findings do not hinge on the exact number of controls selected. Second, we run a placebo exercise in which we drop the actual treatment and randomly assign it to any of the four controls. The results, presented in columns 4 to 6, are reassuring as none of the coefficients of interest are statistically significant.

In the baseline regressions (panel A in Table 2), we focus on changes in employment in an eight-year time window. We do this as opposed to examining yearly changes for two reasons. First, (potential) anticipation effects might mean that employment falls in the year(s) prior to a plant closure. Second, the local response to a plant closure might take more than one year to take effect. To determine whether these possibilities are relevant in our application, in panel B of Table 2 we examine yearly employment changes between 2000 and 2008. In these regressions, we include the main explanatory variable (*job losses*) in the year the closure occurs as well as three lags and leads of this variable. In terms of control variables, Panels A and B adhere to the same logic, although the addition of the time dimension changes the nature of the fixed-effects that can be accounted for. Specifically, column 4 only includes case year fixed-effects while column 5 includes both these and the pre-treatment employment controls, namely,

---

[16] This is the average effect across the 45 closures using the 2005 Catalan Input–Output Table built by Statistics Catalonia (IDESCAT)

the 2000 and 1990 industry and overall employment levels. In column 6, we pool all manufacturing industries and, in addition to the pre-treatment employment controls, we introduce case industry year fixed-effects and area fixed-effects. We find no statistically significant results for any of the lag and lead variables. This finding suggests that anticipation effects are not especially relevant in our application and that the bulk of the adjustment takes place within a year of plant closure. These results are largely consistent with Figure 2 in which we show the evolution in the level of employment in the treated and control groups. However, the contemporaneous closure point estimates are slightly higher (in absolute value) than those found using 2000-2008 differences. Specifically, the point estimates using yearly variation range between -0.687 and -0.728. This is consistent with a slight recovery in employment levels in the treated areas in the years after the plant closure.

In section 3, when describing the matching procedure used, it was acknowledged that the effects of a plant closure might extend beyond the borders of a municipality. In Table 3 we explore in depth the geographical scope of the effects under study. To this end, we estimate variants of the following specification:

$$\Delta employment_{mj} = \alpha_c + \beta_0\, job\ losses_{mj}\, I_0 + \beta_{10}\, job\ losses_{ij} I_{10} + \gamma I_0 + X'_{mj}\delta + u_{mj} \tag{2}$$

where $\Delta employment_{mj}$ is the 2000-2008 change in the number of jobs in municipality *m* and industry *j*. Note that there are four types of municipality. Returning to the example illustrated in Figure 1, there is one treated area (*Burgos*) and four control areas (*Llinars del Vallès*, *Logroño*, *Alcalá de Henares* and *Silla*). In turn, each area comprises the municipality itself (dark gray) and the municipalities within a 10-km radius of it (light gray). Hence, we have treated municipalities, treated neighbors, untreated municipalities and untreated neighbors. I_0 indicates if the municipality itself is a treatment or a control (dark gray municipality) while I_{10} takes the value of one for the remaining municipalities within the treated and control areas (light gray municipalities). In the regressions we interact these indicators with our main explanatory variable and, thus, we estimate the employment effect in the municipality directly affected by the closure (β_0) and in the municipalities within a 10-km radius of the plant that has been closed down (β_{10}). Since the number of jobs in the plant being closed down does not form part of the neighbors' employment figures, no effects being recorded in neighboring municipalities implies β_{10}= 0. The results are presented in Table 3.

[Table 3 here]

Here again column 1 only includes case fixed-effects and the indicator variable I_0. Column 2 additionally includes, as controls, 1990 and 2000 (pre-treatment) employment levels measured here at the municipality level. Finally, column 3 pools the data from all manufacturing industries. We find no evidence that the effects of a big plant closure extend beyond the municipality in which the closure has occurred. Hence, our finding that plant closures spur employment growth in local firms operating in the same industry and area is driven solely by the behavior of firms located in the same municipality as that which has suffered the plant closure[17].

4.2 Effects on other manufacturing industries and services

According to input-output predictions, a plant closure has a negative impact on the employment in other industries. To determine whether this prediction is supported by the data, in columns 1 and 2 of Table 4 we evaluate the effects of plant closures on employment in manufacturing industries (excluding for each case, the industry directly affected by the closure). Analogously, we test in columns 3 and 4 whether the layoffs caused by the plant closure reduce employment in the services sector. The results are reported in Table 4.

[Table 4 here]

Table 4 reports the outcomes of specifications in which the 2000-2008 employment change at the (2-digit) industry level is regressed on the job losses attributable directly to the closure and case industry fixed-effects. In columns 2 and 4 we also include pre-treatment employment controls. All the coefficients in Table 4 are statistically insignificant and close to zero, suggesting that plant closures have no effect on employment levels outside the industry

---

[17] Additional evidence that interactions between firms are highly localized has been provided by Rosenthal and Strange (2003) and Arzaghi and Henderson (2008) for the US and by Viladecans-Marsal (2004) and Jofre-Monseny (2009) for the Spanish case.

directly affected by the closure. Since one job directly lost in the closure reduces employment in that industry by less than one job, it is important to keep in mind that the regressions reported in Table 4 measure the impact of net job reductions in the affected industry. This goes some way to reconciling our results with those reported by Moretti (2010), which suggest that reductions in tradable jobs reduce employment in the non-tradable industries.

4.3 The effects of plant closures on incumbents and new entrants

The results reported in section 4.1 indicate that for each job lost due to a plant closure only around 0.6 jobs are lost in the affected industry. This suggests that jobs are created in the industry and area directly affected by the closure. In this regard, it is interesting to determine whether these jobs are created by incumbent or new firms. To answer this question we draw on data from the SABI (firm-level) database. Although SABI does not cover the universe of Spanish firms, its coverage is extensive (around 80 percent of the firms on the Social Security register) and it does include the self-employed[18]. We identify in the SABI database all firms reported as being active in the industry affected by the plant closure. This means the industry definition applied here is somewhat wider than that used above as a firm might be active in more than one industry. Columns 1 to 3 in Table 5 re-estimate the baseline analysis using local employment levels built with the SABI database. We exclude the jobs in the plant closed down and, thus, the 'mechanical effect' now becomes zero.

[Table 5 here]

The results indicate that for each job lost due to a plant closure, between 0.5 and 0.6 jobs are created in the local industry affected by the closure. These point estimates are slightly higher than those recorded in Table 3, which lie between 0.3 and 0.5. This result is, however, consistent with the broader industry definition used in the SABI database and the fact that SABI also includes the self-employed. Importantly, the results obtained with this alternative dataset

[18] SABI is a firm and not a plant database. Nevertheless, the Spanish economy is dominated by small and medium sized firms. In fact, only 1.1 percent of the firms in Spain in 2006 were multi-plant firms (Encuesta sobre Estrategias Empresariales, 2008).

confirm our main qualitative results, namely, that the net employment effects of large plant closures are not as high as the direct job losses associated with the closure itself. In columns 4 to 9 in Table 5 we re-run the analysis, breaking down the changes in levels of employment between incumbent firms (columns 4 to 6) and new entrants (columns 7 to 9). According to the results, the impact on jobs is concentrated in the incumbents, that is, in firms that existed before the plant was closed down.

5. Conclusions

Local and regional governments around the world use subsidies to attract large plants. Similarly, large incumbent plants will often try to hold regional governments to 'ransom' under the threat of relocating production. The argument frequently made to justify such subsidies is that large plant closures have marked effects on employment that can extend beyond those of the collective dismissal itself. Indeed, the input-output framework has been used in predicting very large net employment losses. In this paper, we have empirically estimated the 'real' net local employment responses to large manufacturing plant closures.

Specifically, we have estimated the employment effects of the closure of 45 large manufacturing plants in Spain, which relocated to low-wage countries between 2001 and 2006. We match each municipality experiencing a closure to a small set of comparable municipalities in terms of employment level and mix in the year 2000. We find that treatments and controls do not differ in their 1990-2000 (pre-treatment) employment trends, thereby lending credence to the identification assumption underpinning our differences-in-differences estimates. Our results show that when a plant closes, for each job directly lost in the plant closure, only between 0.3 and 0.6 jobs are actually lost in the local economy, with the adjustment being concentrated in local incumbent firms in the industry having suffered the closure. One implication of these findings is that they suggest traditional input-output analyses tend to overstate the net employment losses of large plant closures. In our application, the input-output prediction overestimates the negative employment consequences by an order of three.

A couple of considerations are worth making regarding the external validity of our findings. First, among the countries of the OECD, Spain's employment protection regulations are among the strictest. At the same time, following a big plant closure, Spain's regional governments often intervene to facilitate the re-employment of some of the dismissed workers in local firms. Hence, employment responses may differ in contexts with less government intervention. Second, the closures we analyze occurred in a period (2001-2006) in which the Spanish economy was growing. It could well be that the consequences of massive layoffs are far more negative in stagnant economies. This said, our findings suggest that, in normal times, local employment responses do not seem to justify the payment of large subsidies to avoid the relocation of large manufacturing plants.

Table 1. Differences between treatments and controls. Pre-treatment employment levels in 1990 and 2000

	Employment in the affected industry				**Overall employment**	
	1990	2000	1990	2000	1990	2000
	Municipality		Area (Municipality & neighbors)		Area (Municipality & neighbors)	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Treatments	-60.03 (308.7)	-70.07 (264.9)	-40.55 (338.4)	-67.43 (276.1)	14,704 (20,118)	19,541 (28,205)
Case dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.799	0.795	0.877	0.881	0.682	0.684
Observations	217	217	217	217	217	217

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Table 2. Impact of a plant closure on the affected industry.

	A: 2000-2008 long differences			B: 2000-2008 yearly differences		
	Industry affected by plant closure		Pooled industries	Industry affected by plant closure		Pooled industries
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Job losses	-0.521**	-0.628***	-0.556**			
	(0.228)	(0.231)	(0.227)			
Job losses (-3)				0.001	0.029	0.070
				(0.132)	(0.117)	(0.069)
Job losses (-2)				-0.025	0.000	-0.017
				(0.096)	(0.096)	(0.097)
Job losses (-1)				-0.021	0.002	-0.036
				(0.071)	(0.068)	(0.053)
Job losses (0)				-0.700***	-0.687***	-0.728***
				(0.168)	(0.178)	(0.133)
Job losses (+1)				0.046	0.059	0.072
				(0.095)	(0.09)	(0.049)
Job losses (+2)				-0.061	-0.061	-0.087
				(0.103)	(0.103)	(0.118)
Job losses (+3)				-0.087	-0.088	-0.039
				(0.064)	(0.065)	(0.064)
Case fixed-effects	Yes	Yes	No	No	No	No
Pre-treatment employment controls	No	Yes	Yes	No	Yes	Yes
Case year fixed-effects	No	No	No	Yes	Yes	No
Case industry fixed-effects	No	No	Yes	No	No	No
Case industry year fixed-effects	No	No	No	No	No	Yes
Area fixed-effects	No	No	Yes	No	No	Yes
R-squared	0.649	0.797	0.799	0.189	0.194	0.165
Observations	217	217	4,991	1,720	1,720	39,792

Notes: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). The dependent variable in columns 1 to 3 is the change in employment between 2000 and 2008 at the 2-digit industry level. The dependent variable in columns 4 to 6 are 2000-2008 yearly changes. Columns 1, 2, 4 and 5 include only the treated industry for each case while columns 3 and 6 include all manufacturing industries. Pre-treatment employment controls are the 2000 and 1990 levels at the appropriate industry level as well as in total employment. There are 23 (2-digit) industries in columns 3 and 6.

Table 3. The geographical scope of the employment effects of a big plant closure. 2000-2008 long differences.

	Industry affected by plant closure		Pooled industries
	(1)	**(2)**	**(3)**
Job losses in own municipality (β_0)	-0.800*** (0.14)	-0.515*** (0.122)	-0.634*** (0.121)
Job losses in neighboring municipality (β_{10})	0.023 (0.024)	-0.018 (0.021)	-0.01 (0.021)
Case fixed-effects	Yes	Yes	No
I_0 indicator	Yes	Yes	Yes
Pre-treatment employment controls	No	Yes	Yes
Case industry fixed-effects	No	No	Yes
Area fixed-effects	No	No	Yes
R-squared	0.14	0.454	0.491
Observations	2,514	2,514	57,822

Notes: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). The dependent variable is the change in employment between 2000 and 2008 at the industry and municipality level. I_0 as defined in the text. Columns 1 and 2 include only the treated industry for each case, while column 3 includes all manufacturing industries in each municipality. Pre-treatment employment controls are the 2000 and 1990 levels at the appropriate industry level as well as in total employment at the municipality level. There are 23 (2-digit) industries in columns 3.

Table 4. Impact of a plant closure on other industries 2000-2008

	Other manufacturing industries		Services	
	(1)	**(2)**	**(3)**	**(4)**
Job losses	0.111 (0.089)	-0.003 (0.008)	0.000 (0.000)	0.001 (0.003)
Case industry fixed-effects	Yes	Yes	Yes	Yes
Pre-treatment employment controls	No	Yes	No	Yes
R-squared	0.498	0.787	0.626	0.806
Observations	4,774	4,774	3,255	3,255

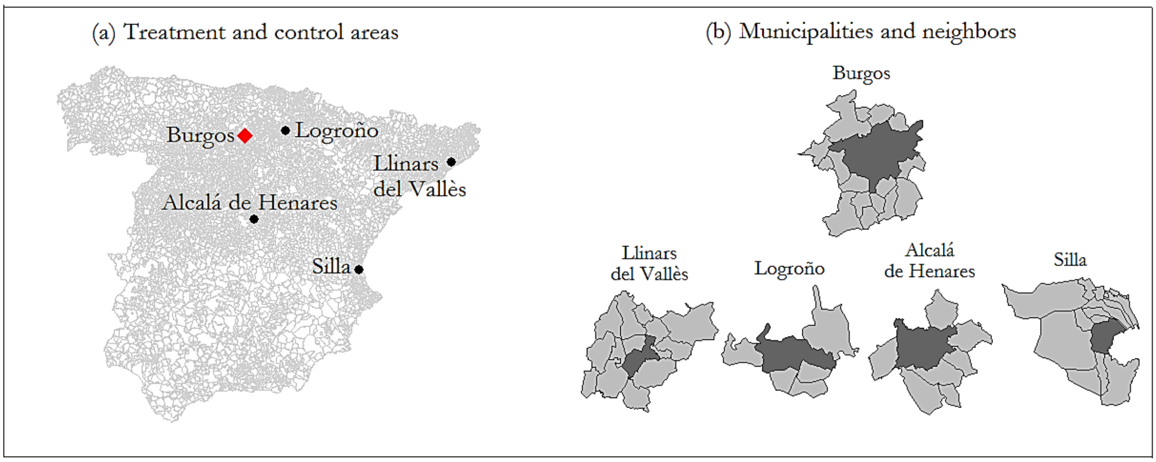
Notes: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). The dependent variable is the change in employment between 2000 and 2008 at the industry and area level. Pre-treatment employment controls are the 2000 and 1990 levels at the appropriate industry level as well as in total employment. There are 23 (2-digit) industries in columns 1 and 2 and 15 in columns 3 and 4.

Table 5. Impact of a plant closure on the affected industry. SABI database. 2000-2008 changes.

	Overall			New firms			Incumbent firms		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Job losses	0.519**	0.511**	0.618**	0.013	0.009	0.022	0.533**	0.520**	0.595**
	(0.243)	(0.239)	(0.247)	(0.038)	(0.038)	(0.05)	(0.243)	(0.237)	(0.242)
Case fixed-effects	Yes	Yes	No	No	No	No	No	No	No
Pre-treatment employment controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Case industry fixed-effects	No	No	Yes	No	No	No	No	No	No
Area fixed-effects	No	No	Yes	No	No	Yes	No	No	Yes
R-squared	0.318	0.341	0.367	0.597	0.627	0.507	0.311	0.327	0.354
Observations	217	217	4,991	217	217	4,991	217	217	4,991

Note: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). The dependent variable is the change in employment between 2000 and 2008 at the 2-digit industry level computed using the SABI database and excluding the plant forced to close. Columns 1, 2, 4, 5, 7 and 8 include only the treated industry for each case while columns 3, 6 and 9 include all manufacturing industries. Pre-treatment employment controls are the 2000 and 1990 levels at the appropriate industry level as well as in total employment. There are 23 (2-digit) industries in columns 3, 6 and 9.

Figure 1. A plant closure example: Treatment and control areas



Note: The example corresponds to Cellophane Española, a rubber and plastics plant in Burgos closing in 2001. Panel a shows the location of treatment and control areas within Spain while Panel b shows the selected municipalities (dark gray) and neighbors (light gray).

Figure 2. Employment in the plant closing industry

Note: The year and employment level are normalized to zero at the plant closure year

Appendix

Table A1. Big Plant Closures Sample

Case	Firm	Municipality	2-digit Industry Classification	Year	Nº of Job losses	Destination
1	Jumberca S.A.	Badalona	29 - Machinery and equipment	2002	201	China
2	Proflex S.A.	Calaf	24 - Chemicals and chemical products	2004	105	Czech Republic
3	Torcidos Ibéricos S.A.	Castellbell i el Vilar	17 - Textiles	2005	116	India
4	Braun Española S.L.	Esplugues de Llobregat	29 - Machinery and equipment	2006	684	China
5	DB Apparel Spain S.A.	Igualada	17 - Textiles	2003	255	Morocco
6	Tenería Moderna S.A.L.	Mollet del Vallès	19 - Leather and leather Products	2003	131	--
7	Hilados y Tejidos Puigneró S.A.	Sant Bartomeu del Grau	17 - Textiles	2002	502	--
8	Galler Textiles S.A.	Sant Boi de Llobregat	17 - Textiles	2003	313	Thailand
9	ZF Sistemas de dirección Nacam S.L.	Sant Boi de Llobregat	34 - Motor vehicles, trailers and semi-trailers	2006	185	Germany/France
10	José Ribatallada S.L.	Cerdanyola del Vallès	15 - Food products and beverages	2005	117	--
11	Celestica S.L.	Cerdanyola del Vallès	30 - Office machinery and computers	2004	320	Czech Republic
12	Selecciones Americanas S.A.	Sitges	18 - Wearing apparel, dressing and dyeing of fur	2005	124	China
13	IMC Toys S.A.	Terrassa	36 - Furniture and other manufacturing	2003	139	China
14	Autotex S.A.	Viladecavalls	17 - Textiles	2004	189	Czech Republic
15	TRW Automotive España S.L.	Burgos	34 - Motor vehicles, trailers and semi-trailers	2005	318	Poland/Czech Republic
16	La Cellophane Española S.A.	Burgos	25 - Rubber and plastics products	2001	310	--
17	Delphi Automotive Systems España S.L.	Puerto Real	34 - Motor vehicles, trailers and semi-trailers	2006	1,600	Morocco
18	Panasonic Iberia S.A.	Celrà	29 - Machinery and equipment	2004	214	China
19	Tybor S.A.	Massanes	17 - Textiles	2003	149	China
20	La Preparación Textil S.A.	Ripoll	17 - Textiles	2004	145	China
21	Promek S.L.	Azuqueca de Henares	34 - Motor vehicles, trailers and semi-trailers	2004	350	Poland/Czech Republic
22	Moulinex España, S.A.	Barbastro	29 - Machinery and equipment	2003	270	China
23	JoyCo España S.A.	Alcarràs	15 - Food products and beverages	2004	213	China
24	Lear Corporation Spain S.L.	Cervera	31 - Electrical machinery and apparatus	2001	1,280	Poland
25	Delphi Componentes S.A.	Agoncillo	34 - Motor vehicles, trailers and semi-trailers	2001	578	Poland
26	Electrolux España S.A.	Fuenmayor	29 - Machinery and equipment	2005	454	Hungary
27	Yoplait España S.L.	Alcobendas	15 - Food products and beverages	2001	185	France
28	Sanmina-SCI España S.L.	Leganés	32 - Radio, television and communication equipment	2001	250	Hungary
29	Vitelcom Mobile Technology S.A.	Málaga	32 - Radio, television and communication equipment	2004	433	Korea

30	Calseg S.A.	Artajona	19 - Leather and leather Products	2001	150	Tunisia
31	Findus España S.L.	Marcilla	15 - Food products and beverages	2001	471	Italy/UK
32	Viscofan S.A.	Pamplona	25 - Rubber and plastics products	2006	742	Brazil/Czech Republic
33	TRW Automotive España S.A.	Orkoien	34 - Motor vehicles, trailers and semi-trailers	2002	382	Poland
34	Valeo Sistemas de Conexión Eléctrica S.L.	San Cibrao das Viñas	31 - Electrical machinery and apparatus	2004	264	Poland
35	MMN&P Acconta S.A.	Segovia	34 - Motor vehicles, trailers and semi-trailers	2001	190	Morocco
36	Levi Strauss de España S.A.	Ólvega	17 - Textiles	2003	561	Poland/Hungary
37	Delphi Packard España S.L.	Ólvega	34 - Motor vehicles, trailers and semi-trailers	2001	560	Morocco/Romania
38	GDX Automotive Ibérica S.L.	Valls	25 - Rubber and plastics products	2005	153	Germany/Czech Republic
39	Sanmina-SCI España S.L.	Toledo	32 - Radio, television and communication equipment	2005	430	Thailand/China
40	Alcatel Lucent España S.A.	Toledo	32 - Radio, television and communication equipment	2002	150	Hungary
41	Grupo Tavex S.A.	Alginet	17 - Textiles	2006	300	Brazil/Mexico
42	Bayer Cropscience S.A.	Quart de Poblet	24 - Chemicals and chemical products	2006	300	Portugal
43	Valeo España S.A.	Abrera	31 - Electrical machinery and apparatus	2001	406	Morocco/Tunisia
44	IAR Ibérica S.A.	Montcada i Reixac	29 - Machinery and equipment	2004	423	Hungary
45	Fisipe Barcelona S.A.	El Prat de Llobregat	17 - Textiles	2006	270	China

Notes: (1) Source: Authors' own elaboration.
(2) In cases 6,7,10 and 16 we have been unable to identify the country to which the firm relocated.

Table A2. Impact of a plant closure in the affected industry. 2000-2008 employment changes. Robustness checks.

	Industry affected by plant closure		Pooled industries	Industry affected by plant closure		Pooled industries
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Job losses	-0.597**	-0.771***	-0.645**	0.227	0.074	0.040
	(0.288)	(0.276)	(0.269)	(0.214)	(0.251)	(0.232)
Case fixed-effects	Yes	Yes	No	No	No	No
Pre-treatment employment controls	No	Yes	Yes	No	Yes	Yes
Case industry fixed-effects	No	No	Yes	No	No	No
Area fixed-effects	No	No	Yes	No	No	Yes
R-squared	0.596	0.787	0.822	0.626	0.841	0.832
Observations	131	131	3,013	172	172	3,956

Notes: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1). The dependent variable is the change in employment between 2000 and 2008 at the 2-digit industry level. Columns 1, 2, 4 and 5 include only the treated industry for each case while columns 3 and 6 include all manufacturing industries. Pre-treatment employment controls are all the outcomes examined in Table 1.

References

Abadie, A. and Gardeazabal, J. (2003), "The economic costs of conflict: A case study of the Basque Country", The American Economic Review, 93(1), pp. 113-132.

Arzaghi, M. and Henderson, J.V. (2008), "Networking Off Madison Avenue", Review of Economic Studies, 75(4), pp. 1011-1038.

Edmiston, K.D. (2004), "The net effects of large plant locations and expansions on county employment", Journal of Regional Science, 44(2), pp. 289-320.

Ellison, G., Glaeser, E. and Kerr, W. (2010), "What causes industry agglomeration? Evidence from coagglomeration patterns", American Economic Review, 100, pp. 1,195-1,213.

Encuesta sobre Estrategias Empresariales. 2008. Las empresas industriales en 2006. Madrid. Fundación SEPI.

Faggio, G. and Overman, H. (2014), "The effect of public sector employment on local labour markets", Journal of Urban Economics, 79, pp. 91-107.

Faggio, G., Silva, O. and Strange, W.C. (2015), "Heterogeneous agglomeration", Discussion Paper No. 0152, Spatial Economics Research Centre, London School of Economics.

Fox, W.F. and Murray M.N. (2004), "Do economic effects justify the use of fiscal incentives?", Southern Economic Journal, 71(1), pp. 78-92

Glaeser, E.L (2001), "The economics of location-based tax incentives", Discussion Paper No. 1932. Cambridge, MA: Harvard Institute of Economic Research.

Greenstone, M. and Moretti, E., (2004), "Bidding for industrial plants: Does winning a 'million dollar plant' increase welfare?", mimeo.

Greenstone, M., Hornbeck, R. and Moretti, E., (2010), "Identifying agglomeration spillovers: evidence from winners and losers of large plant openings", Journal of Political Economy, 118 (3), pp. 536-598.

Hooker, M.A. and Knetter, M.M. (2001), "Measuring the economic effects of military base closures", Economic Inquiry, 39(4), pp. 583-598.

Jofre-Monseny, J. (2009), "The scope of agglomeration economies: Evidence from Catalonia", Papers in Regional Science, 88(3), pp. 575-590.

Jofre-Monseny, J., Marín-López, R. and Viladecans-Marsal, E. (2011), "The mechanisms of agglomeration: Evidence from the effect of inter-industry relations on the location of new firms", Journal of Urban Economics, 70, pp. 61-74.

Krugman, P. (1991), *Geography and Trade*, MIT Press, Boston.

Marshall, A. (1890), *Principles of Economics*, MacMillan, London

Moretti, E. (2010), "Local Multipliers", The American Economic Review, 100(2), pp. 373-377.

Myro, R. and Fernández-Otheo, C.M. (2008), "Profitability of Spanish foreign direct investment", Journal GCG Georgetown University-Universia, 2(3), pp. 76-99.

Overman, H. and Puga, D. (2010), "Labor pooling as a source of agglomeration: An empirical investigation", in Glaeser, E. (Ed.), *Agglomeration Economics*, Chicago University Press: Chicago.

Poppert, P.E. and Herzog Jr., H.W. (2003), "Force reduction, base closure, and the indirect effects of military installations on local employment growth", Journal of Regional Science, 43(3), pp. 459-482.

Rosenthal, S.S. and Strange, W.C. (2003): "Geography, industrial organization, and agglomeration", Review of Economics and Statistics, 85(2), pp. 377-393.

Viladecans-Marsal, E (2004), "Agglomeration economies and industrial location: city-level evidence", Journal of Economic Geography, 4, pp. 565-582.

Wilson, J.D. (1999), "Theories of tax competition", National Tax Journal, 52(2), pp. 269-304.