Short-Time Work and Employment in the Great Recession in France

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Abstract

We provide a model which shows that short-time work can save jobs in firms hit by strong negative revenue shocks, but not in other firms, where hours worked are reduced, without saving jobs. Nevertheless, short-time work can save jobs at much lower costs than other policies that aim to sustain employment using financial incentives, because short-time work targets jobs at risk of being destroyed more effectively. Relying on administrative data covering all French establishments, we do find that short-time work has had a positive impact on employment for firms which faced dramatic drop in their revenue, but not for the other firms, in 2009, during the great recession. The cost per saved job was also very low relative to other policies aimed at sustaining employment. Our findings suggest that short-time work can be an effective way to save jobs when the economy is hit by a recession, but they also call for a careful design of short-time work schemes.

1 Introduction[1]

In 2008 and 2009, France was severely hit by the great recession. In response, public authorities decided to dramatically expand short-time work. Also called short-time compensation, short-time work is a public program intended to preserve jobs at establishments experiencing temporarily low revenue by providing income support to employees whose hours of work are reduced. From the end of 2008, the Ministry of Labor not only expanded its budget, but also wrote circulars and directives, in order to promote the use of short-time work as rapidly as possible. As a result, the share of employees on short-time work increased from 0.3%, in 2007 just before the great recession, to 4% in 2009, the expansion year (Figure 1). Subsidies per non-worked hour and subsidies per employee were respectively multiplied by 1.4 and by 2.5 between these two dates (Figure 2). The cost of the policy trebled, multiplied by a factor of 20.

This paper examines the impact of short-time work on employment and survival of firms taking advantage of its massive expansion during the great recession. We first present the various components of the program, both its principles and its practical implementation. Then, we develop a directed search and matching model with multi-worker firms which shows that short-time work saves jobs when firms face a sharp fall in their revenue but, for firms facing a more limited fall in revenues, hours are reduced without saving jobs. Hence, short-time work may create windfall effects for some firms and their employees. Nevertheless, we show that these windfall effects are likely to be much smaller than for other policies that try to prevent employment destruction or boost employment creation using financial incentives, such as wage subsidies or hiring subsidies, because short-time work can directly target those firms with jobs at risk of being destroyed, and even more precisely the most fragile jobs within firms those firms, whereas other policies have no such possibility. To put it differently, short-time work target more effectively than wage subsidies or hiring subsidies low productivity jobs that need financial support to exist. Hence, short-time work can help sustain firms' employment at a much smaller cost than hiring subsidies or wage subsidies. Moreover, we show that short-time work can raise the total number of hours worked if the firms using short-time work are hit by

[1]We thank Katharine Abraham, Joseph Altonji, Geoffrey Barrows, Denis Fougère, Andrea Garnero, Alexander Hijzen, Pedro Portugal, Arne Uhlendorff, Rune Vejlin for helpful comments. We also thanks participants in seminars at Aarhus University, Banque de France, Ecole Polytechnique, IZA, OECD, University of Louvain la Neuve,

large negative productivity shocks.

Then, we use administrative data providing remarkably detailed information not only about short-time work use or employment and financial characteristics for all French establishments at annual frequency over the period 2007-2011 but also about the implementation of the program for each applying establishment: date of application, response time of the administration... In line with the model, we do find that short-time work has a clear positive impact on employment and survival of firms facing the largest drop in their revenue. By contrast, we find no effect of short-time work on employment and survival of other firms; about half of the short-time work users in 2009 appear to benefit from large windfall effects since they received short-time work subsidies without saving jobs. Nevertheless, short-time work saved jobs overall and also limited the drop in the total number of hours worked. We estimate that every short-time work employee in 2009 induced 0.2 saved job on average and entailed an increase in the total volume of hours worked equal to about 10% of her usual annual number of hours worked. We also find that short-time work did allow firms that were temporarily impacted by the great recession but profitable in the long run to overcome temporary financial constraints, at a time when financial markets were collapsing. Still in line with the model, we find that, despite the windfall effects mentioned above, the cost per saved job (i.e. the total amount of subsidy needed to save a job) by short-time work is very low – about 7% of the average labor cost – when compared to other policy interventions aimed at sustaining employment. Since available evidence suggests that the government saves about 25% of the average labor cost when a low-wage individual moves from non-employment to employment,[2] this suggests that short-time work allowed the government to reduce public expenditures.

On the theoretical side, short-time work was shown to be favorable to employment at the cost of distorting downwards the number of hours worked per employee,[3] to improve welfare by mitigating those distortions caused by public unemployment insurance,[4] and to be welfare-improving when firms do not fully insure employees against income shocks.[5] Here, we develop a simple directed search and matching model with multi-worker firms which shows that short-time work saves jobs in firms that face large drops in their revenue but reduces hours worked

[2] See Cahuc *et al.* (2017) who show that this figure is relevant for France in 2009, i.e. the time period under study.

[3] Burdett and Wright (1989), Van Audenrode (1994).

[4] Braun and Bruegemann (2017).

[5] Niedermayer and Tilly (2017).

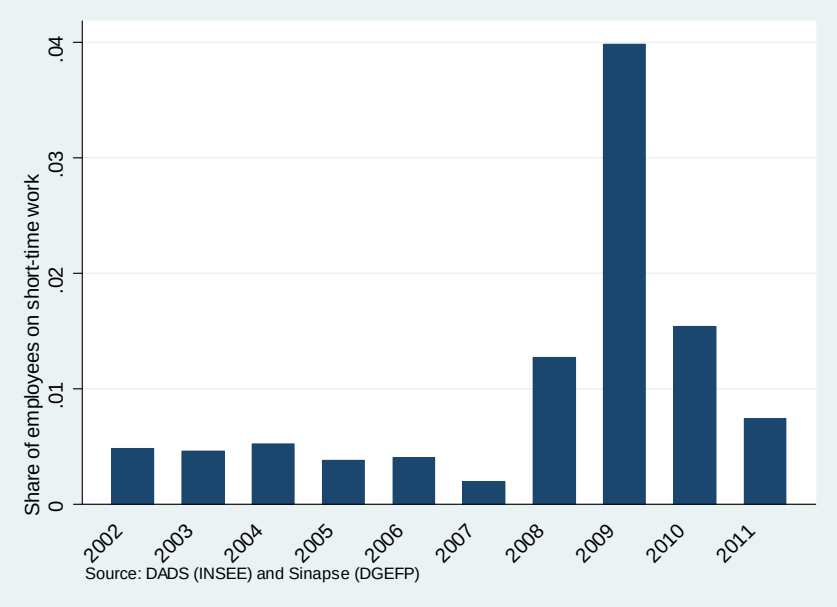

Figure 1: Proportion of short-time work employees
Sources: *DADS* (*INSEE*) and *Sinapse* (*DGEFP*). **Scope:** ◇ Mainland France excluding Corsica. ◇ Market sectors excluding agriculture. ◇ Establishments using short-time work for economic reasons.

without saving any job in firms which face limited drops.[6] Moreover, we also prove that short-time work can sustain employment at low cost if compared with either wage subsidies or hiring subsidies.

On the empirical side, macroeconomic evaluations, using cross-country data,[7] or cross-state data in the U.S.,[8] have generally identified a positive impact on employment. Their conclusions are mostly drawn from a small number of observations, limiting their identification ability. Microeconomic evaluations are scarce and mostly use firm level sources in Germany and France. In Germany, all analyses rely on the IAB Establishment Panel, an annual survey with approximately 16,000 firms, representing 1% of all firms and 7% of all employees, interrogated in 2003, 2006 and 2009. Resulting estimates heavily depend on the method used to correct

[6] Cooper et al. (2017) analyze short-time work in a random search and matching model with multi-worker firms. Our directed search model allows us to provide a more simple framework in which we introduce the heterogeneity of jobs within firms which is not present in the paper of Cooper et al. Accounting for the heterogeneity of jobs within firms is important to analyze employment impact of short-time work.

[7] Abraham and Houseman (1994), Boeri and Bruecker (2011), Brey and Hertweck (2016), Cahuc and Carcillo (2011), Hijzen and Martin (2013), Hijzen and Venn (2011), Van Audenrode (1994).

[8] Abraham and Houseman (2014).

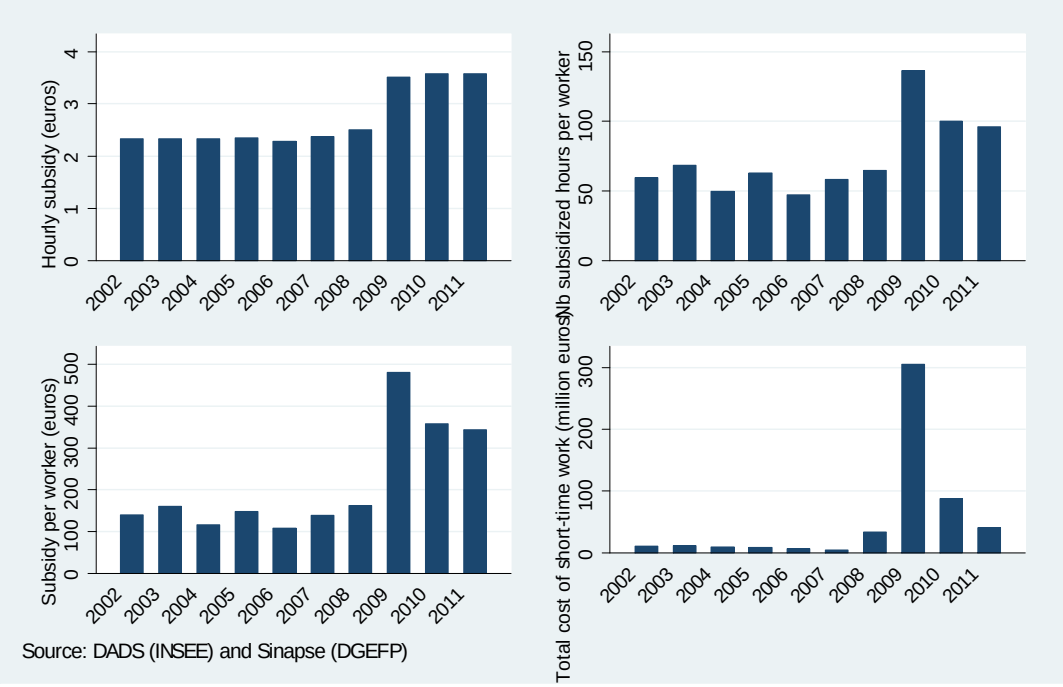

Figure 2: Hourly short-time work subsidy (top left), individual number of short-time work hours (top right), individual short-time work subsidy (bottom left) and total short-time work subsidy (bottom right)

Sources: *DADS* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ◇ Mainland France excluding Corsica. ◇ Market sectors excluding agriculture. ◇ Establishments using short-time work for economic reasons.

for selection into short-time work, with no obvious lesson.[9] The main reason for the lack of consensus on the impact of short-time work in Germany seems to be the inadequacy of data to deal with the selection issue. This literature analyzes the impact of short-time work on employment by running regressions where employment growth is explained by short-time work use and by a set of control variables including the revenue growth of the firm. But it has long been acknowledged that the correlation between employment and revenue is very weak overall and heterogeneous across firms. To avoid bias induced by selection of firms with specific adjustment of employment into short-time work, this literature uses, in line with Boeri and Bruecker (2011), the prior experience of firms with the program when trying to instrument short-time work. As stressed by Bellmann et al. (2015), this is questionable since empirical evidence shows that firms which use short-time work tend to adjust *more strongly* employment when output falls than firms which do not use short-time work. This behavior of short-time work users may result from technical constraints: firms have more incentives to use short-time work if features of their production process imply that it is more costly to store production or to find productive activities to incumbent employees when demand drops. Hence, it is not surprising to see no positive effects of short-time work on employment if the selection of firms into the program is not properly accounted for. Instrumenting program use with prior experience does not fully solve this selection issue and is likely to lead to underestimate the potential positive impact of short-time work on employment. Indeed, most contributions using this instrument find no positive effect on employment. In France, Calavrezo *et al.* (2010) face a similar difficulty. The data are more extensive, since they use administrative data covering the universe of French establishments over the period 2000-2005. Selection into short-time work uses propensity score matching. Their results tend to show that establishments authorized to use short-time work are more likely to go bankrupt.

Our paper uses extremely rich administrative data covering the universe of French establishments, from 2007 to 2011. In particular, our data sources allow us to follow extremely precisely the *administration* of the program.[10] Like in the German data, we observe that firms

[9] Balleer *et al.* (2016), Boeri and Bruecker (2011), Niedermayer and Tilly (2017) find positive effects of short-time work on employment. Bellmann and Gerner (2011), Bellmann *et al.* (2015), Kruppe and Scholz (2014) find no effects of short-time work on employment.

[10] In addition, our data are more comprehensive than those used by previous studies. In particular, Calavrezo *et al.* (2010) had information on the authorizations by the administration to use short-time work while we have information about the effective use of short-time work and on the authorizations. About one third of the authorizations are not used by firms.

which use short-time work adjust *more* employment when output falls than firms which do not use short-time work. To deal with the selection issue, we first document the role of the local administration in charge of managing the policy at the *département* level. The local administration duties comprise informing firms about the policy, the management of applications, and the payment of short-time work subsidies to firms. Their autonomy in management creates strong behavioral heterogeneity, in particular in their response time to applications, across the 95 *départements* of mainland France before the recession. This administrative response time is shown to play a key role in the implementation of short-time work. Establishments located in *départements* with a long response time before the recession use short-time work less intensively during the recession, in 2009. This result holds true for single-establishment firms and for multi-establishment firms, the latter using short-time work more intensively in their establishments located in *départements* with a shorter response time. Furthermore, Nevoux *et al.* (2017) have highlighted the spatial concentration of short-time work and the local diffusion of its use. In line with these findings, we also document how the policy diffuses between firms at the *local* level. Geographical proximity of short-time work users before the recession is shown to favor the use of short-time work in 2009, controlling for the response time of the administration. In particular, short-time work use diffuses in 2009 from those multi-establishment firms which used short-time work in 2008 because they were located in a *département* with a short response time. Hence, diffusion from firm-to-firm, even though unknown in its exact details, appears to have a key role. This diffusion may stem from firm-to-firm information transmission. It may also arise from a *"not going alone"* effect, which reduces the negative signal (for potential financial difficulties) associated with using short-time work *vis à vis* the firm's employees, the firm's trading partners or the firm's creditors.

Because a) the response time of the *département* before 2009 has an impact on short-time work use in 2009 of single-establishment and multi-establishment firms and b) short-time work use diffuses from multi-establishment firms, we construct the following instruments for the use of short-time work *in 2009* – for firms which did *not* use short-time work in the two years preceding 2009 – a) the 2008 response time to short-time work applications in the firm's *département* and b) by the (physical) distance of the firm to the closest *multi-establishment* firm which used short-time work *in 2008*. As expected from the analysis of our theoretical model, the results underline the very heterogeneous impact of short-time work on employment and hours

worked, an issue neglected so far by the literature. Beyond its heterogeneous impact, short-time work saved jobs and helped firms survive, even years after the great recession. Although the benefits were limited to those firms that were strongly hit, short-time work was effective at preserving jobs during this period. Nevertheless, our analysis suggests that short-time work is not a panacea. Effective for a small subset of firms, there is no evidence that short-time work was useful for a larger set.[11]

2 Policy

The regulations of short-time work have changed multiple times since the inception of the policy, in 1951. In the following, we present the rules prevailing in 2009.

All private establishments located in France and all their employees are eligible to short-time work. There are six potential valid motives when asking for short-time work: (i) economic situation; (ii) modernization, restructuring and transformation; (iii) problems in the provision of raw materials; (iv) accident; (v) exceptionally adverse weather conditions; (vi) other exceptional circumstances. Our paper will restrict attention onto the first such motive.

When applying for short-time work, an establishment must specify the extent of its application; i.e. either a part or the totality of the establishment; either a reduction or a temporary suspension of activity. Then, short-time work applies to hours unworked below the weekly legal duration (35 hours, or below the weekly collectively-agreed or contractual duration when it is below 35 hours). The yearly number of subsidized hours per employee and per year cannot exceed 800 (1,000 hours in the industries most severely hit by the great recession; in particular the textile and automobile industries). For any employee, periods of short-time work cannot exceed 6 consecutive months (and 6 weeks in the case of total suspension of activity). Otherwise, she becomes unemployed, even though her contract still holds.

Under short-time work, each hour worked is paid using the employee's previous gross hourly wage as a reference. The short-time work benefit amounts to 60% of this reference, with a lower limit of 6.84€. The monthly sum of the wage and of the benefit cannot be inferior to the monthly minimum wage and cannot exceed the reference wage. The benefits are paid the same way as wages are paid in France, i.e. on a monthly basis by the establishment. The

[11] Cooper *et al.* (2017) find that short-time work can impair the allocative efficiency of the labor market if it is widespread.

establishment is then reimbursed by the State. It receives a subsidy of 3.84€ per hour and per employee in establishments within firms with 250 employees or less, and of 3.33€ per hour and per employee for establishments within firms with 251 employees or more.

To be allowed to benefit from short-time work, the establishment initiates a procedure which includes three steps: application, examination, and consumption. First, the establishment and its works council discuss the possibility of using short-time work and at the end of this consultation, the works council issues a written recommendation. The establishment fills the short-time work application form (including the establishment identification number, industry, type, contact details, number of employees) as well as the short-time work demand (area, reason, period, number of covered employees, number of hours and corresponding level of subsidies). Then, the establishment sends the form with the recommendation together with a document proving its economic difficulties to the Local (*département* level) Agency in charge of Labor Relations (*DIRECCTE*), who are the public authorities in charge of managing short-time work in the *département*.

Second, the local public authority examines the short-time work application, most particularly its validity. The *DIRECCTE* may ask the labor inspection authority to examine the exact situation of this establishment. Then, it decides whether to reject or grant the application (in which case it specifies the authorization period, the number of covered employees, number of hours, and the corresponding level of subsidies) and informs the establishment of its decision.

Third, when the application is granted, the establishment may use short-time work within the limits set by the local authority. In case it is used, the establishment sends the local authority a reimbursement form (including the number of employees and hours that effectively used short-time work during the month, and the corresponding level of short-time work subsidies). Once received, the local authority checks the validity of the request and pays the establishment the corresponding sum.

As stressed above, the large expansion in short-time work at the start of the great recession, displayed in Figure 1, resulted from a deliberate effort of public decision-makers who enacted laws, expanded the budget, released circulars and directives to boost short-time work usage. In December 2008, the maximal number of short-time work hours per employee per year increased from 600 to 800; the maximal short-time work duration in case of total suspension of activity was expanded from 4 to 6 weeks. In January 2009, the per-hour employee benefit increased

from 50 to 60% of the previous gross hourly wage. Simultaneously, the subsidy received by the establishment was expanded.[12] In May 2009, *long-term short-time work* was created. An establishment was allowed to use long-term short-time work for support with minimum length of 3 months up to a maximum of 12 months. Under long-term short-time work, the per-hour employee benefit was set to 75% of the previous gross hourly wage. The establishment received an additional subsidy, jointly financed by the State and the unemployment insurance system.[13]

Furthermore, several ministerial circulars and directives were sent to local authorities, calling for an easier access to the policy. In particular, local authorities were asked to interpret the eligibility conditions in a flexible way, resulting in an increased acceptance of applications. Indeed, during the great recession, the fraction of applications rejected by the *DIRECCTE* declined by a factor of 2, as shown by Figure 3.

After 2009, the policy experienced no major change until 2012.[14] However, in response to a second economic slowdown and to the associated requests formulated by businesses' and workers' unions, reforms were implemented in March 2012, again expanding access to short-time work.

3 Model

This section presents a model which highlights the impact of short-time work on hours worked and employment.

3.1 Framework

The framework is a one-period static directed search and matching model with multi-worker firms and endogenous job destruction.[15] There are two goods: labor and a final output produced with labor only. There is a large number of firms and a large number of workers. All workers are unemployed and all firms have zero employee at the start of the period. The preferences of

[12] The subsidy received by the establishment increased from 2.44 to 3.84€ for those belonging to firms with 250 employees or less, and from 2.13 to 3.33€ for those belonging to firms with 251 employees or more.

[13] On top of the "standard" subsidy, the state pays 1.90€ per hour up to the 50th long-term short-time work hour of a given employee and the unemployment insurance system pays 3.90€ beyond the 50th hour.

[14] The only change over this period was the increase in the maximal number of short-time work hours per employee per year from 800 to 1,000 hours, in 2010.

[15] See Moene (1997) for the seminal directed search model and Kaas and Kircher (2015) for a directed search model with multi-worker firms.

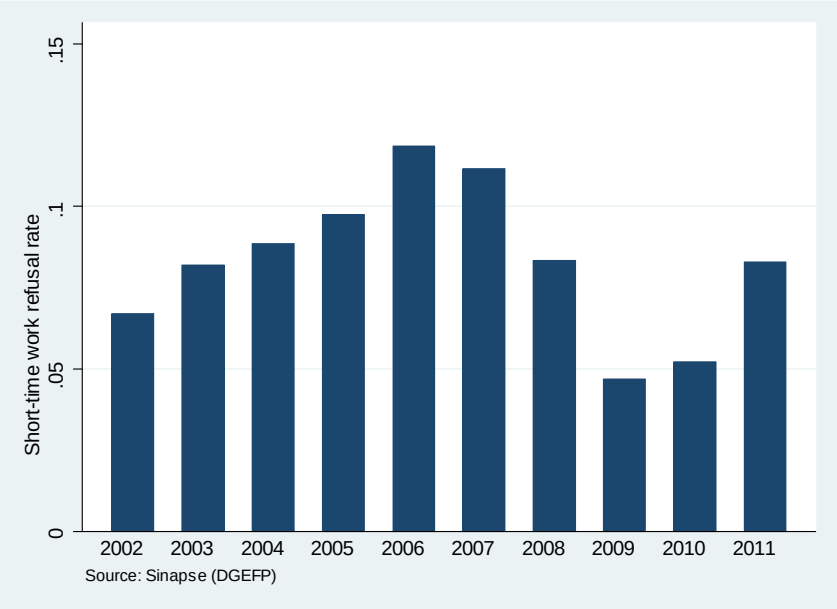

Figure 3: Short-time work refusal rate

Sources: *DADS* (*INSEE*) and *Sinapse* (*DGEFP*). **Scope**: ◇ Mainland France excluding Corsica. ◇ Market sectors excluding agriculture. ◇ Establishments using short-time work for economic reasons. **Definition**: Short-time work refusal rate is defined as the number of short-time work applications that are refused divided by the total number of short-time work applications.

workers are represented by the utility function $c - \phi(h)$, where c stands for the consumption of the final output and h for the number of hours worked. ϕ is an increasing, convex and twice continuously derivable function. Each firm can create v job vacancies at cost $C(v)$, increasing and convex. Each firm has a labor pool where job vacancies and unemployed workers are matched together according to a constant returns to scale matching function, $M(u, v)$, strictly increasing with respect to the u unemployed persons and the v vacant jobs in its labor pool. In consequence, the probability to fill a vacancy and to find a job is respectively equal to $m(\theta) = M(1/\theta, 1)$ and $\theta m(\theta)$, where $\theta = v/u$ is the labor market tightness of the labor pool of the firm. The mobility of workers between labor pools is perfect. Job seekers are assumed to have perfect information on the situation in each labor pool. The search activity of job seekers can be directed toward their preferred employment pool.

The ouput per filled job is equal to the product of two independent random variables, z and ε. z is firm specific and ε is job specific. Their realization is discovered by firms and workers once the jobs have been filled. The distribution of ε is identical in all firms. The cumulative distribution function of output per worker, $y = z\varepsilon$, denoted by $G(y) = \Pr[z\varepsilon < y]$, is continuously derivable on its support. In this framework, firms are ex-ante identical, but ex-post heterogeneous.

Each vacancy is associated with a non-renegotiable contract posted by the firm, which stipulates the wage $w(y)$, the hours worked $h(y)$ contingent on the realization of productivity y, and the productivity set Ω for which the job is not destroyed. When there is a match between a job seeker and a vacant job, the contract is signed. Then, the realizations of z and ε are observed and the contract is implemented.

Short-time work allows firms and employees to get subsidies to compensate hours not worked below the threshold $\bar{h}$. The short-time work subsidy depends on hours worked but not on productivity, because y is not observed by public authorities. The amount of subsidies per employee is equal to $\sigma \max(\bar{h} - h, 0)$. Short-time work subsidies are financed by a lump sum tax paid by workers.

3.2 Labor market equilibrium

The hypothesis of directed search by workers and perfect mobility implies that the expected utility of a job seeker, W_u, is the same in all the labor pools. This implies that the expected

utility W_u of a person in search of work, the expected utility of an employee in any labor pool, denoted by W, and the associated labor market tightness θ satisfy the no-arbitrage condition:[16]

$$W_u = \theta m(\theta) W + \left[1 - \theta m(\theta)\right] \left[b - \phi(0)\right], \forall(\theta, W) \tag{1}$$

where b denotes the gains of an unemployed person and

$$W = \int_{y \in \Omega} w(y) + \sigma \max\left[\bar{h} - h(y), 0\right] - \phi(h(y)) \mathrm{d}G(y) + \int_{y \notin \Omega} \left[b - \phi(0)\right] \mathrm{d}G(y) \tag{2}$$

Equation (1) yields a negative relation between the expected utility associated to the contract offered by the firm and the labor market tightness in its labor pool:

$$\frac{\mathrm{d}\theta}{\mathrm{d}W} = -\frac{\theta}{(1-\eta)\left[W - b + \phi(0)\right]} < 0, \tag{3}$$

where $\eta = -\theta m'(\theta)/m(\theta) \in (0,1)$ is the elasticity of the matching function with respect to unemployment. The interpretation of this relation is that there are more job seekers, and then a lower labor market tightness, in the labor pools that offer better labor contracts. According to equation (3) the labor market tightness reacts more to the expected utility associated to the offered contract when the elasticity η of the matching function with respect to unemployment is higher.

Each firm solves the maximization program:

$$\max_{v, w(y), \Omega, h(y) \geq 0} v m(\theta) \Pi - C(v) \tag{4}$$

where θ satisfies equation (1), and

$$\Pi = \int_{y \in \Omega} y h(y) - w(y) + \sigma \max\left[\bar{h} - h(y), 0\right] \mathrm{d}G(y), \tag{5}$$

is the expected value of a filled job.

In this framework (see Appendix A.1 for the solution), the number of vacant jobs is determined by the equalization of their marginal cost to their marginal returns

$$C'(v) = m(\theta)\Pi, \tag{6}$$

[16] The labor market tightness θ and the expected utility W are labor pool specific. Indexes for labor pools are not used to save on notation.

and the optimal labor contracts have the following properties . The expected utilty of employees increases with the expected profits of filled jobs:

$$W - [b - \phi(0)] = \frac{\eta}{1-\eta}\Pi. \tag{7}$$

Each employee is laid-off if the productivity falls below the threshold denoted by $\tilde{y}$ and the number of hours of work $h(y)$ increases with productivity y.

3.3 The effects of short-time work on hours worked and on employment

The effect of short-time work on hours worked can be analyzed from the relation $h(y)$ between hours worked and productivity stipulated in the equilibrium labor contracts. The shape of $h(y)$ is depicted on Figures 4 and 5. Figure 4 displays the relation between the number of hours worked and productivity absent short-time work ($\sigma = 0$).

Figure 5 shows the effects of short-time work in this case. The number of hours worked drops below the threshold level of hours $\bar{h}$ under which hours not worked are subsidized. Short-time work reduces the number of hours worked over the interval $[\tilde{y}, \bar{y})$ where jobs would not have been destroyed absent short-time work. The drop in hours worked increases with the subsidy σ. However, short-time work also diminishes the number of layoffs, since the threshold value of productivity below which jobs are destroyed is lowered by short-time work. Figure 5 displays a situation in which there are layoffs since the threshold level of productivity below which jobs are destroyed, denoted by $\tilde{y}_1$ when the firm uses short-time work, is strictly positive. Nevertheless, it is possible to have situations without layoff, if the amount of short-time work subsidy at zero hour worked, equal to $\sigma\bar{h}$, is bigger than the unemployment benefit b. This means that it can be optimal to keep jobs with zero hours worked if the short-time work subsidy σ is large enough.[17]

All in all, short-time work can significantly reduce job destruction in firms facing bad realization of their firm specific productivity shock z, inducing many jobs to be at risk of being destroyed (i.e. $y = z \times \varepsilon < \tilde{y}$) in the absence of short-time work. This result is illustrated on the bottom part of Figure 6 which displays the situation of a low productivity firm, in which there is a high probability that the productivity lies below the reservation value $\tilde{y}$ below which jobs

[17] see Appendix A.1.

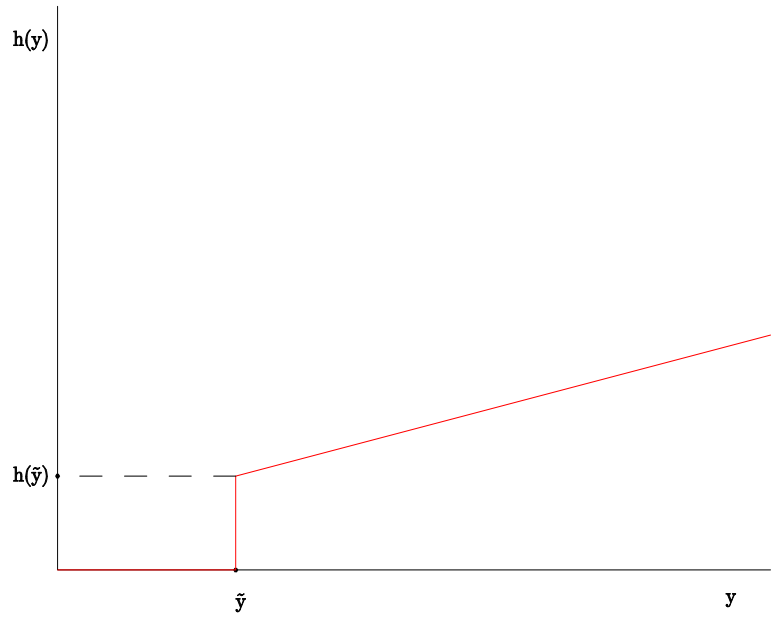

Figure 4: The relation between productivity y and hours worked $h(y)$ absent short-time work
Note: $\tilde{y}$ stands for the threshold value of productivity below which jobs are destroyed absent short-time work.

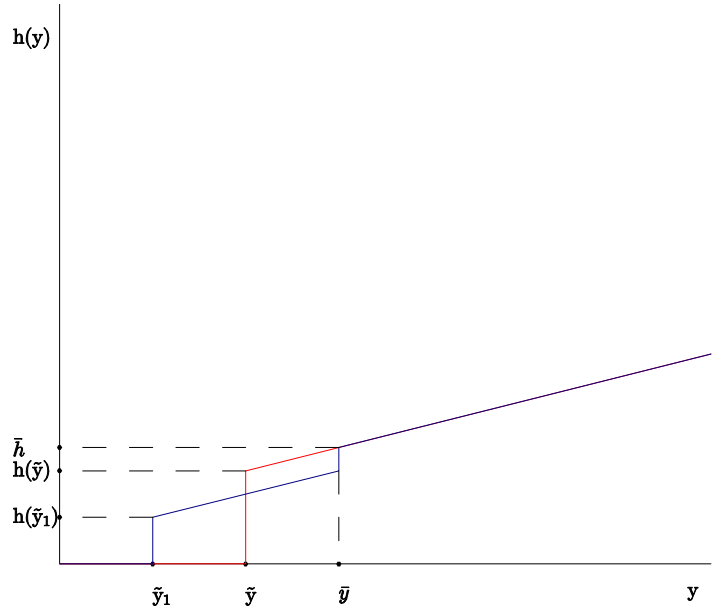

Figure 5: The effects of short-time work on hours worked and on layoffs
Notes: $\diamond$ $\bar{h}$ stands for the threshold number of hours worked below which short-time work applies. $\diamond$ $\tilde{y}$ stands for the threshold value of productivity below which jobs are destroyed absent short-time work. $\diamond$ $\tilde{y}_1$ stands for the value of this threshold when there is short-time work.

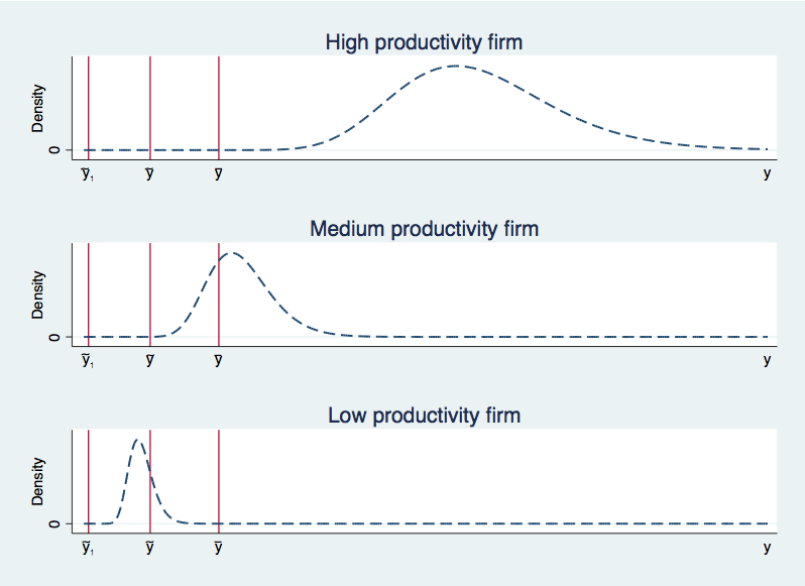

Figure 6: The effects of short-time work according to the productivity of firms

Notes: $\diamond$ $\bar{y}$ stands for the threshold value of productivity $y = \varepsilon \times z$ below which short-time work is used $\diamond$ $\tilde{y}$ stands for the threshold value of productivity below which jobs are destroyed in the absence of short-time work. $\diamond$ $\tilde{y}_1$ stands for the threshold value of productivity below which jobs are destroyed when there is short-time work. $\diamond$ ε has a log-normal distribution with parameters $(4, 0.2)$. $\diamond$ $z = 1, 0.4, 0.15$ for high, medium, low productivity firm respectively.

are destroyed in the absence of short-time work. Absent short-time work, this firm destroys all jobs of productivity $\tilde{y}$. Short-time work saves all jobs of specific productivity $y \in [\tilde{y}_1, \tilde{y})$; all surviving jobs of productivity $y < \bar{y}$ use short-time work. It is clear that short-time work can have a significant impact on employment in the low productivity firm. For the worse realizations of the firm specific productivity shock z, some firms may have no profitable job absent short-time work, meaning that short-time compensation may help them surviving. However, the situation is very different in the medium productivity firm, displayed in the middle graph of Figure 6, where a large share of jobs use short-work but where short-time work saves very few jobs. The main impact of short-time work is to reduce the number of hours worked with very little effects on employment. In the high productivity firm, displayed in the upper graph of Figure 6, the probability to use short-time work is very small because the probability that y is below $\bar{y}$ is very small.

Short-time work generates windfall gains for both workers and firms insofar as short-time work is used by workers whose job would not be destroyed in the absence of this policy. However

these windfall gains are smaller than for usual job subsidies which do not allow the government to target effectively low productivity jobs. Short-time work provides subsidies to jobs of productivity below $\bar{y}$ whereas wage subsidies or hiring subsidies provide support to jobs independently of their productivity. Such subsidies are often conditional on the type of worker, for instance when they are targeted at unskilled workers, low-wage workers or previously long-term unemployed workers, or the type of firm, for instance small firms, but they do not depend on the realization of productivity which is usually not verifiable by the government. By contrast, short-time work allows the government to target low productivity jobs because firms and workers choose less hours worked for these jobs only. Seen from this perspective, short-time work is a more effective tool than job subsidies when trying to sustain employment. It is shown in Appendix A.2 that the ratio between the number of jobs created by short-time work and by job subsidies for an identical cost per employee (or equivalently an identical expenditure) is given by equation

$$\frac{\text{Number of jobs created by short-time work}}{\text{Number of jobs created by job subsidies}} = \frac{Nm(\theta)v\left[1-G(\tilde{y})\right]}{Nm(\theta)v\int_{\tilde{y}}^{\bar{y}}\frac{\bar{h}-h(y)}{\bar{h}-h(\tilde{y})}\mathrm{d}G(y)} \tag{8}$$

where N denotes the number of firms in the economy. The numerator of this expression is the number of employees and the denominator is the weighted number of employees using short-time work, each of these employees being weighted by its number of short-time work hours relative to the maximum number of short-time work hours per employee in the economy. The ratio between the number of jobs created by short-time work and the number of jobs created by job subsidies is clearly larger than one, for two reasons. First, in general, short-time work is used by a fraction of employees, those who face large drop in productivity. This means that job subsidies are provided to all the $Nm(\theta)v\left[1-G(\tilde{y})\right]$ employees while short-time compensations are provided to the subset $Nm(\theta)v\left[G(\bar{y})-G(\tilde{y})\right]$, where $\bar{y}$, the threshold value of productivity below which short-time work is used, is generally smaller than the highest productivity level. Second, short-time work subsidizes non-worked hours only. Non-worked hours increase when productivity drops because the number of hours worked raises with productivity. This implies that the sum of weights $\left[\bar{h}-h(y)\right]/\left[\bar{h}-h(\tilde{y})\right]$ in the integral of equation (8) is smaller than one, and then that the denominator is smaller than $Nm(\theta)v\left[G(\bar{y})-G(\tilde{y})\right]$. Put together, these two mechanisms imply that the cost per job created by short-time work is potentially much lower than the cost per job created by job subsidies. In 2009, short-time work was used by about 4% of

employees (see Figure 1). Thus, according to equation (8), the cost per job created by short-time work should be about 25 times lower than the cost per job created by job subsidies provided to all jobs. Obviously, job subsidies are generally targeted to specific categories of workers, such as low wage workers or young unskilled workers, or to small firms. But targeting subsidies on such broad categories is not very effective at targeting jobs at risk of being destroyed. From this perspective, our model stresses that the cost per job created by short-time work is indeed potentially much smaller than the cost per job created by job subsidies.

An important disadvantage of short-time work is its negative impact on hours worked. However, it is worth noting that short-time work can increase the total number of hours worked through its positive employment effects. This situation arises[18] if the reservation productivity, $\tilde{y}$, lies in a region where the slope of the density of the distribution of productivity y is negative. For standard distributions, with a single mode, this means that the reservation productivity is above the mode (but possibly lower than the median and the mean if the distribution is log-normal, for instance), as displayed in the bottom graph of Figure 6 which represents the case of low productivity firms. It is possible that such situations arise during recessions when negative aggregate shocks hit many firms. This result suggests that short-time work may raise the total number of hours worked during recessions, but not in normal time.

4 Data

In order to assess the effect of short-time work on survival, employment, and hours worked in French establishments, we merge several data sources**.**

4.1 Data Sources

4.1.1 Sinapse-Chômage Partiel

To measure short-time work in all its components, *administrative and economic*, we use *Sinapse-Chômage Partiel*, a source produced by the Statistical Department of the French Labor Ministry (*DARES*) in collaboration with the Employment and Vocational Training Agency (*DGEFP*). Data were collected for the years 2007 to 2014 by the *DIRECCTE*. To do so, a software called *Aglae-Chômage Partiel* creates a record per short-time work application received from an es-

[18] See Appendix A.3.

tablishment located in the *département*. The application allows the record to be filled at each step of the short-time work application process. Then, two data sets are made out of these applications. In one, all variables generated by the application process are included: application identification number, information on the applying establishment (identification number, name, city, labor pool, *département*, *région*, industry, weekly legal and collective work duration, number of employees); the nature of the reduction in hours (identification number, reason, area, repeated use, hourly short-time work subsidy, maximum number of short-time work hours per employee and per year, works council recommendation, labor inspection recommendation, application date); authorized short-time work (decision status, decision date, authorization period, number of authorized short-time work employees in total and by occupation and work duration, number of authorized short-time work hours and the associated amount of subsidies). In the second data set, variables on monthly consumption are included: identification number, short-time work consumption month and its sequential number relative to the first month of the authorization period, number of monthly employees effectively under short-time work, number of short-time work consumed hours and the associated amount of subsidies.

4.1.2 DADS-Établissements

The *Déclaration Annuelle de Données Sociales* (*DADS*) is produced by the French National Institute for Statistical and Economic Studies (*INSEE*). Each establishment sends the gross wage, inclusive of employer and employee-paid payroll taxes and net wage for each of its employee to the tax authority. *INSEE* then processes these variables to yield various aggregates, at the individual, establishment, and firm levels. We use in what follows the establishment version which allows us to measure the industry, the city, employment, hours, and the wage bill for each establishment in our matched sample.

The *DADS* provides quite reliable information on employment and labor contract types. However, information on hours worked is less precise insofar as about 20% of employees are paid on a daily basis. Moreover, if the *DADS* information is not transmitted in the relevant format through the automated Unified Social Data Reporting (*DADS-U*), the information about the number of hours is absent, and the number of hours worked is imputed. Therefore, the quality of the information on hours is not sufficient to analyze the impact of short-time work on the hours worked.

4.1.3 FICUS and FARE

The *INSEE*-Section "Production of Annual Firms' Statistics" (*ESANE*) produces the so-called *FICUS* (until 2007) and *FARE* (since 2008) data sets using the financial and fiscal accounts sent by all French firms to the fiscal authority. The variables are constructed using the annual tax returns and other administrative sources based on these accounts. The above data sets contain, among other things, the firm identification number, sales, and debt.

4.1.4 Geocoded Data

In order to precisely locate all French establishments, we use the *Système d'Identification des ENtreprises et des Établissements* (*SIENE*), the *Système Informatique pour le Répertoire des Entreprises et des Établissements* (*SIRENE*) and the *Système d'Identification au Répertoire des Unités Statistiques* (*SIRUS*). The *SIENE*, the *SIRENE* and the *SIRUS* are three administrative datasets produced by the *INSEE* which provide information about the location of all French establishments. Thanks to these four data sources, we create a unified dataset containing the address, the zipcode and the city of all establishments that we geocode using the software *ArcGIS* and matching with the *BD ADRESSE* (a dataset produced by the French National Institute for Information about Geography and Forest (*IGN*) and containing all geocoded French addresses). This process generates the geographic coordinates of all establishments in the format *Lambert 93* which enables us to compute the Euclidean distance between establishments.

4.2 Descriptive Statistics

Using the firm (*SIREN*) and the establishment identification number (*SIRET*), we merge the above data sources. Table 1 displays the characteristics of firms using short-time work for economic reasons in 2009 and those of the firms which do not use short-time work in the same year. We restrict our attention to single-establishment firms essentially because accounts are only available at the firm level whereas the rest of our sources are establishment level, noting that our theory needs a measure of the shock that hits the entity. We also concentrate on the establishments using short-time work for the first time in 2009, i.e. not using short-time work in 2007 or 2008, to avoid establishments using short-time work recurrently to cope with seasonal fluctuations. As shown by Table 1, on average, firms using short-time work have more employees, pay higher wages, have a lower share of temporary jobs and a lower worker turnover;

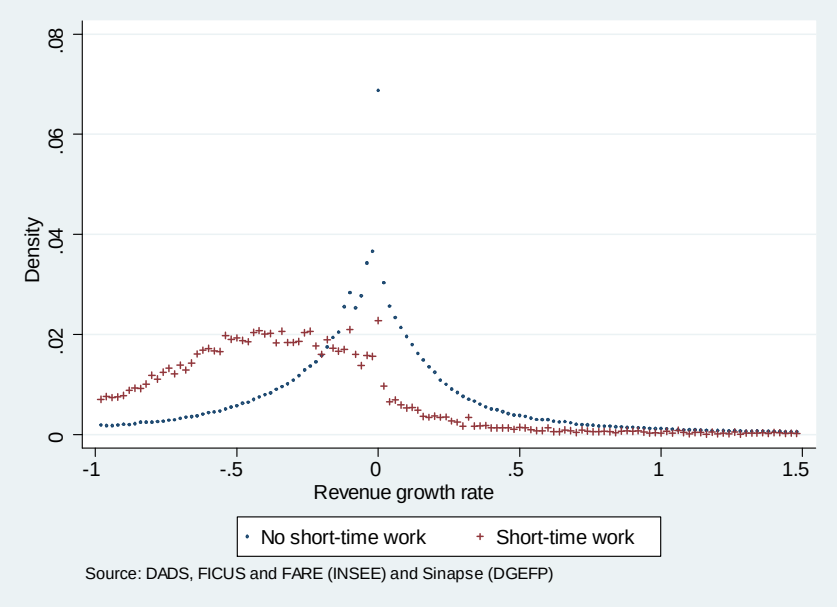

Figure 7: Density of the revenue growth rate of firms with and without short-time work use in 2009

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ◇ Mainland France excluding Corsica. ◇ Market sectors excluding agriculture.

Note: "Short-time work" stands for the establishments using short-time work for economic reasons in 2009; "None" stands for the establishments not using short-time work in 2009.

their employment growth rate and their revenue growth rate are also lower. Figure 7 shows the density of the revenue growth rate for firms with and without short-time work use. The growth rate for the former is much smaller on average and more dispersed than for the latter.

5 Empirical Strategy and Identification

Our model shows that the effect of short-time work on employment depends on the change in revenue of the firm: short-time work "*really saves*" jobs for firms with a large drop in revenue. This leads us to evaluate the impact of short-time work in 2009 in firm i by estimating the following regression:

$$L_i = \alpha_0 + STW_i\alpha_1 + Y_i\alpha_2 + X_i\alpha_3 + \varepsilon_i \tag{9}$$

where the dependent variable, L_i, denotes the employment growth rate (employment corresponds to the number of employees on the 31st of December). We also explore the effects of

short-time work on the survival rate of firms (a firm survives in year t if and only if it has a positive number of employees on the 31st of December of year t), on the share of permanent jobs, on the growth rate of permanent jobs and on the growth rate of temporary jobs. STW_i is an indicator variable equal to one if the firm uses short-time work for economic reasons and to zero otherwise. Y_i denotes the revenue growth rate of firm i. X_i is a vector of control variables,[19] and ε_i is an error term.

Short-time work may have an impact on the revenue growth rate Y_i showing up in equation (9). In order to deal with the endogeneity of revenue, we predict the revenue growth rate of firm i by the leave one out mean growth rate of revenues in the industry and commuting zone, denoted by $\bar{Y}_i$,[20] as well as by its short-time work use:

$$Y_i = b_0 + STW_i b_1 + \bar{Y}_i b_2 + X_i b_3 + \varepsilon_{1i} \tag{10}$$

Short-time work use is also potentially correlated with the error term ε_i of equation (9) because unobserved confounding variables can influence employment growth, revenue growth, and short-time work take-up. In particular, firms have more incentives to use short-time work if it is more costly to store production or to find productive replacement activities to incumbent workers when the demand drops. This issue is potentially empirically important insofar as the correlation between the revenue growth rate and the employment growth rate of the firm is weak and heterogeneous. The (Pearson) correlation coefficient between the two is equal to 0.07 in 2008. This coefficient is also very heterogeneous across industries. Figure 8 reports the take-up rate of short-time work in 2009 (y-axis) and the correlation of the revenue growth rate with the employment growth rate of the firm in 2008 (x-axis) *by industry*. As shown by this Figure, the adjustment of employment to fluctuations in revenue is very heterogeneous. Industries where the correlation is large in 2008 tend to also have a larger short-time work take-up in 2009. This result confirms that of Bellmann et al. (2015, p 196), who find that firms which use short-time work tend to adjust more strongly employment when output falls than firms which do not use

[19] The control variables include past mean hourly wage, the past number of hours worked per employee, the past job turnover, the past share of temporary jobs, the age of the firm, the leverage of the firm and (728) industry fixed effects to control for potential sector-specific trends. We also include indicator variables to account for regulations which may differently influence the adjustment of employment depending on the size of the firm in previous year (10, 50, 250, and 1,000 employees).

[20] Namely, we compute for each sector $\times$ commuting zone cell the revenue growth rate as $\sum_{j \neq i}(Y_{j,2009} - Y_{j,2008})/Y_{j,2008}$ where $Y_{j,t}$ denotes revenue of firm j in year t belonging to the same sector and commuting zone as firm i.

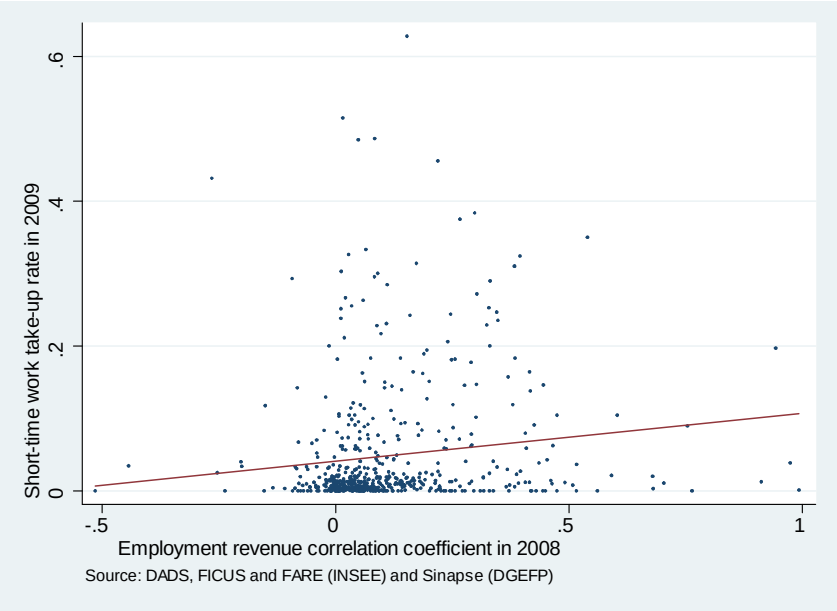

Figure 8: Proportion of short-time work establishments in 2009 (vertical axis) and employment revenue correlation coefficient in 2008 (horizontal axis)

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ◇ Mainland France excluding Corsica. ◇ Market sectors excluding agriculture.

Definition: The employment revenue correlation coefficient is defined as the correlation between the revenue growth rate and the employment growth rate.

Notes: ◇ The proportion of short-time work establishments and the employment revenue correlation coefficient are computed at the sector level. ◇ The equation corresponding to the linear regression is: $STW_i = \underset{(.004)}{.040} + \underset{(.021)}{.066}\rho_i$, $R^2 = .015$ and $N = 552$ where i denotes the sector, STW_i denotes the proportion of short-time work establishments and ρ_i denotes the employment revenue correlation coefficient.

short-time work. This phenomenon is very likely to induce the ordinary least squares estimate for short-time work in equation (9) to be biased downwards, since firms using of short-time work more frequently are also those more likely to adjust employment downwards when their revenue drops.

To deal with this potential endogeneity, we use an instrumental variable strategy. We identify two main channels to explain how the decision to take-up short-time work in 2009 is influenced by its past and present environment.

First, the DIRECCTE – the départemental agencies in charge of labor relations – play a key role in administrating the implementation of short-time work regulations. They are in charge of processing the applications and the payment of short-time work subsidies. This creates

heterogeneity in the response time to short-time work applications across départements. A long response time can be a signal of bad management. It may also reflect stringent requirements in granting short-time work subsidies, insofar as the local administration takes a long time to examine the applications, to ask for complementary documents proving the economic difficulties of the establishment, and to ask the labor inspection authority to assess the exact situation of the establishment. Hence, a long response time is potentially a reflection of good or bad management of the local administration. This long response time is likely to affect negatively short-time work use at a moment when establishments need to react promptly to a sharp drop in their revenue. Figure 9 shows that there is a strong variation in the 2008 response time to short-time work applications across *départements* even though short-time work was barely used at that time. The fraction of response times above 14 workdays – which corresponds to the median response time in 2008 – goes from 0% (in 10 *départements*) to 90% (in one *département*) when the average fraction across *départements* is equal to 38%. Although several ministerial circulars and directives were sent to local authorities, calling for an easier access to the policy in 2009, Figure 10 shows that the *départements* where the response time was longer in 2008 are also those that had longer response time in 2009. Therefore, firms could anticipate that the access to short-time work in such *départements* would be more difficult even during the great recession.

Figure 11 indeed clearly shows that there is a negative correlation between the response time of the *départemental* administration and the short-time work take-up before the recession, in 2008. This relation holds controlling for a large set of potential confounding factors, including (728) sector fixed effects and the average *départemental* employment growth to ensure that this relation is not driven by congestion effects induced by differences in *départemental* employment growth. Figure 11 displays a strong negative relation between the short-time work take-up rate in 2009 and the response time of the *départemental* administration in 2008. The short-time work take-up rates in 2009 are twice higher in the *départements* belonging to the lowest ventile (bottom five centiles) of our measure of response time in 2008 than in those belonging to the highest ventile (top five centiles).

The response time of the *départemental* administration is also related to, potentially even causing, choices made by multi-establishment firms. Table 2 shows that multi-establishment

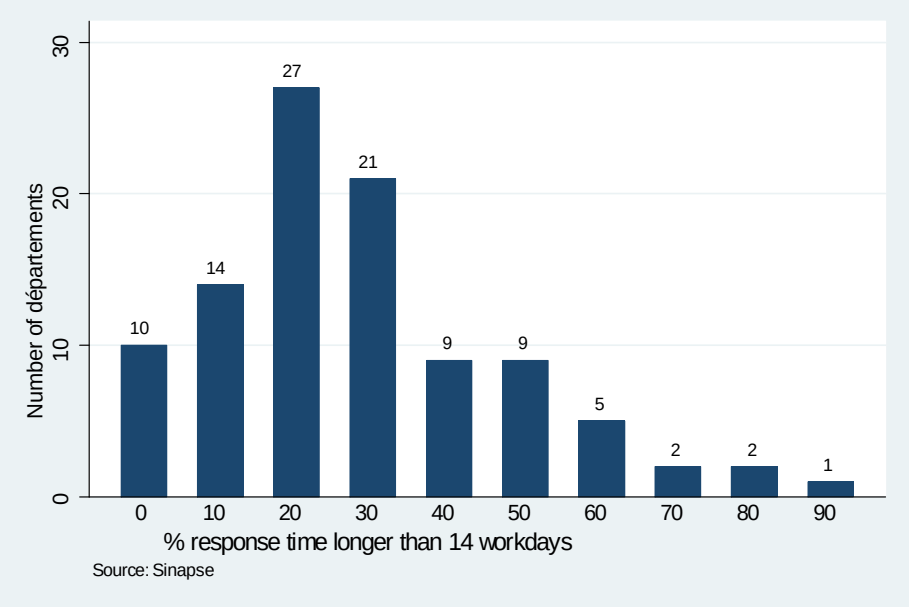

Figure 9: Number of *départements* (vertical axis) and proportion of short-time work applications whose response time is longer than 14 days (horizontal axis) in 2008

Source: *Sinapse* (*DGEFP*).

Scope: ◇ Mainland France excluding Corsica. ◇ Market sectors excluding agriculture. ◇ Establishments using short-time work.

Definition: Response time is defined as the number of workdays elapsed between the receipt date and the decision date regarding the short-time work application.

Reading: 27 *départements* had 20% of short-time work applications whose response time is longer than 14 days in 2008.

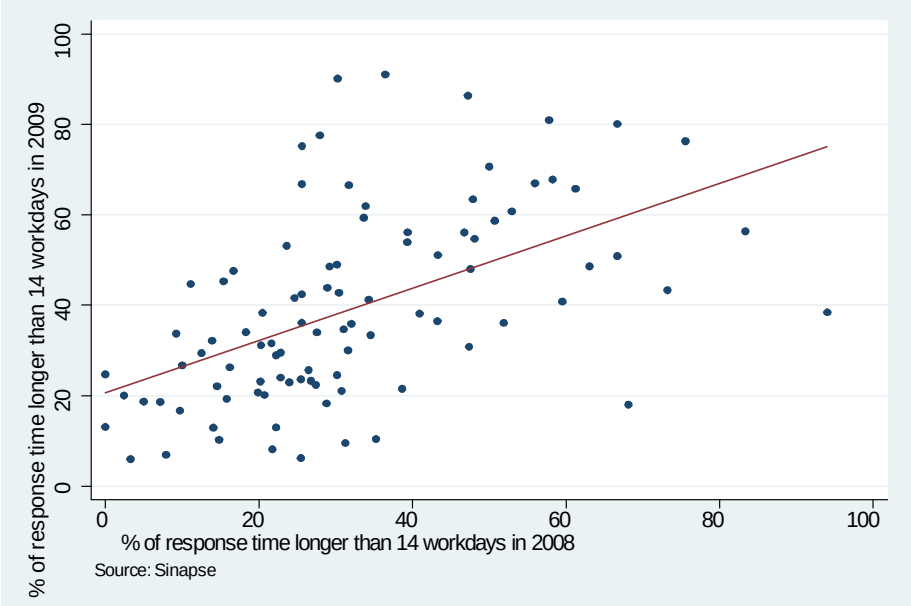

Figure 10: Proportion of short-time work applications whose response time is longer than 14 days in 2009 (vertical axis) and in 2008 (horizontal axis)

Source: *Sinapse* (*DGEFP*).

Scope: ◇ Mainland France excluding Corsica. ◇ Market sectors excluding agriculture. ◇ Establishments using short-time work.

Definition: Response time is defined as the number of workdays elapsed between the receipt date and the decision date regarding the short-time work application.

Notes: ◇ The proportion of short-time work applications whose response time is longer than 14 days is computed at the *département* level. ◇ The equation corresponding to the linear regression is: $y_i = \underset{(3.7)}{20} + \underset{(.09)}{.058}x_i$, $AdjR^2 = .27$ and $N = 94$ where i denotes the *département*, y_i denotes the proportion of short-time work applications whose response time is longer than 14 days in 2009 and x_i denotes the proportion of short-time work applications whose response time is longer than 14 days in 2008.

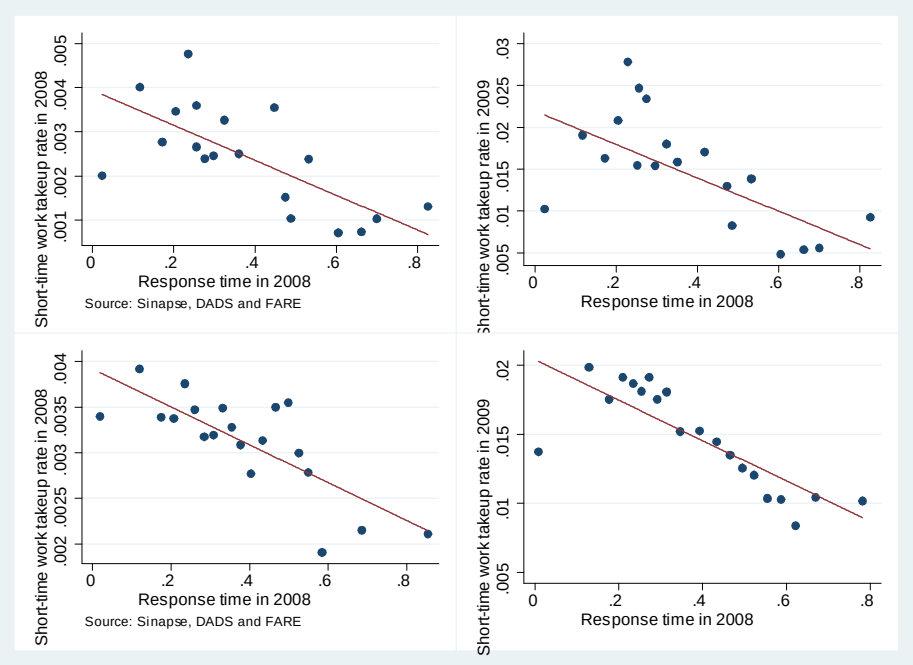

Figure 11: Proportion of short-time work establishments in 2008 (left) and in 2009 (right) (vertical axis) and proportion of short-time work applications whose response time is longer than 14 days in 2008 (horizontal axis)

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ◇ Mainland France excluding Corsica. ◇ Market sectors excluding agriculture.

Notes: ◇ Each graph represents a binscatter which groups the variable on the horizontal axis into equal-sized bins, computes the mean of the variables on the horizontal and vertical axes within each bin, and creates a scatterplot of these data points. ◇ Top graphs report the mean of the short-time work take-up rates whereas the bottom graphs report the mean conditional on the revenue growth rate, the leverage rate, the hourly gross wage, the number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees, the age of the firm and (728) sector-specific fixed effects, départemental employment growth.

Definitions: ◇ Response time is defined as the number of days elapsed between the receipt date and the decision date regarding the short-time work application. ◇ The revenue growth rate is defined as the difference in the revenue between 2009 (respectively 2008) and 2008 (respectively 2007), divided by the absolute value of the revenue in 2008 (respectively 2007). ◇ The leverage rate is defined as the level of debt divided by the level of assets, in the previous year. ◇ The hourly gross wage is defined as the total labor cost divided by the total number of hours worked, in the previous year. ◇ The number of hours worked per worker is defined as the total number of hours worked divided by the average number of employees, in the previous year. ◇ The turnover rate is defined as the total number of employees divided by the average number of employees, in the previous year. ◇ The share of temporary jobs is defined as the number of employees under non-permanent contracts divided by the total number of employees, in the previous year. ◇ The number of employees is defined as an indicator variable of the number of employees on the 31st of December of the previous year (10, 50, 250, and 1,000 employees). ◇ The age is defined as the difference between 2009 (respectively 2008) and the year of creation of the firm.

firms used short-time work more frequently in 2008, before the recession, in their establishments located in the *départements* where the response time was shorter in 2008. This result holds conditional on a large set of characteristics of establishments including the average hourly wage, the share of temporary jobs, the average number of annual hours worked per worker, the revenue growth in the commuting zone, and industry fixed effects. Indeed, the information transmission mechanism across establishments is likely to be very different for single and multi-establishment firms: multi-establishments firms will clearly rely pretty heavily on within-firm between-establishments information from their own (firm level) human resources department as well as direct flows between establishments. As for single-establishment firms, the process is analyzed now.

Indeed, the behavior of single-establishment firms in 2009 is not only influenced by the past response time of the local administration, but also by the 2008 choices of geographically close establishments belonging to a multi-establishment firm. We study the following equation which models the decision of a firm i – which did not use short-time work in 2007 or in 2008 – to use short-time work in 2009:[21]

$$STW_i = a_0 + RP_i a_1 + DM_i a_2 + \bar{Y}_i a_3 + X_i a_4 + \eta_i \tag{11}$$

where RP_i denotes the share of response time to short-time work applications longer than 14 days of the *départemental* administration of firm i in 2008; DM_i stands for the distance to the closest establishment, belonging to a multi-establishment firm, which used short time work in 2008. Equation (11) states that the short-time work take-up of firm i depends on these two variables, on the leave one out revenue mean growth rate of the industry $\times$ commuting zone cell of firm i, and on the other variables X_i likely to influence employment growth in equation (9). Table 4 shows that short-time work use of single-establishment firms in 2009 is negatively correlated with the response time of the *départemental* administration in 2008 and with the distance to the closest establishment, belonging to a multi-establishment firm, which used short time work in 2008.

This indicates that the impact of the response time of the *départemental* administration on the short-time work use of single-establishment firms is amplified by multi-establishment firms, whose choice of using short-time work more intensively in *départements* with shorter

[21] Henceforth, firms which used short-time work in 2007 or 2008 are excluded from the sample to avoid repeated users which have previously benefited from the treatment.

response times diffuses to single-establishment firms. This phenomenon is illustrated on Figure 12 which displays the diffusion of short-time work in two *départements*, Savoie and Rhône, from December 2008 to December 2009, among firms belonging to the sector of industrial mechanics. The red squares of the first map represent the establishments belonging to multi-establishment firms applying for short-time work in December 2008. The green diamonds of the second map add the single-establishment firms operating in 2008. The blue triangles of the third map add the single-establishment firms applying for the first time for short-time work for economic reasons for short-time work between the 1st and the 15th of January 2009, and so on. As time goes by, some green diamonds located close to the red squares progressively turn into blue triangles, highlighting the spatial diffusion of short-time work use from multi-establishment firms to single-establishment ones. Hence, it is clear that short-time work spreads in single-establishment firms located close to establishments belonging to multi-establishment firms which applied for short-time work in 2008. The diffusion is more intense in Rhône in which the response time of the administration is shorter (15% of reponse time longer than 14 workdays, versus 24% in Savoie). Although not displayed here, this result is not specific to the sector of industrial mechanics but also holds true for all firms. Obviously, this Figure is only illustrative insofar as the geographical spread of short-time work may be influenced by confounding variables. To shed more light on the diffusion process, we analyze the relation between the date of short-time work take-up of single establishment firms in 2009 and their distance to establishments belonging to multi-establishment firms which used short-time work in 2008. We group the single establishment firms by quartiles of distance to establishments belonging to multi-establishment firms which used short-time work in 2008. Since the short time work take-up is concentrated at the beginning of 2009,[22] we look whether single establishment firms located closer to establishments belonging to multi-establishment firms which used short-time work in 2008 use short-time work more frequently in the first quarter of 2009 than later in the same year. Table 3 shows that the probability that single establishment firms which belong to the first quartile[23] use short-time work in the first quarter of 2009 is 5 percentage points higher relative to single establishment firms which belong to the other quartiles. This relation

[22] The share of single establishment firms using short-time work in the first, second, third and fourth quarter of 2009 is 0.45, 0.27, 013 and 0.15 respectively.

[23] The average distance in the first quartile is equal to 1.1 kilometers and the maximum distance in this quartile is 2.2 kilometers.

is robust to the inclusion of many potential confounding variables including the revenue growth rate of the firm in 2009, the quarterly employment growth rate of its sector (accounting for 728 sectors) and the *départemental* response time.

These results confirm that diffusion of short-time work use from firm-to-firm, even though unknown in its details, appears to have a key role. The diffusion may arise from the transmission of information. It may also arise from a reluctance to be the only establishment to apply when some coordination may reduce the potential negative signal associated with a short-time work application for the firm's employees, its trading partners, and its creditors as it highlights the financial difficulties a firm is facing.

Hence, the 2009 short-time work use is correlated with two variables that are very unlikely to have an impact on how the firm adjusts employment when its demand falls: the 2008 response time of the *départemental* administration to short-time work applications and the distance to the closest establishment, belonging to a multi-establishment firm, which used short-time work in 2008. Therefore, these two variables are used as instruments for short-time work. Equations (10) and (11) imply that short-time work use and the revenue growth rate are explained by equations

$$STW_i = \beta_0 + RP_i\beta_1 + DM_i\beta_2 + \bar{Y}_i\beta_3 + X_i\beta_4 + \eta_i \quad (12)$$

$$Y_i = \gamma_0 + RP_i\gamma_1 + DM_i\gamma_2 + \bar{Y}_i\gamma_3 + X_i\gamma_4 + \xi_i \quad (13)$$

Assuming that the error term of equation (9) is correlated neither with the response time to short-time work applications of the *départemental* administration of firm i in 2008 (i.e. $\mathbb{E}(\varepsilon_i|RP_i) = 0$) nor with the distance to the closest establishment, belonging to a multi-establishment firm, which used short time work in 2008 (i.e. $\mathbb{E}(\varepsilon_i|DM_i) = 0$), nor with the revenue growth rate in the industry and commuting zone (i.e. $E\left(\varepsilon_i|\overline{Y_i}\right) = 0$), equation (9) can be consistently estimated with two stages least squares, using RP_i, DM_i and $\bar{Y}_i$ as instruments for the firm's decision to take-up short-time work and for its revenue growth rate.

The estimates of the first-stage equations (12) and (13) presented in Table 4 show that short-time work used in 2009 is strongly correlated with the instruments. Besides these instruments, several features of the firms exert an influence on short-time work use. Firms with higher labor turnover and higher share of temporary contracts in 2008 used short-time work less frequently in 2009. It is likely that these firms had less need to rely on short-time work when they were

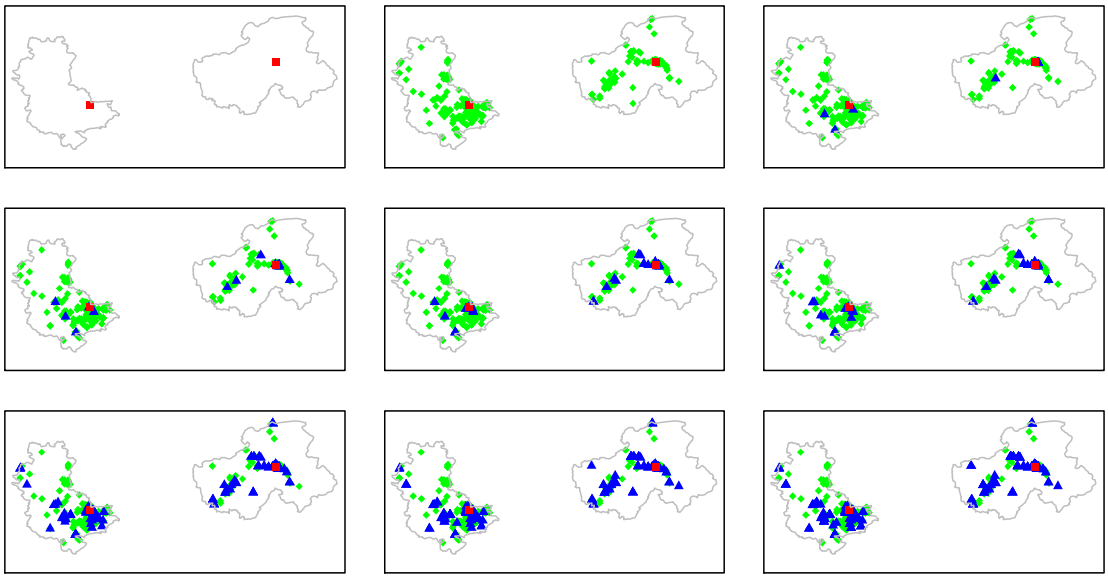

Figure 12: The diffusion of short-time work in Rhône (left-hand side *département* on each map) and Savoie (right-hand side *département* on each map) from December 2008 to December 2009

Sources: *DADS* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ◇ *Départements* of Rhône and Savoie (belonging to the same *région* Rhône-Alpes and separated by the *département* of Isère). ◇ Sector of industrial mechanics.

Notes: ◇ The red squares stand for the establishments, belonging to a multi-establishment firm, which applied for short-time work in December 2008. ◇ The blue triangles stand for the establishments, belonging to a single-establishment firm, which applied for the first time for short-time work for economic reasons between the 1st of January 2009 and the 15th of January 2009 (map 3), between the 1st of January 2009 and the 31st of January 2009 (map 4), between the 1st of January 2009 and the 15th of February 2009 (map 5), between the 1st of January 2009 and the 28th of February 2009 (map 6), between January 2009 and May 2009 (map 7), between January 2009 and October 2009 (map 8), between January 2009 and December 2009 (map 9). ◇ The green diamonds stand for the establishments, belonging to a single-establishment firm and operating in 2009.

hit by negative shocks on their revenue because the adjustment of manpower was less costly for them. Larger firms, firms with higher leverage and firms in which the average number of annual hours of work was higher in 2008 used short-time work more frequently in 2009.

6 Effects of Short-Time Work

We start by analyzing the global firm level impact of short-time work before looking at heterogeneous effects. This heterogeneity is measured by the magnitude of the fall in revenues during the great recession, as suggested by our model. Finally, we use our results to compute the cost per job saved by the short-time work policy.

6.1 Global Effects

Table 5, rows 1 and 2, presents the impact of short-time work on employment growth and on firms' death in 2009. Column (OLS) shows that the ordinary least squares short-time work estimate of equation (9) is negative and strongly significant for employment growth. This result confirms our previous discussion: firms using short-time work have less opportunities to smooth the activities of their employees and to store production when their demand falls. As a result, those firms, also more likely to use this scheme, have a greater propensity to layoff their employees. Hence, the negative sign and the strong significance of the estimate suggest that the ordinary least squares estimates are strongly biased downwards.

The instrumental variable estimates of the impact of short-time work on employment, presented in Table 5, column (IV), are very different from the ordinary least squares estimates. The instrumental variable estimate of the impact of short-time work on employment growth is positive and not significantly different from zero. The instrumental variable estimates show that short-time work has a positive impact on the share of permanent jobs, suggesting that short-time work makes it easier to keep employees with permanent contracts, as their labor services can be adjusted at the intensive margin. Apart from the positive impact of short-time work on the share of permanent jobs, the instrumental variable strategy does not allow us to detect any significant effect of short-time work on employment at the aggregate level. This is not surprising insofar as our theoretical framework indicates that the effect of short-time

work on employment is very heterogeneous, with no effect for firms which faced a small drop in revenue and positive effects for those that faced a large one.

6.2 Heterogeneous Effects

Our theoretical model predicts that short-time work has heterogeneous effects across firms, depending on the strength of the shock that hits them. In particular, short-time work is structured to help firms hit by a very negative shock, whereas short-time work is a windfall in other firms. To highlight this phenomenon, we stratify the firms in quintile of their revenue growth rate in 2009 predicted by equation (10). In this equation, the revenue growth rate of each firm is explained by the leave one out revenue growth rate of its industry $\times$ commuting zone cell, industry fixed effects to control for potential industry-specific trends, and several firm-specific variables including the past share of temporary jobs, the past mean hourly wage, the past number of hours worked per employee, the past labor turnover, the past firm leverage, and the age of the firm.

Table 6 shows that short-time work is concentrated in the (first) quintile of firms with the lowest predicted revenue growth rate. There, the take-up is three times larger than in the second quintile and 6.5 times larger than in the fifth quintile. Nevertheless, 47% of firms use short-time work but do not belong to the first quintile. This first quintile mostly comprises larger and older firms (see Table 7).

6.2.1 Heterogeneous Effects in 2009

Tables 8 and 9 report both the first and the second stages of our instrumental variable estimation of equation (9) for each quintile of the predicted revenue growth rate of firms.

The estimates for the first stage of the instrumental variable estimation reported in Table 8 show that the instruments are jointly significant for every quintiles. Table 9 shows that the estimated second stage coefficients are clearly significantly different from zero for both the growth of employment and the growth of permanent jobs *only in the lowest quintile of predicted revenue growth*. In other quintiles, estimated coefficients are never signicantly different from zero and decrease with the predicted revenue growth. Table 9 shows that short-time work raises employment growth by about 16% points in the first quintile – with 95% confidence interval

equal to $[6\%, 26\%]$– , which corresponds to one half of the standard deviation of employment growth in that quintile. Overall, as firms belonging to the first quintile of the predicted revenue growth are much larger than other firms, short-time work saved about 11% of jobs of all firms which used short-time work – with 95% confidence interval equal to $[4\%, 18\%]$.[24] This implies that every worker on short-time induces 0.17 saved job on average[25] – with 95% confidence interval equal to $[0.06, 0.29]$. This order of magnitude is in line with other evaluations.[26]

Table 9 shows that short-time work saves permanent jobs but has not impact on temporary jobs. As a result, the share of permanent jobs increases in firms using short-time work, relative to other firms; in line with the empirical literature that uses cross-country data.[27]

As shown by Table 9, row 5, short-time work reduces the death probability for firms in the first quintile of the distribution of predicted revenue growth rate. Hence, short-time work "helps" those firms that face the greatest survival hazard. The effect is economically significant: the death rate of firms benefiting from short-time work decreases by 9% points, one third of the standard deviation of the death rate in the first quintile (mean equal to 6.4%). This positive effect, which also contributes to save jobs, disappears above the lowest quintile.

In order to check the robustness of these heterogeneous effects, Tables 10 to 13 report the results when the distribution of firms is stratified in terciles instead of quintiles. Table 12 shows that the instruments are very significant for every terciles. The comparison of the instrumental variable estimates of the impact of short-time work on employment growth in

[24] Let us denote by $\mathbb{E}(\Delta\ell_i)/\ell_i$ the expected employment growth rate in firm i, where ℓ_i denotes employment in firm i on 31 December 2008. According to equation (9), the impact of short-time work on the expected employment change in firm i is $\mathbb{E}(\Delta\ell_i) = \hat{\alpha}_1\ell_i$. Therefore, total employment change in the first quintile is equal to $\hat{\alpha}_1 \sum_{i\in Q_1} \ell_i$ where Q_1 denotes the set of firms using short-time work that belong to the first quintile of the predicted revenue growth rate. There are 185,676 jobs in 2008 in the firms using short-time work that belong to the first quintile and 74,538 in the short-time work users that belong to the other quintiles. This implies that short-time work increases employment in all firms that use short-time work by $\hat{\alpha}_1 \times 185,676/260,214 = 0.113$ taking $\hat{\alpha}_1 = 0.158$ from the first Column of Table 9.

[25] We divide the number of jobs created by short-time work in 2009 by the number of short-time work employees in 2009 to get this number. Note that this figure is consistent with the claim that short-time work saved about 13% of jobs of all firms which used short-time work because all employees are not necessarily on short-time work in firms using short-time work.

[26] This result can be compared to Boeri and Bruecker (2011) who find that a short-time work employee saved about 0.35 jobs during the great recession in Germany – with a 95% confidence interval equal to $[0.04, 0.70]$. The impact on employment is larger than in France, although less precisely estimated (the number of observations is smaller in Germany). The stronger impact on employment in Germany is likely due to the larger drop in hours worked of short-time work employees which reached 40% on average, versus 7% in France. As a short-time work employee experiences a reduction in her hours worked by 40% and created 0.35 jobs in Germany, short-time work has had a very uncertain impact on the total number of hours according to this evaluation in this country.

[27] Cahuc and Carcillo (2011), Hijzen and Venn (2011).

Tables 13 and 9 indicates that the coefficient is significantly larger in the first quintile than in the first tercile. Accounting for the difference in the number of short-time work users in the first tercile and in the first quintile, these results point to similar number of jobs created, with a point estimate equal to 10% of the total number of jobs of firms that used short-time work – with a 95% confidence interval equal to $[1\%, 19\%]$– versus 11% of jobs of all firms which used short-time work – with a 95% confidence interval equal to $[4\%, 18\%]$ – when firms are stratified in quintiles instead of terciles. Again, the employment effects are concentrated onto permanent jobs. Assessing robustness with respect to the survival of firms, Table 9 shows that short-time work significantly reduces the death rate of firms in the lowest quintile, whereas the estimate is negative but not significantly different from zero in the first tercile (p-value = .102 - see Table 13). These results are consistent: they indicate that short-time work improves the survival of firms hit by very strong negative shocks, and only those. The employment impact of short-time work is stronger for firms hit by strong negative shocks with the positive impact of short-time work on firm survival contributing to this employment effect.

6.2.2 Heterogeneous Effects after 2009

Short-time work may help firms with limited access to financial markets, hit by transitory negative shocks, to recover and grow in the following years. However, short-time work may also help structurally weak firms, without recovery potential, to keep jobs that will soon be destroyed. In order to examine this issue, we analyze the impact of the take-up of short-time work *in 2009* on firm's employment growth in the year following taking-up short-time work and firm's survival. Table 14 reports the result of the instrumental variable estimation of equation (9) in which the dependent variable is either the growth rate of the indicated variable or the death rate of firm from 2009 to 2010. Only firms which survived at the end of 2009, i.e. which had strictly positive employment on the 31st of December 2009, are included in these regressions. Hence, the estimates reported by Table 15 measure the impact of using short-time work in year 2009 on employment growth and survival, conditional on survival (at least) until the end of 2009. Firms in the first quintile, for which short-time work had positive employment effects in 2009, grow also faster from 2009 to 2010, suggesting that short-time work helped them to recover faster potentially because they retained their workforce despite the negative shock. Short-time work appears to be used by firms having faced a temporary negative shock rather

than by structurally weak firms. Table 15 shows the robustness of this result by reporting estimates for a stratification of firms into terciles. Again, firms faced with the largest drop in predicted revenue in 2009 have a marginally faster employment growth in the following year than firms belonging to the same tercile and which did not use short-time work.

6.3 Cost per Job Saved

On average, each employee on short-time work in 2009 reduced her working time by 123 hours and employers received 3.70 euros per subsidized non-worked hour, or 460 euros per employee on short-time work. This amount is small when compared to the average annual labor costs – 38,600 euros – in firms which used short-time work.

To compute the cost per job saved thanks to short-time work, we divide the total amount of subsidies received by all firms in 2009 by the number of jobs saved in 2009 in the first quintile of the distribution of predicted revenue growth, assuming that no job has been created in the other quintiles. This approach yields a conservative evaluation of the impact of short-time work on job creation consistent with the results displayed by Table 9.[28] The costs per job saved in 2009 amount to 2619 euros, which corresponds to 6.8% of the average annual labor costs in our set of firms – with a 95% confidence interval equal to $[4.2\%, 18.4\%]$. This sum is very small compared to the costs (per job created) of wage subsidies, usually estimated to lie between 100% and 200% of annual labor costs.[29] As shown by our theoretical model, the specific strength of short-time work is its targeting of employees at risk of losing their job because their marginal productivity falls below their marginal labor cost, whereas wage subsidies are usually given to all employees (who belong to some targeted category based on age or past labor market experience, for instance) even if their marginal productivity is actually well above their marginal labor cost. Short-time work turned out to be more effective at creating jobs than hiring subsidies during the great recession in France, even though hiring subsidies also target marginal jobs.[30] Since available evidence suggests that the government saves about 25% of the

[28] Using the stratification of firms by tercile instead yields similar results.

[29] The cost per job created of a permanent wage subsidy amounts to the labor cost divided by the absolute value of the elasticity of labor demand with respect to labor cost (Cahuc *et al.* (2017)). Assuming that this elasticity lies between -1 and -0.5 (Hamermesh (2014)), the cost per job created of a wage subsidy lies between 100% and 200% of the labor cost.

[30] Cahuc *et al.* (2017) assess the impact of hiring subsidies in France during the great recession and find that the cost per job created by a hiring credit in France in 2009 amounts to about 25% of the labor cost of a job.

average labor cost when a low-wage individual goes from non-employment to employment,[31] this suggests that short-time work allowed the government to reduce public expenditure.

Although short-time work has windfall effects, they are much smaller than windfall effects induced by wage subsidies policies. Short-time work subsidies paid to firms outside the lowest quintile of predicted revenue growth rate in 2009 correspond to windfall effects to the extent that short-time work reduced hours worked but did not save jobs for these firms. Nevertheless, these windfall effects are relatively small because these firms, which represent about half of all firms with positive short-time work take-up in 2009, only used 25% of the total number of subsidized hours in 2009 and received 25% of the total amount of subsidies. These last numbers are consistent with our theoretical model, which predicts that the drop in hours worked is smaller for jobs that would not have been destroyed absent short-time work than for jobs that would have been destroyed absent short-time work, as shown by Figure 5.

In addition to the cost per job saved for public finance, we also evaluate the impact of short-time work on the total amount of hours worked. To do this, we assume that the average number of annual hours worked of jobs saved by short-time work is identical to the average number of annual hours worked of other jobs. This allows us to compute the number of hours of work of the jobs saved by short-time work. Substracting the number of hours consumed by short-time work employees from this number, we get the impact of short-time work on the total number of hours worked. We find that every employee on short-time work in 2009 entailed an increase in the total volume of hours worked equal to 10% – with a 95% confidence interval equal to $[-1\%, 21\%]$– of its usual annual number of hours worked. Accordingly, the direct reduction in the volume of hours worked due to short-time work is more than offset by the creation of jobs induced by short-time work. This means that short-time work not only saved jobs but also limited the drop in total hours.[32] Although it might be surprising that short-time work, which subsidizes reductions in hours worked, raises the total number of hours worked, this is in line with our model[33] which shows that such situations can arise during recessions when negative aggregate shocks hit a large share of firms.

[31] See Cahuc *et al.* (2017), this figure also pertains for France in 2009.

[32] As a short-time work employee experienced a reduction in her hours worked by 40% and created 0.35 jobs in Germany, short-time work has had a very uncertain impact on the total number of hours in this country according to the evaluation of Boeri and Bruecker (2011).

[33] See above, Section 3.3.

7 Conclusion

Germany from being the sick man of Europe in the start of the 2000s became its Superstar in the 2010s (Dustmann et al., 2014). Hence, French politicians have repeatedly tried to copy some of German policies, without much success. Apprenticeship, seen as the way out of the France's high youth unemployment rate, has never taken off on the west side of the Rhine. Hartz-style reforms, seen as the way out of an inflexible labor market, have mostly generated mass protests and strikes. Short-time work, seen as the way to preserve employment in the face of negative economic shocks, is an exception. Used in France before the great recession, albeit much less than in Germany, it was successfully expanded when the great recession hit France. All regulations and institutions managing short-time work were already in place and allowed increased funding to be directed to firms that applied to the program. The structure and functioning of these institutions are central in our empirical strategy by allowing us to construct instrumental variables for the use of short-time work. The conclusions of this empirical analysis are pretty straightforward: short-time work preserved employment even though the number of hours worked decreased. Permanent jobs, rather than temporary ones, benefited from the policy. The cost of saving those jobs was low, even very low compared to other job-preserving policies, previously used in France, such as wage subsidies, creation of public jobs, or hiring subsidies. However, only those firms that faced a large negative shock benefited from this policy whereas (we show that) the policy had no discernable effect on firms faced with smaller shocks.

Hence, short-time work has good properties in a deep recession such as the great recession. But the effectiveness of short-time work hinges on its designs. From this perspective, our results suggest ways to optimize short-time work schemes.

First, the scheme should be targeted at firms facing large drops in their revenues. A way to screen firms might be to subsidize short-time work for a sufficiently large number of non-worked hours per employee, but not from the first non-worked hour below the usual contractual number of hours worked, as is the case in France, to the extent that employees whose hours worked are reduced by small amounts are less at risk to see their jobs destroyed.

Introducing experience rating is also a means to reduce the windfall effects, as stressed by Burdett and Wright (1989). When financial markets are imperfect, short-time work may help firms in financial distress to overcome temporary shocks. If firms can use short-time work at no cost, some firms may *"over-use"* it rather than search for other ways to overcome their

temporary difficulties.

Finally, short-time work was never used by a large fraction of French firms, all the contrary since the take-up was at most 1% even in the depths of the great recession. Even though short-time work had positive employment effects for a fraction of this small share of firms, extending its scope might reduce its effectiveness. Moreover, short-time work can decrease the allocative efficiency of the labor market, resulting in significant output losses if it is widely used, as stressed by Cooper *et al.* (2017). These are open questions left for future research.

References

[1] Abraham, K. G. and Houseman, S. N. (1994). Does employment protection inhibit labor market flexibility? lessons from Germany, France, and Belgium. In Blank, R. M., editor, *Social Protection Versus Economic Flexibility? Is There a Trade-Off?*, pages 59–93. University of Chicago Press.

[2] Abraham, K. G. and Houseman, S. N. (2014). Short-time compensation as a tool to mitigate job loss? evidence on the U.S. experience during the recent recession. *Industrial Relations: A Journal of Economy and Society*, 53(4):543–567.

[3] Balleer, A., Gehrke, B., Lechthaler, W., and Merkl, C. (2016). Does short-time work save jobs? a business cycle analysis. *European Economic Review*, 84:99–122.

[4] Bellmann, L. and Gerner, H.-D. (2011). Reversed roles? wage and employment effects of the current crisis. In Immervoll, H., Peichl, A., and Tatsiramos, K., editors, *Who Loses in the Downturn? Economic Crisis, Employment and Income Distribution*, volume 32 of *Research in Labor Economics*, pages 181–206. Emerald Group.

[5] Bellmann, L., Gerner, H.-D., and Upward, R. (2015). The response of German establishments to the 2008-2009 economic crisis. In Commendatore, P., Kayam, S., and Kubin, I., editors, *Complexity and Geographical Economics: Topics and Tools*, volume 19 of *Dynamic Modeling and Econometrics in Economics and Finance*, pages 165–207. Springer.

[6] Boeri, T. and Bruecker, H. (2011). Short-time work benefits revisited: some lessons from the **g**reat **r**ecession. *Economic Policy*, 26(68):697–765.

[7] Braun, H. and Bruegemann, B. (2017). Welfare effects of short-time compensation. Discussion Paper, Tinbergen Institute.

[8] Brey, B. and Hertweck, M. S. (2016). The extension of short-time work schemes during the **g**reat **r**ecession: a story of success? Discussion Paper 5, Department of Economics of the University of Konstanz.

[9] Burdett, K. and Wright, R. (1989). Unemployment insurance and short-time compensation: the effects on layoffs, hours per worker, and wages. *Journal of Political Economy*, 97(6):1479–1496.

[10] Cahuc, P. and Carcillo, S. (2011). Is short-time work a good method to keep unemployment down? *Nordic Economic Policy Review*, 1(1):133–165.

[11] Cahuc, P., Carcillo, S., and Le Barbanchon, T. (2017). The effectiveness of hiring credits. *Review of Economic Studies*, forthcoming.

[12] Calavrezo, O., Duhautois, R., and Walkowiak, E. (2010). Short-time compensation and establishment exit: an empirical analysis with French data. Discussion Paper 4989, Institute of Labor Economics (IZA).

[13] Cooper, R., Meyer, M. and Schott, I. (2017), The employment and output effects of short-time work in Germany. Working Paper 23688, National Bureau of Economic Research (NBER).

[14] Dustmann, C., Fitzenberger, B., Schoenberg, U., and Spitz-Oener, A. (2014). From sick man of Europe to economic superstar: Germany's resurgent economy. *Journal of Economic Perspectives*, 28(1):167-188.

[15] Hamermesh, D. (2014). Do labor costs affect companies' demand for labor? *World of Labor*, page 3. Institution of Labor Economics (IZA).

[16] Hijzen, A. and Martin, S. (2013). The role of short-time work schemes during the global financial crisis and early recovery: a cross-country analysis. Discussion Paper 7291, Institute of Labor Economics (IZA).

[17] Hijzen, A. and Venn, D. (2011). The role of short-time work schemes during the 2008-2009 recession. Social, Employment and Migration Working Paper 115, Organization for Economic Cooperation and Development (OECD).

[18] Kaas, L., and Kircher, P. (2015), Efficient Firm Dynamics in a Frictional Labor Market, American Economic Review, 105(10), pp.3030-60..

[19] Kruppe, T. and Scholz, T. (2014). Labour hoarding in Germany: employment effects of short-time work during the crises. Discussion Paper 17, Institute for Employment Research (IAB).

[20] Moene, E. (1997), Competitive Search Equilibrium, Journal of Political Economy, 105: 385-411

[21] Nevoux, S., Marcon, E., and Puech, F. (2017). Local diffusion of short-time work. Mimeo.

[22] Niedermayer, K. and Tilly, J. (2017). Employment and welfare effects of short-time work. Mimeo.

[23] Van Audenrode, M. A. (1994). Short-time compensation, job security, and employment contracts: evidence from selected OECD countries. *Journal of Political Economy*, 102(1):76–102.

A Appendix

A.1 Competitive Equilibrium Contract

This Appendix determines the solution to program (4) which defines the optimal number of vacancies and the optimal contract $\{w(y), h(y), \Omega\}$. Since the equilibrium value of the labor market tightness θ in each labor pool is determined by the no-arbitrage condition (1), it is clear that θ in each labor pool does not depend on the number of vacant jobs v posted by the firm. It is determined by the expected utility W associated with the contract posted by the firm. Therefore, maximization of $vm(\theta)\Pi - C(v)$ with respect to v yields equation (6).

In order to find the optimal contract, it is convenient to solve the program of the firms in two stages. In the first stage, we determine the profit maximizing expected utility W associated with the contract posted by the firm. In the second stage, we determine the properties of the optimal contract.

First, let us define the expected job surplus

$$S = W - [b - \phi(0)] + \Pi. \tag{A1}$$

The definition of the expected job surplus implies that $\Pi = S - W + [b - \phi(0)]$. Therefore, for any value of S the firm chooses the expected utility W that solves

$$\max_{W} m(\theta) \left[S - W + [b - \phi(0)]\right]$$

where θ satisfies the no-arbitrage condition (1). The solution is

$$W - [b - \phi(0)] = \eta S \tag{A2}$$

where $\eta = -\theta m'(\theta)/m(\theta) \in (0, 1)$ is the elasticity of the matching function with respect to unemployment. Using the definition (A1) of the surplus, this solution can also be written $\Pi = (1 - \eta)S$. Since the expected profit of the firm is proportional to the expected job surplus at the optimum, the optimal contract necessarily maximizes the expected job surplus.

In the second stage, let us maximize the expected job surplus with respect to Ω and $h(y) \geq 0$. Let us denote by $\mu(y)$ the multiplier associated with the constraint $h(y) \geq 0$. The Lagrangian of this maximization problem is

$$\mathcal{L} = S + \int_{y \in \Omega} \mu(y) h(y) \mathrm{d}y,$$

The expected surplus can be written, using equations (2) and (5):

$$S = \int_{y \in \Omega} s(y) \mathrm{d}G(y),$$

where

$$s(y) = yh(y) - \phi(h(y)) + \sigma \max\left[\bar{h} - h(y), 0\right] - [b - \phi(0)] \tag{A3}$$

stands for the surplus of jobs of productivity y. Maximization of the Lagrangian with respect to $h(y)$ yields

$$\frac{\partial \mathcal{L}}{\partial h(y)} = 0 \Rightarrow h(y) = \begin{cases} \phi'^{-1}(y) & \text{if } y \geq \bar{y} \\ \phi'^{-1}(y - \sigma) & \text{if } y_0 \leq y < \bar{y} \\ 0 & \text{if } y \leq y_0 \end{cases} \tag{A4}$$

where $\bar{y} = \left\{y | \phi'(\bar{h}) = y\right\}$ and $y_0 = \left\{y | \phi'(0) = y\right\}$.

Now, let us determine the optimal productivity set Ω. The envelope theorem implies that $s'(y) = h(y) \geq 0$ at the optimum. This means that $s'(y)$ is either positive or equal to zero.

Let us first consider the case where $s'(y) = 0$. We know from equation (A4) that this case is possible only if there exists $y \leq y_0$ such that $h(y) = 0$. When $h(y) = 0$, equation (A3) yields $s(y) = \sigma\bar{h} - b$. If $\sigma\bar{h} - b > 0$, it is optimal to keep all jobs whatever the realization of y since it suffices to set $h(y) = 0$ to get a positive job surplus. In this case, the firm keeps workers who work zero hour when their productivity drops below the threshold y_0.

In the more relevant empirical case where the maximum value of the short-time compensation $\sigma\bar{h}$ is smaller than the unemployment benefit b, $\sigma\bar{h} - b$ is negative and the constraint $h(y) \geq 0$ cannot bind, because it cannot be optimal to keep jobs which yield a negative surplus. In this case, we have $h(y) > 0$ and $s'(y)$ is strictly positive for all y. Maximization of $\mathcal{L}$ requires that if $y' \in \Omega$ all $y > y'$ also belong to Ω. Therefore, assuming that the bottom value of y, denoted by $y_{\min}$, satisfies $s(y_{\min}) < 0$, the optimal set of productivities for which the jobs are not destroyed is $\Omega = \{y | y > \tilde{y}\}$ where $\tilde{y} = \{y > y_{\min} | s(y) = 0\}$, which implies, using the definition (A3) of $s(y)$, that $\tilde{y}$ statisfies

$$\tilde{y}h(\tilde{y}) - \phi(h(\tilde{y})) - b + \phi(0) + \sigma \max\left[\bar{h} - h(\tilde{y}), 0\right] = 0. \tag{A5}$$

Equations (A4) and (A5) define the optimal contingent hours worked $h(y)$ and the reservation productivity $\tilde{y}$. Then, all wage functions $w(y)$ which satisfy condition (A2) can belong to the optimal contract. The shape of $h(y)$ and the reservation productivity are depicted on Figures 4 and 5.

A.2 Comparison of Job Subsidies and Short-Time Work Compensation

The model allows us to show that short-time work reduces job destruction at lower cost for the government than job subsidies, provided to all jobs, that do not depend on hours worked. Let χ denote the subsidy per job. We compare the impact of short-time work compensation, equal to $\sigma \max\left[\bar{h} - h(y), 0\right]$,

to the subsidy χ per job in the neighborhood of $\sigma = \chi = 0$. Insofar as these two schemes have, by definition in the present context, the same impact on the expected labor cost of each firm, and then on the creation of vacant jobs, we do not need to account for their effects on job vacancies to compare their impact on employment.

The impact of the job subsidy χ on the threshold value of productivity $\tilde{y}$ below which jobs are destroyed is defined by equation (A5) which can be written, in presence of the job subsidy

$$\tilde{y}h(\tilde{y}) - \phi(h(\tilde{y})) - [b - \phi(0)] + \chi = 0, \tag{A6}$$

Equation (A6) implies, together with the envelope theorem, that $\mathrm{d}\tilde{y}/\mathrm{d}\chi = -1/h(\tilde{y})$. Therefore, since the density of jobs of productivity $\tilde{y}$ is equal to $vm(\theta)g(\tilde{y})$ in each firm, the subsidy χ creates

$$\frac{1}{h(\tilde{y})} N v m(\theta) g(\tilde{y}) \chi \tag{A7}$$

jobs in the economy, where N denotes the (exogenous) number of firms at the start of the period. Note that ex-post, once the productivity shocks z and ε have been realized, some firms may have zero employee, meaning that they are destroyed.

The impact of short-time work compensation can be computed from equation (A5), which defines $\tilde{y}$ when there is short-time work. Differentiation of equation (A5) implies that $\mathrm{d}\tilde{y}/\mathrm{d}\sigma = -\left[\bar{h} - h(\tilde{y})\right]/h(\tilde{y})$. Therefore, the short-time compensation equal to $\sigma \max\left[\bar{h} - h(y), 0\right]$ creates

$$\frac{\bar{h} - h(\tilde{y})}{h(\tilde{y})} N v m(\theta) g(\tilde{y}) \sigma \tag{A8}$$

jobs and costs $\sigma \int_{\tilde{y}}^{\bar{y}} \frac{\bar{h} - h(y)}{1 - G(\tilde{y})} \mathrm{d}G(y)$ per employee (including those who do not use short-time work in the firm).

Assume now that the cost per employee of the short-time compensation is equal to the job subsidy χ. This implies that $\sigma = \chi / \int_{\tilde{y}}^{\bar{y}} \frac{\bar{h} - h(y)}{1 - G(\tilde{y})} \mathrm{d}G(y)$. Substituting this expression of σ into equation (A8), we find that short-time work creates

$$\frac{\bar{h} - h(\tilde{y})}{h(\tilde{y}) \int_{\tilde{y}}^{\bar{y}} \frac{\bar{h} - h(y)}{1 - G(\tilde{y})} \mathrm{d}G(y)} N v m(\theta) g(\tilde{y}) \chi \tag{A9}$$

jobs. From equations (A7) and (A9) it can be deduced that the ratio between the number of job created by short-time work and by the job subsidy for an identical cost per employee (or equivalently an identical expenditure) is given by equation (8).

A.3 The effect of short-time work on total hours worked

This appendix computes the impact of the short-time work compensation σ on the total number of hours worked in the neighborhood of $\sigma = 0$ assuming that the number of job creations $vm(\theta)$ is given. This allows us to exhibit a sufficient condition to get a positive effect of short-time work on the total number of hours of work insofar as the short-time compensation (financed by a lump sum tax paid by all workers), which raises the expected value of filled jobs, increases job creation.

By definition, the total number of hours worked is

$$H = m(\theta)vN\left[\int_{\tilde{y}}^{\bar{y}} h(y)\mathrm{d}G(y) + \int_{\bar{y}}^{\infty} h(y)\mathrm{d}G(y)\right]$$

where $\bar{y} = \left\{y|h(y) = \bar{h}\right\}$, $\tilde{y}$ is the threshold value of productivity below which jobs are destroyed and N is the number of firms in the economy. From this definition, and the fact that $\mathrm{d}h(y)/\mathrm{d}\sigma = 0$ if $y \geq \bar{y}$, shown in Appendix A.1, we get

$$\frac{1}{m(\theta)vN}\frac{\mathrm{d}H}{\mathrm{d}\sigma} = -\frac{\mathrm{d}\tilde{y}}{\mathrm{d}\sigma}h(\tilde{y})g(\tilde{y}) + \int_{\tilde{y}}^{\bar{y}} \frac{\mathrm{d}h(y)}{\mathrm{d}\sigma}\mathrm{d}G(y).$$

From equation (A4), we know that $\mathrm{d}h(y)/\mathrm{d}\sigma = -\mathrm{d}h(y)/\mathrm{d}y$, and from equation (A5) we have $\mathrm{d}\tilde{y}/\mathrm{d}\sigma = -\left[\bar{h} - h(\tilde{y})\right]/h(\tilde{y})$, which implies that

$$\frac{1}{m(\theta)vN}\frac{\mathrm{d}H}{\mathrm{d}\sigma} = \left[\bar{h} - h(\tilde{y})\right]g(\tilde{y}) - \int_{\tilde{y}}^{\bar{y}} \frac{\partial h(y)}{\partial y}\mathrm{d}G(y).$$

Integration by parts gives

$$\frac{\mathrm{d}H}{\mathrm{d}\sigma} = -m(\theta)vN\int_{\tilde{y}}^{\bar{y}} \bar{h} - h(\tilde{y})\mathrm{d}g(y).$$

This expression is positive if $g'(y) < 0$ for $y \in [\tilde{y}, \bar{y}]$.

Table 1: Characteristics of firms with and without short-time work in 2009

	$STW = 1$	$STW = 0$
Revenue growth rate	$-.17$	$.05$
	(.39)	(.52)
Leverage rate	.25	.27
	(0.49)	(1.86)
Employment growth rate	$-.14$	$-.05$
	(.30)	(.40)
Hourly gross wage	14.21	13.81
	(5.13)	(62.83)
Hours worked per worker	1687.16	1617.36
	(363.32)	(937.11)
Turnover rate	1.33	1.67
	(0.74)	(1.96)
Share of temporary jobs	.11	.20
	(0.23)	(0.31)
Number of employees	20.32	6.95
	(57.52)	(28.28)
Observations	11,313	757,030

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture. ♦ Single-establishment firms.

Definitions: ♦ The revenue growth rate is defined as the difference in the revenue between 2009 and 2008, divided by the revenue in 2008. ♦ The leverage rate is defined as the level of debt divided by the level of assets ♦ The employment growth rate is defined as the difference in the number of employees between the 31^{st} of December 2009 and the 31^{st} of December 2008, divided by the number of employees on the 31^{st} of December 2008. ♦ The hourly gross wage is defined as the total labor cost divided by the total number of hours worked. ♦ The number of hours worked per worker is defined as the total number of hours worked divided by the average number of employees. ♦ The turnover rate is defined as the total number of employees present at least one hour in the firm during the year divided by the average number of employees. ♦ The share of temporary jobs is defined as the number of employees under non-permanent contracts divided by the total number of employees. ♦ The number of employees is defined as the number of employees on the 31^{st} of December 2008.

Notes: ♦ $STW = 1$ stands for the firms using short-time work for economic reasons in 2009; $STW = 0$ stands for the firms not using short-time work in 2009. ♦ Standard deviations are reported in parentheses.

Table 2: Determinants of the short-time work take-up of the establishments belonging to multi-establishment firms in 2008.

	Short-time work take-up
Share of response time>14 days	$-.226^{***}$
	(.048)
Commuting zone revenue growth rate	-3.412^{***}
	(.810)
Hourly gross wage	.003
	(.002)
Hours worked per worker	.000
	(.000)
Turnover rate	$-.003$
	(.002)
Share of temporary jobs	$-.057^{***}$
	(.002)
Sector-specific fixed effect	Yes
Firm-specific fixed effect	Yes
Adj-R^2	0.41
Observations	322,517

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: ♦ The dependent variable is equal to 100 if the establishment uses short-time work for economic reasons in 2009 and to 0 otherwise. ♦ The share of response time longer than 14 days is defined as the proportion of short-time work applications whose response time is longer than 14 days in the *département* of the establishment in 2008. ♦ The commuting zone revenue growth rate is defined as the average at the commuting zone level of the revenue growth rate, defined as the difference in the revenue between 2008 and 2007, divided by the absolute value of the revenue in 2007. ♦ The leverage is equal to 1 if the leverage rate, defined as the level of debts divided by the level of assets, belongs to the highest quartile, in 2007. ♦ The hourly gross wage is equal to 1 if the hourly gross wage, defined as the total labor cost divided by the total number of hours worked, is above the median wage, in 2007. ♦ The number of hours worked per worker is defined as the total number of hours worked divided by the average number of employees, in 2007. ♦ The turnover rate is defined as the total number of employees divided by the average number of employees, in 2007. ♦ The share of temporary jobs is defined as the number of employees under non-permanent contracts divided by the total number of employees, in 2007. ♦ The number of employees is defined as an indicator variable of the number of employees on the 31^{st} of December 2007 (10, 50, 250, and 1,000 employees). ♦ The age is defined as the difference between 2009 and the year of creation of the firm.

Notes: ♦ This table displays the ordinary least squares estimation of the short-time work take-up of establishments belonging to multi-establishment firms. ♦ The sector-specific fixed effects of the establishments are disaggregated in 728 sectors. ♦ The number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees and the age are also included in the regressors. ♦ Robust standard errors are clustered at the sector x *département* level. ♦ The t statistics are reported in parentheses: * p<0.10, ** p<0.05, *** p<0.01.

Table 3: The probability of short-time work use in the first quarter of 2009 and the distance to multi-establishment firms

	(1)	(2)	(3)
Dep variable:	Short-time work use in first quarter of 2009		
Distance	$-.042^{***}$	$-.053^{***}$	$-.053^{***}$
	(.012)	(.012)	(.012)
Adj-R^2	0.001	0.014	0.014
Observations	12,304	12,304	12,304

Sources: *DADS*, *FICUS*, *FARE* (*INSEE*), *DMMO*, *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: ♦ The dependent variable is either equal to 1 if the single establisment firm uses short-time work in the first quarter of 2009 instead of later in the year or equal to zero otherwise. ♦ 'Distance' is either equal to 0 if the single establishment firm belongs to the first quartile of distance to establishments belonging to multi-establishment firms which used short-time work in 2008, or equal to 1 otherwise.

Notes: ♦ The results reported in column (1) do not include any covariate, ♦ Column (2) includes the following covariates: the revenue growth rate, the leverage rate, the hourly gross wage, the number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees, the age and (728) sector-specific fixed effects, the départemental proportion of short-time work applications whose response time is longer than 14 days in 2008. The revenue growth rate is defined as the difference in the revenue between 2009 (respectively 2008) and 2008 (respectively 2007), divided by the absolute value of the revenue in 2008 (respectively 2007). The leverage rate is defined as the level of debt divided by the level of assets, in the previous year. The hourly gross wage is defined as the total labor cost divided by the total number of hours worked, in the previous year. The number of hours worked per worker is defined as the total number of hours worked divided by the average number of employees, in the previous year. The turnover rate is defined as the total number of employees divided by the average number of employees, in the previous year. The share of temporary jobs is defined as the number of employees under non-permanent contracts divided by the total number of employees, in the previous year. The number of employees is defined as an indicator variable of the number of employees on the 31st of December of the previous year (10, 50, 250, and 1,000 employees). The age is defined as the difference between 2009 (respectively 2008) and the year of creation of the firm. ♦ Column (3) adds the quarterly employment growth rate of the sector of the firm (728 sectors) to the covariates of column (2). ♦ OLS estimation. ♦ Robust standard errors are clustered at the sector x *département* level. ♦ The t statistics are reported in parentheses: * p<0.10, ** p<0.05, *** p<0.01.

Table 4: Determinants of the short-time work take-up and of the revenue growth rate of single-establishment firms in 2009.

	Short-time work take-up	Revenue growth rate
Share of response time>14 days	$-.953^{***}$	$-.151$
	(0.113)	(0.363)
Distance to the past short-time work user	$-.007^{***}$	$-.013^{***}$
	(.001)	(0.005)
Leverage	$.167^{***}$	1.005^{***}
	(.032)	(0.214)
Hourly gross wage	$.147^{***}$	-1.237^{***}
	(.033)	(0.155)
Hours worked per worker	$.205^{***}$	-3.921^{***}
	(.023)	(0.119)
Turnover rate	$-.191^{***}$	$.607^{***}$
	(.033)	(0.128)
Share of temporary jobs	$-.136^{***}$	1.355^{***}
	(.030)	(0.120)
$10 \leq$ Number of employees < 50	1.724^{***}	-1.526^{***}
	(.102)	(.177)
$50 \leq$ Number of employees < 250	1.724^{***}	-3.607^{***}
	(.322)	(.355)
$250 \leq$ Number of employees < 1000	5.232^{***}	-7.205^{***}
	(.023)	(1.093)
$1000 \leq$ Number of employees	8.180	22.54
	(3.478)	(17.45)
Adj-R^2	.090	0.209
Prob $F > 0$	.000	.0192
Observations	768,343	768,343

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: ♦ The first dependent variable is equal to 100 if the establishment uses short-time work for economic reasons in 2009 and to 0 otherwise. ♦ The second dependent variable is the revenue growth rate, defined as the difference in the revenue between 2009 and 2008, divided by the absolute value of the revenue in 2008, and expressed in percentage. ♦ The share of response time longer than 14 days is defined as the proportion of short-time work applications whose response time is longer than 14 days in the *département* of the establishment in 2008. ♦ The distance to the past short-time work user is defined as the distance to the closest establishment, belonging to a multi-establishment firm, which used short-time work in 2008. ♦ The leverage is equal to 1 if the leverage rate, defined as the level of debts divided by the level of assets, belongs to the highest quartile, in 2008. ♦ The hourly gross wage is equal to 1 if the hourly gross wage, defined as the total labor cost divided by the total number of hours worked, is above the median wage, in 2008. ♦ The number of hours worked per worker is defined as the total number of hours worked divided by the average number of employees, in 2008. ♦ The turnover rate is defined as the total number of employees divided by the average number of employees, in 2008. ♦ The share of temporary jobs is defined as the number of employees under non-permanent contracts divided by the total number of employees, in 2008. ♦ The number of employees is defined as an indicator variable of the number of employees on the 31^{st} of December 2008 (10, 50, 250, and 1,000 employees). ♦ The age is defined as the difference between 2009 and the year of creation of the firm.

Notes: ♦ This table displays the ordinary least squares estimation of equations (12) and (13). ♦ The sector x commuting zone revenue growth rate, the leverage, the hourly gross wage, the number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees, the age and the (728) sector-specific fixed effects are also included in the regressors. ♦ Robust standard errors are clustered at the sector x *département* level. ♦ The t statistics are reported in parentheses: * p<0.10, ** p<0.05, *** p<0.01. ♦ The F statistic for the joint significativity of the 2 explanatory variables is reported.

Table 5: Short-time work take-up, survival and employment growth of firms in 2009.

	OLS	IV
Death rate	-0.030^{***}	$-.0216$
	(.002)	(0.0432)
Employment growth rate	$-.028^{***}$	.051
	(.003)	(.069)
Share of permanent jobs	0.025^{***}	$.098^{**}$
	(.002)	(.047)
Relative growth rate of permanent jobs	$-.003$	.086
	(.003)	(.077)
Relative growth rate of temporary jobs	-0.017^{***}	$-.038$
	(.002)	(.058)
Observations	768,343	768,343

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: ♦ The death rate is equal to 1 if the firm has zero employee on the 31^{st} of December 2009 and 0 otherwise. ♦ The employment growth rate is defined as the difference in the number of employees between the 31^{st} of December 2009 and the 31^{st} of December 2008, divided by the number of employees on the 31^{st} of December 2008. ♦ The share of permanent jobs is defined as the number of permanent jobs divided by the total number of employees, on the 31^{st} of December 2009. ♦ The relative growth rate of permanent jobs is defined as the difference in the number of employees under permanent contracts between the 31^{st} of December 2009 and the 31^{st} of December 2008, divided by the total number of employees on the 31^{st} of December 2008. ♦ The relative growth rate of temporary jobs is defined as the difference in the employees under non-permanent contracts between the 31^{st} of December 2009 and the 31^{st} of December 2008, divided by the total number of employees on the 31^{st} of December 2008. ♦ See Table 4.

Notes: ♦ This table displays the estimation of the β_1 coefficient of equation (9) with ordinary least squares (column OLS) and instrumental variable (column IV). ♦ The instruments are the share of response time longer than 14 days, the distance to the past short-time work user, and the sector x commuting zone revenue growth rate. ♦ The leverage, the hourly gross wage, the number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees, the age and the (728) sector-specific fixed effects are also included in the regressors. ♦ Robust standard errors are clustered at the sector x *département* level. ♦ The t statistics are reported in parentheses: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Table 6: Characteristics of firms by quintile of their predicted revenue growth rate.

Quintile	Number of firms	Short-time work rate (in percent)	Revenue growth rate $STW = 1$	Revenue growth rate $STW = 0$	p-value
1	153,669	3.92	−.26 (.26)	−.12 (.23)	.000
2	153,669	1.27	−.17 (.29)	−.04 (.30)	.000
3	153,668	0.9	−.14 (.32)	−.01 (.29)	.000
4	153,669	0.7	.09 (.38)	.04 (.41)	.000
5	153,668	0.6	.31 (.96)	.38 (.88)	.000

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: ♦ The short-time work rate is defined as the number of firms using short-time work for economic reasons divided by the total number of firms, in 2009. ♦ The revenue growth rate is defined as the difference in the revenue between 2009 and 2008, divided by the absolute value of the revenue in 2008.

Notes: ♦ This table displays the features of the quintiles of firms according to their revenue growth rate in 2009 predicted by equation (5). ♦ $STW = 1$ stands for the single-establishment firms using short-time work for economic reasons in 2009; $STW = 0$ stands for the single-establishment firms not using short-time work in 2009. ♦ The last column reports the p-value for the null hypothesis: Revenue growth rate ($STW = 0$) = Revenue growth rate ($STW = 1$). ♦ The standard deviations are reported in parentheses.

Table 7: Characteristics of firms using short-time work in 2009 by quintile of their predicted revenue growth rate.

Quintile	Number of firms	Revenue	Number of employees	Age
1	6,020	4,393.72	27.15	17.28
		(19,144.53)	(66.46)	(14.48)
2	1,963	1,963.71	13.89	16.98
		(7,357.18)	(32.91)	(13.49)
3	1,397	1,319.05	10.51	13.39
		(4,529.2)	(25.42)	(11.67)
4	1,001	1,349.48	11.02	9.83
		(11,778.21)	(58.07)	(10.61)
5	932	2,283.39	14.53	5.33
		(12,113.67)	(64.20)	(8.86)

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture. ♦ establishments using short-time work for economic reasons.

Definitions: ♦ The number of employees is defined as the number of employees on the 31^{st} of December 2008. ♦ The age is defined as the difference between 2009 and the year of creation of the firm.

Notes: ♦ This table displays the features of firms using short-time work in 2009 by quintile (among all firms, including short-time work users and other firms) of their revenue growth rate in 2009 predicted by equation (5). ♦ The standard deviations are reported in parentheses.

Table 8: Determinants of the short-time work take-up of firms in 2009 (first stage short-time work estimates of the instrumental variable estimation) by quintile of their predicted revenue growth rate.

Quintile	1	2	3	4	5
Share of response time>14 days	-1.854^{***} (0.348)	$-.968^{***}$ (.178)	$-.832^{***}$ (.0149)	$-.552^{***}$ (.0124)	$-.412^{***}$ (.0117)
Distance to the past short-time work user	$-.020^{***}$ (.004)	$-.001$ (.002)	$-.007^{***}$ (.002)	$-.006^{***}$ (.002)	$-.001$ (.002)
Adj-R^2	.14	.03	.02	.03	.02
Prob $F > 0$	.000	.000	.000	.000	.000
Observations	153,669	153,669	153,668	153,669	153,668

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: See Table 4.

Notes: ♦ This table displays the first stage short-time work estimates of the instrumental variable estimation of equation (4). ♦ The regressions are run by quintile of revenue growth rate of firms in 2009 predicted by equation (5). ♦ The commuting zone revenue growth rate, the leverage, the hourly gross wage, the number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees, the age and the (728) sector-specific fixed effects are also included in the regressors. ♦ Robust standard errors are clustered at the sector x *département* level. ♦ The t statistics are reported in parentheses: * p<0.10, ** p<0.05, *** p<0.01. ♦ The F statistic for the joint significativity of the 2 explanatory variables is reported.

Table 9: Short-time work take-up, survival and employment growth of firms in 2009 by quintile of their predicted revenue growth rate.

Quintile	1	2	3	4	5
Death rate	$-.0876^{***}$	$-.040$	.029	$.237^{*}$	.226
	(.033)	(.087)	(.096)	(.127)	(.155)
Employment growth rate	$.158^{***}$	.108	.058	$-.129$	$-.309$
	(.051)	(.140)	(.167)	(.201)	(.273)
Share of permanent jobs	$.068^{**}$	.145	$.199^{*}$	$-.013$	.235
	(.032)	.090)	(.167)	(.149)	(.173)
Relative growth rate of permanent jobs	$.176^{***}$	$-.221$	.193	$-.237$	$-.187$
	(.053)	(.137)	(.164)	(.207)	(.280)
Relative growth rate of temporary jobs	.007	$-.082$	.145	.001	$-.154$
	(.039)	(.110)	(.144)	(.176)	(.228)
Observations	153,669	153,669	153,668	153,669	153,668

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: See Table 5.

Notes: ♦ This table displays the estimation of equation (4) with instrumental variable. ♦ The regressions are run by quintile of revenue growth rate of firms in 2009 predicted by equation (5). ♦ The endogeneous variables are the short-time work take-up and the revenue growth rate. ♦ The instruments are the share of response time longer than 14 days, the distance to the past short-time work user, and the sector x commuting zone revenue growth rate. ♦ The leverage, the hourly gross wage, the number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees, the age and the (728) sector-specific fixed effects are also included in the regressors. ♦ Robust standard errors are clustered at the sector x *département* level. ♦ The t statistics are reported in parentheses: * p<0.10, ** p<0.05, *** p<0.01.

Table 10: Characteristics of firms by tercile of their predicted revenue growth rate.

Tercile	Number of firms	Short-time work rate (in percent)	Revenue growth rate $STW = 1$	Revenue growth rate $STW = 0$	p-value
1	256,115	2.90	−.25 (.24)	−.09 (.28)	.000
2	256,114	0.90	−.13 (.32)	−.01 (.33)	.000
3	256,114	0.61	.15 (.77)	.25 (.75)	.000

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: ♦ The short-time work rate is defined as the number of firms using short-time work for economic reasons divided by the total number of firms, in 2009. ♦ The revenue growth rate is defined as the difference in the revenue between 2009 and 2008, divided by the absolute value of the revenue in 2008.

Notes: ♦ This table displays the features of the terciles of firms according to their revenue growth rate in 2009 predicted by equation (5). ♦ $STW = 1$ stands for the single-establishment firms using short-time work for economic reasons in 2009; $STW = 0$ stands for the single-establishment firms not using short-time work in 2009. ♦ The last column reports the p-value for the null hypothesis: Rev growth rate (STW=0) = Rev growth rate (STW=1). ♦ The standard deviations are reported in parentheses.

Table 11: Characteristics of firms using short-time work in 2009 by tercile of their predicted revenue growth rate.

Tercile	Number of firms	Revenue	Number of employees	Age
1	7,340	2,024.90 (21,776.36)	24.79 (61.87)	18.35 (16.29)
2	2,301	1,173.90 (10,492.39)	10.36 (24.59)	14.35 (12.25)
3	1,572	962.46 (15,001.66)	13.80 (67.31)	7.97 (10.12)

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: ♦ The number of employees is defined as the number of employees on the 31^{st} of December 2008. ♦ The age is defined as the difference between 2009 and the year of creation of the firm.

Notes: ♦ This table displays the features of firms using short-time work in 2009 by tercile (among all firms, including short-time work users and other firms) of their revenue growth rate in 2009 predicted by equation (5). ♦ The standard deviations are reported in parentheses.

Table 12: Determinants of the short-time work take-up of firms in 2009 (first stage short-time work estimates of the instrumental variable estimation) by tercile of their predicted revenue growth rate.

Tercile	1	2	3
Share of response time>14 days	-1.548^{***}	$-.754^{***}$	$-.475^{***}$
	(.245)	(.123)	(.097)
Distance to the past short-time work user	$-.0116^{***}$	$-.005^{***}$	$-.003^{**}$
	(.00295)	(.002)	(.001)
Adj-R^2	.12	.02	.03
Prob $F > 0$	.000	.000	.000
Observations	256,115	256,114	256,114

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: See Table 4.

Notes: ♦ This table displays the first stage short-time work estimates of the instrumental variable estimation of equation (4). ♦ The regressions are run by tercile of revenue growth rate of firms in 2009 predicted by equation (5). ♦ The commuting zone revenue growth rate, the leverage, the hourly gross wage, the number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees, the age and the (728) sector-specific fixed effects are also included in the regressors. ♦ Robust standard errors are clustered at the sector x *département* level. ♦ The t statistics are reported in parentheses: * p<0.10, ** p<0.05, *** p<0.01. ♦ The F statistic for the joint significativity of the 2 explanatory variables is reported.

Table 13: Short-time work take-up, survival and employment growth of firms in 2009 by tercile of their predicted revenue growth rate.

Tercile	1	2	3
Death rate	−.057	.009	.218
	(.035)	(.096)	(.141)
Employment growth rate	.125**	−.135	−.173
	(.054)	(.158)	(.247)
Share of permanent jobs	.084**	.139	.225
	(.033)	(.118)	(.158)
Relative growth rate of permanent jobs	.176***	−.197	.001
	(.056)	(.166)	(.271)
Relative growth rate of temporary jobs	−.018	−.154	−.238
	(.041)	(.141)	(.202)
Observations	256, 115	256, 114	256, 114

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: See Table 5.

Notes: ♦ This table displays the estimation of equation (4) with instrumental variable. ♦ The regressions are run by tercile of revenue growth rate of firms in 2009 predicted by equation (5). ♦ The endogeneous variables are the short-time work take-up and the revenue growth rate. ♦ The instruments are the share of response time longer than 14 days, the distance to the past short-time work user, and the sector x commuting zone revenue growth rate. ♦ The leverage, the hourly gross wage, the number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees, the age and the (728) sector-specific fixed effects are also included in the regressors. ♦ Robust standard errors are clustered at the sector x *département* level. ♦ The t statistics are reported in parentheses: * p<0.10, ** p<0.05, *** p<0.01.

Table 14: Short-time work take-up, survival and employment growth of firms in 2009-2010 by quintile of their predicted revenue growth rate.

Quintile	1	2	3	4	5
Death rate	−.045	.131	−.124	−.046	−.073
	(.039)	(.112)	(.120)	(.141)	(.163)
Employment growth rate	.146**	−.134	−.246	−.028	−.215
	(.066)	(.171)	(.203)	(.240)	(.255)
Observations	130,331	133,147	131,899	126,307	116,822

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: ♦ The death rate is equal to 1 if the firm has zero employee on the 31^{st} of December 2010 and 0 otherwise. ♦ The employment growth rate is defined as the difference in the number of employees between the 31^{st} of December 2010 and the 31^{st} of December 2009, divided by the number of employees on the 31^{st} of December 2009. ♦ See Table 4. ♦ The sector x *département* death rate is defined as the average at the sector x *département* level of the death rate, equal to 1 if the firm has zero employee on the 31^{st} of December 2010 and 0 otherwise. ♦ The sector x *département* employment growth rate is defined as the average at the sector x *département* level of the employment growth rate, defined as the difference in the number of employees between the 31^{st} of December 2010 and the 31^{st} of December 2009, divided by the number of employees on the 31^{st} of December 2009. ♦ The sector x *département* revenue growth rate is defined as the average at the sector x *département* level of the revenue growth rate, defined as the difference in the revenue between 2010 and 2009, divided by the absolute value of the revenue in 2009. ♦ The 2010 short-time work take-up is equal to 1 if the establishment uses short-time work in 2010 and to 0 otherwise.

Notes: ♦ This table displays the estimation of equation (4) with instrumental variable. ♦ The regressions are run by quintile of revenue growth rate of firms in 2009 predicted by equation (5). ♦ The endogeneous variables are the short-time work take-up and the revenue growth rate. ♦ The instruments are the share of response time longer than 14 days, the distance to the past short-time work user, and the sector x commuting zone revenue growth rate. ♦ The leverage, the hourly gross wage, the number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees, the age, the (728) sector-specific fixed effects, the sector x *département* death rate, the sector x *département* employment growth rate, the sector x *département* revenue growth rate and the 2010 short-time work take-up are also included in the regressors. ♦ Robust standard errors are clustered at the sector x *département* level. ♦ The t statistics are reported in parentheses: * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Table 15: Short-time work take-up, survival and employment growth of firms in 2009-2010 by tercile of their predicted revenue growth rate.

Tercile	1	2	3
Death rate	−.014	−.168	.067
	(.04)	(.116)	(.136)
Employment growth rate	.128*	.282	−.118
	(.067)	(.197)	(.257)
Observations	219,030	219,372	200,104

Sources: *DADS*, *FICUS* and *FARE* (*INSEE*) and *Sinapse* (*DGEFP*).

Scope: ♦ Mainland France excluding Corsica. ♦ Market sectors excluding agriculture.

Definitions: See Table 14.

Notes: ♦ This table displays the estimation of equation (4) with instrumental variable. ♦ The regressions are run by tercile of revenue growth rate of firms in 2009 predicted by equation (5). ♦ The endogeneous variables are the short-time work take-up and the revenue growth rate. ♦ The instruments are the share of response time longer than 14 days, the distance to the past short-time work user, and the sector x commuting zone revenue growth rate. ♦ The leverage, the hourly gross wage, the number of hours worked per worker, the turnover rate, the share of temporary jobs, the number of employees, the age, the (728) sector-specific fixed effects, the sector x *département* death rate, the sector x *département* employment growth rate, the sector x *département* revenue growth rate and the 2010 short-time work take-up are also included in the regressors. ♦ Robust standard errors are clustered at the sector x *département* level. ♦ The t statistics are reported in parentheses: * p<0.10, ** p<0.05, *** p<0.01.