# Determinants of earnings losses of displaced workers

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**Abstract**

Using an unusually rich matched employer-employee data set for Portugal, we studied the persistent earnings losses of workers displaced due to firm closure, collective dismissals and individual dismissals. We found that those losses are rather severe and persistent, representing around 50 percent of the pre-displacement wages, six years after the separation event. Those losses are largely explained by the joblessness experience of the displaced workers.

We explored the sources of those losses, estimating a three-way high-dimensional fixed effects regression model, which enabled us to obtain worker, firm, and job title fixed effects. We found that the allocation into lower-paid job titles accounts for half of the total average wage loss. Sorting into firms also plays a significant role to explain the wage loss of displaced workers.

Keywords: Earnings losses, displaced, high dimensional fixed effects

JEL codes: J31, J63, J65, E24

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# 1 Introduction

Every year, thousands of workers all over the world are affected by the negative consequences of displacement (Kuhn (2002)). Worker displacement is the subject of an extensive and growing literature. The costs of job loss in terms of unemployment, future employment and earnings-change have been the most studied aspects of job displacement. Displaced workers are defined in this chapter as all workers who separate from a dying, or shrinking firm in a given year. Such workers are unlikely to have left as a result of their own poor performance and therefore it reduces the importance of the selectivity bias.

During the 1980s a number of empirical studies appeared analyzing workers' post-displacement wages in the U.S. [(see, for instance, Podgursky and Swaim (1987), Kruse (1988), Addison and Portugal (1989), Kletzer (1989)].[1] Basically, these studies provide a snapshot view of short-term earnings losses, defined as the difference between pre- and post-displacement earnings of displaced workers.

However, this type of analysis, focusing solely on workers who have been displaced, is likely to underestimate the magnitude of wage losses, since it does not account for the earnings growth that would have occurred in the absence of job loss. A simple comparison of pre- with post-separation earnings for displaced workers is insufficient. The seminal paper by Jacobson et al. (1993) introduced a different approach to the study of worker displacement and earnings losses. These authors compare the earnings changes of displaced workers over a long-term period with the earnings changes that would have occurred if the displaced had not lost their jobs. Since this latter variable is not observable, a comparison group of non-displaced workers is used. The emphasis in worker displacement research has shifted from short-term wage losses to long-term dynamics. In fact, in recent years the existence of suitable longitudinal data sets in the U.S. and Europe matching workers and firms enables the comparison of wage patterns for displaced and identical non-displaced workers.

Few of these studies, however, attempted to appropriately decompose the earnings

[1] See Hamermesh (1989) for an enlightening discussion of this literature.

gap between displaced and non-displaced workers into its main determinants. Understanding the causes of these reductions might shed some light on potential policy options to ease the burden of adjustment on these workers.

Hence, the main goal in this study is to measure the earnings losses of displaced workers resulting from firm closure or collective dismissals having in mind that as in Jacobson et al. (1993) joblessness and wage rate decline play an important role. Furthermore, monthly wage losses are decomposed into different components related to worker, firm, and job title characteristics (both observed and unobserved). Taking into account job characteristics is crucial to obtain reliable estimates of the earnings losses following displacement, since earlier empirical work has shown that industry, firm, and match characteristics are an important determinants of earnings (see, for example, Podgursky and Swaim (1987), Addison and Portugal (1989), Carrington (1993), Neal (1995)).

Indeed, from a theoretical point of view, it is to be expected that reemployment wages of displaced workers will be lower than those of workers who remain employed. As mentioned by Fallick (1996), there are at least four reasons that can explain this pattern. First is the loss of human capital specific to the firm or industry. To the extent that these skills are non-transferable, their contribution to worker's productivity is permanently lost when a job loss occurs. Second, payments by seniority in order to provide incentives not to shirk may delay higher earnings to the latter part of the career. In this case, a permanent separation reduces lifetime earnings. Third, there is the loss of a high quality job match between the worker and the firm. In fact, some authors claim that standard estimates of the return to job-specific training are biased upward by job match and individual unobserved heterogeneity.[2] A long job tenure may signal a high quality match between the firm and the worker and/or a high ability worker, because more able workers and workers in good jobs are less likely to separate. Along this line of research, Addison and Portugal (1989) and Kletzer (1989) showed that tenure in the pre-displacement job is positively associated

[2]See, among others, the studies of Abraham and Farber (1987, 1988), Altonji and Shakotko (1987), Topel (1991) and Dustmann and Meghir (2005).

with post-displacement earnings, reflecting heterogeneity in worker ability and the transferability of skills. Fourth, to the extent that the firm's and/or industry characteristics also play a role in the process of wage determination, a displaced worker may lose some wage premium that he was previously receiving, such as insider rents, union premiums, or efficiency wage differentials.

Thus, beyond worker and firm characteristics, a third important dimension of wage formation is considered in this study - job title heterogeneity. Job title heterogeneity may influence wage rates for a number of reasons. First, it is well known that tasks that involve risks of death or serious accident are better paid than less risky tasks. One should therefore expect significant compensating differentials for occupations such as deep sea divers or bullfighters. Second, jobs that need to be executed under difficult or stressful conditions are also expected to be better remunerated than jobs that take place under pleasant conditions. For example, one should observe higher wages for individuals working on offshore oil platforms or in mines. Third, the complexity of some tasks may require intense special training and/or unusual skills. This is the reason why, for example, brain surgeons or jet fighter pilots have higher earnings. Fourth, some occupations are known to be chronically overcrowded, whereas others are thought to be in excess demand. For decades it has been argued that there is an oversupply of teachers and an undersupply of nurses. Fifth, by their nature some jobs put the workers in a position where they can inflict serious losses on their employers and/or the society. In such cases, the trade unions are powerful enough to extract significant rents in the form of higher wages. Industrial action by commercial airline pilots, flight controllers, train motormen, or more generally, by workers that are part of the natural monopolies workforce, often leads to a substantial wage premium. Sixth, entry barriers to some occupations, such as those ruled by worker associations (for example, closed shop occupations, medical associations, lawyers' associations, etc.) also enhance the labor income of their members. Seventh, the kind of technology being used may favor the organization of labor through unionization of the workplace, allowing unions to push for higher wages. Production

activities that imply the concentration of a large number of workers in a single plant (say, the auto industry or ship building) facilitate industrial action, and thus, better worker conditions.

Potential losses of displaced worker can be related to the firm and job-title that they hold before and after displacement. The heterogeneity among firms wage policies is very large and accounts for more than one third of the wage total variation (Torres et al. (2012)). Different wage policies are favored by the existence of industry rents (due to unionization or incentive pay premiums) or the operation of wage efficiency policies. In such an environment, the worker may benefit from engaging in job search to locate the firms with more suitable (more generous) wage offers. Good matches will be made and survive. Bad matches will be resisted and undone. However, with the occurrence of a displacement event, successful job searchers may loose their "job shopping" investment.

The role of job-title heterogeneity explaining total variation is also significant (around 50 percent). Job-titles summarize the general and specific skills of the worker, in particular those that are industry and occupation specific. Given the way those job titles were identified, they may also reflect the bargaining power of the workers. Because job-titles contain the skill requirements of the position hold by the the worker, it will also retain the hierarchical standing of the workers. Again, with the event of a displacement, a human capital will be destroyed, largely associated with the loss of his pre-displacement job-title. This was previously measured by looking at the effect of industry and occupation mobility. We now address directly this source of wage loss by looking at job-title fixed effects.

To properly incorporate these plethora of wage determinants a wage equation with three high-dimensional fixed effects - worker, firm, and job title - will be estimated using a nationally representative matched employer-employee data set - *Quadros de Pessoal*. The universal coverage of the employed population in the private sector in Portugal combined with the appropriate tools creates the optimal conditions for this exercise.

Two main objectives drive the investigation. The first is to follow Jacobson et al. (1993) (JLS) methodology to investigate the monthly earnings losses, including zeros whenever the individuals are out of work. The second objective is to extend the Jacobson et al. (1993) (JLS) methodology by incorporating firm and job title fixed effects in the monthly wage equation (excluding zeros), allowing us to estimate the monthly wage losses of displaced workers. We decompose the monthly wage losses into their main sources using the methodology developed in Gelbach (2010).

The structure of the remainder of the chapter is as follows. In Section 2 a brief review of the literature is given. Section 3 summarizes the institutional wage setting in Portugal. Section 4 describes the data and the sample construction. The empirical strategy is presented in Section 5 and Section 6 reports the results. Section 7 concludes.

## 2 Earlier literature on earnings losses of displaced workers

As mentioned before, there is an extensive empirical literature on the earnings impact of worker displacement.[3] For a variety of surveys and methodologies the studies for the U.S. have established that displaced American workers usually experience short spells of unemployment, but substantial and persistent reductions in earnings - on the order of 8 to 25 percent for prime-aged workers, in comparison with their non-displaced counterparts (Couch and Placzek (2010)) lasting over 15-20 years (von Wachter (2010)). This literature also establishes two stylized facts - high-tenure workers and industry switchers suffer the greatest earnings losses (see, for example, Kletzer (1989), Jacobson et al. (1993), Carrington (1993), Neal (1995) and Stevens (1997)).

Ruhm (1991) and Stevens (1997) use the Panel Study of Income Dynamics (PSID) and find that in the 1970s and early 1980s, the post-displacement earnings of displaced

[3]See Fallick (1996) and Kletzer (1998) for surveys.

workers droped between 7 and 13 percent.

Jacobson et al. (1993) use administrative earnings records from the Unemployment Insurance (UI) system of Pennsylvania for the period 1974-86. Their sample includes workers aged between 20 and 49 who reported positive earnings in the first quarter of the sample's period, were continuously employed during the first six years in a firm with at least 50 employees, and reported positive earnings at least once thereafter. Workers are considered to be displaced whenever their firm faces a drop in employment of at least 30% in the year before displacement. They found that high-tenure displaced workers suffer long-term earnings losses averaging 25 percent per year six years after displacement. These losses start to appear approximately three years before separation and are substantial even for workers reemployed in similar firms.

Couch and Placzek (2010) have cast some doubts on the magnitude of the estimates obtained by Jacobson et al. (1993). They argue that the results should be interpreted with some caution, as in the late 1970s and early 1980s U.S. industry suffered a significant restructuring that had a considerable impact on the state of Pennsylvania in particular. Using data for the state of Connecticut for the 1993-2004 period, their estimates are roughly half those found for Pennsylvania. They also found that long-term earnings losses are greater among unemployment insurance (UI) recipients, which seems to explain the difference in the earnings losses estimates across the two samples, as the data for Pennsylvania report a high incidence of UI receipt when compared with the Connecticut data.

The studies by Schoeni and Dardia (2003) and von Wachter et al. (2009) for California, and by Kodrzycki (2007) for Massachusets based on data for the 1990s, show that the magnitude and persistence of the losses are fairly consistent across different states of the U.S.

Using data from the Displaced Workers Survey (DWS) for different time periods, Farber (1993, 1997, 2005) finds that displaced American workers lose around 8 to 12 percent in comparison with their non-displaced counterparts. Using also DWS data for workers who lost their jobs in the recent recession of 2007-2009, Farber (2011)

reports an estimate of 11 percent, i.e., full-time job losers who find new full-time jobs earned 11 percent less, on average, at their new jobs than they would have had they not been displaced.

Regarding losses by worker characteristics such as gender, age, and education, some conclusions seem to emerge in the most recent studies for the U.S. Using data from the DWS for 1981 to 2003, Farber (2005) finds that while in the 1980s more educated displaced workers experienced smaller earnings decreases in comparison with their less-educated nondisplaced counterparts, the situation seems to be reversed in the early 2000s. Regarding gender or race, no significant differences were found. von Wachter et al. (2009) also found that in California, in the 1990s, workers with a college degree had smaller earnings losses than workers without a high school degree, who, on the other hand, performed better than workers with some college or a high-school degree.

Chan and Stevens (2001) use the Health and Retirement Surveys (HRS) and find that older displaced workers suffer greater losses in earnings than those found for prime-aged workers when using DWS or PSID data. Kletzer and Fairlie (2003) use the National Longitudinal Survey of Youths (NLSY) to analyze the earnings losses of young workers, aged between 14 to 36 years, in the period from 1979 to 1993. They find that younger workers have similar long-term earnings losses in comparison with individuals having greater labor market experience.

For Europe the empirical evidence is less clear-cut. Some studies have concluded for the existence of large earnings losses (Bender et al. (2002) and Lefranc (2003)), while others have concluded for the existence of reduced earnings losses (Burda and Mertens (2001), Lehmann et al. (2005) and Hijzen et al. (2010)). On one point, however, these studies seem to be in agreement. A displaced worker who experiences a period of non-employment suffers a large penalty in earnings (Gregory and Jukes (2001), Bender et al. (2002)) and Abbring et al. (2002).

Burda and Mertens (2001) provide estimates for Germany using data from both the German Socioeconomic Panel (GSOEP) and the Social Insurance File (IAB)

covering the 1985-94 period. They found a modest wage decline upon reemployment (about 3.6% in the year following displacement). They also concluded that large wage losses are associated with changes of industry, but not of firm.

Couch (2001) also used the GSOEP from 1988 to 1996 in order to examine the effects of displacement due to plant closure on annual earnings and unemployment duration. He reported an estimated loss of around 13.5% in the displacement year and a loss of 6.5% two years later.

Lefranc (2003) analyzed the sources of wage losses of displaced workers in France and the U.S. using micro-data from labor force surveys. He showed that while the magnitude of the wage losses are very similar in the two countries (around 10 to 15 percent), the sources of wage adjustment differ considerably. In the U.S., earnings losses stem mostly from the loss of search rents on the displacement job, while in France, most of the earnings losses result from the loss of accumulated firm-specific human capital.

Using labor force survey data from Estonia covering the period from 1989 to 1999, Lehmann et al. (2005) find that the main cost of displacement is the cumulative income loss measured as the difference between wages and out-of-work benefits, which is large for the minority of workers who experience long-term non-employment.

Hijzen et al. (2010) used a matched employer-employee data set for the U.K. to estimate the income loss of displaced workers from firm closure and mass layoffs. They showed that workers whose firm closes down lose 18-35 percent per year of their income, while workers who exit a firm that suffers a mass layoff lose 14-25 percent. In contrast to JLS, they found that income losses are driven mainly by non-employment spells rather than by wage losses.

# 3 Wage setting in Portugal

Portugal is considered to have a regulated labor market, with minimum wages, strong employment protection, and collective bargaining widely applied (OECD (2001) and

Cardoso (2006)). In the 1990s Portugal was characterized by low unemployment rates, approximately 3-4 percentage points below the EU-15 average. In 1994, the minimum legal monthly wage was 246 euros, representing around 37% of the median total monthly earnings of full-time employees (Eurostat).[4]

The Portuguese Constitution provides the juridical principles of collective bargaining, and grants unions the right to negotiate. The effects of the agreements are formally recognized and considered valid sources of labor law.

Concerning the bargaining mechanisms, a distinction should be made between the conventional regime and the mandatory regime. Conventional bargaining results from direct negotiation between employers' and workers' representatives. A mandatory regime, on the other hand, does not result from direct bargaining between these two, but is instead dictated by the Ministry of Labor. The Ministry can extend an existing collective agreement to other workers initially not covered by it or it can create a new one if it is not viable to extend the application of an existing document. A mandatory regime is applied when workers are not covered by unions, when one of the parties involved refuses to negotiate, or bargaining is obstructed in any other way.

Beyond the existence of compulsive extension mechanisms, voluntary extensions are also possible, when one economic partner (workers' representative or employer) decides to subscribe to an agreement that it had initially not signed. Therefore, the impact of collective bargaining goes far beyond union membership and the distinction between union and non-union workers or firms becomes largely meaningless.

Collective negotiations are conducted at the industry, or occasionally, at the occupation level. Firm-level negotiation, which for a time was a common practice in large public enterprises, has lost importance. The law does not establish mechanisms of coordination between agreements reached in different negotiations; however, preference is given to vertical over horizontal agreements, and the principle of the most favorable condition to the worker generally applies.

Since most collective agreements are industry-wide, covering companies with very

[4]Minimum wage is updated every year by government proposal, taking into account inflation and GDP growth as well as the social partners' expectations.

different sizes and economic conditions, their contents tend to be general, setting minimum working conditions, in particular the base monthly wage for each category of worker, overtime pay, and the normal duration of work. Moreover, only a narrow set of topics is updated annually, and therefore the content of collective agreements is often pointed out as being too immobile and containing little innovation.

Whatever the wage floor agreed upon for each category of worker at the collective bargaining table, firms are free to pay higher wages, and they often deviate from that benchmark, adjusting to firm-specific conditions. Cardoso and Portugal (2005) call this the "wage cushion", the difference between the contractual part of the wage and the actual wage. They estimate that in 1999 actual wages exceeded the level of bargained wages by 20-50%.

# 4 The Data

## 4.1 Quadros de Pessoal data set

It is well established that the nature of the data sets implies the use of different identification strategies and may lead to distinct results. Survey data usually contain more detailed information on observable worker and firm characteristics than administrative data. However, administrative data sets typically cover a long time span, are larger, allow one to follow workers and firms over the years, and enable the use of a control group of non-displaced workers. The use of administrative data in comparison with retrospective survey data reduces recall and reporting errors. Administrative data also usually provide more accurate identification of the timing and nature of the separation arising from firm closure or collective dismissals.

In this study, a longitudinal matched employer-employee data set, called *Quadros de Pessoal* (QP – "Lists of Personnel") is used for the 1997-2008 period. The data are gathered annually by the Portuguese Ministry of Employment, based on an inquiry that every establishment with at least one wage-earner is obliged by law to fill in.[5]

[5]From 1994 onwards the information refers to the month of October of each year.

Reported data cover the firm, the establishment, and each of its workers.[6] Currently QP gathers information for more than 300,000 firms and about 3 million workers. Given the mandatory nature of the survey plus the fact that these data cover all wage earners in the private sector in Portugal, problems commonly associated with panel data sets, such as panel attrition, are considerably reduced.

Reported data on the worker side include gender, age, schooling, and detailed information on monthly earnings - base wages, regular payments (e.g., seniority), irregular benefits (profits distribution and premiums), overtime payments, and hours of work (normal and overtime). The information on earnings is reported by the employer, which is known to be subject to less measurement error than worker-provided earnings data. All earnings variables were deflated using the Consumer Price Index (with base-year 2008). The firm data include detailed information on region, industry, ownership type, and size.

It is worth noting that workers also have an identification number based on a (scrambling) transformation of his/her social security number, which allows us to follow them over the years and to match workers and their firms.

### 4.2 Sample Construction

The samples used in this study are selected as in Jacobson et al. (1993) and Couch and Placzek (2010). Thus, we considered displacements due to firm closure, collective dismissals and individual dismissals. In the next section, we explain how firm closures and collective dismissals were identified. To be included in the sample a worker must report positive earnings in the year that immediately precedes the displacement event (reference year is $D_0$) and must be continuously employed with the same employer during the first three years (screening period).[7] This means that workers are selected into the sample with at least three years of tenure by the time of the reference year.

[6] See Cardoso(2006) for more details.

[7] In order to guarantee that the worker was employed with the same employer three years before separation, we control for worker's admission year in the firm. In the year prior to displacement the worker must have at least two years of tenure with the employer.

Furthermore, a worker must report positive earnings at least once thereafter, and have known information on their age, gender and education. The sample was restricted to full-time wage earners in the private non-farm sector aged between 20 and 49 years during the final year of the screening period and that were employed in a firm with at least 20 employees (these exclusions reduced the sample size by 21%).

To construct the estimation sample, we proceed as follows. We separate the sample into a control and a treatment group for each possible year of displacement (all years between 2002 and 2006). For example, the 2002 treatment group comprises individuals who were working in 2002 and experienced a displacement event between years 2002 and 2003 (the firm closed down between November 2002 and September 2003).[8] The 2002 control group is the one with those who did not experience any separation between October 2002 and September 2003.

For estimation purposes we define a measure of time relative to the displacement event ($D_0$). For example, we define $D_0$ in 2002 for the 2002 displaced group, $D_0$ in 2003 for the 2003 displaced group, and so on. The data set combines five cohorts (2002-2006) ranging from $D_{-6}$ up to $D_6$.[9]

As mentioned above, the sample includes all displaced individuals who are employed in the year of the displacement $D_0$ and at least two periods before displacement ($D_{-2}$) and who are present in the QP registers in at least one year of the post-displacement period. Table 1 reports the number of displacement events in each year. 11,399 displaced due to firm closure and 31,542 displaced due to collective dismissals meet these conditions.

After excluding those observations with missing values in the explanatory variables and the extreme values in wages, we obtained a control group composed of 2,811,367 non-displaced worker/year and 91,547 displaced worker/year resulting from firm closure and 253,267 displaced worker/year due to collective dismissals and 201,893 displaced worker/year due to individual dismissals. Table 2 reports the number of

[8] Thus, a worker should be identified as displaced in year t if (s)he was employed in year t-1 and experienced a separation between year t-1 and t.

[9] It should be noticed that worker files are not available for the year 2001.

Table 1: Displacement events in the reference period, 2002-2006

| Year | Firm closure | Collective dismissals | Individual dismissals |
|---|---|---|---|
| 2002 | 2591 | 9755 | 7552 |
| 2003 | 2121 | 6593 | 5448 |
| 2004 | 2008 | 5368 | 4638 |
| 2005 | 3100 | 6250 | 3806 |
| 2006 | 1579 | 3576 | 3084 |
| 2002-2006 | 11,399 | 31,542 | 24,528 |

Notes: This table reports the number of displacement spells per year resulting from firm closure, collective dismissals and individual dismissals, that meet the conditions. The sample includes all displaced individuals who are employed in the year of the displacement $D_0$ and at least two periods before displacement ($D_{-2}$) and who are in employment in at least one year before the end of the sample period.

Table 2: Sample composition, 1997-2008

| | | Displaced | | |
|---|---|---|---|---|
| Year | Non-displaced | Firm closure | Collective dismissal | Individual dismissal |
| 1997 | 222576 | 7379 | 20503 | 15508 |
| 1998 | 242560 | 7764 | 21812 | 17069 |
| 1999 | 274808 | 9249 | 25566 | 20056 |
| 2000 | 308367 | 9547 | 26000 | 20485 |
| 2002 | 308006 | 11312 | 31455 | 24524 |
| 2003 | 247774 | 7621 | 21864 | 18027 |
| 2004 | 241190 | 7374 | 20039 | 16722 |
| 2005 | 242018 | 7576 | 20373 | 16675 |
| 2006 | 235030 | 6903 | 18734 | 16420 |
| 2007 | 226502 | 8012 | 22489 | 17613 |
| 2008 | 262536 | 8810 | 24432 | 18794 |
| 1997-2008 | 2,811,367 | 91,547 | 253,267 | 201,893 |

Notes: This table reports the sample composition in terms of non-displaced and displaced workers resulting from firm closure, collective dismissals and individual dismissals, by year.

worker/years in the sample, namely non displaced workers, workers displaced due to firm closure and workers displaced due to collective dismissals. To clarify the link between the two tables we focus on firm closures occurring on 2002. 2591 workers were displaced in 2002 due to firm closures. The difference between 11312 and 2591 were individuals that experienced a displacement event due to firm closures after 2002 and were observed in the pre-displacement period.

Table 6 in Appendix B presents the descriptive statistics of the key variables in the data set in the reference year. The statistics are presented separately for the group of displaced and non-displaced workers. Displaced workers are slightly younger, with fewer years of education and tenure in comparison with their non-displaced counterparts. Moreover, the proportion of women is higher in both groups of displaced workers when compared with the group of non-displaced. As expected, firms that close down are smaller and are mainly operating in the sectors of manufacturing and wholesale and retail trade.

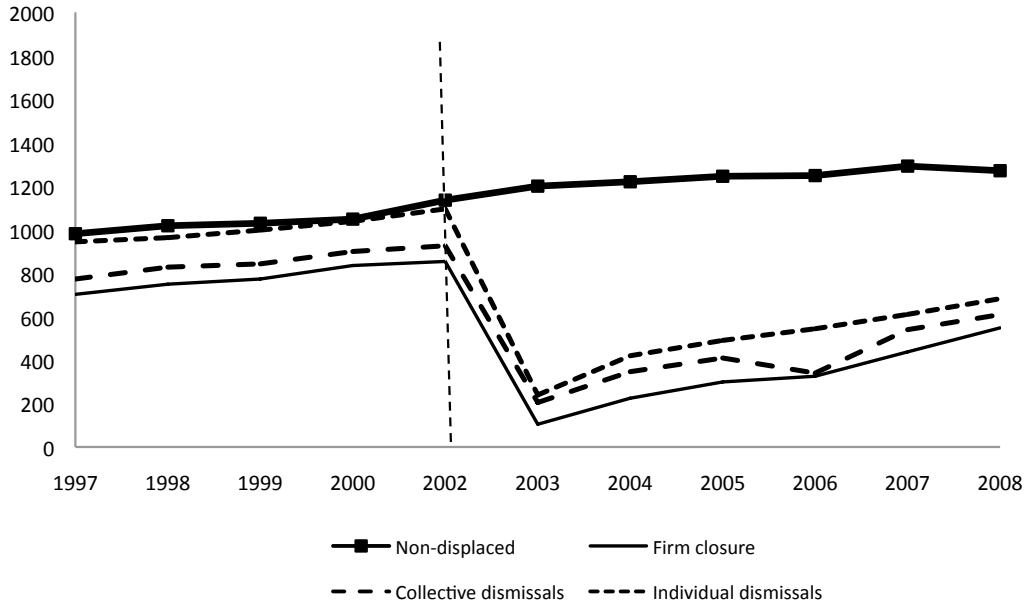
A simple descriptive statistics comparison suggests that displaced workers experienced substantial long-term monthly earnings losses. As shown in Figure 1, the average monthly earnings of workers that separated in 2002 fell sharply in comparison with their non-displaced counterparts.

### 4.3 Identification of displacements due to firm closure

The data set has a longitudinal dimension, which makes it particularly well suited for analyzing the issues of firms' entry and exit. Each firm entering the database is assigned a unique identifying number and the Ministry implements several checks to ensure that a firm that has already reported to the database is not assigned a different identification number. Using this identifier it is possible to pinpoint all firms that have entered and exited economic activity. In particular, an exit from the database should signal a firm that has ceased its activity.[10]

[10]This criteria, however, is not entirely accurate, due to the fact that some of the firms may temporarily exit the database. A temporary exit may occur for a number of reasons other than cessation of activity, a very likely reason being that the survey form was not received in the Ministry

Figure 1: **Monthly earnings of workers separating in year 2002 and non-displaced workers**




Notes: Average monthly earnings (2008 Euros).

To ensure that we are in the presence of firms' true closures and not mergers or acquisitions, we also excluded from the sample those workers that appeared in the database in the period following displacement with a year of admission in the new job less than the year of displacement minus one.[11] These exclusions reduced the sample size by around 0.1%.

Within the reference period, some individuals observe successive spells of firm closure in firms that are necessarily different. For identification purposes, we only

of Employment before the date when the recording operations were closed. Almost all of these temporary exits last less than two years, but can still cause an identification problem if they occur in the terminal years. In order to account for this problem, the information on the last two years after displacement was used solely to control for temporary exits in the intermediate years. Thus, a firm is classified as an exiting firm in year t+1 if it is present in year t, but absent in t+1 and t+2.

[11] If, for example, a worker's displacement year is 2002 and (s)he appears in the database in the post-displacement period with a year of admission in the new job of 2001 or earlier, (s)he is excluded from the sample.

used information from the first firm closure within the reference period. Thus, only the first firm closure is used to identify a displacement and the years before and after are used relative to that year of displacement. Thus, the group of displaced workers due to firm closure includes 5 cohorts of workers that lost their jobs between 2002 and 2006.

### 4.4 Identification of displacements due to collective dismissal

To identify a displacement due to a collective dismissal we follow the identification strategy used by Jacobson et al. (1993) and Couch and Placzek (2010). An individual is displaced due to a collective dismissal between t and t+1 if the firm's employment dropped between year t and year t+1, 30 percent or more below its level at year t. The group of displaced workers due to collective dismissal includes 5 cohorts of workers that lost their jobs between 2002 and 2006.

When calculating these employment changes, the magnitude of the flows is much more volatile for small employers. For this reason, and following again Jacobson et al. (1993) and Couch and Placzek (2010), those working for employers with fewer than 20 employees are removed from the sample.

Within the reference period, some individuals observe successive spells of collective dismissals in firms that are necessarily different. For identification purposes, we only used information from the first collective dismissal within the reference period. Thus, only the first collective dismissal is used to identify a displacement and the years before and after are used relative to that year of displacement.

### 4.5 Identification of individual dismissals

To identify an individual dismissal we follow the identification strategy used by Jacobson et al. (1993) and Couch and Placzek (2010). A worker is displaced due to an individual dismissal between t and t+1 if he separated from a firm where there was no mass layoff or firm closure. The group of displaced workers due to an individual dismissal includes 5 cohorts of workers that separated from their jobs between 2002

and 2006.

When calculating these employment changes, the magnitude of the flows is much more volatile for small employers. For this reason, and following again Jacobson et al. (1993) and Couch and Placzek (2010), those working for employers with fewer than 20 employees are removed from the sample.

Within the reference period, some individuals observe successive spells of individual dismissals in different firms. For identification purposes, we only used information from the first separation within the reference period. Thus, only the first individual dismissal is used to identify a separation and the years before and after are used relative to that year of separation.

### 4.6 Identification of non-displaced workers

The group of non-displaced workers (the control group) includes all individuals that were employed at year t in a firm that did not close in year t+1 and the firm's employment did not drop 30 percent or more and they were not subject to an individual dismissal. The group of non-displaced workers was also restricted to full-time wage earners in the private non-farm sector aged between 20 and 49 years during the final year of the screening period with at least 3 years of tenure and that were employed in a firm with at least 20 employees.

In order to guarantee that the worker was employed with the same employer in the pre-displacement period, we checked the firms identifying number assigned to the worker over that period. These workers were followed over the post-displacement period if they remained with the same employer over that period. Thus, to be included in the sample the worker should appear in at least one of the years between t+1 and t+6.

# 5 Empirical strategy

This section is divided into three sub-sections. The first presents the methodology used by Jacobson et al. (1993). In the second we explore the empirical model with controls for worker, firm and job title observed and unobserved permanent heterogeneity. Later in this section, we show how to disentangle the independent contribution of each fixed effect to the wage losses of displaced workers, using the methodology developed in Gelbach (2010).

## 5.1 Jacobson et al. (1993) statistical specifications

To evaluate the effect of displacement on earnings we use the methodological framework used by Jacobson et al. (1993). The first statistical specification assumes that workers' earnings at a given time period depend on displacement and on some controls for fixed and time-varying characteristics:

$$w_{it} = \alpha_i + \gamma_t + \beta X_{it} + \sum_{k \geq -m} D_{it}^k \delta_k + \epsilon_{it} \tag{1}$$

where $w_{it}$ represents the earnings (in euros) for each individual $i$ in year $t$. Labor earnings are taken as zero whenever the individuals are out of work. $\delta_k$ represents the effect of displacement on worker's earnings k years prior to, and following, its occurrence, the worker fixed effect, $\alpha_i$, captures the impact of permanent differences among worker's observed and unobserved characteristics, and $\gamma_t$ are calendar year fixed effects and they are included to capture the general aggregate time pattern of earnings in the economy. Finally, the vector $X_{it}$ controls for age and age squared. $\epsilon_{it}$ is an error term, assumed to be uncorrelated with the covariates.

Jacobson et al. (1993) used another specification to allow for the possibility that workers have different trend rates of earnings and firms react to these patterns, firing or hiring workers with specific trends. This is modeled by the following equation:

$$w_{it} = \alpha_i + \omega_i t + \gamma_t + \beta X_{it} + \sum_{k \geq -m} D_{it}^k \delta_k + \epsilon_{it} \quad (2)$$

In equation (2) we add to equation (1) a set of "worker-specific time trends", $\omega_i t$.[12]

### 5.2 The three-way high-dimensional fixed effects regression model

As discussed above, the main contribution of this study is to decompose the earnings losses due to job displacement into its main sources. To do so the JLS methodology is extended by incorporating firm and job title fixed effects in the wage equation defined in (1) and (2). This extension is made for the monthly wage and discards observations where labor earnings are zero.

In fact, the QP data set provides a rich set of information that enables us to identify firms and job titles. Each firm entering the database is assigned a unique identification number, which allows tracking them over the years. Furthermore, for each worker we are able to identify the occupational category in each collective agreement.

It is worth noting that the Ministry of Employment collects the QP data in order to check if employers are complying with the wage floors agreed upon for each occupational category. The collective agreement defines wage floors for each job title (called *categoria profissional*). On average, the collective agreement defines the wage floor for around 100 job titles. Overall, in a given year, one can classify each worker according to about 30,000 job title collective agreement combinations.[13]

Thus, we are confident that by incorporating job title fixed effects in the wage regression we can account well for job title heterogeneity, and by so doing, we should

[12]This specification is estimated by replacing the dependent variable, the time dummies, the Xs, and the displacement dummies by deviations from worker-specific time trends in these variables. In a second step we estimate the resulting model with the detrended variables using ordinary least squares (OLS).

[13]It should be noticed that workers in the same occupational category may have different wages, as they are covered by a different collective agreement, e.g., a secretary in the banking industry agreement, as opposed to a secretary in the retail trade collective agreement.

be able to provide refined estimates (filtered from job title heterogeneity) of worker and firm fixed effects.

The baseline specification is:

$$w_{ijft} = \alpha_i + \theta_f + \lambda_j + \gamma_t + \beta X_{it} + \epsilon_{ijft} \tag{3}$$

where $\alpha_i$ is a worker fixed effect, $\theta_f$ is a firm fixed effect and $\lambda_j$ is a job title fixed effect. $w_{ijft}$ represents the monthly wage for each individual $i$ in job $j$ working for firm $f$ in year $t$. $X_{it}$ controls for age and age squared for each individual i in year t, $\gamma_t$ are calendar year fixed effects, $\epsilon_{ijft}$ is assumed to follow the conventional assumptions.

In order to estimate this model that incorporates three high-dimensional fixed effects we need to use a modified version of the methodology initially developed by Abowd et al. (1999) and Abowd et al. (2002).

In matrix format, the stacked system has the following form:

$$\mathbf{W} = \alpha\mathbf{F_1} + \theta\mathbf{F_2} + \lambda\mathbf{F_3} + \phi\mathbf{Z} + \epsilon \tag{4}$$

In this equation, $F_1$, $F_2$, and $F_3$ are high-dimensional matrices for the worker, firm and job fixed effects, respectively. $Z$ is a matrix of the explanatory variables and calendar year fixed effects from equation (3).

The least squares estimator of $\phi$, $\alpha$, $\theta$, and $\lambda$ solve the following equations:

$$\begin{bmatrix} Z'Z & Z'F_1 & Z'F_2 & Z'F_3 \\ F_1'Z & F_1'F_1 & F_1'F_2 & F_1'F_3 \\ F_2'Z & F_2'F_1 & F_2'F_2 & F_2'F_3 \\ F_3'Z & F_3'F_1 & F_3'F_2 & F_3'F_3 \end{bmatrix} \begin{bmatrix} \phi \\ \alpha \\ \theta \\ \lambda \end{bmatrix} = \begin{bmatrix} Z'W \\ F_1'W \\ F_2'W \\ F_3'W \end{bmatrix} \tag{5}$$

It is computationally difficult to invert the left matrix due to the large number of workers, firms, and job titles. Herein we use an iterative solution that alternates between estimation of $\phi$, $\alpha$, $\theta$, and $\lambda$.

$$\begin{bmatrix} \phi \\ \alpha \\ \theta \\ \lambda \end{bmatrix} = \begin{bmatrix} (Z'Z)^{-1}Z'(W - \alpha F_1 - \theta F_2 - \lambda F_3) \\ (F_1'F_1)^{-1}F_1'(W - \theta F_2 - \lambda F_3 - \phi Z) \\ (F_2'F_2)^{-1}F_2'(W - \alpha F_1 - \lambda F_3 - \phi Z) \\ (F_3'F_3)^{-1}F_3'(W - \alpha F_1 - \theta F_2 - \phi Z) \end{bmatrix}$$

It is clear from the previous equations that at each iteration the fixed effects are simply computed as averages of the residuals. For an example, $(F_3'F_3)^{-1}F_3'$ is simply a demeaning operator for the job title fixed effect. The iteration protocol was developed by Guimarães and Portugal (2010). The iterative solution alternates between estimation of $\phi$, $\alpha$, $\theta$, and $\lambda$ and proceeds as follows. First, the algorithm makes use of the Frish-Waugh-Lovell theorem to remove the influence of the three high-dimensional fixed effects from each individual variable. Through the recursive algorithm the current value of $\phi$ can be used to estimate the current value of $\alpha$. In estimating $\theta$ the previous values of $\phi$ and $\alpha$ are used. In estimating $\lambda$ the previous values of $\theta$, $\phi$, and $\alpha$ are used. Then the algorithm restarts and will converge because the parameter updates are chosen according to the equations in (5). Next, we estimate the regression using the transformed variables with a correction to the degrees of freedom. This approach yields the exact least squares solution for the coefficients and standard errors.

The fixed effects in equation (3) were estimated using the complete data set that covers the employed population in the private sector in Portugal with all available information from 1986 to 2008. The identification problem for the worker, firm and job title effects was circumvented by applying the algorithm by Abowd et al. (2002) and an extension of the state code provided by Cornelissen (2008) to the three fixed effects, based on graph theory to determine groups of connected individuals, firms and job titles. A connected group exists when at least one element of a worker, job title and firm links the rest of the group. The largest connected group represents more than 99% of the sample.

### 5.3 Individual unobserved fixed effect contribution

It is possible to calculate the independent contribution of each unobserved fixed effect to the monthly wage losses of displaced workers. We use the methodology developed in Gelbach (2010), which appeals to the omitted variables bias formula to compute a detailed decomposition.

To illustrate Gelbach's decomposition, we use the base model with no fixed effects:

$$w_{it} = \gamma_t^{base} + \beta^{base} X_{it} + \sum_{k \geq -m} D_{it}^k \delta_k^{base} + \epsilon_{it}^{base} \tag{6}$$

where $\delta_k^{base}$ are the relevant coefficients. This equation has omitted variables bias. It is also necessary to represent the full model with the three fixed effects:

$$w_{ijft} = \hat{\alpha}_i + \hat{\theta}_f + \hat{\lambda}_j + \gamma_t^{full} + \beta^{full} X_{it} + \sum_{k \geq -m} D_{it}^k \delta_k^{full} + \epsilon_{ijft}^{full} \tag{7}$$

This equation adds the three fixed effects to the base model. The base-full difference equals the sample analogue of the omitted variables bias formula. Gelbach's algorithm allows us to decompose the difference $\delta_k^{base} - \delta_k^{full}$ into the separate effect deriving from each excluded variable (each fixed effect). The algorithm is as follows: use ordinary least squares to estimate the vector of coefficients on each covariate in the base model in a set of auxiliary models with each of the three covariates $\hat{\alpha}_i$, $\hat{\theta}_f$, and $\hat{\lambda}_j$ acting as the dependent variable; this estimate is $\hat{\tau}_k^{\alpha}$, $\hat{\tau}_k^{\theta}$, and $\hat{\tau}_k^{\lambda}$, respectively, for each of the fixed effects.

This algorithm results in decomposing the difference $\delta_k^{base} - \delta_k^{full} = \hat{\tau}_k^{\alpha} + \hat{\tau}_k^{\theta} + \hat{\tau}_k^{\lambda}$, for each time period $k$.

In summary, the decomposition proposed by Gelbach is a computationally simple and econometrically meaningful procedure that takes advantage, in a surprisingly ingenious way, of the conventional OLS omitted variable bias formula. If the base specification is a parsimonious useful benchmark, and in our case it is simply a conditional gross measure of the displacement wage rate losses, the decomposition is also

economically meaningful, providing an unambiguous measure of the contribution of each omitted variable (each fixed effect) to the change in the original coefficients of the displacement dummies. For example, the fact that the inclusion of firm fixed effects contributes to decrease the wage loss of displaced workers, simply accounts for the evidence that displaced workers tend to sort themselves into firms that pay, on average, lower wages. When we compare the impact of firm fixed effects before and after displacement, we are simply isolating the dominant influence of movements from higher paying firms into lower paying firms. A similar interpretation applies to the role of job-title fixed effects.

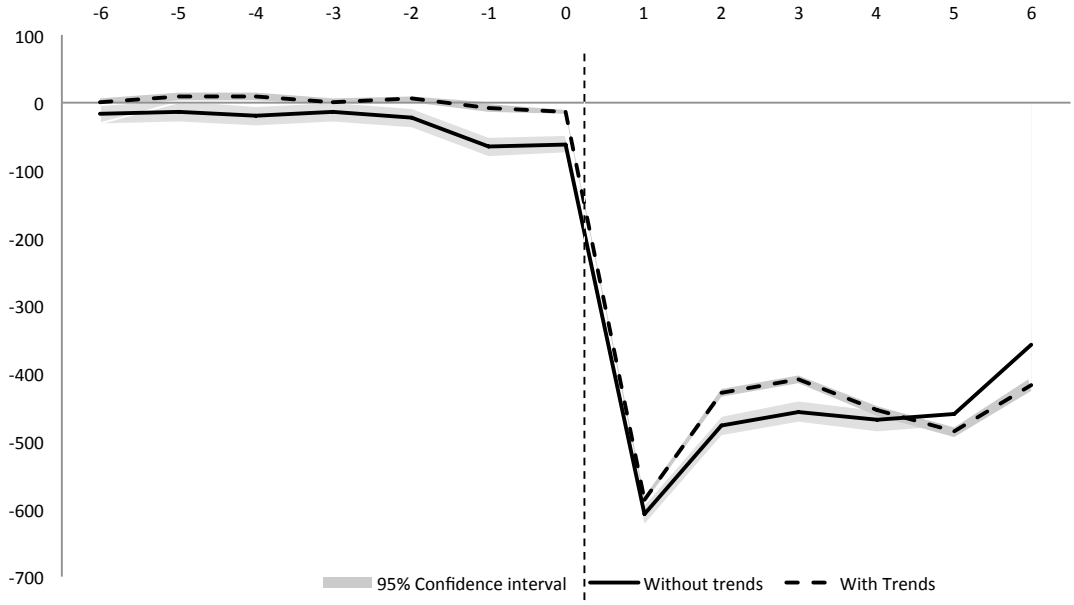
# 6 Empirical Results

The results from the estimation of the JLS model, described in equations (1) and (2), are summarized in Figure 2. In accordance with the individual trend specification, the monthly earnings losses amount to 587 Euros (72 percent of average pre-displacement wages) 1 year after the shutdown of the firm, and are attenuated to 416 (51 percent), 6 years after displacement.[14]

The size of the loss is largely driven by the joblessness experience of the displaced workers, where, in accordance with JLS, labor earnings are taken as zero whenever the individuals are out of work. The upswing of earnings after the first year of displacement is generated mostly by the reemployment of workers. Conditional on being displaced and returning, 18 percent of the individuals return in the first year, 27 percent return after 2 years, 23 percent return after 3 years, 14 percent return after 4 years, 11 percent return after 5 years, and 7 percent return after 6 years. Indeed, the impact of reemployment in earnings recovery more than offsets the significant monthly wage rate of displaced workers documented below. Note that the estimates produced by the fixed effects and the random trend models are identical, as in Couch

[14]As for the fixed-effects specification, the monthly earnings losses amounted to 608 euros (74 percent of average pre-displacement wages) 1 year after the shutdown of the firm, and decreased to 356 (44 percent), 6 years after displacement.

Figure 2: **Monthly earnings loss of displaced workers due to firm closure**

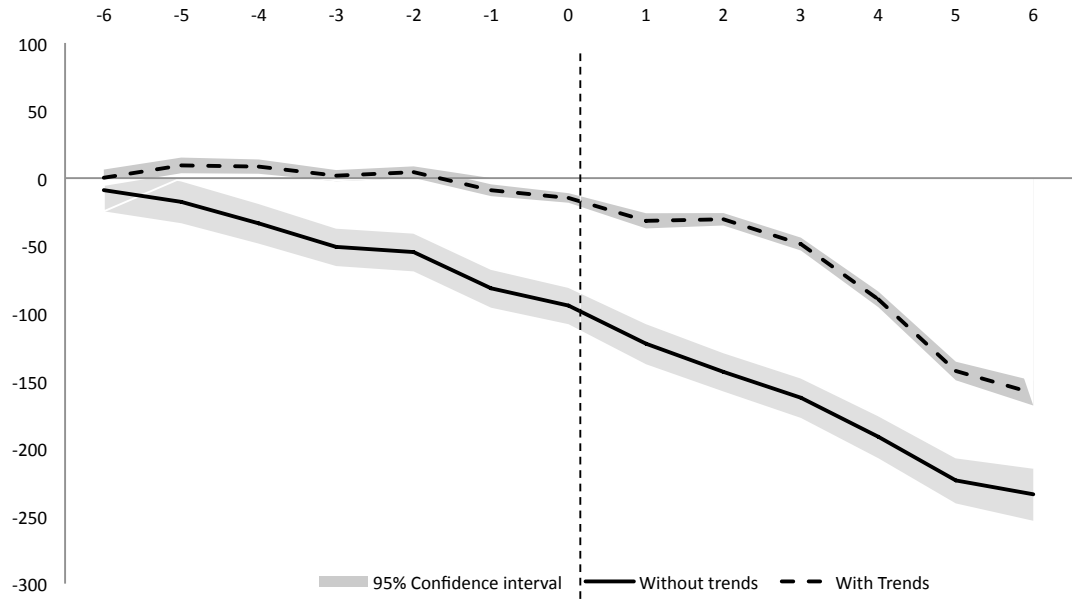



Notes: Monthly earnings losses, including zeros (2008 Euros). In the horizontal axis, the relative time to firm closure is plotted in years. In the regressions we control for age and age squared and calendar year fixed effects.

and Placzek (2010). In contrast with Jacobson et al. (1993) but in line with Couch and Placzek (2010), we fail to observe a severe earnings dip prior to displacement. In our individual-trend specification there is no indication that earnings had fallen before the firm closure. For the fixed-effects specification, however, there is some evidence that earnings fell modestly.

The results from the estimation of the deepen analysis from equations (1) and (2) therefore excluding the joblessness events are summarized in Figure 3. When we restrict our analysis to the profile of monthly wages before and after displacement, we find that wage rates started declining one year before the shutdown of the firm and continued to decline for up to five years after firm closure, reaching 17 percent (27 percent) in the case of the random trend (fixed effects) specification. At least

Figure 3: **Monthly wage loss of displaced workers due to firm closure**

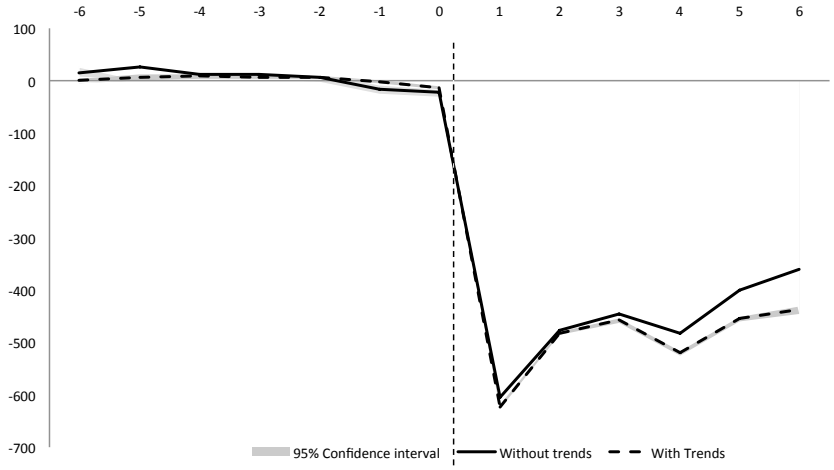



Notes: Monthly wage losses, excluding zeros. In the horizontal axis, the relative time to firm closure is plotted in years. In the regressions we control for age and age squared and calendar year fixed effects.

three mechanisms may be a work. First, it may be that workers who found relatively higher wage offers returned earlier to employment. Second, longer joblessness duration may have impaired the human capital of displaced workers. And third, it may take some time for unemployed individuals to realize that their expectations about the relevant wage offer distribution is unrealistic, in particular in a labor market where the potential duration of unemployment benefits is very generous (reaching up to 57 months).

When we repeat the same exercise for collective dismissals, we find broadly similar results (see Figure 4). One year after the separation, earnings fell by 631 Euros (605 Euros), which corresponds to 69 percent (67 percent) of average earnings, for the random trend (fixed effects) specification. Conditional on returning, 16 percent of

Figure 4: **Monthly earnings loss of displaced workers due to collective dismissals**

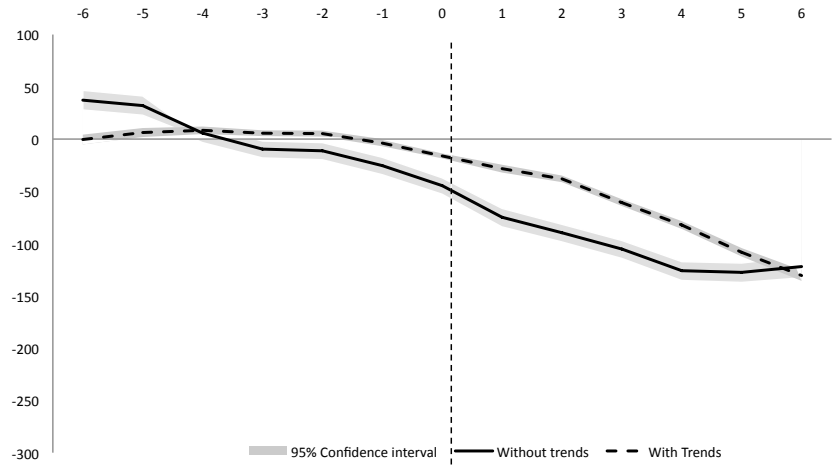



Notes: Monthly earnings losses, including zeros (2008 Euros). In the horizontal axis, the relative time to separation through a collective dismissal is plotted in years. In the regressions we control for age and age squared and calendar year fixed effects.

the individuals return in the first year, 23 percent return after 2 years, 21 percent return after 3 years, 16 percent return after 4 years, 14 percent return after 5 years, and 10 percent return after 6 years. Here, not even a small fall on earnings prior to separation is observed. The overall shape of the evolution of wage rates again mimics those observed for firm closures, even if the fall is not as large (see Figure 5). Wage rates decline 14 percent for the random trend model and 14 percent for the fixed-effects model, six years after displacement.

Figures 6 and 7 replicate the previous exercise using a third sample group based on workers that separated due to an individual dismissal. Workers displaced due to a collective dismissal contrast with the ones from individual dismissals because their separation is by definition involuntary. One year after the separation, monthly earnings fell by 721 Euros (606 Euros), which corresponds to 54 percent (64 percent) of average earnings, for the random trend (fixed effects) specification. The fall in

Figure 5: **Monthly wage loss of displaced workers due to collective dismissals**



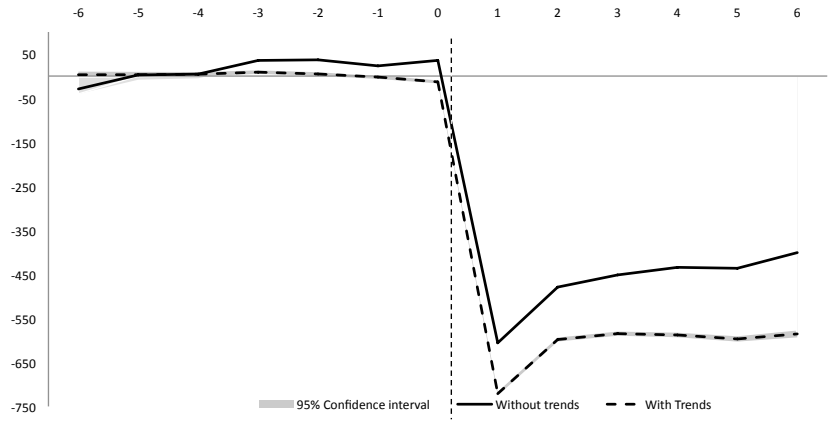

Notes: Monthly wage losses, excluding zeros. In the horizontal axis, the relative time to separation through a collective dismissal is plotted in years. In the regressions we control for age and age squared and calendar year fixed effects.

percentage was smaller for this group. In Figure 7 one year after displacement workers that lost their job due to an individual dismissal observed a virtually no change in their monthly wages. Only after the third year their monthly wages start falling. Thus, the loss in earnings was made almost entirely through the joblessness spell.

To better understand the nature of the wage rate changes that affected displaced workers in comparison to non-displaced workers, we turn to the estimation of the three-way high-dimensional fixed effects regression model as given in equation (3). Computation of the three fixed effects is based on all the wage earners observed between 1986 and 2008, corresponding to 28,212,770 observations. The interpretation of the parameters of this model is straightforward and the decomposition exercise enabled by it, that is, the role of worker, firm, and job title heterogeneity - is discussed at length by Torres et al. (2012).

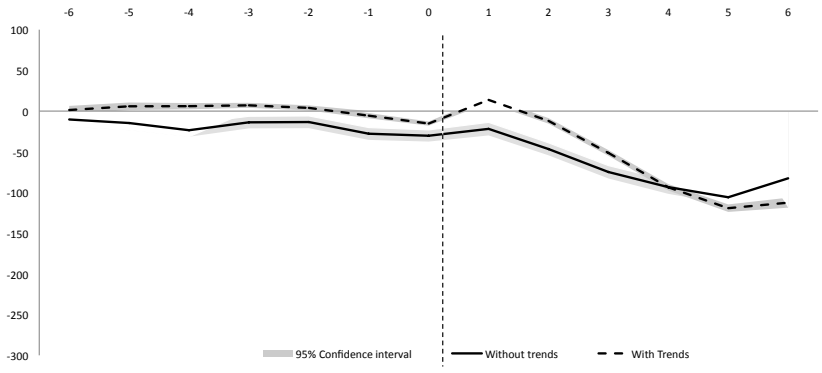
After restricting the data set to the group of displaced workers due to firm closure and their control group of non-displaced workers, we end up with a longitudinal sample

Figure 6: **Monthly earnings loss of displaced workers due to individual dismissals**




Notes: Monthly earnings losses, including zeros (2008 Euros). In the horizontal axis, the relative time to separation through an individual dismissal is plotted in years. In the regressions we control for age and age squared and calendar year fixed effects.

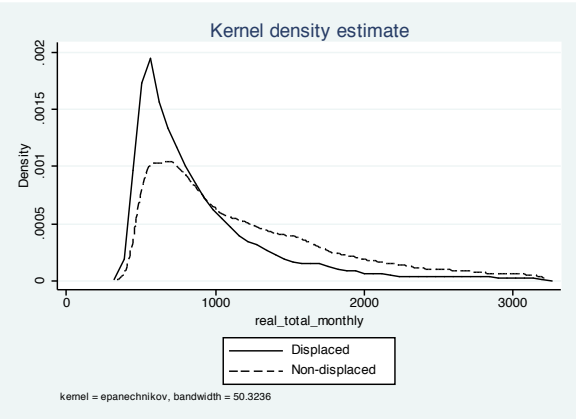
Figure 7: **Monthly wage loss of displaced workers due to individual dismissals**



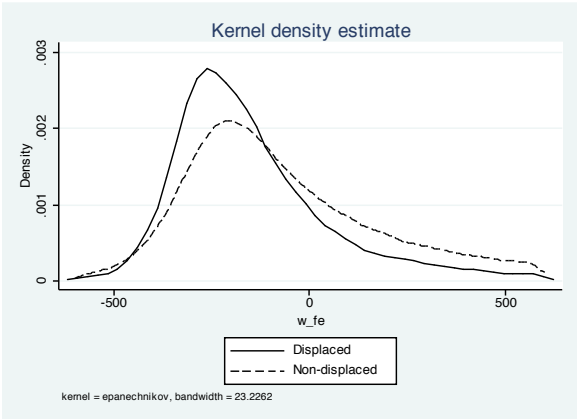

Notes: Monthly wage losses, excluding zeros. In the horizontal axis, the relative time to separation through an individual dismissal is plotted in years. In the regressions we control for age and age squared and calendar year fixed effects.

of 2,811,367 worker-year observations. We start by graphing the empirical (log)wage distributions of workers displaced due to firm closures and their non-displaced counterparts in Figure 8 (a). It is clear that the wages of displaced workers are lower (28 percent, on average) and less dispersed when compared with those of the non-displaced. The overall shape of the wage distribution can be better understood by looking at the distributions of the worker, firm, and job title fixed effects.

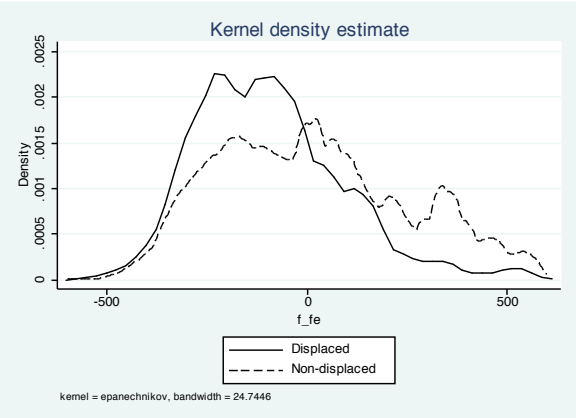
Figure 8: **The empirical distribution of wages pre-displacement (reference year $D_0$)**



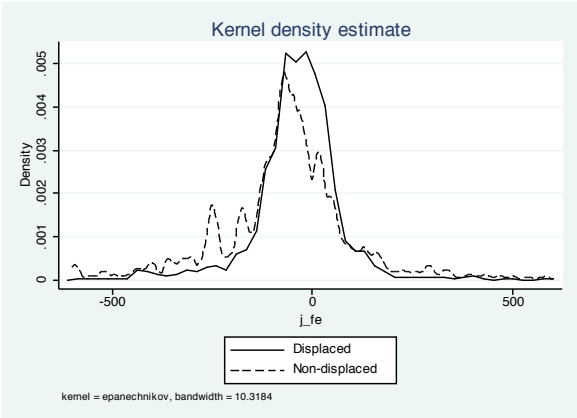

**(a) Monthly wage distribution**




**(b) Worker permanent heterogeneity**




**(c) Firm permanent heterogeneity**




**(d) Job title permanent heterogeneity**

Notes: This figure plots the empirical distributions of different variables before displacement of workers displaced due to firm closures and their non-displaced counterparts (reference year $D_0$).

Figure 8 (b) depicts the empirical distribution of permanent worker heterogeneity, both observed (such as gender or schooling) and unobserved. A high worker fixed effect (high-wage worker) is an individual with total compensation higher than expected on the basis of observable time-varying regressors and for the heterogeneity of firms and job titles. A distinction is made between continuing and destroyed matches due to firm closures. The graph is based on the estimation of 409,687 worker fixed effects. Not surprisingly, the shape of the distributions closely resembles the distributional shape of log wages. The linear correlation between log wages and worker fixed effects is 0.75. From comparison between displaced and non-displaced workers it is clear that those workers who exited their firms have permanent (observed and unobserved) characteristics that are associated with significantly lower wages.

Less well studied is the heterogeneity of wage policies across firms. In Figure 8 (c) we present the empirical distribution of the 33,390 firm fixed effects. A high firm fixed effect (high-wage policy from the firm) is a firm with total compensation higher than expected on the basis of observable time-varying regressors and for the heterogeneity of workers and job titles. The role of firm heterogeneity on wage formation is quite important. The linear correlation coefficient between log wages and firm fixed effects is no less than 0.69. Not surprisingly, the comparison between the two distributions shows that displaced workers earned much lower wages in large part because the firms from which they separated exhibited a less generous wage policy. On average the firm fixed effect attached to those displaced workers is 63% less than those of the control group.

The heterogeneity of job title fixed effects is likely to be generated by variations across occupations and skills and by differences across collective wage agreements. As discussed above, the notion of job title comes simply from the identification of distinct occupational categories within each collective wage agreement. Over the years of the survey we could estimate 46,295 job title fixed effects. A high job title fixed effect (job title premium) is a job title with total compensation higher than expected on the basis of observable time-varying regressors and for the heterogeneity of workers and

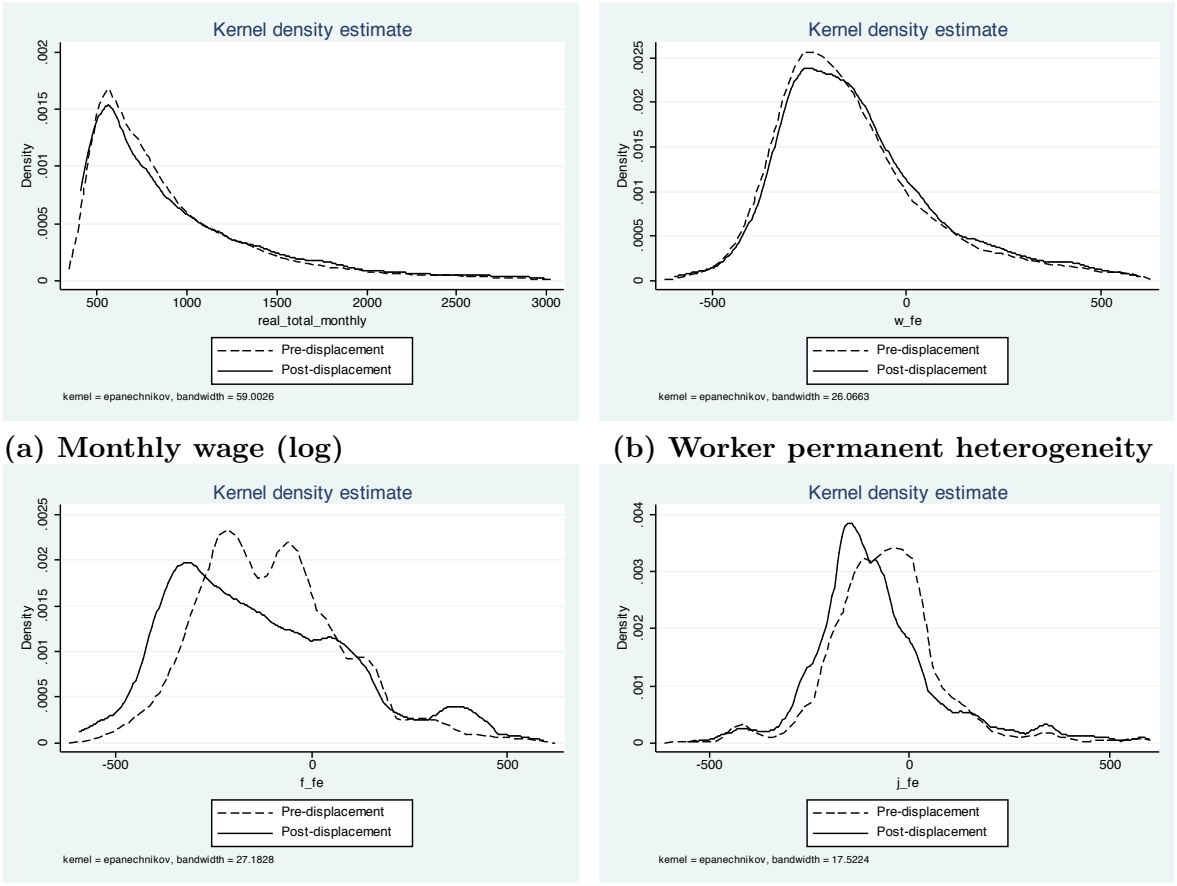
firms. Job title heterogeneity has a non-trivial impact on the determination of wages. The linear correlation between job title fixed effects and wages is a respectable 0.45. From panel (d) in Figure 8 it is clear that prior to firm closure displaced workers filled positions that were paid above those of the non-displaced.

In Figure 9 we compare the distribution of wages (and its components) of displaced workers before and after displacement. Panel (a) of the figure shows that the distribution of wages was displaced to the left, evincing significant wage losses associated with firm closures. Panel (b) exhibits the worker fixed effect distribution. Except for the self-selection generated by different timing of reemployment, the two distributions should coincide exactly, which for the most part they do, suggesting that the time profile of reemployment is not a serious concern, at least in the worker heterogeneity dimension. Panels (c) and (d) both reveal that workers moved to lower paying firms and job titles, especially, in the right tail of the two distributions.

To investigate how the coefficient estimates of the displacement dummies change with the inclusion of three fixed effects we implemented the conditional decomposition method suggested by Gelbach (2010), discussed above. As hinted earlier, this procedure allows us to unambiguously disentangle the contribution of each excluded variable (each fixed effect) to the change in the coefficient estimate of the variables under scrutiny.

The results of the Gelbach decomposition are seen in Table 3. The first two columns of the table give the coefficient estimates for the benchmark OLS regression and for a regression that includes, in addition, the three fixed effects. Thus, in the fourth line of the tables we can see that three years prior to the shut-down of the firm, displaced workers received wages that were 298.7 euros below those of the non-displaced. Once we account for worker, firm, and job title fixed effects, the remaining unexplained difference in wages falls to -18.4 euros. This means that the inclusion of the fixed effects accounts for 280.3 euros of the difference between the wages of displaced and non-displaced workers, where 141.9 euros are accounted for by the worker fixed effect, 184 euros are accounted for by the firm fixed effect, and 46.2

Figure 9: **The empirical distribution of wages of displaced workers: pre- and post-displacement**




**(a) Monthly wage (log)** **(b) Worker permanent heterogeneity**

**(c) Firm permanent heterogeneity** **(d) Job title permanent heterogeneity**

Notes: Displaced workers' density distributions one year before displacement and one year after displacement.

euros are accounted for by the job title fixed effect. On average, after displacement, the difference in wages is 61.1 percent (next to the last line). Worker heterogeneity is responsible for 20.4 percentage points, firm heterogeneity explains 33.6 percentage points, and 6.4 percentage points are related with job title heterogeneity, totaling 60.3 percentage points. When we look at average differences in the periods before and after displacement, we arrive at a wage loss of 22.1 percent (last line). The three fixed effects account for 20.6 percentage, which can be disentangled as 2 percentage

points due to worker composition, 8.2 percentage points due to sorting into lower paying firms, and 10.5 percentage points due to sorting into lower paying job titles.[15]

Table 3: **Decomposition of the wage loss - displaced workers due to firm closure**

| Period relative to displacement | Base OLS monthly wage | Full OLS monthly wage | $\delta_k^{base} - \delta_k^{full}$ | Worker fixed effect | Firm fixed effect | Job title fixed effect | checksum |
|---|---|---|---|---|---|---|---|
| $D_{-6}$ | -270.2 | 17.6 | -287.9 | -135.7 | -212.9 | 62.3 | -1.6 |
| $D_{-5}$ | -278.2 | 8.8 | -287.0 | -130.4 | -213.4 | 58.0 | -1.2 |
| $D_{-4}$ | -295.4 | -2.5 | -292.8 | -152.8 | -181.0 | 41.7 | -0.7 |
| $D_{-3}$ | -298.7 | -18.4 | -280.3 | -141.9 | -184.0 | 46.2 | -0.7 |
| $D_{-2}$ | -322.0 | 11.1 | -333.1 | -151.0 | -214.8 | 33.2 | -0.5 |
| $D_{-1}$ | -395.5 | -10.5 | -384.9 | -168.1 | -220.5 | 4.0 | -0.3 |
| $D_0$ | -376.1 | 32.1 | -408.2 | -172.8 | -229.1 | -6.1 | -0.1 |
| $D_1$ | -421.2 | -12.7 | -408.5 | -137.4 | -237.8 | -33.2 | -0.1 |
| $D_2$ | -492.6 | -6.1 | -486.5 | -178.8 | -253.0 | -54.6 | 0.0 |
| $D_3$ | -514.6 | 3.9 | -518.4 | -185.8 | -264.8 | -67.9 | 0.0 |
| $D_4$ | -574.7 | -10.1 | -564.6 | -198.8 | -300.5 | -65.4 | 0.1 |
| $D_5$ | -508.0 | 19.3 | -527.3 | -180.5 | -290.6 | -56.5 | 0.3 |
| $D_6$ | -492.3 | -35.4 | -456.9 | -119.3 | -302.3 | -35.4 | 0.1 |
| $D_{-6} - D_0$ | -319.4 | 5.4 | -324.9 | -150.4 | -207.9 | 34.2 | -0.7 |
| $D_1 - D_6$ | -500.6 | -6.8 | -493.7 | -166.8 | -274.8 | -52.2 | 0.1 |
| $\Delta$ | -181.1 | -12.3 | -168.8 | -16.4 | -66.9 | -86.3 | 0.8 |
| Results in percentage | | | | | | | |
| $D_{-6} - D_0$ | -39.0 | 0.7 | -39.7 | -18.4 | -25.4 | 4.2 | -0.1 |
| $D_1 - D_6$ | -61.1 | -0.8 | -60.3 | -20.4 | -33.6 | -6.4 | 0.0 |
| $\Delta$ | -22.1 | -1.5 | -20.6 | -2.0 | -8.2 | -10.5 | 0.1 |

Notes: This table reports the Gelbach decomposition of the three fixed effects of the wage loss of displaced workers. In the regressions we control for age and age squared and calendar year fixed effects. In each column, $D_{-6} - D_0$ is the computed average between the first seven lines ($D_{-6}$ to $D_0$). $D_1 - D_6$ is the computed average between the next six lines ($D_1$ to $D_6$). In the line $\Delta$ we compute the difference between the previous two lines. In the last three lines we compute the results in percentage by dividing the respective numbers by the average wage of displaced workers in the pre displacement period (819 euros).

This suggests that the most important factor driving the wage penalty of these displaced workers is the fact that they are reemployed into job categories (and or collective agreements) that are less generously remunerated. The unfavorable allocation into job titles accounts for roughly half of the total average wage loss. Sorting into firms also plays an important role, accounting for one third of the total average wage loss.

Workers in our sample affected by collective dismissals faced a much lower wage

[15]The contribution of the worker fixed effect can be taken as an indication that self-selection (at least the one that is based on the observable and unobservable permanent characteristics of the worker) does not play a dominant role.

penalty (12 pp) than those that suffered from a firm closure (see Table 14). As before, sorting into job titles is the most influential factor, accounting for 54 percent of the total average loss. The allocation into firms with different wage policies, however, explains 44 percent of the loss. Only a small part of the wage penalty (0.9 pp) could not be accounted for.

Table 4: **Decomposition of the wage loss - displaced workers due to collective dismissals**

| Period relative to displacement | Base OLS monthly wage | Full OLS monthly wage | $\delta_k^{base} - \delta_k^{full}$ | Worker fixed effect | Firm fixed effect | Job title fixed effect | checksum |
|---|---|---|---|---|---|---|---|
| $D_{-6}$ | -194.9 | 6.6 | -201.5 | -86.1 | -179.8 | 65.1 | -0.7 |
| $D_{-5}$ | -229.7 | -1.5 | -228.2 | -99.3 | -191.0 | 63.0 | -0.8 |
| $D_{-4}$ | -220.3 | -4.6 | -215.7 | -96.0 | -176.5 | 57.4 | -0.5 |
| $D_{-3}$ | -212.1 | -9.1 | -203.1 | -87.7 | -168.4 | 53.5 | -0.5 |
| $D_{-2}$ | -232.1 | 0.3 | -232.4 | -95.7 | -178.0 | 41.8 | -0.5 |
| $D_{-1}$ | -285.6 | -10.5 | -275.2 | -107.2 | -189.2 | 21.6 | -0.4 |
| $D_0$ | -277.0 | 26.5 | -303.5 | -117.4 | -196.0 | 10.2 | -0.3 |
| $D_1$ | -226.2 | -12.4 | -213.8 | -39.8 | -171.4 | -2.5 | -0.1 |
| $D_2$ | -307.8 | -14.4 | -293.4 | -80.5 | -201.3 | -11.6 | 0.0 |
| $D_3$ | -366.3 | -0.4 | -365.9 | -107.0 | -230.4 | -28.5 | 0.1 |
| $D_4$ | -459.7 | -0.3 | -459.4 | -145.1 | -277.0 | -37.4 | 0.1 |
| $D_5$ | -365.3 | -12.4 | -352.8 | -121.0 | -244.2 | 12.2 | 0.1 |
| $D_6$ | -342.2 | -4.8 | -337.4 | -111.8 | -235.1 | 9.3 | 0.1 |
| $D_{-6} - D_0$ | -236.0 | 1.1 | -237.1 | -98.5 | -182.7 | 44.7 | -0.5 |
| $D_1 - D_6$ | -344.6 | -7.4 | -337.1 | -100.9 | -226.5 | -9.7 | 0.0 |
| $\Delta$ | -108.6 | -8.6 | -100.1 | -2.4 | -43.8 | -54.4 | 0.6 |
| Results in percentage | | | | | | | |
| $D_{-6} - D_0$ | -26.1 | 0.1 | -26.2 | -10.9 | -20.2 | 4.9 | -0.1 |
| $D_1 - D_6$ | -38.1 | -0.8 | -37.3 | -11.1 | -25.0 | -1.1 | 0.0 |
| $\Delta$ | -12.0 | -0.9 | -11.1 | -0.3 | -4.8 | -6.0 | 0.1 |

Notes: This table reports the Gelbach decomposition of the three fixed effects of the wage loss of displaced workers. In the regressions we control for age and age squared and calendar year fixed effects. In each column, $D_{-6} - D_0$ is the computed average between the first seven lines ($D_{-6}$ to $D_0$). $D_1 - D_6$ is the computed average between the next six lines ($D_1$ to $D_6$). In the line $\Delta$ we compute the difference between the previous two lines. In the last three lines we compute the results in percentage by dividing the respective numbers by the average wage of displaced workers in the pre displacement period (905 euros).

Workers in our sample affected by individual dismissals faced an even lower wage penalty (8.5 pp) than those that suffered from a firm closure (see Table 5). Contrary to the previous results, sorting into firms is the most influential factor, accounting for 71 percent of the total average loss. The unfavorable allocation into job titles does not play a significant role in explaining the loss of these workers. Only a small part

Table 5: **Decomposition of the wage loss - displaced workers due to individual dismissals**

| Period relative to displacement | Base OLS monthly wage | Full OLS monthly wage | $\delta_k^{base} - \delta_k^{full}$ | Worker fixed effect | Firm fixed effect | Job title fixed effect | checksum |
|---|---|---|---|---|---|---|---|
| $D_{-6}$ | -45.0 | -24.2 | -20.8 | 32.4 | -86.8 | 34.2 | -0.5 |
| $D_{-5}$ | -33.2 | -18.7 | -14.4 | 39.5 | -88.6 | 34.8 | -0.2 |
| $D_{-4}$ | -4.9 | -13.5 | 8.6 | 46.1 | -65.6 | 27.9 | 0.2 |
| $D_{-3}$ | -32.7 | -21.5 | -11.2 | 29.1 | -69.5 | 29.3 | -0.1 |
| $D_{-2}$ | -29.1 | 0.8 | -29.9 | 24.6 | -81.9 | 27.8 | -0.4 |
| $D_{-1}$ | -76.4 | -22.0 | -54.3 | 16.4 | -89.9 | 19.5 | -0.4 |
| $D_0$ | -17.2 | 75.0 | -92.2 | -5.1 | -101.7 | 14.8 | -0.1 |
| $D_1$ | 44.1 | 4.1 | 40.1 | 92.0 | -91.8 | 39.9 | -0.1 |
| $D_2$ | -71.9 | -0.7 | -71.2 | 30.4 | -127.1 | 25.4 | 0.1 |
| $D_3$ | -142.8 | -10.6 | -132.2 | 9.0 | -153.5 | 12.2 | 0.1 |
| $D_4$ | -185.5 | -9.9 | -175.6 | -12.1 | -177.1 | 13.2 | 0.4 |
| $D_5$ | -218.2 | -12.6 | -205.6 | -31.2 | -182.1 | 7.2 | 0.5 |
| $D_6$ | -204.7 | 31.4 | -236.1 | -42.1 | -191.4 | -2.9 | 0.3 |
| $D_{-6} - D_0$ | -34.1 | -3.5 | -30.6 | 26.1 | -83.4 | 26.9 | -0.2 |
| $D_1 - D_6$ | -129.8 | 0.3 | -130.1 | 7.7 | -153.8 | 15.9 | 0.2 |
| $\Delta$ | -95.7 | 3.7 | -99.5 | -18.5 | -70.4 | -11.0 | 0.5 |
| Results in percentage | | | | | | | |
| $D_{-6} - D_0$ | -3.0 | -0.3 | -2.7 | 2.3 | -7.4 | 2.4 | 0.0 |
| $D_1 - D_6$ | -11.5 | 0.0 | -11.6 | 0.7 | -13.7 | 1.4 | 0.0 |
| $\Delta$ | -8.5 | 0.3 | -8.8 | -1.6 | -6.3 | -1.0 | 0.1 |

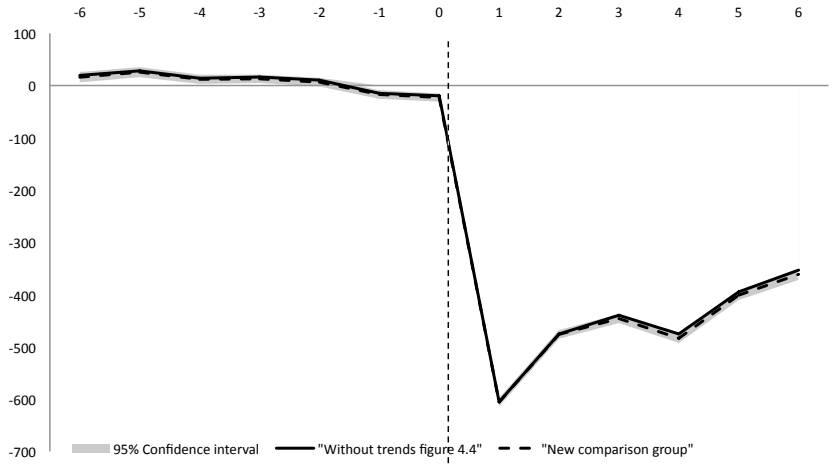
Notes: This table reports the Gelbach decomposition of the three fixed effects of the wage loss of displaced workers. In the regressions we control for age and age squared and calendar year fixed effects. In each column, $D_{-6} - D_0$ is the computed average between the first seven lines ($D_{-6}$ to $D_0$). $D_1 - D_6$ is the computed average between the next six lines ($D_1$ to $D_6$). In the line $\Delta$ we compute the difference between the previous two lines. In the last three lines we compute the results in percentage by dividing the respective numbers by the average wage of displaced workers in the pre displacement period (1126 euros).

of the wage penalty (0.3 pp) could not be accounted for.

## 6.1 Sensitivity of losses to comparison group

The idea to use a comparison group in the framework proposed by Jacobson et al. (1993) is to estimate the earnings changes that would have occurred if there was no displacement. Instead of using all non-displaced workers we can use the co-workers that were in the same firm where the displacement occurred. In this section we compare displaced workers' earnings to those of non-displaced workers in the same firm. These workers are a better comparison group because they are more similar to the displaced workers. In Figures 10 and 11 we replicate respectively Figures 4 and 6 using this new comparison group. We see that results are not affected by the use of this new comparison group.

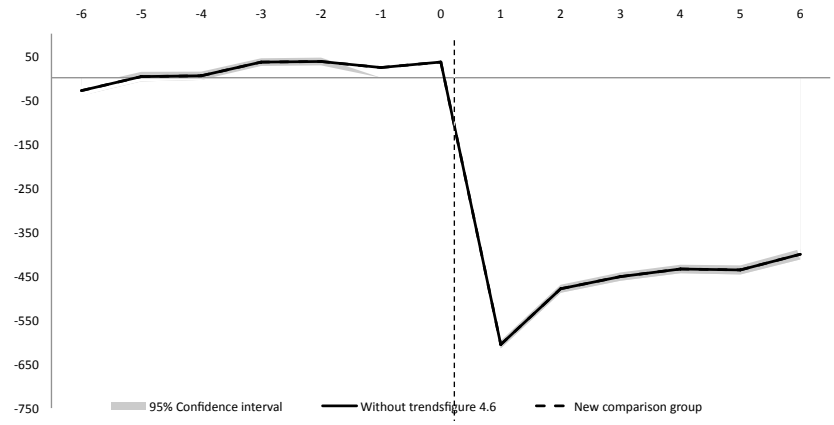
Figure 10: **Sensitivity of monthly earnings losses of collective dismissals to different comparison group**




Notes: Monthly earnings losses, including zeros (2008 Euros). In the horizontal axis, the relative time to separation through a collective dismissal is plotted in years. In the regressions we control for age and age squared and calendar year fixed effects. Both lines are based in the model from equation (1).

These findings suggest that stayers in firms that had individual or even collective dismissals do not observe any changes in their wages (Jacobson et al. (1993)). The

Figure 11: **Sensitivity of monthly earnings losses of individual dismissals to different comparison group**




Notes: Monthly earnings losses, excluding zeros. In the horizontal axis, the relative time to separation through an individual dismissal is plotted in years. In the regressions we control for age and age squared and calendar year fixed effects. Both lines are based in the model from equation (1).

separations of other workers do not create any pressure for the earnings of workers that remain working at the firm. These results reinforce the quality of the comparison group used in the rest of the chapter.

# 7 Concluding remarks

Using an unusually rich matched employer-employee data set for Portugal, we studied the persistent earnings losses of workers displaced due to firm closure, collective dismissals and individual dismissals. We found that those losses are rather severe and persistent, representing 51 percent (48 percent and 52 percent) of the pre-displacement wages for firm closures (collective dismissals and individual dismissals), six years after the separation event. Those losses are largely explained by the joblessness experience of the displaced workers, during which labor earnings are absent. Wage rates also tumble for displaced workers, in comparison with non-displaced workers, amounting to a 19 percent monthly wage fall in the case of firm shut downs, and 14 percent in the case of collective dismissals, and 10 percent in the case of individual dismissals, six years after displacement.

Potential losses of displaced worker can be related to the firm and job-title that they hold before and after displacement. We thus explored the sources of those losses, estimating a three-way high-dimensional fixed effects regression model, which enabled us to obtain worker, firm, and job title fixed effects. To investigate the estimates of the wage losses with the inclusion of three fixed effects, we implemented the conditional decomposition method suggested by Gelbach (2010). We found that the allocation into lower-paid job titles plays the most important role in explaining the wage losses of displaced workers, accounting for half of the total average wage loss in the case of firm closure, and 54 percent in the case of collective dismissals, but not in the case of individual dismissals, where it accounts only for 11 percent of the loss. Given the way those job titles were identified, they may also reflect the bargaining power of the workers. Because job-titles contain the skill requirements of the position hold by the the worker, it will also retain the hierarchical standing of the workers. Again, with the event of a displacement, a human capital will be destroyed, largely associated with the loss of his pre-displacement job-title.

Sorting into firms also plays a significant role for workers displaced through firm

closures, accounting for 40 percent of the total average wage loss, and 44 percent in the case of collective dismissals, and 71 percent of the loss in the case of individual dismissals. Different wage policies are favored by the existence of industry rents (due to unionization or incentive pay premiums) or the operation of wage efficiency policies. In such an environment, the worker may benefit from engaging in job search to locate the firms with more suitable (more generous) wage offers. However, with the occurrence of a displacement event, successful job searchers may loose their ?job shopping? investment.

# 8 Appendix

## Appendix A - Description of variables

**Firm closure**: A firm closure is observed if the identification number of one firm appeared in period t but did not appear in t+1 and t+2.

**Collective dismissals**: Firms where employment has declined by at least 30 percent. This reduces the likelihood that voluntary leavers and workers fired for cause are included in the sample.

**Individual dismissals**: A worker is displaced due to an individual dismissal between t and t+1 if he separated from a firm where there was no mass layoff or firm closure.

**Total monthly earnings**: Labor earnings that are a combination of several components: base wage, regular payments (e.g., seniority and transportation), irregular benefits (profits and premium), and overtime hours payments.

**Hourly wage**: Ratio between total monthly earnings and total hours of work (normal+overtime) in real euros, measured in logarithms.

**Tenure**: Number of years an employee has worked for his firm.

**Age**: Age of the individual measured in years.

**Education level**: Six education categories were defined: (1) Less than Basic School, which includes individuals with fewer than 4 years of schooling, (2) Basic School, which includes individuals with 4 completed years of schooling, (3) Preparatory, which includes individuals with 6 completed years of schooling, (4) Lower Secondary, which

includes individuals with 9 completed years of schooling, (5) Upper Secondary, which includes individuals with secondary schooling and (6) College, which includes individuals with at least a bachelor degree.

**Firm size**: The number of workers currently working in the firm, measured in logarithm.

**Industry**: Six categories were defined: (1)Manufacturing, (2)Construction, (3)Wholesale and retail trade, (4)Transports, (5)Finance and business services, and (6)Education and Health.

# Appendix B

Table 6: Descriptive statistics in reference year (2002)

| | Non-displaced | Firm closure | Collective dismissals | Individual dismissals |
|---|---|---|---|---|
| Age (years) | 37 | 35 | 34 | 34 |
| Tenure (years) | 11 | 10 | 9 | 8 |
| Female | 40 | 46 | 46 | 35 |
| Total monthly wage (2008 euros) | 1136 | 819 | 905 | 1126 |
| Minimum monthly wage (2008 euros) | 408 | 408 | 408 | 408 |
| Hourly wage (2008 euros) | 2,08 | 1,49 | 1,64 | 2,07 |
| | | | | |
| Education (percentages): | | | | |
| Less than basic school | 1 | 1 | 1 | 1 |
| Basic school | 23 | 30 | 27 | 17 |
| Preparatory | 23 | 33 | 30 | 23 |
| Lower Secondary | 19 | 15 | 16 | 19 |
| Upper Secondary | 23 | 15 | 19 | 27 |
| College | 11 | 6 | 7 | 14 |
| | | | | |
| Firm size (no. co-workers) | 1460 | 195 | 567 | 1391 |
| | | | | |
| Industry (percentages): | | | | |
| Manufacturing | 41 | 60 | 53 | 37 |
| Construction | 7 | 13 | 12 | 9 |
| Wholesale and retail trade | 20 | 17 | 18 | 30 |
| Transports | 10 | 2 | 7 | 5 |
| Finance and business services | 13 | 7 | 8 | 16 |
| Education and Health | 9 | 1 | 2 | 3 |
| | | | | |
| No. Observations | 308,006 | 11,312 | 31,455 | 24,524 |

Notes: This table reports summary statistics (mean) for the reference year used in the analysis to construct the sample. The second column shows statistics computed using non displaced workers (control group) and on the third, fourth and fifth columns they are computed using the sample of displaced workers resulting from firm closure and collective dismissals and non-mass layoff dismissals (treatment groups). Variables represented are those described in detail in Appendix A. The units are explained in front of the variables while gender, education and industry are shown as a percentage.

# Appendix C

Table 7: **Detailed results from Figure 2**

| without trends | | | | | | | with trends | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] | | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] |
| $D_{-6}$ | -15.1 | 8.1 | -1.9 | 0.1 | -31.0 | 0.8 | $D_{-6}$ | 0.3 | 3.3 | 0.1 | 0.9 | -6.1 | 6.7 |
| $D_{-5}$ | -12.3 | 8.2 | -1.5 | 0.1 | -28.3 | 3.7 | $D_{-5}$ | 9.3 | 3.1 | 3.0 | 0.0 | 3.2 | 15.4 |
| $D_{-4}$ | -19.1 | 7.7 | -2.5 | 0.0 | -34.2 | -3.9 | $D_{-4}$ | 8.4 | 2.8 | 3.0 | 0.0 | 2.8 | 13.9 |
| $D_{-3}$ | -13.1 | 7.3 | -1.8 | 0.1 | -27.5 | 1.2 | $D_{-3}$ | 2.0 | 2.2 | 0.9 | 0.4 | -2.3 | 6.4 |
| $D_{-2}$ | -22.9 | 7.4 | -3.1 | 0.0 | -37.3 | -8.4 | $D_{-2}$ | 4.9 | 2.3 | 2.2 | 0.0 | 0.5 | 9.4 |
| $D_{-1}$ | -64.7 | 7.4 | -8.7 | 0.0 | -79.3 | -50.2 | $D_{-1}$ | -7.8 | 2.3 | -3.3 | 0.0 | -12.4 | -3.2 |
| $D_0$ | -60.5 | 7.1 | -8.5 | 0.0 | -74.5 | -46.6 | $D_0$ | -13.6 | 1.9 | -7.2 | 0.0 | -17.4 | -9.9 |
| $D_1$ | -607.7 | 7.4 | -82.7 | 0.0 | -622.1 | -593.2 | $D_1$ | -586.6 | 2.3 | -255.2 | 0.0 | -591.1 | -582.0 |
| $D_2$ | -476.2 | 7.4 | -64.1 | 0.0 | -490.8 | -461.6 | $D_2$ | -428.5 | 2.3 | -183.6 | 0.0 | -433.1 | -423.9 |
| $D_3$ | -455.7 | 7.7 | -59.3 | 0.0 | -470.8 | -440.7 | $D_3$ | -408.0 | 2.5 | -160.7 | 0.0 | -412.9 | -403.0 |
| $D_4$ | -468.8 | 8.1 | -57.7 | 0.0 | -484.7 | -452.8 | $D_4$ | -455.5 | 3.1 | -147.7 | 0.0 | -461.5 | -449.5 |
| $D_5$ | -458.5 | 8.7 | -52.9 | 0.0 | -475.5 | -441.5 | $D_5$ | -486.6 | 3.7 | -131.9 | 0.0 | -493.8 | -479.4 |
| $D_6$ | -356.1 | 10.0 | -35.6 | 0.0 | -375.7 | -336.6 | $D_6$ | -416.0 | 5.0 | -82.8 | 0.0 | -425.9 | -406.2 |

Notes: Monthly earnings loss of displaced workers due to firm closure, including zeros (2008 Euros). In the regressions we control for age and age squared and calendar year fixed effects.

Table 8: **Detailed results from Figure 3**

| without trends | | | | | | | with trends | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] | | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] |
| $D_{-6}$ | -8.9 | 8.0 | -1.1 | 0.3 | -24.6 | 6.8 | $D_{-6}$ | 0.3 | 3.1 | 0.1 | 0.9 | -5.8 | 6.3 |
| $D_{-5}$ | -17.6 | 8.1 | -2.2 | 0.0 | -33.4 | -1.8 | $D_{-5}$ | 9.4 | 3.0 | 3.2 | 0.0 | 3.6 | 15.2 |
| $D_{-4}$ | -33.5 | 7.6 | -4.4 | 0.0 | -48.5 | -18.5 | $D_{-4}$ | 8.5 | 2.7 | 3.2 | 0.0 | 3.2 | 13.8 |
| $D_{-3}$ | -50.9 | 7.2 | -7.0 | 0.0 | -65.1 | -36.7 | $D_{-3}$ | 1.8 | 2.1 | 0.9 | 0.4 | -2.3 | 5.9 |
| $D_{-2}$ | -54.7 | 7.3 | -7.5 | 0.0 | -69.0 | -40.4 | $D_{-2}$ | 4.4 | 2.2 | 2.0 | 0.0 | 0.1 | 8.7 |
| $D_{-1}$ | -81.5 | 7.3 | -11.1 | 0.0 | -95.9 | -67.2 | $D_{-1}$ | -9.0 | 2.2 | -4.0 | 0.0 | -13.3 | -4.6 |
| $D_0$ | -94.3 | 7.0 | -13.4 | 0.0 | -108.1 | -80.5 | $D_0$ | -14.7 | 1.8 | -8.2 | 0.0 | -18.2 | -11.1 |
| $D_1$ | -122.5 | 7.7 | -15.8 | 0.0 | -137.7 | -107.3 | $D_1$ | -31.6 | 2.9 | -11.0 | 0.0 | -37.2 | -26.0 |
| $D_2$ | -143.3 | 7.4 | -19.4 | 0.0 | -157.8 | -128.8 | $D_2$ | -30.5 | 2.3 | -13.0 | 0.0 | -35.1 | -25.9 |
| $D_3$ | -162.5 | 7.6 | -21.4 | 0.0 | -177.4 | -147.6 | $D_3$ | -48.8 | 2.4 | -20.1 | 0.0 | -53.6 | -44.0 |
| $D_4$ | -191.4 | 8.1 | -23.6 | 0.0 | -207.2 | -175.5 | $D_4$ | -89.7 | 3.0 | -30.4 | 0.0 | -95.5 | -83.9 |
| $D_5$ | -223.6 | 8.7 | -25.8 | 0.0 | -240.7 | -206.6 | $D_5$ | -142.7 | 3.5 | -40.7 | 0.0 | -149.6 | -135.8 |
| $D_6$ | -233.9 | 10.0 | -23.4 | 0.0 | -253.5 | -214.3 | $D_6$ | -159.1 | 4.7 | -34.1 | 0.0 | -168.2 | -149.9 |

Notes: Monthly wage loss of displaced workers due to firm closure, including zeros (2008 Euros). In the regressions we control for age and age squared and calendar year fixed effects.

## Table 9: **Detailed results from Figure 4**

| without trends | | | | | | | with trends | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] | | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] |
| $D_{-6}$ | 19.4 | 5.0 | 3.9 | 0.0 | 9.5 | 29.3 | $D_{-6}$ | -0.4 | 2.7 | -0.1 | 0.9 | -5.7 | 4.9 |
| $D_{-5}$ | 28.1 | 4.9 | 5.7 | 0.0 | 18.4 | 37.7 | $D_{-5}$ | 6.2 | 2.5 | 2.5 | 0.0 | 1.3 | 11.1 |
| $D_{-4}$ | 14.0 | 4.5 | 3.1 | 0.0 | 5.2 | 22.7 | $D_{-4}$ | 8.7 | 2.1 | 4.1 | 0.0 | 4.6 | 12.8 |
| $D_{-3}$ | 16.2 | 4.1 | 3.9 | 0.0 | 8.2 | 24.3 | $D_{-3}$ | 5.6 | 1.6 | 3.5 | 0.0 | 2.5 | 8.8 |
| $D_{-2}$ | 10.3 | 4.2 | 2.5 | 0.0 | 2.1 | 18.6 | $D_{-2}$ | 6.1 | 1.7 | 3.7 | 0.0 | 2.9 | 9.3 |
| $D_{-1}$ | -14.9 | 4.3 | -3.5 | 0.0 | -23.3 | -6.6 | $D_{-1}$ | -1.7 | 1.8 | -1.0 | 0.3 | -5.1 | 1.7 |
| $D_0$ | -19.6 | 4.0 | -4.9 | 0.0 | -27.5 | -11.8 | $D_0$ | -13.5 | 1.4 | -9.9 | 0.0 | -16.2 | -10.9 |
| $D_1$ | -605.2 | 4.2 | -145.5 | 0.0 | -613.4 | -597.1 | $D_1$ | -630.9 | 1.7 | -373.0 | 0.0 | -634.2 | -627.6 |
| $D_2$ | -475.4 | 4.2 | -111.9 | 0.0 | -483.7 | -467.1 | $D_2$ | -485.8 | 1.7 | -279.3 | 0.0 | -489.2 | -482.4 |
| $D_3$ | -439.5 | 4.4 | -100.5 | 0.0 | -448.1 | -431.0 | $D_3$ | -448.3 | 1.8 | -242.6 | 0.0 | -451.9 | -444.7 |
| $D_4$ | -475.3 | 4.5 | -104.8 | 0.0 | -484.2 | -466.4 | $D_4$ | -514.1 | 2.1 | -246.7 | 0.0 | -518.2 | -510.0 |
| $D_5$ | -394.8 | 4.8 | -82.8 | 0.0 | -404.2 | -385.5 | $D_5$ | -446.4 | 2.4 | -186.0 | 0.0 | -451.1 | -441.7 |
| $D_6$ | -353.2 | 5.4 | -65.6 | 0.0 | -363.7 | -342.6 | $D_6$ | -426.1 | 3.1 | -136.7 | 0.0 | -432.3 | -420.0 |

Notes: Monthly earnings loss of displaced workers due to collective dismissals, including zeros (2008 Euros). In the regressions we control for age and age squared and calendar year fixed effects.

## Table 10: **Detailed results from Figure 5**

| without trends | | | | | | | with trends | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] | | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] |
| $D_{-6}$ | 37.2 | 4.8 | 7.7 | 0.0 | 27.8 | 46.7 | $D_{-6}$ | -0.4 | 2.4 | -0.2 | 0.9 | -5.1 | 4.2 |
| $D_{-5}$ | 32.0 | 4.7 | 6.8 | 0.0 | 22.8 | 41.3 | $D_{-5}$ | 6.3 | 2.2 | 2.9 | 0.0 | 2.0 | 10.6 |
| $D_{-4}$ | 5.7 | 4.3 | 1.3 | 0.2 | -2.7 | 14.1 | $D_{-4}$ | 8.4 | 1.8 | 4.6 | 0.0 | 4.8 | 12.0 |
| $D_{-3}$ | -9.6 | 4.0 | -2.4 | 0.0 | -17.3 | -1.8 | $D_{-3}$ | 5.6 | 1.4 | 4.0 | 0.0 | 2.8 | 8.4 |
| $D_{-2}$ | -11.2 | 4.0 | -2.8 | 0.0 | -19.1 | -3.3 | $D_{-2}$ | 5.2 | 1.5 | 3.6 | 0.0 | 2.4 | 8.1 |
| $D_{-1}$ | -25.4 | 4.1 | -6.2 | 0.0 | -33.4 | -17.4 | $D_{-1}$ | -3.9 | 1.5 | -2.5 | 0.0 | -6.9 | -0.8 |
| $D_0$ | -44.6 | 3.8 | -11.7 | 0.0 | -52.1 | -37.1 | $D_0$ | -16.1 | 1.2 | -13.4 | 0.0 | -18.5 | -13.8 |
| $D_1$ | -74.8 | 4.4 | -17.2 | 0.0 | -83.3 | -66.3 | $D_1$ | -28.3 | 1.9 | -14.8 | 0.0 | -32.0 | -24.5 |
| $D_2$ | -89.6 | 4.1 | -21.7 | 0.0 | -97.7 | -81.5 | $D_2$ | -38.1 | 1.6 | -23.6 | 0.0 | -41.2 | -34.9 |
| $D_3$ | -105.2 | 4.2 | -24.9 | 0.0 | -113.5 | -97.0 | $D_3$ | -60.8 | 1.6 | -37.3 | 0.0 | -64.0 | -57.6 |
| $D_4$ | -125.9 | 4.4 | -28.3 | 0.0 | -134.6 | -117.2 | $D_4$ | -82.2 | 1.9 | -43.3 | 0.0 | -85.9 | -78.5 |
| $D_5$ | -127.5 | 4.6 | -27.9 | 0.0 | -136.5 | -118.6 | $D_5$ | -108.3 | 2.0 | -52.9 | 0.0 | -112.3 | -104.3 |
| $D_6$ | -122.0 | 5.1 | -23.8 | 0.0 | -132.0 | -111.9 | $D_6$ | -130.5 | 2.6 | -49.8 | 0.0 | -135.7 | -125.4 |

Notes: Monthly wage loss of displaced workers due to collective dismissals, including zeros (2008 Euros). In the regressions we control for age and age squared and calendar year fixed effects.

## Table 11: **Detailed results from Figure 6**

| without trends | | | | | | | with trends | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] | | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] |
| $D_{-6}$ | -29.3 | 5.7 | -5.1 | 0.0 | -40.5 | -18.1 | $D_{-6}$ | 3.0 | 3.6 | 0.8 | 0.4 | -4.1 | 10.1 |
| $D_{-5}$ | 2.6 | 5.5 | 0.5 | 0.6 | -8.3 | 13.4 | $D_{-5}$ | 3.1 | 3.3 | 1.0 | 0.3 | -3.3 | 9.5 |
| $D_{-4}$ | 4.4 | 4.8 | 0.9 | 0.4 | -5.0 | 13.8 | $D_{-4}$ | 4.2 | 2.5 | 1.7 | 0.1 | -0.7 | 9.2 |
| $D_{-3}$ | 35.5 | 4.4 | 8.0 | 0.0 | 26.8 | 44.2 | $D_{-3}$ | 8.8 | 2.0 | 4.4 | 0.0 | 4.9 | 12.8 |
| $D_{-2}$ | 36.8 | 4.5 | 8.2 | 0.0 | 28.0 | 45.6 | $D_{-2}$ | 4.7 | 2.1 | 2.3 | 0.0 | 0.7 | 8.7 |
| $D_{-1}$ | 23.1 | 4.6 | 5.1 | 0.0 | 14.1 | 32.0 | $D_{-1}$ | -2.3 | 2.1 | -1.1 | 0.3 | -6.5 | 1.9 |
| $D_0$ | 35.6 | 4.3 | 8.3 | 0.0 | 27.2 | 43.9 | $D_0$ | -13.3 | 1.7 | -7.7 | 0.0 | -16.7 | -9.9 |
| $D_1$ | -605.8 | 4.5 | -134.5 | 0.0 | -614.6 | -596.9 | $D_1$ | -721.0 | 2.2 | -331.9 | 0.0 | -725.3 | -716.8 |
| $D_2$ | -479.1 | 4.7 | -102.7 | 0.0 | -488.3 | -470.0 | $D_2$ | -598.2 | 2.3 | -261.4 | 0.0 | -602.7 | -593.7 |
| $D_3$ | -451.5 | 4.8 | -94.2 | 0.0 | -460.9 | -442.1 | $D_3$ | -584.8 | 2.4 | -242.3 | 0.0 | -589.5 | -580.1 |
| $D_4$ | -434.3 | 4.9 | -88.0 | 0.0 | -443.9 | -424.6 | $D_4$ | -587.8 | 2.6 | -224.2 | 0.0 | -593.0 | -582.7 |
| $D_5$ | -436.4 | 5.3 | -83.1 | 0.0 | -446.7 | -426.1 | $D_5$ | -596.8 | 3.1 | -195.0 | 0.0 | -602.8 | -590.8 |
| $D_6$ | -400.8 | 6.0 | -66.7 | 0.0 | -412.6 | -389.0 | $D_6$ | -585.4 | 4.0 | -147.5 | 0.0 | -593.2 | -577.7 |

Notes: Monthly earnings loss of displaced workers due to individual dismissals, including zeros (2008 Euros). In the regressions we control for age and age squared and calendar year fixed effects.

## Table 12: **Detailed results from Figure 7**

| without trends | | | | | | | with trends | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] | | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] |
| $D_{-6}$ | -10.3 | 4.6 | -2.3 | 0.0 | -19.2 | -1.4 | $D_{-6}$ | 1.4 | 2.6 | 0.5 | 0.6 | -3.7 | 6.4 |
| $D_{-5}$ | -14.7 | 4.5 | -3.3 | 0.0 | -23.5 | -5.9 | $D_{-5}$ | 5.9 | 2.4 | 2.5 | 0.0 | 1.2 | 10.5 |
| $D_{-4}$ | -23.5 | 4.1 | -5.8 | 0.0 | -31.4 | -15.6 | $D_{-4}$ | 6.0 | 2.0 | 3.1 | 0.0 | 2.2 | 9.9 |
| $D_{-3}$ | -13.8 | 3.8 | -3.6 | 0.0 | -21.2 | -6.4 | $D_{-3}$ | 7.1 | 1.6 | 4.5 | 0.0 | 4.0 | 10.1 |
| $D_{-2}$ | -13.4 | 3.8 | -3.5 | 0.0 | -20.9 | -6.0 | $D_{-2}$ | 3.9 | 1.6 | 2.5 | 0.0 | 0.8 | 7.0 |
| $D_{-1}$ | -27.8 | 3.9 | -7.2 | 0.0 | -35.4 | -20.2 | $D_{-1}$ | -5.6 | 1.6 | -3.4 | 0.0 | -8.8 | -2.4 |
| $D_0$ | -30.3 | 3.7 | -8.3 | 0.0 | -37.4 | -23.1 | $D_0$ | -15.3 | 1.3 | -11.5 | 0.0 | -17.9 | -12.7 |
| $D_1$ | -21.8 | 4.1 | -5.3 | 0.0 | -29.9 | -13.8 | $D_1$ | 13.8 | 2.0 | 6.8 | 0.0 | 9.8 | 17.7 |
| $D_2$ | -46.6 | 3.9 | -11.9 | 0.0 | -54.3 | -38.9 | $D_2$ | -12.0 | 1.7 | -7.0 | 0.0 | -15.4 | -8.6 |
| $D_3$ | -74.8 | 4.0 | -18.6 | 0.0 | -82.7 | -66.9 | $D_3$ | -51.4 | 1.8 | -28.7 | 0.0 | -54.9 | -47.9 |
| $D_4$ | -93.4 | 4.2 | -22.2 | 0.0 | -101.6 | -85.1 | $D_4$ | -93.6 | 2.0 | -46.5 | 0.0 | -97.6 | -89.7 |
| $D_5$ | -105.8 | 4.5 | -23.6 | 0.0 | -114.6 | -97.1 | $D_5$ | -119.2 | 2.4 | -50.6 | 0.0 | -123.9 | -114.6 |
| $D_6$ | -82.6 | 5.2 | -15.9 | 0.0 | -92.7 | -72.4 | $D_6$ | -112.5 | 3.1 | -35.9 | 0.0 | -118.6 | -106.4 |

Notes: Monthly wage loss of displaced workers due to individual dismissals, including zeros (2008 Euros). In the regressions we control for age and age squared and calendar year fixed effects.

## Table 13: **Detailed results from Figure 10**

| without trends figure 4 | | | | | | | Without trends with new comparison group | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] | | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] |
| $D_{-6}$ | 19.4 | 5.0 | 3.9 | 0.0 | 9.5 | 29.3 | $D_{-6}$ | 15.9 | 5.0 | 3.2 | 0.0 | 6.1 | 25.8 |
| $D_{-5}$ | 28.1 | 4.9 | 5.7 | 0.0 | 18.4 | 37.7 | $D_{-5}$ | 25.5 | 4.9 | 5.2 | 0.0 | 15.9 | 35.2 |
| $D_{-4}$ | 14.0 | 4.5 | 3.1 | 0.0 | 5.2 | 22.7 | $D_{-4}$ | 11.9 | 4.5 | 2.7 | 0.0 | 3.1 | 20.6 |
| $D_{-3}$ | 16.2 | 4.1 | 3.9 | 0.0 | 8.2 | 24.3 | $D_{-3}$ | 12.8 | 4.1 | 3.1 | 0.0 | 4.7 | 20.9 |
| $D_{-2}$ | 10.3 | 4.2 | 2.5 | 0.0 | 2.1 | 18.6 | $D_{-2}$ | 6.4 | 4.2 | 1.5 | 0.1 | -1.8 | 14.7 |
| $D_{-1}$ | -14.9 | 4.3 | -3.5 | 0.0 | -23.3 | -6.6 | $D_{-1}$ | -17.1 | 4.3 | -4.0 | 0.0 | -25.5 | -8.8 |
| $D_0$ | -19.6 | 4.0 | -4.9 | 0.0 | -27.5 | -11.8 | $D_0$ | -22.9 | 4.0 | -5.7 | 0.0 | -30.7 | -15.1 |
| $D_1$ | -605.2 | 4.2 | -145.5 | 0.0 | -613.4 | -597.1 | $D_1$ | -605.8 | 4.1 | -146.1 | 0.0 | -613.9 | -597.7 |
| $D_2$ | -475.4 | 4.2 | -111.9 | 0.0 | -483.7 | -467.1 | $D_2$ | -476.1 | 4.2 | -112.4 | 0.0 | -484.4 | -467.8 |
| $D_3$ | -439.5 | 4.4 | -100.5 | 0.0 | -448.1 | -431.0 | $D_3$ | -445.8 | 4.4 | -101.8 | 0.0 | -454.4 | -437.3 |
| $D_4$ | -475.3 | 4.5 | -104.8 | 0.0 | -484.2 | -466.4 | $D_4$ | -483.6 | 4.6 | -106.1 | 0.0 | -492.5 | -474.6 |
| $D_5$ | -394.8 | 4.8 | -82.8 | 0.0 | -404.2 | -385.5 | $D_5$ | -401.1 | 4.8 | -83.6 | 0.0 | -410.5 | -391.7 |
| $D_6$ | -353.2 | 5.4 | -65.6 | 0.0 | -363.7 | -342.6 | $D_6$ | -361.2 | 5.4 | -66.7 | 0.0 | -371.9 | -350.6 |

Notes: Monthly earnings loss of displaced workers due to firm closure, including zeros (2008 Euros). In the regressions we control for age and age squared and calendar year fixed effects. Results from the left side of the table are a replication of "without trends figure 4". Right side of the table uses the new comparison group.

## Table 14: **Detailed results from Figure 11**

| without trends figure 4 | | | | | | | Without trends with new comparison group | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] | | Coef. | Std. Err. | t | P>t | [95% Conf. | Interval] |
| $D_{-6}$ | -29.3 | 5.7 | -5.1 | 0.0 | -40.5 | -18.1 | $D_{-6}$ | -29.4 | 5.7 | -5.1 | 0.0 | -40.6 | -18.1 |
| $D_{-5}$ | 2.6 | 5.5 | 0.5 | 0.6 | -8.3 | 13.4 | $D_{-5}$ | 2.5 | 5.5 | 0.5 | 0.6 | -8.3 | 13.3 |
| $D_{-4}$ | 4.4 | 4.8 | 0.9 | 0.4 | -5.0 | 13.8 | $D_{-4}$ | 4.4 | 4.8 | 0.9 | 0.4 | -5.1 | 13.8 |
| $D_{-3}$ | 35.5 | 4.4 | 8.0 | 0.0 | 26.8 | 44.2 | $D_{-3}$ | 35.4 | 4.4 | 8.0 | 0.0 | 26.7 | 44.1 |
| $D_{-2}$ | 36.8 | 4.5 | 8.2 | 0.0 | 28.0 | 45.6 | $D_{-2}$ | 36.8 | 4.5 | 8.2 | 0.0 | 28.0 | 45.6 |
| $D_{-1}$ | 23.1 | 4.6 | 5.1 | 0.0 | 14.1 | 32.0 | $D_{-1}$ | 23.1 | 4.6 | 5.1 | 0.0 | 14.1 | 32.0 |
| $D_0$ | 35.6 | 4.3 | 8.3 | 0.0 | 27.2 | 43.9 | $D_0$ | 35.6 | 4.3 | 8.3 | 0.0 | 27.2 | 44.0 |
| $D_1$ | -605.8 | 4.5 | -134.5 | 0.0 | -614.6 | -596.9 | $D_1$ | -605.7 | 4.5 | -134.5 | 0.0 | -614.6 | -596.9 |
| $D_2$ | -479.1 | 4.7 | -102.7 | 0.0 | -488.3 | -470.0 | $D_2$ | -479.1 | 4.7 | -102.6 | 0.0 | -488.2 | -469.9 |
| $D_3$ | -451.5 | 4.8 | -94.2 | 0.0 | -460.9 | -442.1 | $D_3$ | -451.5 | 4.8 | -94.2 | 0.0 | -460.9 | -442.1 |
| $D_4$ | -434.3 | 4.9 | -88.0 | 0.0 | -443.9 | -424.6 | $D_4$ | -434.2 | 4.9 | -88.0 | 0.0 | -443.9 | -424.6 |
| $D_5$ | -436.4 | 5.3 | -83.1 | 0.0 | -446.7 | -426.1 | $D_5$ | -436.4 | 5.3 | -83.1 | 0.0 | -446.7 | -426.1 |
| $D_6$ | -400.8 | 6.0 | -66.7 | 0.0 | -412.6 | -389.0 | $D_6$ | -400.8 | 6.0 | -66.7 | 0.0 | -412.6 | -389.0 |

Notes: Monthly earnings loss of displaced workers due to firm closure, including zeros (2008 Euros). In the regressions we control for age and age squared and calendar year fixed effects. Results from the left side of the table are a replication of "without trends figure 6". Right side of the table uses the new comparison group.

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