Public support to clusters: a firm level study of French 'local productive systems'

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ABSTRACT

Public Support to Clusters: A Firm Level Study of French "Local Productive Systems"*

This paper analyzes empirically a public policy promoting industrial clusters in France. Cluster policies have become popular in many countries but have not been extensively evaluated empirically. We use data on production and employment for firms that benefited from the policy and on firms that did not, both before and after the policy started. We first show that the policy selected firms in relative decline. Furthermore, our results suggest that the policy had no major effect on their productivity but may have helped them in terms of employment.

JEL Classification: C23, R10, R11 and R12
Keywords: clusters, localization economies and public policies

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1 Introduction

Industrial clusters are popular among policy makers. Since the end of the 1980s, national and local governments in Germany, Brazil, Japan, South Korea, the Spanish Basque country, and France, inter alia, have attempted to foster their development. The work by Michael Porter (1998, 2000), the leading figure of cluster strategies, has been very influential in this matter and is invariably used as a justification for cluster policies. There is however little macro or micro empirical analysis of their effect on firms performance. The present paper attempts to fill this gap by analyzing the effect, on individual firms, of a specific cluster policy in France.

A typical defense of cluster policies is that clusters bring economic gains and should therefore receive public support. Porter's definition of a cluster – "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" – is not very far from what economists call an agglomeration. The idea that clusters bring economic gains because firms perform better when located near other firms in the same sector is hardly new. In the late nineteenth century, Alfred Marshall identified several benefits of clusters or industrial districts. The different sources of agglomeration externalities, were first analyzed by Marshall and later rediscovered by Kenneth Arrow and Paul Romer. Those are 1) input externalities that save on transportation costs and make inputs purchases more efficient; 2) Labour market externalities that foster the creation of pools of specialized workers, who acquire cluster-specific skills valuable to the firms; 3) Knowledge externalities through which industrial clusters facilitate the exchange of information and knowledge.

Advocates of cluster policies need to address three questions:

1. How large are the gains from agglomeration? In particular, how much does the productivity of a firm increase when other firms from the same sector decide to locate nearby?

2. Do firms internalize these gains when making their location decisions? In particular, are "natural" clusters too small?

3. Can public policies that attempt to foster clusters affect positively the performance of the firms that belong to those clusters?

There is a large empirical literature that has attempted to answer the first question. The survey of Rosenthal and Strange (2004) reports that in the many empirical studies on agglomeration, the doubling of the size a cluster (generally measured as employment of a given sector in a given region) leads to a productivity gain between 3% and 8%. In another paper on French firm-level data, (Martin, Mayer, and Mayneris (2008)), we estimate this elasticity to be around 4%. The starting point of those who defend cluster strategies is thus right: economic gains of clusters exist. Their enthusiasm should however be tamed; these effects are modest. In the same paper, we also find evidence that French firms internalize part of these productivity gains when they choose where to locate: the size of existing "natural" clusters is not very different from the size that would maximize productivity gains[1]. The observed size of clusters is slightly smaller than the one that would be optimal but the productivity

[1]The estimated positive elasticities in the literature, taken literally, would suggest that larger clusters are always better. In fact, we find that productivity gains first increase then decrease (due to congestion costs) with the size of clusters, allowing us to estimate an optimal size of the cluster.

gains that would be obtained by increasing the size of existing clusters are estimated to be small. Overall, the existing empirical work on clusters suggests that they produce economic gains and that these gains are not fully internalized by firms. Hence, the case for public intervention in favor of clusters can be made but there is no evidence that the expected gains should be large.

Finally, even if one assumes that there is a case for public intervention (gains from clusters exist and there are not entirely internalized by firms), there is little evidence on the answer to the third question, on which the present paper focuses. Can cluster policies actually help?

They could do so in two main dimensions. First, cluster policies could increase the size of existing clusters and thus improve the performance of firms if the cluster size is suboptimally small. Second, cluster policies could improve the workings of externalities (input markets externalities, labour markets externalities and technological externalities) inside clusters for a given size of the cluster. Both mechanisms could increase productivity of firms in the cluster.

In this paper, we exploit a rich French firm-level dataset to analyze the impact of a specific cluster policy that was implemented in 1999, by the Délégation Interministérielle à l'Aménagement et à la Compétitivité des Territoires (Diact, ex Datar), the French administration in charge of spatial planning and regional policy. The policy provided support to a group of firms, located in the same area and belonging to the same industry, called the "Local Productive Systems" (LPS). The main aim of the policy was to encourage cooperation among firms and to increase the competitiveness of firms in the cluster.

We assess the impact of public support to LPS on firms' total factor productivity (TFP) and on firms' employment. We use a difference in difference approach exploiting this detailed dataset that spans over the 1996 to 2004 period, during which a subsample of firms where selected to benefit from the policy.

We first analyze the characteristics of firms that were chosen by the authorities. This is interesting because it raises important political economy issues. Our results show clearly that the French LPS policy targeted firms located in backward regions and operating in declining industries. Hence, the policy turned out to be of a defensive type. The official objective was to promote agglomeration externalities and clusters dynamics and was supposed to mark a radical shift of the French regional policy, from traditional spatial equity to efficiency considerations. Our results suggest that the traditional equity objective was in reality still at play.[2] We also find that LPS firms receive more public subsidies in general than others. This is consistent with the study by Beason and Weinstein (1996) on Japan. They show that the reality of industrial policies implemented between 1955 and 1990 clashed with the official objective to help the growth of winners. Indeed, they find a negative correlation between the growth of a given industry and the intensity of the aid it received. Our results on the French cluster policy we study as well as those of Beason and Weinstein (1996) are consistent with two interpretations. One is that subsidies to declining industries reveal government political preferences (Corden (1974), Krueger (1990)). Another possible mechanism is provided by Baldwin and Robert-Nicoud (2007). These authors show why governments often "pick losers" or more exactly why public subsidies are captured by firms in decline which have a greater incentive to lobby for subsidies.

We also find that the public support has been unable to reverse the relative decline of TFP at work for firms selected by the policy. However, it may have had a slight positive

[2]An additional indication of that spatial equity objective is that the LPS projects are relatively evenly spread out on the national territory.

impact in terms of employment. Hence, it may have delayed the exit of declining firms, and in this case such policies could have had a negative impact on aggregate productivity.

This is also what Criscuolo, Matin, Overman, and Van Reenen (2007) conclude in a study that analyzes the impact of the Regional Selective Assistance in UK. They find that the policy, designed to subsidize firms in backward areas, has had a positive impact on firms' employment and investment but no effect on firms' productivity. By supporting less efficient firms, the authors judge that such a policy may slow down reallocations from less efficient plants and affect negatively aggregate productivity growth.

A more positive conclusion is reached by Branstetter and Sakakibara (2002) who analyze Japanese R&D public policy and its effect on the patenting activity of firms involved in government-sponsored research consortia. They find a positive impact, though quite small when all controls are included. Their method, which consists in examining the relative patenting path of consortia firms the years after the inception of the consortium is close to ours.

A related literature has analyzed the effect of subsidies given to firms to locate in specific regions. Crozet, Mayer, and Mucchielli (2004) study for example the determinants of location choice by foreign investors in France over the period 1985-1995. They measure the impact of a French subsidy (the "Prime d'Aménagement du Territoire", PAT) and of European grants for regional policy on firms' location choice. They find a generally positive, but very weak and hardly significant effect of those policies. Head, Ries, and Swenson (1999) analyze the effect of state level policies in United States to attract Japanese firms and find that the probability to attract these firms increases with the subsidies. However, given that all states have such policies, the location of firms is not affected in equilibrium. Finally, Devereux, Griffith, and Simpson (2007) study the effect of Regional Selective Assistance (RSA) grants[3] on firms location in United Kingdom. They also find a positive but very weak effect of the policy.

The paper is structured as follows. We first describe in section 2 the Local Productive Systems policy and our data. We then lay out in section 2.5 our empirical strategy. We present our results in section 3 and some robustness checks in section 4. Section 5 concludes.

2 What are the "Local Productive Systems"?

2.1 The policy

The French agency in charge of regional policy (DIACT) issued in 1998 a tender intended to fund collaborative projects between firms of a given industry located in the same area. The purpose was clearly to promote agglomeration externalities and clusters dynamics. This policy corresponds to a quite radical shift in the objectives of French regional policy, from traditional spatial equity to taking more into account efficiency considerations in the geographic distribution of economic activities. One of the motivations was to replicate the alleged success of Italian industrial districts in the 1980's: the idea was to enhance, through public intervention, collaborations which developed "naturally" in Italy.

Around one hundred projects were submitted and around fifty of them received a subsidy in 1999. An additional fifty were funded in 2000, when the agency in charge issued a new tender. The tender was then transformed into a permanent one, and each year new or old

[3]Which are very similar to the French PAT.

propositions (only a handful of them now) are getting approved and funded by an ad hoc national commission.

The stated aim of the policy was to give a small monetary incentive (the average subsidy is around 37,500 euros) to set off or reinforce clusters. Conditions to receive this subsidy were not very restrictive at the beginning of the process. Conditions are now more demanding (established collaborations, credibility of the proposed action, knowledge of direct competitors etc.). Officially, the policy funds a project and not directly a group of firms. Very often, the official candidate organizing the project is a local public authority, and private firms join once the structure has secured the necessary funding. A wide range of actions can be funded: A study of feasibility for the development of a common brand, the creation of a grouping of employers or the implementation of collective actions in the field of exports for instance. The geographical scale of a LPS is generally the département or the employment area[4].

The LPS can be seen as the first cluster policy in France. A new policy, called "Competitiveness clusters" that started in 2005 is a much more ambitious and costly cluster policy than the one analyzed here (note however that a quarter of LPS projects have been transformed into competitiveness clusters).

2.2 The data and methodology

We use French annual business survey[5] data, provided by the French ministry of Industry. We have information at both the firm and plant levels. This is restricted to firms with more than 20 employees and all the plants of those firms. Our data cover the period 1996-2004. At the firm level, we have all the balance-sheet data (in particular, production, value-added, employment, capital, exports, aggregate wages) and information about firm location, firm industry classification and firm structure (e.g. number of plants).

At the plant level, data are less exhaustive; they contain plant location, plant industry classification, plant number of employees and information about the firm the plant belongs to.

We obtained from the public authority in charge of the LPS policy, the DIACT, the list of LPS and the information about the subsidies obtained as well as the structure which administers. We contacted individually during the year 2006 around 90 LPS, to ask them the list of their adherents. Workable files were obtained for 56 of them, which represents 3,234 firms. We however lost information when we merged these firms with the annual business surveys to obtain data on production and employment. Many of the LPS reported the name and the address of firms, but not their national identification number. We consequently had to find out most firms in the annual business surveys thanks to their name and their zip code only. We merged successfully only 641 firms (the others are probably firms with less than 20 employees or with badly collected information), from 45 LPS created between 1999 and 2003.

From a geographic point of view, we dropped all firms located in Corsica and in overseas départements. Consequently, our sample covers the 94 continental French départements and 341 employment areas. From a sectoral point of view, we only retained firms belonging to manufacturing sectors[6]. In particular, food-proceeding firms had to be dropped.

[4]The départements are administrative areas. Employment areas are economic entities defined on the basis of workers' commuting. There are 94 départements and 341 employment areas in continental France

[5]Called in French "Enquêtes Annuelles d'Entreprises".

[6]In the French 2-digit classification, we kept sectors 17 to 36, sector 23 excluded.

More observations are dropped: the ones for which value-added, employment or capital is missing, negative or null. We also dropped all the firms which changed geographical unit or industrial sector during the period, in order to use the geographical and sectoral dummies that control for spatial and industrial unobservable characteristics[7]. We deflated value-added data by a branch price-index and capital data by a an investment price index valid for all industrial sectors. In the end, the sample is an unbalanced panel involving 417 firms which belong to a LPS. Eighty-eight 3-digit industrial sectors and thirty-nine LPS are represented.

For employment areas data, we use the "Atlas des zones d'emploi" published by the INSEE, the French institute for national statistics, in 1998.

2.3 Which industries are targeted by LPS?

Some simple descriptive statistics on the industries targeted by the LPS policy are useful. We distinguish the manufacturing industries which are not represented in the LPS (24 non-treated industries), the industries represented by less than 10 LPS firms (49 industries) and the industries represented in the LPS by at least 10 firms (14 industries). The average of several indicators for these three categories are presented in table 1.

Table 1: Industry level summary statistics

Variables	Non LPS-treated industries	Industries with less than 10 LPS-treated firms	Industries with at least 10 LPS-treated firms
	Average level in 2004		
Labour productivity	59.72	56.89	50.45
Capitalistic intensity	103.04	82.15	57.22
Export share	0.37	0.36	0.28
	Evolution between 1996 and 2004 (in %)		
Employees	-10.68	-9.43	-1.04
Value added	19.30	22.60	28.96
Labour productivity	34.54	33.10	32.64
Exports	23.19	50.06	58.08

Note: Labour productivity=value added/employees, capitalistic intensity=capital stock/employees, export share=export value/sales. Values are in thousands of real euros.

In 2004, the average labour productivity is lower in LPS industries than in the rest of manufacturing industries. This result is particularly clear for the industries where LPS are the most important. LPS industries are also much more labour intensive than the others.

Between 1996 and 2004, the employment loss for the average French non-LPS manufacturing industries is 10.68%. LPS intensive industries lost much less employment (1.04%). Their value added also increased more (28.96% vs 19.30%), but not proportionally to employment, so that labour productivity increased on average by 34.54% in non-LPS industries, and by only 32.64% in the 14 main LPS industries. Finally, LPS firms belong to industries that export less than the average but their exports grew faster over the period.

To summarize, LPS industries are on average much more labour intensive than the rest of manufacturing; they destroyed less employment than other industries in the 1996-2004 period

[7]We also dropped outliers, dropping 1% extremes for the following variables: average work productivity, capital intensity, yearly capital growth rate, yearly employment growth rate, yearly average work productivity growth rate, yearly average capital intensity growth rate. We also had to drop the "Weapons and ammunitions" industry, which is a clear outlier.

but their productivity gains were also lower.

2.4 Who are LPS firms?

We now analyze the characteristics of firms that participated to one of the selected LPS. Table **??** presents summary statistics about the LPS firms of our sample. They are larger and less productive than non LPS firms. However, the standard deviation for all their characteristics is lower than for other firms. This suggests that the policy targeted firms with specific characteristics.

Table 2: Summary statistics about firms

	LPS firms			Non LPS firms		
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Value added	2701	10357.31	29727.32	146599	6038.23	42534.43
Employees	2701	219.70	538.03	146599	123.79	651.70
Capital Stock	2701	14466.74	55573.65	146599	7623.53	107991.50
Labour productivity	2701	39.83	16.41	146599	41.24	19.22

Note: Value added, capital, capital intensity, labour productivity and exports are expressed in thousands of real euros

To go further in this analysis, we estimate, with a logit model, the probability for a firm to become a LPS-firm. We take into account average firm-level characteristics prior their entrance in a LPS. We also control for characteristics of the employment areas where the firms are located. The way we compute firm-level average characteristics is not trivial. Our panel is unbalanced. Moreover, firms entered the LPS scheme in different years between 1999 and 2003. Hence, the number of years for which we can observe the firm characteristics prior their entrance in a LPS is not the same for all firms. If firms' characteristics are affected by annual common shocks, the computation of pre-LPS average characteristics could therefore be noisy; hence, we correct all individual observations for yearly trends. We then compute for each firm its average characteristics for the years before its "entry" in a LPS. For non-LPS firms and firms in LPS sustained in 2003, these average characteristics are computed with all the available de-trended observations from 1996 to 2003. We keep in the end 335 LPS firms in the sample.

The results are displayed in table 3. The index of TFP we use is obtained with an estimate of a production function, following an OLS approach. In the appendix, we show that our results are robust when we use a GMM estimation for TFP (see table 20). Column (1) presents results from a simple logit, where we control for the size (number of employees) of the firm, its TFP, the amount of subsidies (other than LPS) it receives and the number of workers in other firms of the same industry-area. It appears that in this very simple specification, LPS firms are bigger than the others and receive more public subsidies overall. These two characteristics of LPS are very robust. One interpretation is that LPS firms are important for local politicians because they are big employers and that they are good at lobbying for public subsidies.

The inclusion of industry-fixed effects does not change these results (regression (2)) but the inclusion of départements fixed effects (regression (3)) does: LPS are more productive than the other firms of their département. Given that the coefficient on TFP is close to zero

Table 3: LPS determinants

Model :	Dependent Variable: lps_status			
	(1)	(2)	(3)	(4)
Mean (ln Employees$_{iszt}$)	0.187^{a}	0.176^{a}	0.237^{a}	0.243^{a}
	(0.069)	(0.068)	(0.071)	(0.072)
Mean (TFP$_{iszt}$)	-0.087	0.037	0.416^{b}	0.360^{c}
	(0.186)	(0.164)	(0.179)	(0.189)
Mean (ln Subsidies$_{iszt}$)	0.073^{a}	0.068^{a}	0.053^{a}	0.052^{a}
	(0.016)	(0.016)	(0.017)	(0.017)
Mean [ln (Employees$_{szt}$ − Employees$_{iszt}$ + 1)]	-0.023	-0.014	0.212^{b}	0.169^{c}
	(0.022)	(0.030)	(0.094)	(0.088)
ln Mean (Taxable net income$_{z1994}$)				4.424^{b}
				(1.868)
ln Mean (Taxable net income growth rate$_{z1984-1994}$)				-2.593^{a}
				(0.968)
ln Population density$_{z1994}$				-0.328^{c}
				(0.191)
ln Industrial jobs share$_{z1994}$				1.771^{a}
				(0.420)
ln Share of population with vocational training$_{z1990}$				-2.723^{c}
				(1.480)
Industry fixed effects	no	yes	yes	yes
Département fixed effects	no	no	yes	yes
N	18196	18196	18196	18196
R^2	0.014	0.053	0.19	0.215

Note: Robust standard errors in parentheses ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All regressions are clustered at the emloyment area level. Necessarily, t ≤ lps_year

and not significant when we do not control for département fixed effects, this means that LPS firms are located in less productive départements[8]

Note also that the number of employees in the other firms of the same industry-département, which is a proxy for potential localization economies, is close to zero and not significant in the simple OLS regression. This is surprising since the LPS policy is supposed to be a cluster-promotion policy. It may be partly due to the fact that LPS firms are bigger than the others, which mechanically reduces, for a given size of the industry in the département, the number of employees in surrounding firms. But the coefficient is strongly positive and significant when départements fixed effects are added. Hence, another non exclusive explanation would be that the LPS policy targeted clusters which are relevant at a local level, but not at a national level.

In regression (6), we include some characteristics of the employment areas where firms are located. The results are robust to this inclusion. Moreover, these regressions show that, relative to the average in the département, LPS firms are located in areas which are less dense, more dependent on industry, richer, and with less workers with vocational training. Note however, their average taxable income growth was smaller over the 1984-1994 period. We will use this regression and what it tells us about the observable characteristics of LPS firms to construct our sample for the matching approach when we analyze the impact of LPS status on firm performance.

[8]This is confirmed by the fact that LPS firm are located in départements which receive the “Prime d’Aménagement du territoire” (PAT), one of the main instruments of regional policy in France and which have a high share of subsidized employment: see table 21 in the Appendix).

2.5 Empirical methodology: a difference-in-difference approach

The stated objective of the LPS policy is to improve firms' competitiveness. To analyze whether the LPS was successful in this respect we quantify the impact of the LPS policy on firms' total factor productivity (TFP). We also analyze its impact on firm's employment. The approach we choose is based on the standard "difference-in-difference" method (DD) (see Bertrand, Duflo, and Mullainathan (2004)).

y_{it} is our dependent variable (firms' TFP or employment). The relation we bring to data is the following:

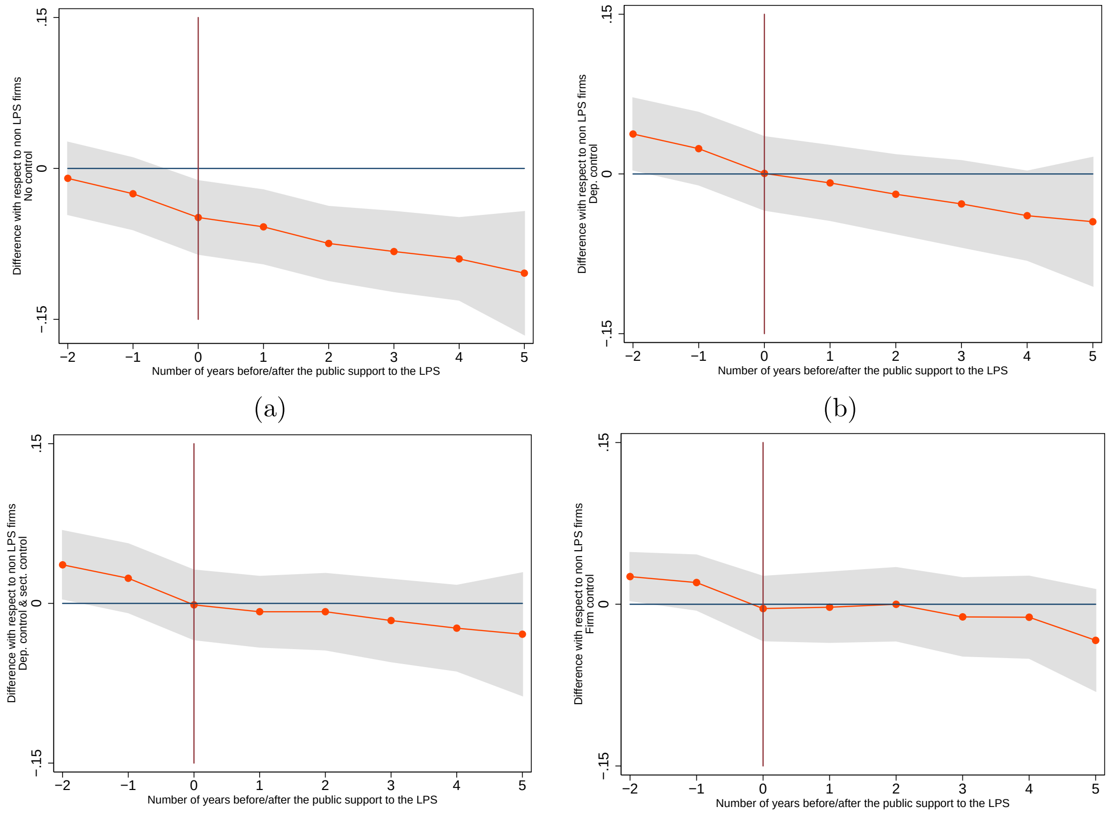
$$y_{it} = \gamma \mathrm{lps}_i + \theta \mathrm{lps\_in}_{it} + \mathrm{d}_t + \epsilon_{it} \tag{1}$$

where lps_i is a dummy variable which identifies LPS firms which at some point benefit from the LPS label. This dummy captures all time-invariant unobservable characteristics specific to firms targeted by the LPS policy. $\mathrm{lps\_in}_{it}$ is a dummy which equals 1 for LPS firms the year it receives the subsidy and thereafter. d_t is a time trend, common to all firms. If ϵ_{it} is orthogonal to the regressors, θ is the DD estimator of the effect of LPS policy on firm's performance. It is indeed obtained by comparing the evolution of performance for a LPS firm before and after its entry in the LPS, to the evolution of performance for a non-LPS firm during the same period. Section 2.4 however showed that LPS firms had particular characteristics, especially in terms of location and industries, which both determined their probability of belonging to a LPS and their performance before. This suggests several sources of bias in our estimates of γ and θ. If the fact of being in a LPS is also correlated to specific shocks or to temporal trends (if $\epsilon_{it} = \mathrm{u}_i + \eta_{it}$ and if $E(\eta_{it+1} - \eta_{it})$ is different for LPS and non-LPS firms), our estimation will suffer from a simultaneity bias. The best way to control for both unobserved invariant characteristics and unobserved idiosyncratic shocks would be to instrument the LPS variables. There is however no obvious set of natural instruments that would be good predictors of entry into the LPS scheme, while being unrelated to the firm's performance. We will consequently address the invariant part of that endogeneity issue by adding different sets of fixed effects. This amounts to assuming that the biggest part of the problem mentioned is a correlation of LPS participation with u_i rather than with η_{it}. We combine this with a matching approach, which accounts for the fact that LPS firms are quite specific in the observable characteristics and identifies a group of non treated firms with the most similar set of such observables.

3 Results

3.1 LPS and Productivity

We first present our results on TFP. To estimate firm TFP, we regress firm value-added on employment and capital and keep the residuals; the estimated elasticities for employment and capital are respectively 0.85 and 0.15. In the appendix, we discuss the limitations of the OLS approach to TFP estimation and perform robustness checks where we estimate TFP with GMM. Results are very similar. In unreported investigations, we also tested our results using a Levinsohn and Petrin (2003) approach for the estimation of firms' TFP. Again, results (available upon request) are qualitatively robust.



(a) (b) (c) (d)

Figure 1: LPS firms and evolution of OLS TFP

3.1.1 A graphical exploration

We start with a graphical analysis of the evolution of productivity differential between LPS and non-LPS firms. We estimate the following four regressions:

$$\mathrm{tfp}_{it} = \sum_{j=-2}^{5} \alpha_j \mathrm{lps\_in}_{ijt} + \mathrm{d}_t + \epsilon_{it} \tag{2}$$

$$\mathrm{tfp}_{it} = \mathrm{fe}_z + \sum_{j=-2}^{5} \alpha_j \mathrm{lps\_in}_{ijt} + \mathrm{d}_t + \epsilon_{it} \tag{3}$$

$$\mathrm{tfp}_{it} = \mathrm{fe}_z + \mathrm{fe}_s + \sum_{j=-2}^{5} \alpha_j \mathrm{lps\_in}_{ijt} + \mathrm{d}_t + \epsilon_{it} \tag{4}$$

$$\mathrm{tfp}_{it} = \mathrm{fe}_i + \sum_{j=-2}^{5} \alpha_j \mathrm{lps\_in}_{ijt} + \mathrm{d}_t + \epsilon_{it} \tag{5}$$

where $\mathrm{lps\_in}_{ijt}$ equals 1 if j years separate time t from the moment when firm i will become (resp. has become) a LPS firm. The first regression simply estimates the difference of productivity between LPS and non-LPS firms according to the number of years which separate the LPS firm from the reception of the subsidy. We then add fixed effects with increasing levels of detail: region z, then region z/sector s, and finally firm-level i. Only the last regression actually yields a difference-in-difference estimator of the LPS effect. The four sets of results are presented in panels (a) to (d) of figure 1.

We first perform the estimation on the whole sample. The grey zone on each panel corresponds to the 5% confidence interval. According to the first estimation, without any control in panel (a), LPS firms are not significantly different from the others two years before their entry in a LPS, but a negative and significant productivity gap grows over time between both types of firms. With départements controls in panel (b), LPS firms appear more productive than the others before their entry in a LPS; this suggests that LPS firms are located in less productive départements. Nevertheless, LPS firms still seem to be on a declining path in terms of productivity, even though the differential with non-LPS firms for a given year is never significant at the 5% level. Those results clearly show that LPS firms are on a different temporal trend than the others. When firm fixed effects are controlled for in panel (d), the declining path seems to be stopped during two years after the entry in the LPS; but then, the decline with respect to other firms starts again.

Figure 2 presents the same results for single-plant firms. Indeed, the LPS policy is supposed to help firms better coordinate their strategies with firms nearby and more generally to enable firms to benefit more from the network of firms in the region. Multi-plant firms, which are also typically bigger, may be less dependent on their local environment and therefore respond less to the LPS policy. Moreover, and maybe more importantly, we do not have the information on the LPS status at the plant level. Hence, for multi-plant firms, the effect of the policy may be both weaker and mis-measured. Hence, we analyze the case of single plant firms (304 LPS firms) which do not suffer from those problems. Comments are roughly the same, except that with firm fixed effects, the declining path is not only stopped but reversed into a rising pattern; two years after the entry in a LPS, single plant firms are 3.4% more productive than the others (significant at 10%). But it is a very short run effect.

We now turn to proper difference-in-difference econometric analysis to investigate the robustness of those first results more systematically. In table 4, the simple OLS regression shows that the LPS firms are not "structurally" different from the others (with a negative but insignificant coefficient on the LPS dummy). However, they experience a negative and very significant productivity drop once they are in a LPS. When we introduce industry fixed effects, the coefficient of the variable "Being in a LPS" increases from -0.071 to -0.049, which suggests that LPS firms belong to declining industries. Interestingly, once départements fixed effects are taken into account (regression (3)), the coefficient on "LPS firms" becomes positive and significant; again this means that LPS firms are located in less productive départements. Nevertheless, "Being in a LPS" still has a negative and significant coefficient which persists when we introduce firm fixed effects in regression (6), though closer to zero. There are several possible interpretations of this rather pessimistic result on the LPS policy. One is that the LPS policy causes this negative effect. It is possible that the firms that receive the LPS label become more receptive to public pressure to postpone workers layouts. In this interpretation, firms may choose to forego labor saving productivity improvements. In section 3.2, we present results on employment which are consistent with this interpretation. Another interpretation - not exclusive of the first one - is that firms that enter a LPS do it when they face difficulties: η_{it} and lps_in_{it} are certainly correlated and there would consequently be a simultaneity bias in the estimation of the causal impact of the policy on firms' TFP. The graphical analysis tends to corroborate that idea since even with firm and year fixed effects, LPS firms still appear different from the others before the implementation of the policy; it should not be the case in the absence of specific temporal trends. We try to address this issue in subsection 3.1.2. Results on single plant firms are presented in table 5. They confirm our main conclusions but some subtle differences emerge: LPS single-plant firms tend to be located in less productive

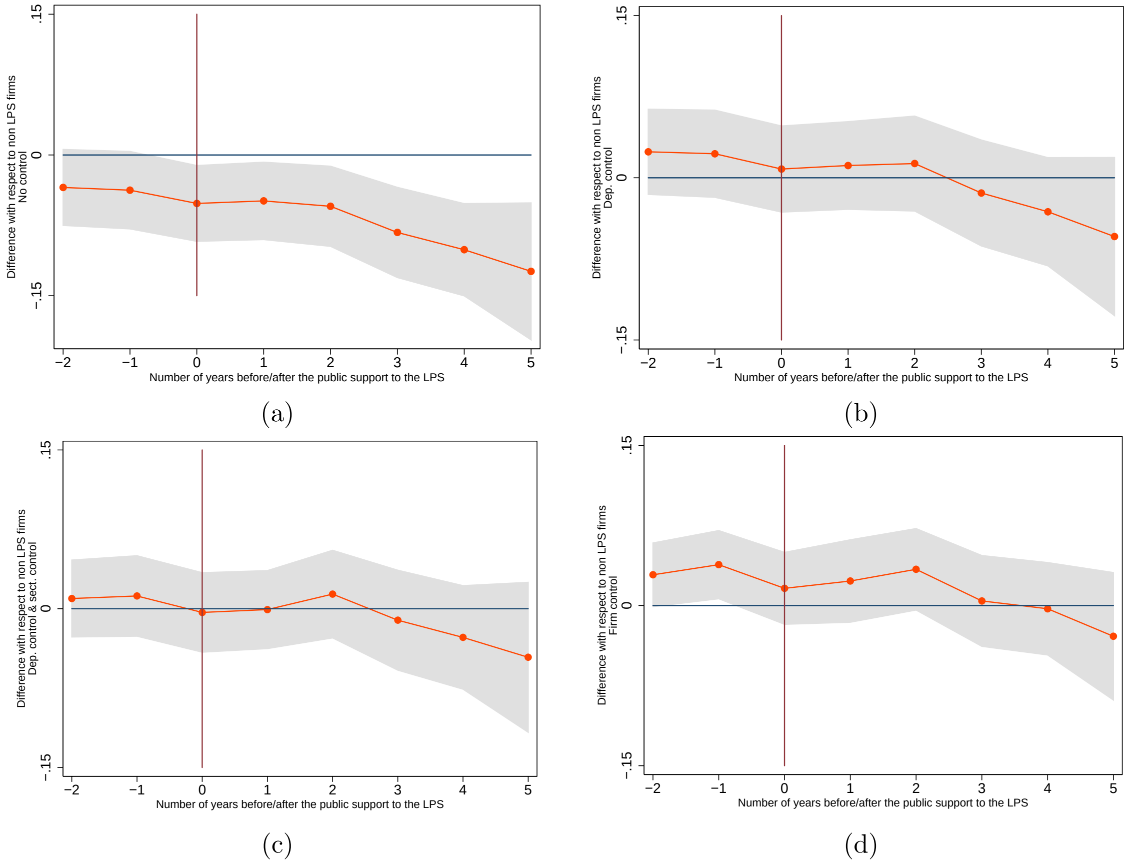


Figure 2: LPS single-plant firms and evolution of OLS TFP

départements and once they enter the LPS policy, their productivity stagnates. Overall, however, the LPS policy appears less negative or even slightly positive for the single plant firms, as we saw with the graphical analysis. But it is a very short effect and with the GMM TFP index, this positive effect cannot be detected.

Table 4: LPS and OLS TFP

	Dependent Variable: TFP				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	-0.003	-0.000	0.039[b]	0.031[b]	
	(0.017)	(0.015)	(0.016)	(0.015)	
Being in a LPS	-0.071[a]	-0.049[a]	-0.060[a]	-0.044[a]	-0.021[c]
	(0.015)	(0.014)	(0.014)	(0.014)	(0.012)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	149300	149300	149300	149300	149300
R^2	0.03	0.18	0.13	0.24	0.03

Note: Standard errors in parentheses. [a], [b] and [c] respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

3.1.2 LPS and temporal endogeneity

We saw that the entry into a LPS coincides with a decline in productivity and that this decline could be explained by sectoral and geographical determinants. The existence of such

Table 5: LPS and OLS TFP-Single plant firms

	Dependent Variable: ln TFP				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	-0.028	-0.031^c	0.024	0.007	
	(0.019)	(0.017)	(0.018)	(0.017)	
Being in a LPS	-0.045^b	-0.024	-0.031^c	-0.017	-0.008
	(0.018)	(0.017)	(0.017)	(0.017)	(0.014)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	104175	104175	104175	104175	104175
R^2	0.03	0.19	0.14	0.24	0.03

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

a correlation biases the estimation of the “causal” impact of the policy.

We resort to two different strategies:

- we introduce département-time and industry-time fixed effects in order to purge the estimation from all the geographic and sectoral shocks, common to all firms over the period.
- we saw in subsection 2.4 that there was a clear selection of LPS firms on observable characteristics. If those characteristics are also correlated with the evolution of firms' TFP, we can improve the estimation of LPS policy impact by using a matching strategy. Using the last regression of table 3 in subsection 2.4, we compute the probability for all firms to belong to a LPS. Note that in this regression, all the firms in industries or départements which are not represented in the LPS have already been eliminated . To comply more confidently to the common support condition of the matching approach, we drop from the sample those firms which have a probability above the 99th percentile for non-LPS firms and below the 5th percentile of LPS ones. 238 LPS firms remain in the sample, from which 178 are single plant firms.

In table 6, we see that for the whole sample, the introduction of département-time fixed effects does not affect the results with respect to a simple départements fixed effects estimation. On the contrary, the observed negative drop is larger with industry-time fixed effects than with industry fixed effects. This confirms that LPS firms operate in declining sectors. The LPS policy would have a static redistributive dimension (towards structurally less productive départements) and a more dynamic one (towards declining sectors). For single plant firms (table 7), as soon as industry-time fixed effects are controlled for, the drop after the entry in the LPS is not significant any more. Matching approach on both samples tends to reduce or cancel that drop too (tables 8 and 9). Our main results remain nevertheless unchanged: the LPS policy does not succeed in reversing the negative trend observed with simple OLS estimation.

Table 6: LPS and OLS TFP

Model :	Dependent Variable: TFP (1)	(2)	(3)	(4)	(5)
LPS firm	-0.003	-0.004	0.039^{a}	0.027^{a}	0.030^{a}
	(0.017)	(0.010)	(0.011)	(0.009)	(0.011)
Being in a LPS	-0.071^{a}	-0.043^{a}	-0.060^{a}	-0.037^{a}	-0.035^{b}
	(0.015)	(0.013)	(0.015)	(0.012)	(0.015)
Year fixed effects	yes	n.a	n.a	n.a	n.a
Industry-time fixed effects	no	yes	no	yes	no
Département-time fixed effects	no	no	yes	no	no
Département fixed effects	no	no	no	yes	no
Industry-Département-time fixed effects	no	no	no	no	yes
N	149300	149300	149300	149300	149300
R^2	0.03	0.00	0.00	0.07	0.00

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 7: LPS and OLS TFP-Single plant firms

Model :	Dependent Variable: TFP (1)	(2)	(3)	(4)	(5)
LPS firm	-0.028	-0.034^{a}	0.021	0.004	-0.006
	(0.019)	(0.011)	(0.013)	(0.011)	(0.013)
Being in a LPS	-0.045^{b}	-0.019	-0.026	-0.011	0.007
	(0.018)	(0.015)	(0.017)	(0.015)	(0.018)
Year fixed effects	yes	n.a	n.a	n.a	n.a
Industry-time fixed effects	no	yes	no	yes	no
Département-time fixed effects	no	no	yes	no	no
Département fixed effects	no	no	no	yes	no
Industry-Département-time fixed effects	no	no	no	no	yes
N	104175	104175	104175	104175	104175
R^2	0.03	0.00	0.00	0.07	0.00

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 8: LPS and OLS TFP-Matching

Model :	Dependent Variable: TFP (1)	(2)	(3)	(4)	(5)
LPS firm	-0.017	-0.031^{c}	0.008	-0.003	
	(0.022)	(0.018)	(0.019)	(0.017)	
Being in a LPS	-0.063^{a}	-0.036^{b}	-0.041^{b}	-0.028^{c}	-0.002
	(0.018)	(0.016)	(0.016)	(0.016)	(0.013)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
Observations	57337	57337	57337	57337	57337
R^2	0.03	0.18	0.14	0.24	0.03

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 9: LPS and OLS TFP-Single plant firms, matching

	Dependent Variable: TFP				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	-0.031	-0.055^a	-0.005	-0.023	
	(0.023)	(0.019)	(0.020)	(0.019)	
Being in a LPS	-0.040^b	-0.008	-0.020	-0.003	0.014
	(0.020)	(0.019)	(0.019)	(0.019)	(0.015)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
Observations	40506	40506	40506	40506	40506
R^2	0.03	0.18	0.14	0.24	0.03

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

3.1.3 Further issues

A possible defense of the LPS policy is that the absence of a measurable effect comes from the small size of the monetary subsidy involved. In other words, the policy is good but should receive more funds. To test this idea, we use for all single-plant firms[9] involved in a LPS the information on the amount of the subsidy perceived by the LPS they belong to. The average subsidy for this group is 45,000 euros. In table 10, the significantly negative coefficient on the amount of the subsidy suggests that the strongest monetary support goes to weaker firms. This negative coefficient cannot be interpreted in causal terms since the subsidy variable has no impact once individual fixed-effect are introduced.

Table 10: LPS, OLS TFP and Subsidy

	Dependent Variable: ln TFP				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	-0.025	-0.032^c	0.027	0.008	
	(0.022)	(0.019)	(0.020)	(0.019)	
Being in a LPS	0.498^c	0.680^a	0.422	0.652^a	0.015
	(0.265)	(0.243)	(0.265)	(0.241)	(0.196)
Being in a LPS×ln(Subsidy+1)	-0.150^b	-0.192^a	-0.124^c	-0.182^a	-0.007
	(0.071)	(0.065)	(0.071)	(0.064)	(0.052)
N	103860	103860	103860	103860	103860
R^2	0.03	0.19	0.14	0.24	0.03
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation. Subsidy is in thousands real euros. average subsidy≈45, median subsidy≈38.

[9]Since we do not know which plant obtained the subsidy, we concentrate on single-plant firms. These are also the firms for which a positive effect, if it exists, should be best measured. We have the necessary information for 252 firms.

We also tested the policy could have a different impact on firms of different size, on firms belonging to LPS of different size on firms belonging to LPS with different governance structure: no significant heterogeneity could be detected.

We also tested whether the LPS policy had an effect on the size of the clusters they targeted. Table 11 shows that LPS firms belong to pre-existing clusters: the number of employees from the same industry in the other firms of the département (the left hand side variable in the regressions of this table) is much higher for LPS firms once département fixed effects have been introduced. However, there is no indication that the cluster policy was attractive to other firms of the same sector. If anything, the years the LPS are implemented are years during which the size of the cluster to which these firms belong decreases. Since Martin, Mayer, and Mayneris (2008) have shown that the size of clusters has a positive impact on French firms productivity, this result may partly explain why we do not find productivity gains for LPS firms.

Table 11: LPS and localization economies

	Dependent Variable: ln (Employees, same industry-area, other firms)$_{iszt}$		
Model :	(1)	(2)	(3)
LPS firm	0.165^c	0.531^a	0.438^a
	(0.096)	(0.107)	(0.057)
Being in a LPS	-0.173^b	-0.135^c	-0.118^c
	(0.075)	(0.078)	(0.070)
Year fixed effects	yes	n.a	n.a
Département fixed effects	no	yes	yes
Industry-year fixed effects	no	no	yes
Observations	100937	100937	100937
R^2	0.00	0.00	0.33

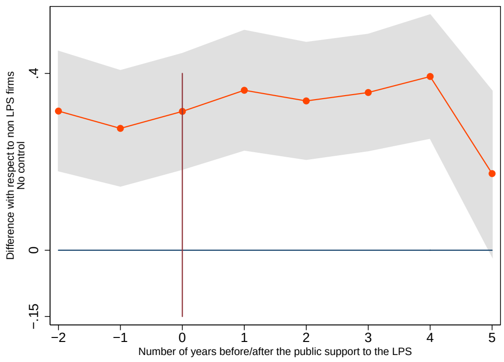
Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are clustered at the firm-level in regression (1), at the industry-time level in regressions (2) and (3).

3.2 LPS and firms' labour demand

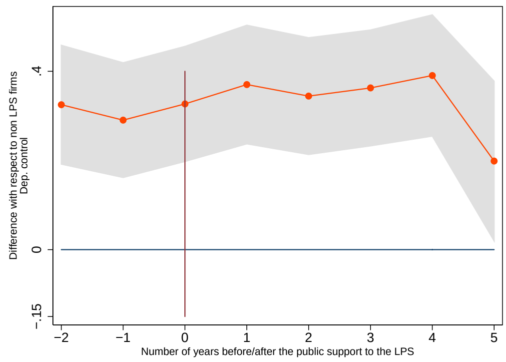
Up to now, the LPS policy, in spite of the official discourse presenting it as a clear break with policies in favor of regions and industries in difficulty, appears clearly as a defensive policy. If political economy factors are at the origin of the gap between the stated objectives and what we measure, we may be missing all the action when looking at the effect of the policy on productivity. The most important objective for national and local policy makers involved in the policy may in fact be employment of these firms. Preserving jobs rather than increasing productivity may have been the real objective. This is what Criscuolo, Matin, Overman, and Van Reenen (2007) conclude from the study of Regional Selective Assistance in the UK.

To look at this, we adopt the same strategy as for productivity and start with graphical analysis. It appears on figures 3 and 4 that LPS firms are "structurally" bigger than the others. Once individual fixed effects have been taken into account, LPS firms still appear bigger than the others. But they do before and after their entry in a LPS, without any clear change in the pattern of their size, so that it is difficult to identify a specific role of the policy.

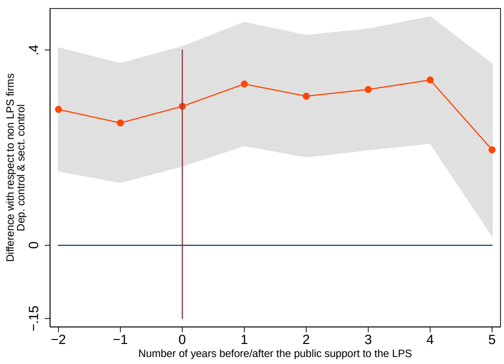
We then concentrate on the econometric analysis. We regress firms' current employment



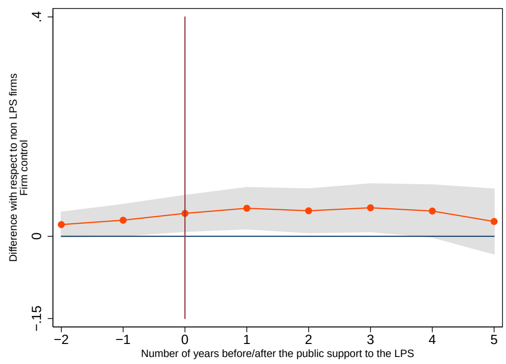
(a)



(b)



(c)



(d)

Figure 3: LPS firms and evolution of employment

on the two variables "LPS firm" and "Being in a LPS". We develop in appendix a more structural approach, which yields similar results.

LPS firms are significantly bigger employers than the others, something we know from subsection 2.4. Interestingly, tables 12 and 13 for all firms and single plant firms respectively, show that LPS firms perform better in terms of employment once they are in the LPS. This is so once we control for firm fixed effects. The effect on employment is however quite modest, not specific to the period post-subsidy as suggested by the graphical analysis, and disappears completely with the matching estimations (tables 14 and 15).

Table 12: LPS and firms' labour demand

	Dependent Variable: ln Employees$_{it}$				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	0.303^a	0.253^a	0.309^a	0.261^a	
	(0.067)	(0.062)	(0.067)	(0.063)	
Being in a LPS	0.033	0.050	0.037	0.046	0.031^b
	(0.042)	(0.040)	(0.041)	(0.039)	(0.015)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	149300	149300	149300	149300	149300
R^2	0.00	0.11	0.04	0.14	0.05

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

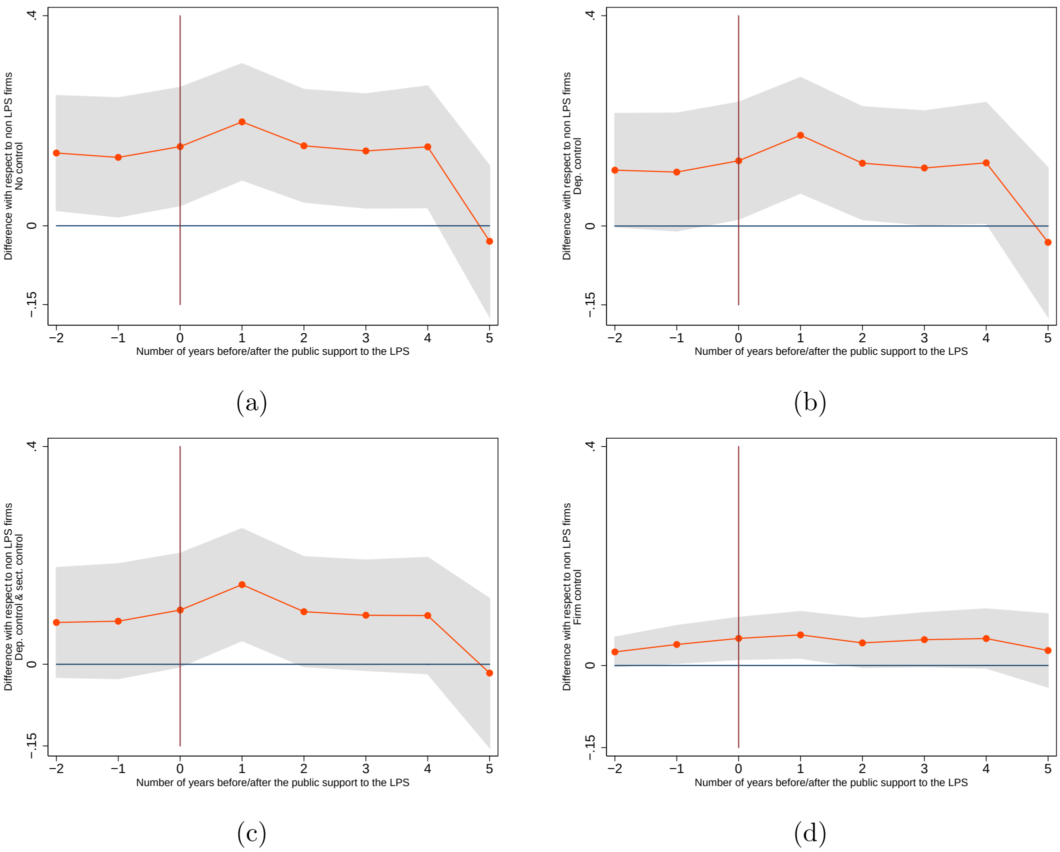


Figure 4: LPS single-plant firms and evolution of employment

Table 13: LPS and single plant firms' labour demand

	Dependent Variable: ln Employees$_{it}$				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	0.136^b	0.097^b	0.106^b	0.074	
	(0.053)	(0.049)	(0.052)	(0.049)	
Being in a LPS	0.004	0.018	0.008	0.020	0.028^c
	(0.041)	(0.039)	(0.039)	(0.038)	(0.016)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	104175	104175	104175	104175	104175
R^2	0.00	0.09	0.03	0.12	0.05

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 14: LPS and firms' labour demand-Matching estimations

	Dependent Variable: ln $Employees_{it}$				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	0.018	0.031	0.120^{c}	0.158^{b}	
	(0.067)	(0.065)	(0.064)	(0.062)	
Being in a LPS	0.057	0.063	0.073^{c}	0.056	0.005
	(0.038)	(0.039)	(0.037)	(0.036)	(0.017)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	57337	57337	57337	57337	57337
R^2	0.00	0.13	0.11	0.21	0.06

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 15: LPS and single plant firms' labour demand-Matching estimations

	Dependent Variable: ln $Employees_{it}$				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	-0.005	-0.006	0.053	0.067	
	(0.056)	(0.055)	(0.056)	(0.055)	
Being in a LPS	0.009	0.023	0.017	0.022	-0.009
	(0.043)	(0.042)	(0.041)	(0.041)	(0.019)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	40506	40506	40506	40506	40506
R^2	0.00	0.11	0.06	0.15	0.06

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

4 Robustness checks

We have conducted so far our analysis at the firm level. Two issues arise about this methodological choice:

1. Proponents of cluster policies often claim that these policies do not only affect the firms directly targeted but the whole sector in the region. In the presence of this type of externality, the estimation of the LPS policy at the firm level may underestimate its true economic impact.

2. There is possible measurement error in our sample of LPS firms: in our survey, it is possible that some LPS firms are identified as control firms. The reason is that we have to rely on partially incomplete information provided by managers in response to our survey.

To address both issues, we now present our analysis at the industry-département level rather than at the firm level. This allows to capture possible local spillover effects. This also reduces the measurement error since the geographical scale of the LPS policy is the département.

4.1 LPS and industry-départements' productivity and employment

We define the total factors productivity in industry s and département z at time t as a weighted sum of firms' TFP:

$$\mathrm{TFP}_{szt} = \sum \left[\left(\frac{\mathrm{emp}_{iszt}}{\mathrm{emp}_{szt}} \right) \times \mathrm{TFP}_{iszt} \right] \tag{6}$$

where emp_{iszt} is the number of employees of firm i from industry s, in département z at time t and emp_{szt} is the number of employees from industry s, in département z at time t.

We define an industry-département cell as being affected by the LPS policy when at least one firm from industry s and département z has been involved in LPS over the period.

Conclusions remain very similar to those obtained at firm-level except that when industry-département fixed effects are included, the negative productivity differential consecutive to the LPS treatment is not significant anymore[10]. In unreported regressions, we use single-plant firms only to construct the indices of industry-département level productivity; all coefficients are insignificant, either with OLS index or GMM index.

From the point of view of employment growth, results are also very similar: the number of employees in LPS industry-département is structurally higher than the average and its growth is significantly higher when industry-département fixed effects are included. Once again, the positive employment differential after LPS treatment is not significant when we consider single-plant firms only.

We test heterogeneity in industry-département performance by distinguishing, as in section 2, "core" LPS industries (represented by at least 10 firms) and the others. This did not yield conclusive results.

To sum up, the analysis at a more aggregated level is consistent with the analysis at the firm level. This suggests that spillovers effects and measurement errors are not crucial.

[10] When using GMM index, results at firm level and industry-département level are also very similar, even with industry-département fixed effects

Table 16: LPS and OLS TFP-Industry/Département analysis

	Dependent Variable: TFP_{szt}				
Model :	(1)	(2)	(3)	(4)	(5)
LPS industry-département	0.017	0.024	0.029^c	0.031^b	
	(0.016)	(0.014)	(0.015)	(0.014)	
Being in a LPS	-0.039^a	-0.032^a	-0.036^a	-0.029^b	-0.016
	(0.012)	(0.012)	(0.012)	(0.011)	(0.012)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Industry-département fixed effects	no	no	no	no	yes
Observations	34750	34750	34750	34750	34750
R^2	0.041	0.050	0.045	0.245	0.107

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account autocorrelation at the industry-département level.

Table 17: LPS and number of employees-Industry/Département analysis

	Dependent Variable: $Employees_{szt}$				
Model :	(1)	(2)	(3)	(4)	(5)
LPS industry-département	1.076^a	0.775^a	1.099^a	0.733^a	
	(0.095)	(0.089)	(0.082)	(0.075)	
Being in a LPS	-0.037	-0.024	-0.023	-0.004	0.061^c
	(0.048)	(0.046)	(0.044)	(0.041)	(0.035)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Industry-département fixed effects	no	no	no	no	yes
Observations	34750	34750	34750	34750	34750
R^2	0.033	0.019	0.038	0.236	0.004

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account autocorrelation at the industry-département level.

4.2 LPS and firms' survival

In this subsection, we test the hypothesis that the LPS policy may have affected the probability of exit of firms. Indeed, in our political economy interpretation, this policy may have had a negative effect on productivity but may have helped firms to survive and therefore to maintain employment. We cannot test this hypothesis at the firm level because most of LPS managers gave us only the list of LPS firms still in activity in 2006. Hence, we cannot identify LPS firms which disappeared before our survey.

This is why we conduct the analysis at a more aggregate level. For each industry-département, we compute the share of firms present in the sample in 1996 which are still alive in 2004, so that we have one observation per industry-département.

Table 18: LPS and firms' survival-Industry/Département analysis

	Dependent Variable: Share of surviving firms 1996-2004				
Model :	(1)	(2)	(3)	(4)	(5)
LPS industry-departement	0.063^a	0.057^a	0.038^c	0.047^b	0.030
	(0.020)	(0.020)	(0.020)	(0.021)	(0.021)
Mean OLS Tfp_{sz1996}		0.104^a	0.111^a	0.154^a	0.166^a
		(0.023)	(0.027)	(0.024)	(0.028)
ln (Average firms' size_{sz1996})		0.019^a	0.020^b	0.032^a	0.032^a
		(0.007)	(0.008)	(0.008)	(0.008)
Industry fixed effects	no	no	yes	no	yes
Département fixed effects	no	no	no	yes	yes
Observations	3944	3944	3944	3944	3944
R^2	0.001	0.011	0.010	0.022	0.092

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels.

Table 19: LPS and single plant firms' survival-Industry/Département analysis

	Dependent Variable: Share of surviving firms 1996-2004				
Model :	(1)	(2)	(3)	(4)	(5)
LPS industry-departement	0.086^a	0.086^a	0.061^b	0.068^a	0.045^c
	(0.024)	(0.024)	(0.024)	(0.026)	(0.026)
Mean OLS Tfp_sz1996		0.089^a	0.098^a	0.144^a	0.148^a
		(0.024)	(0.027)	(0.025)	(0.028)
ln (Average firms' size_{sz1996})		0.038^a	0.029^b	0.033^a	0.023^c
		(0.011)	(0.012)	(0.011)	(0.012)
Industry fixed effects	no	no	yes	no	yes
Département fixed effects	no	no	no	yes	yes
Observations	3308	3308	3308	3308	3308
R^2)	0.002	0.011	0.008	0.017	0.070

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels.

The first regression shows that industry-départements targeted by the LPS policy are characterized by a higher survival rate between 1996 and 2004. We then control for the level of productivity and the average size of firms in the industry-département, which both affect positively the share of surviving firms between 1996 and 2004. It is well known that bigger and more productive firms are less likely to die (see for example Alvarez and Görg (2007)).

When controlling for industry and département fixed effects separately, the LPS policy appears associated with a higher survival rate; when both types of fixed effects are added, the coefficient on LPS policy is positive but not significant. We ran the same regressions for single-plant firms only and the coefficient on LPS industry-département remains positive and significant even with sectoral and geographic fixed effects.

These results suggest that the LPS policy is associated with higher survival rates of firms. Even if we cannot interpret these regressions as causal, they are again consistent with our political economy interpretation of the policy: targeted industry-départements were in decline in productivity terms but maintained employment both because employment increased at the firm level and because less firms disappeared. Contrary to the official statements, the objective and may be the impact of the LPS policy was employment and not productivity.

5 Conclusion

Our results on the first cluster policy implemented in France are not very positive. First, the policy targeted firms in regions and sectors that were experiencing difficult times in terms of productivity and therefore competitiveness. This was not its official objective and we can interpret the gap between the stated and revealed objectives results in political economy terms. The administration in charge of the policy, the DIACT, formerly the DATAR, was created to promote territorial equity and to help lagging regions. It appears that it was not able or willing to change in practice and our results point to bureaucratic continuity. Another possible interpretation of the gap between stated and revealed objectives is that the policy was captured by firms. Second, the policy did not succeed in reversing the relative decline in productivity for the targeted firms. We can only detect a very weak and transitory positive effect for single-plant firms. Third, the policy had a positive, even though modest and transitory, effect on the employment of firms involved in the LPS policy. This result is consistent with a political economy interpretation of our results: the revealed objective of the policy was to protect the employment of big firms (LPS firms are larger than average) in declining regions and sectors. Can we say good things about this policy? One could argue that this policy may have had no effect on firm level productivity but at least was not very costly. This low price tag does not apply to a more recent and ambitious cluster policy implemented in France, called competitiveness clusters, which cost 1,5 billion euros.

To our knowledge, our study is the first to analyze empirically, with firm level data, the impact of a cluster policy. It points to the apparent failure of the LPS policy to improve the performance of targeted firms through better cooperation and to increase the attractiveness of existing clusters. Obviously, our results cannot be generalized to other cluster policies which may have performed better. However, we interpret it as a cautionary tale for policy makers intending to commit large amounts of public money to such policies.

References

Alvarez, R., and H. Görg (2007): "Multinationals and Plant Exit: Evidence from Chile," *Review of Economic Studies*, International Review of Economics and Finance.

Baldwin, R. E., and F. Robert-Nicoud (2007): "Entry and Asymmetric Lobbying: Why Governments Pick Losers," *Journal of the European Economic Association*, 5(5), 1064–1093.

Beason, R., and D. E. Weinstein (1996): "Growth, Economies of Scale, and Targeting in Japan (1955-1990)," *The Review of Economics and Statistics*, 78(2), 286–95.

Bertrand, M., E. Duflo, and S. Mullainathan (2004): "How Much Should We Trust Differences-in-Differences Estimates?," *The Quarterly Journal of Economics*, 119(1), 249–275.

Branstetter, L. G., and M. Sakakibara (2002): "When Do Research Consortia Work Well and Why? Evidence From Japanese Panel Data," *American Economic Review*, 92(1), 143–159.

Corden, M. (1974): *Trade Policy and economic Welfare*. Oxford University Press, Oxford.

Criscuolo, C., R. Matin, H. Overman, and J. Van Reenen (2007): "The effect of industrial policy on corporate performance: Evidence from Panel data," Discussion paper.

Crozet, M., T. Mayer, and J.-L. Mucchielli (2004): "How do firms agglomerate? A study of FDI in France," *Regional Science and Urban Economics*, 34(1), 27–54.

Devereux, M. P., R. Griffith, and H. Simpson (2007): "Firm location decisions, regional grants and agglomeration externalities," *Journal of Public Economics*, 91(3-4), 413–435.

Girma, S., H. Görg, E. Strobl, and F. Walsh (2007): "Creating Jobs Through Public Subsidies: An Empirical Analysis," IZA Discussion Papers 3168, Institute for the Study of Labor (IZA).

Griliches, Z., and J. Mairesse (1995): "Production functions: the search for identification," NBER Working paper No. 5067.

Head, C. K., J. C. Ries, and D. L. Swenson (1999): "Attracting foreign manufacturing: Investment promotion and agglomeration," *Regional Science and Urban Economics*, 29(2), 197–218.

Krueger, A. (1990): "Asymmetries in policy between exportables and import-competing goods," in *The political economy of international trade*, ed. by R. Jones, and A. Krueger. Basil Blackwell.

Levinsohn, J., and A. Petrin (2003): "Estimating Production Functions Using Inputs to Control for Unobservables," *Review of Economic Studies*, 70(2), 317–342.

Martin, P., T. Mayer, and F. Mayneris (2008): "Spatial Concentration and Firm-Level Productivity in France," CEPR Discussion Papers 6858, C.E.P.R. Discussion Papers.

Olley, S. G., and A. Pakes (1996): "The dynamics of productivity in the telecommunications equipment industry," *Econometrica*, 64(6), 1263–1297.

Petrin, A., B. P. Poi, and J. Levinsohn (2004): "Production function estimation in Stata using inputs to control for unobservables," *Stata Journal*, 4(2), 113–123.

APPENDIX

Table 20: LPS determinants-GMM TFP

	Dependent Variable: lps_status			
Model :	(1)	(2)	(3)	(4)
Mean (ln Employees$_{iszt}$)	0.175^b	0.176^b	0.272^a	0.273^a
	(0.071)	(0.070)	(0.074)	(0.078)
Mean (GMM TFP$_{iszt}$)	-0.133	0.004	0.362^b	0.312^c
	(0.176)	(0.153)	(0.168)	(0.182)
Mean (ln Subsidies$_{iszt}$)	0.073^a	0.067^a	0.053^a	0.052^a
	(0.016)	(0.016)	(0.017)	(0.017)
Mean [ln (Employees$_{szt}$ $-$ Employees$_{iszt}$ $+ 1$)]	-0.022	-0.014	0.212^b	0.169^c
	(0.023)	(0.030)	(0.094)	(0.088)
ln Mean (Taxable net income$_{z1994}$)				4.447^b
				(1.869)
ln Population density$_{z1994}$				-0.328^c
				(0.191)
ln Industrial jobs share$_{z1994}$				1.775^a
				(0.420)
ln Number of people with a CAP or a BEP$_{z1990}$				-2.718^c
				(1.478)
ln Mean (Taxable net income growth rate$_{z1984-1994}$)				-2.606^a
				(0.967)
Industry fixed effects	no	yes	yes	yes
Département fixed effects	no	no	yes	yes
N	18196	18196	18196	18196
R^2	0.014	0.053	0.19	0.215

Note: Robust standard errors in parentheses ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. All regressions are clustered at the emloyment area level. Necessarily, t $\leq$ lps_year

Table 21: LPS and regional policies

	LPS firm	PAT in the dép.$_{2000-2006}$	Share of subsidized emp. in the dép.$_{2006}$
LPS firm	1		
PAT in the dép.$_{2000-2006}$	0.0436^a	1	
Share of subsidized employment in the dép.$_{2006}$	0.0255^a	0.5215^a	1

Note: Standard errors in parentheses ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels.

Table 22: Summary statistics about single plant firms

	LPS firms			Non LPS firms		
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Value added	1837	3430.65	7931.83	102338	2830.81	7149.24
Employees	1837	86.90	185.10	102338	68.21	131.19
Capital Stock	1837	5839.06	33721.62	102338	3257.03	16707.36
Labour productivity	1837	38.18	15.46	102338	39.88	18.34

Note: Value added, capital, capital intensity, labour productivity and exports are expressed in thousands of real euros

The estimation of TFP

To calculate firms' TFP, we estimate a production function. We use a Cobb-Douglas framework and we suppose that the value-added of firm i at time t, Y_{it}, is:

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{\beta} \tag{7}$$

where K_{it} and L_{it} are respectively the capital and the employees of the firm.
After a log-transformation, the model we will estimate is:

$$y_{it} = \alpha k_{it} + \beta l_{it} + \epsilon_{it} \tag{8}$$

The estimation of such a production function is not trivial. Indeed, some unobserved characteristics can both affect the amount of inputs and the level of output. If the entrepreneur is less risk-averse than the others, he might tend to adopt a particular labor-capital mix, he might have different innovation strategies and also might tend to seek less risky (and potentially less lucrative) markets. On the other hand, if the entrepreneur faces a positive productivity shock, he might produce more and hire more people in the same time. Here again, the estimates of inputs-elasticities may be spurious.

An important literature has developed about the estimation of production functions. We built on Griliches and Mairesse (1995), Olley and Pakes (1996) and Petrin, Poi, and Levinsohn (2004) to calculate three estimates of inputs elasticities. For the GMM estimation, we first-difference all the variables and we instrument inputs by their level at time $t-2$. It yields reasonable coefficients, with slightly increasing returns to scale (0.86 for labour and 0.21 for capital). The Levinsohn-Petrin (LP) method, on the contrary, exhibits a decreasing returns to scale production function, with rather credible coefficients (0.70 for labour and 0.15 for capital). With the Olley-Pakes approach, we obtain abnormally low coefficient on capital (0.76 for labour and 0.04 for capital).

We retain consequently the GMM. We calculate firms' TFP as the residuals of value added, once labour and capital have been taken into account and we use that TFP index as a dependent variable to measure the impact of the LPS policy on firms' productivity. Results are very similar to those obtained with a simple OLS TFP index.

Table 23: LPS and GMM TFP

Model :	Dependent Variable: TFP				
	(1)	(2)	(3)	(4)	(5)
LPS firm	-0.035^c	-0.024	0.008	0.008	
	(0.018)	(0.016)	(0.017)	(0.015)	
Being in a LPS	-0.077^a	-0.056^a	-0.066^a	-0.051^a	-0.025^b
	(0.016)	(0.015)	(0.015)	(0.015)	(0.012)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	149300	149300	149300	149300	149300
R^2	0.02	0.16	0.11	0.21	0.01

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 24: LPS and GMM TFP-Single plant firms

Model :	Dependent Variable: ln TFP				
	(1)	(2)	(3)	(4)	(5)
LPS firm	-0.045^b	-0.041^b	0.011	-0.000	
	(0.020)	(0.018)	(0.019)	(0.018)	
Being in a LPS	-0.051^a	-0.030	-0.038^b	-0.023	-0.012
	(0.019)	(0.019)	(0.018)	(0.019)	(0.014)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	104175	104175	104175	104175	104175
R^2	0.02	0.17	0.14	0.23	0.01

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 25: LPS and GMM TFP

Model :	Dependent Variable: TFP				
	(1)	(2)	(3)	(4)	(5)
LPS firm	-0.035^c	-0.028^b	0.009	0.004	0.001
	(0.018)	(0.011)	(0.011)	(0.010)	(0.011)
Being in a LPS	-0.077^a	-0.050^a	-0.067^a	-0.045^a	-0.044^a
	(0.016)	(0.014)	(0.016)	(0.014)	(0.016)
Year fixed effects	yes	n.a	n.a	n.a	n.a
Industry-time fixed effects	no	yes	no	yes	no
Département-time fixed effects	no	no	yes	no	no
Département fixed effects	no	no	no	yes	no
Industry-Département-time fixed effects	no	no	no	no	yes
N	149300	149300	149300	149300	149300
R^2	0.02	0.00	0.00	0.06	0.00

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 26: LPS and GMM TFP-Single plant firms

Model :	Dependent Variable: TFP (1)	(2)	(3)	(4)	(5)
LPS firm	-0.045^b	-0.044^a	0.008	-0.003	-0.015
	(0.020)	(0.012)	(0.013)	(0.012)	(0.014)
Being in a LPS	-0.051^a	-0.025	-0.033^b	-0.018	0.001
	(0.019)	(0.016)	(0.017)	(0.016)	(0.019)
Year fixed effects	yes	n.a	n.a	n.a	n.a
Industry-time fixed effects	no	yes	no	yes	no
Département-time fixed effects	no	no	yes	no	no
Département fixed effects	no	no	no	yes	no
Industry-Département-time fixed effects	no	no	no	no	yes
N	104175	104175	104175	104175	104175
R^2	0.02	0.00	0.00	0.07	0.00

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 27: LPS and GMM TFP-Matching

Model :	Dependent Variable: TFP (1)	(2)	(3)	(4)	(5)
LPS firm	-0.017	-0.033^c	-0.002	-0.016	
	(0.022)	(0.018)	(0.020)	(0.018)	
Being in a LPS	-0.072^a	-0.046^a	-0.052^a	-0.037^b	-0.003
	(0.019)	(0.017)	(0.017)	(0.017)	(0.014)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
Observations	57337	57337	57337	57337	57337
R^2	0.02	0.15	0.10	0.19	0.01

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 28: LPS and GMM TFP-Single plant firms, matching

Model :	Dependent Variable: TFP (1)	(2)	(3)	(4)	(5)
LPS firm	-0.031	-0.055^a	-0.010	-0.031	
	(0.024)	(0.020)	(0.021)	(0.020)	
Being in a LPS	-0.045^b	-0.014	-0.027	-0.010	0.014
	(0.021)	(0.020)	(0.020)	(0.020)	(0.015)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
Observations	40506	40506	40506	40506	40506
R^2	0.02	0.15	0.10	0.20	0.01

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

The estimation of labour demand

Firm-level labour demand functions are usually estimated in the literature by using a dynamic model. Following Girma, Görg, Strobl, and Walsh (2007), we estimate the following log-linearized empirical model:

$$l_{it} = \alpha l_{it-1} + \beta y_{it} + \beta w_{it} + \epsilon_{it} \tag{9}$$

where l_{it} is labour demand, y_{it} is value added and w_{it} is the average wage of firm i at time t. We consider that firms are price-taker for wages, which seems to be a reasonable assumption given the low degree of variability of average wage across firms (in logarithm, mean(average_wage)=3.06 and sd(average_wage)=0.28[11]. For symmetric reasons to those mentioned about the estimation of production functions, and for technical aspects of the estimation of dynamic models, l_{it-1} and y_{it} are endogenous. Here again, we consequently use a GMM approach on first-differenced variables instrumented by their level at time $t-2$. All the coefficients have the expected sign (the current number of employees in a firm is positively affected by past level of employment and by current level of activity and negatively affected by current average wage) and the results are coherent with the literature.

We calculate the residuals of that regression and we use them to assess the impact of the LPS policy on firms' employment, once "core" determinants of employment have been taken into account.

Table 29: Labour demand

	Dependent Variable: ln Employees$_{it}$
Model :	(1)
ln Employees$_{it-1}$	0.555^b
	(0.016)
ln Value added$_{it}$	0.187^b
	(0.027)
ln average wage$_{it}$	-0.406^b
	(0.03)
N	91547
Centered R^2	0.06
Sargan-Hansen p-value	0.88

Note: Standard errors in parentheses ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are clustered at firm level.

[11]Treating average wage as endogenous yields a positive and significant coefficient, which seems rather improbable.

Table 30: LPS and firms' residual labour demand

	Dependent Variable: ln Res_Employees$_{it}$				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	0.065^{a}	0.051^{a}	0.070^{a}	0.056^{a}	
	(0.018)	(0.017)	(0.018)	(0.017)	
Being in a LPS	0.002	0.013	0.009	0.015	0.011^{b}
	(0.012)	(0.012)	(0.012)	(0.012)	(0.005)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	116134	116134	116134	116134	116134
R^2	0.01	0.12	0.06	0.15	0.02

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 31: LPS and single plant firms' residual labour demand

	Dependent Variable: ln Res_Employees$_{it}$				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	0.023	0.011	0.023	0.009	
	(0.015)	(0.014)	(0.015)	(0.014)	
Being in a LPS	-0.006	0.005	-0.001	0.007	0.005
	(0.014)	(0.013)	(0.013)	(0.013)	(0.006)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	80766	80766	80766	80766	80766
R^2	0.01	0.09	0.03	0.11	0.03

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 32: LPS and firms' residual labour demand-Matching

	Dependent Variable: ln Res_Employees$_{it}$				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	-0.000	-0.003	0.025	0.031^{c}	
	(0.018)	(0.018)	(0.018)	(0.018)	
Being in a LPS	0.003	0.012	0.016	0.015	0.003
	(0.013)	(0.013)	(0.012)	(0.012)	(0.006)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	45503	45503	45503	45503	45503
R^2	0.01	0.14	0.13	0.22	0.02

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.

Table 33: LPS and single plant firms' residual labour demand-Matching

	Dependent Variable: ln Res_Employees$_{it}$				
Model :	(1)	(2)	(3)	(4)	(5)
LPS firm	-0.002	-0.011	0.012	0.009	
	(0.016)	(0.016)	(0.016)	(0.016)	
Being in a LPS	-0.016	-0.002	-0.007	0.000	-0.005
	(0.013)	(0.013)	(0.013)	(0.013)	(0.006)
Year fixed effects	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	no	yes	no
Département fixed effects	no	no	yes	yes	no
Individual fixed effects	no	no	no	no	yes
N	32019	32019	32019	32019	32019
R^2	0.01	0.11	0.07	0.15	0.03

Note: Standard errors in parentheses. ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels. Standard errors are corrected to take into account individual autocorrelation.