Can Firm Subsidies Spread Growth?*

Elodie Andrieu† John Morrow‡

September 2, 2024

Abstract How do firms diffuse resources and do they spillover outside headquarter intensive areas? We show R&D subsidies induce French firms to hire new workers, often in new establishments and commuting zones. Using subsidy induced labor demand shocks and past employment patterns, we estimate a within industry spillover elasticity of .26 to non-subsidy firms, rising to .35 for openings outside of headquarter areas. Spillovers are also significant across firm branches and for firms. While subsidies are nominally awarded to headquarters, firms expand to distribute spillovers more broadly.

Key Words: Multi-establishment Firms; Subsidies; Directed Growth; Spillovers.

JEL Codes: D22, F15, H25, L23, L25, O31.

*We are particularly grateful to Banu Demir, Fabrizio Leone, Javier Miranda, Max Nathan, Ariell Reshef, Seyhun Sakalli, Michel Serafinelli and Farid Toubal for insightful discussions, as well as Kiril Borusyak for econometric wisdom. The paper has also benefited from discussions and comments from numerous seminar participants at KCL-Collège de France Junior Research Day, King's College London (SICKCL Workshop, lunch seminar and symposiums), Queen Mary University, City University, OECD, EU-SPRI Annual Conference, ETSG, Economics of Global Interaction (Bari), CMA-Durham Workshop, CUNY Queens, Shaping Globalization Workshop, Conference AFSE EPP, Geographical Inequalities Sheffield, IWH (Halle), FIW, INSEAD, Brunel University, Freie University, PSE Lunch Seminar STEP, LSE Spatial Disparities RPN Workshop and DIEW 2024.

†Paris School of Economics. Web: https://elodieandrieu.github.io.

‡Queen Mary University of London. Web: https://jmorrow.net

1 Introduction

Well-designed policies can both provide and diffuse resources, potentially generating positive returns and spillovers. Using subsidies, governments often increase firms' incentives to pursue activities such as R&D by direct support or tax incentives. Multi-establishment (ME) firms, nearly half of whom are also multi-location, disproportionately receive R&D subsidies in France. These subsidies need not only be deployed in Headquarters (HQs) as information and know-how spread quickly throughout a firm, and firms may deploy assets tactically to develop and adapt innovations across establishments. In addition, firms may receive spillovers from nearby establishments and generate spillovers themselves. For these reasons, subsidies alter the structure of production *within* firms. In turn, local spillovers influence growth across firm branches.

In 1983, in response to low investment and high unemployment in the face of increasing pressures of globalization, the French government instituted the Crédit d'Impôt Recherche (CIR), a large R&D subsidy program to increase competitiveness and crowd in investment.[1] Recent policies designed to on-shore economic activity, innovation and employment such as the US CHIPS and European Chips acts show signs of crowding in domestic investment, but how these policies will diffuse resources and growth is unknown. The CIR provides similar incentives to a broad base of firms and serves as a laboratory to examine policy effects, such as patenting or intangible asset growth. Over 40 years later we ask a different question: do subsidies spread spillovers through firm branches, and how strong are they, especially in openings outside the HQ? To illustrate, Figure 1 shows Bordes, an area in the South West of France, an area with few HQs but where we will predict high levels of subsidy hiring. The left panel shows Bordes in 2005 with few industrial developments and residential areas, while the right panel shows Bordes in 2021 with both visibly increased.

[1] In the words of Prime Minister Pierre Mauroy, the objective was "to dominate progress, to dominate the machine."

Figure 1: Bordes Commune in Southwestern France

(a) 2005

(b) 2021

Notes: Maps of the commune Bordes, in the Pyrénées-Atlantiques department in southwestern France for 2005 and 2021. Sources: Institut national de l'information géographique et forestière (https://remonterletemps.ign.fr/).

We start by comparing employment spillovers from subsidized firms to non-subsidized firms either from employment or employment in openings outside the HQ Commuting Zone (CZ). Columns 1 and 2 of Table 1 do just this, controlling for industry time and local time trends. Columns 3 and 4 add non-subsidized opening employment as a control for CZ-industry-time factors. Column 3 shows that subsidized firm employment spillovers are positive but insignificantly different from spillovers at the CZ-Industry level. Column 4 shows that spillovers from employment in subsidized openings are even smaller.This suggests that spillovers and consequently, growth from R&D subsidies is no different to ordinary growth. This contradicts the literature on knowledge flows (e.g. Bloom et al. (2013)) and spillovers (e.g. Greenstone et al. (2010)) and presents a puzzle as to why spillovers appear the same or weaker in R&D intensive firms. Furthermore, the estimates of Table 1 are low compared to the review in What Works Centre for Local Economic Growth (2019), and particularly low compared to the most relevant studies (Greenstone et al., 2010; Moretti and Thulin, 2013; Van Dijk, 2017).

Our strategy to resolve this apparent contradiction is to develop a labor demand instrument for hiring due to the subsidy.[2] Motivating this is the observation that establishment

[2] An ideal setting to trace the impact of R&D subsidies would be data tracing expenditure by line item and location to see how new resources are directly used. However, even data this detailed is not perfect since once resources are allocated to a firm, they are fungible within the organization and subsidy expenses might be attributed to expenditure that would have occurred anyway. De Souza (2023) finds evidence of increased hiring of scientists from Brazilian R&D subsidies, but also evidence that scientists previous

Table 1: Employment Spillovers from Subsidized and Non-Subsidized Employment

	Incumbent Employment by Industry-CZ			
	(1)	(2)	(3)	(4)
Overall Employment	0.1984***		0.1674***	
(Subsidized Firms)	(0.0052)		(0.0055)	
Opening Employment		0.0803***		0.0600***
(Subsidized Firms)		(0.0063)		(0.0060)
Opening Employment			0.1484***	0.2019***
(Non-Subsidized Firms)			(0.0066)	(0.0114)
CZ × Year	Yes	Yes	Yes	Yes
Industry × Year	Yes	Yes	Yes	Yes
Observations	27,995	9,504	18,835	8,139
R^2	0.7680	0.8621	0.8370	0.8886

Notes: Robust standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

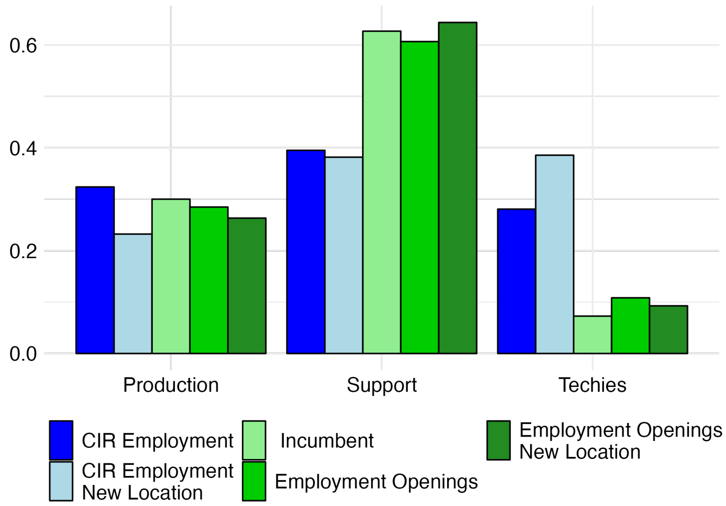
openings reveal changes in firm structure from the CIR subsidy. While the distribution of occupations in non-CIR firms' new and incumbent establishments are similar, CIR firms are tilted towards techies and CIR firm openings even more strongly, as depicted in Figure 2. Such openings are likely in locations to capture and spread spillovers given their 'techie intensity' which other studies have found imperative for R&D activities.[3] Therefore estimating spillovers ignoring establishment churn could underestimate effects in HQ dense areas and completely miss effects in others.

In light of these facts, we develop a labor demand instrument for subsidy hiring. As firms receive CIR subsidies as a percentage of costs, these function as labor demand shifts which we estimate at the firm level to reflect the occupation composition of Figure 2 and aggregate to industry level demand shifts. How these labor demand shocks are distributed follow persistent concentration patterns and can be mapped with past industry employment shares across CZs. This labor demand instrumentation strategy is akin to instruments predicting labor supply locations (e.g. Card (2001)) but on the demand side of the market by 'distributing' industry demand shocks across firm branches. To predict

employment was from another occupation. Lacking that information, we appeal to employer-employee match data that allows us to follow resource allocation via worker hiring.

[3]See for instance Harrigan et al. (2021). Furthermore, multi-establishment, multi-region firms may disperse growth in commuting zones outside their HQ giving a more nuanced view of prevailing understandings of how spillovers are transmitted (Griliches (1992)), such as within the boundaries of the firm across international markets (Bilir and Morales (2020)).

Figure 2: Occupational Hiring: Incumbents vs Openings vs CIR Subsidy Openings



Notes: Descriptives for 2011.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Overall Employment, we use historical employment shares from firm branch data. For Opening Employment, openings for subsidized firms are outside of the HQ CZ 65% of the time, so we use shares outside of each firm's HQ CZ.

To estimate labor demand shifts from subsidies, we estimate employment elasticities using a Firm-CZ shift-share instrument. Within the firm, specialized activities are strategically located, implying endogenous employment shares across CZs as in the framework of Borusyak et al. (2021). Identification stems from the importance of firm branch locations (Firm-CZ shares) and exposure to regional R&D subsidy awards outside the firm's industry (Firm-CZ shifts). Our implicit mechanism is that innovation shifts propagate quickly within the boundaries of the firm, akin to studies showing that shifts propagate across establishments within firm boundaries (Giroud and Mueller (2019); Giroud et al. (2021)). This approach allows inclusion of controls for both firms and local trends in advancing or declining areas, allowing us to focus on the local intra-industry impacts of the subsidy.

Subsidies increase firm employment: A 100 percent increase in the cumulative subsidy increases employment by .88% and techie employment by 2.3%.[4],[5] Our estimates also

[4]See Dortet-Bernadet and Sicsic (2017) for highly qualified workers in SMEs, Bunel et al. (2019) for technicians in SMEs (studying the French CII), Duhautois et al. (2022) for the Community Innovation Survey (CIS), and Salies (2021) for a review of the impact on R&D workers only.

[5]We estimate the effects of cumulative subsidy due to lagged effects and the persistence of receiving it (in 2011, 87% of ME firms also got it in 2012) and in amount, i.e. 54% of firms getting the subsidy in 2011 and 2012 got a higher amount in 2012.

show that subsidies help firms to expand geographically through new techie intensive establishments and to new CZs. In fact, new establishments exhibit a stronger hiring response to the subsidy than continual establishments, and we find little evidence of within firm worker reallocation, suggesting these new establishments are tactical and activity specific. Finally, we use these estimates to predict the employment shifts hired by each industry due to the subsidy.

We combine estimated industry employment shifts with past employment CZ shares of industries to produce instruments for Overall Employment and Opening Employment, the latter better capturing new, R&D targeted resources. Re-estimating Table 1 with this strategy reveals spillover effects from subsidized firm employment to be larger than non-subsidized Opening Employment, with subsidized opening employment spillovers the strongest as suggested by Figure 2. Quantitatively, our estimates are comparable to the (opposite) effect of mass layoffs found by Gathmann et al. (2020). *Within* the firm, we estimate the impact of spillovers to non-subsided firm branches, finding significant but weaker effects, which persist for subsidy spillovers at the firm level. Taken together, our results show an interconnected story of firm growth from both subsidies and knock on effects from spillovers to other firms and across firm branches. Firm subsidies can spread growth outside of HQ intensive areas.

This section continues with a literature review, while Section 2 describes the data, CIR policy and ME firm structure facts. Section 3 estimates the impact of the subsidy on ME firm growth patterns. Section 4 uses these industry shifts with historical shares to estimate spillovers from Overall Employment and Opening Employment. Section 5 concludes.

Related Literature

Firms contribute substantially to the development of economies through trade and foreign direct investment, but less is known about domestic resource diffusion. Establishment level data has revealed spatial and organizational aspects of firms, differentiating firms from establishments. Jiang (2021) explains spatial expansion with the decreasing costs of ICT and investment, while Cao et al. (2019) document US firms' growth through the establishment margin, particularly for large firms. Kleinman (2022) studies the increasing trend of multi-region firms and how this contributes to spatial wage inequalities, as headquarters get more skilled as firm size increases. Gumpert et al. (2021) study managerial organization, exploiting the fact that local economic conditions propagate within the firm. Resource diffusion can be driven by policy (Devereux et al., 2007; van der List, 2024) and that R&D credits can increase growth oriented entrepreneurship (Fazio et al., 2019). We contribute to this literature by following policy effects through ME firm structure to understand how firm branches drive local development.

We also shed light on the structure of activity within firms. Studies show that geographic frictions between the headquarters and establishments have a negative impact on firm performance (Giroud (2013)) as well as in multinational firms (Kalnins and Lafontaine (2013)). Some known mechanisms are at play, such as managerial frictions (Gumpert et al., 2021), knowledge transfer costs (Keller and Yeaple, 2013).Our finding of the key role of techies in new, tactical establishments in response to subsidies is in line with the 'inventors as antennas' theory of Giroud et al. (2024). In fact, replacing employee shares with techie shares in our shift-share IV design yields similar results, albeit on a reduced sample.

We also examine spillovers outside headquarter areas that promote knowledge diffusion. Giroud et al. (2021) confirms the distances between firms matter for spillovers but not within firms.[6] From the multi-establishment perspective, proximity can be both geographic through co-located branches in addition to technological as in Jaffe (1986) or Bloom et al. (2013), or through text analysis as in Myers and Lanahan (2022). Other examples include export spillovers (Koenig et al. (2010), Tian and Yu (2022)), where the knowledge of nearby exporters reduces costs, or shifts, where impacted employment can affect economically close but non-impacted industries (Helm (2020)), knowledge spillovers from openings (Fons-Rosen et al. (2017)), or through subsidies upstream as in Navarra (2023) and Atalay et al. (2023) through production networks. Moretti (2010) highlights the effect of job creation from new manufacturing jobs to non-tradable jobs. As we find skill biases in hiring, this aligns with the importance Akcigit et al. (2020) place on combined R&D subsidies and higher education policy for economic growth, akin to Ioramashvili (2024) who emphasizes vocational training to capture employment spillovers from patenting.

[6] Knowledge sharing has been studied across and within firms and Giroud et al. (2021) show that spillovers between plants but of different firms decrease rapidly with geographical distance, but no distance effect within the boundaries of the firm. Moreover, we find a stronger hiring response for techies in line with literature supporting their (Duranton and Puga (2004); Vernon Henderson (2007)).

Finally, we contribute to a growing literature using the shift-share IV design of Borusyak et al. (2021). To evaluate the causal effect of the subsidy, we use a differential exposure design similar to shift-share IVs.[7] To construct the share component, we use establishment level occupational share data and CZ shifts, a novel instrument for firms.

The next section details the data used, CIR subsidy policy and statistics about its implementation.

2 Data and Policy Description

In this section, we describe the data, sample used, and key variables built using different databases at the firm and establishment level, as well as the Crédit d'Impôt Recherche (CIR) in France, its economic context, and descriptives about the reach of the policy.

Firm level

We use firm financial accounts from the FARE which provides annual information for financial indicators (total revenues, EBITDA, total debt, balance sheet, value added and investment ratio) and R&D investments. The R&D information are standard outcome variables used in the literature on R&D subsidies.[8] We complement this dataset with the firm DADS database using the a unique identifier (SIREN) for information on location and industry. We supplement this with GECIR data that lists all successful applications to the Crédit D'Impôt Recherche (CIR) subsidy, containing the amount granted each year with a coarse decomposition and information on the subsidy payment method (cash transfer, tax credit).

We identify Business Groups (BG) using the French annual survey on Financial Linkages (LIFI for Liaisons Financières) which identifies the head of group operating in France, business structure, and financial relations of firms to the head. Firms surveyed have at least one of the following criterion: more than 500 employees, at least 1.2 million euros of portfolio participation in firms, a turnover above 60 millions of euros, head of group or being directly controlled (owned above 50%) by a foreign enterprise in the previous year.

[7] This design has been used to study local labor market responses to the China import shock (Autor et al. (2013), revisited in Borusyak et al. (2021)), mergers (Cowgill et al. (2021)), the fall in the cost of investments on firm level outcomes (Aghion (2022)).

[8] This is not the focus of the paper but we use them to validate our methodology in the Appendix.

Only the administrative headquarter (*siège social*) is interviewed.

Establishment level

A key data source is the "Déclaration annuelle de données sociales" or DADS (Annual Declaration of Social Data) Establishment database, covering all business establishments in France with at least one employee from 2009 to 2014. For each establishment in the DADS we observe its unique identifier (SIRET) and the firm identifier to which it is attached.[9] The DADS also contain detailed information on the composition of its workforce using occupation codes, wages, number of hours worked and location from which we know the postcode and commuting zone.

The sample

The sample used in most of the analysis is a balanced sample of multi-establishment firms where we can identify a firm's headquarters in each year which does not change.[10] ME firms are not equally represented in industries. Based on the HQ industry, a roughly stable 43% of ME firms are in the Wholesale and Retail Trade sector, 17% in the Scientific and Technical Activities sector and 15% in the Manufacturing sector (Table 5). In most cases, ME firms report as single industry.

2.1 Variables

Geography

We define a local labour market using the approximately 300 metropolitan Zone d'Emploi definition which we refer to as commuting zones (CZ).[11] The French Office for National Statistics (INSEE) construct them where most people reside and work in one area.

Headquarters

Administrative headquarters are called the *siège social* of firms, which is the tax address, typically the largest establishment where most top level decisions are taken. In the DADS

[9] Identifiers are reported at the statistical office (INSEE). SIRET establishment identifiers have two components: SIREN (firm identifier) and the NIC (internal classification number).

[10] We consider firms with at least two establishments at some point over the period with consistent headquarters.

[11] French Office for National Statistics (INSEE) definition: https://www.insee.fr/fr/information/4652957#:~:text=Une%20zone%20d'emploi%20est,pour%20occuper%20les%20emplois%20offerts.

Entreprises data file we are able to identify the HQ establishment using the NIC of the *siège social* variable. Firms with a single establishment are given the HQ label. Headquarters are often the largest establishment, consisting of 58% of the wage bill on average in 2012 for ME firms, and this share is consistent over time.

Occupation categories

We use labour categories in establishments which we define following the work by Charnoz et al. (2018) and defined in Table 2. They classify the French official occupation codes (*Professions et Catégories Socioprofessionnelles (PCS)*), into production and support activities by skill (low, middle and high). We add a technology-related occupation (*"techie"*) following the definition by Harrigan et al. (2021) (see also Bunel et al. (2019)), as "closely related to the installation, management, maintenance, and support of ICT, as well as product and process design and longer-term R&D activities". They show that techie workers are a good measure for technology adoption within French firms.

Table 2: Occupation Classifications

Skill Level	Occupation	Label
	Main Category 1: Jobs in Support Activities	
Low	Office Workers, Clerks and Sellers	S1
Middle	Mid-Level Administrative Managers, Mid-Level Professionals	S2
High	Heads of Businesses, Top Managers and Professionals	S3
	Main Category 2: Jobs in Production Activities	
Low	Industrial, Manual Workers, Drivers, Skilled Transport, Wholesale	P1
Middle	Supervisors and Foremen	P2
High	Science and Educational Professionals	P3
Middle-High	Technicians, Technical Managers and Engineers	Techies

Notes: The table reports the occupation classification we will use through out the paper. Skill level stands for the different skill categories (low, medium and high). The label of occupation stands for the official French occupation classification (CSP) label. And the last column is the variable label that can be used in some graphs and tables.
Sources: Charnoz et al. (2018) and Harrigan et al. (2021)

2.2 The Crédit d'Impôt Recherche (CIR)

In the EU, billions of euros are spent each year in R&D activities, estimated by the OECD to be 10 to 30% publicly funded. In France, other policies targeting R&D, local areas and subsidies exist, the second largest in expenditure being the Crédit d'Impôt Recherche (CIR), which we describe below. The largest is the CICE, a subsidy for low wage workers which is given unconditionally and other examples include the Prime d'Activité, Pole Competitivité, and Zones Franches Urbaines' (ZFUs). While it's an empirical question how any of these policies might interact with the CIR, given the fixed effects at the Commuting Zone-Time level we will use[12], we are most concerned about the ZFU which might target particular Industry-CZ cells. Mayer et al. (2017) find that ZFUs mainly cause reallocation within CZ suggesting the minimal interaction with the CIR at our level of aggregation.

History of the CIR

Any industrial, commercial or agricultural organization subject to corporate tax in France is eligible for this research tax credit. The Crédit d'Impôt Recherche (CIR) was first introduced in 1983 as a temporary plan to stimulate investment in R&D. The previous financial law in place allowed firms to an exceptional depreciation on their research equipment and tools, but firms had little incentive to increase their investment in human and physical capital towards R&D activities. The CIR regulation is still into place today, and is continually changing. Up to 2006[13], the amount of the claim was computed on the increase in R&D expenditures between the year of its declaration and the previous year (calculated as an increment over past spending) as the US R&D tax credit. From 2008, the CIR increased coverage to the total amount of R&D related expenditure. The rate is 30% of the total amount up to 100 millions euros, and 5% over that amount. Since then, the 2008 reform has made the CIR the main R&D support system for firms in France.[14]

To be part of the scheme, firms need to fill a form enabling the identification of the firm and a breakdown of each different R&D related expenditures, this is the declared amount for reimbursement.[15] In addition, firms are asked to provide a supporting file, often composed of two main documents. First, a summary of each of the projects selected for the calculation of declared expenditure ("technical document"), complying with the conditions of the CIR, meaning R&D projects only. Second, a "financial document" stating all detailed information on how the amounts are used, such as labor costs and associated

[12] For instance, these will absorb non-industry specific spillovers from universities, which Bergeaud and Guillouzouic (2024) provide evidence they are. We therefore include industry-CZ-time opening employment as a control since these types of spillovers should be reflected in activities of non-CIR firms.

[13] In 2000 the CIR was completed with an amount up to 10% of the expenditures on R&D

[14] Timeline of the updates in the policy can be found in Salies (2017), https://spire.sciencespo.fr/hdl:/2441/59b98fs2bu8neb8h5au501rtll/resources/evaluation-cir-ofce-avril-2017-755839.pdf, page 19))

[15] See https://www.impots.gouv.fr/sites/default/files/formulaires/2069-a-sd/2023/2069-a-sd_4244.pdf for an example for the form.

hours, invoices, allocation of time on projects etc.[16] Not only does this take time to be recorded, it is often the case that the information is scattered across different work teams. Given the large fixed cost in filing the application, the tax incentive scheme for private corporate R&D favors large companies, unlike in the United Kingdom, Germany and other developed countries.[17]

The CIR exhibits significant persistence in the likelihood of treatment. 87% of ME firms receiving subsidies in 2011 receive it in 2012, and 60% of ME beneficiaries continually receive it.[18] ME firms also get a similar amount over time, 66% of 2011 recipients claim the the *same* or more in 2012.[19] This persistence allows us to view the subsidy as a recurring investment for firms, allowing for longer term investments such as hiring. Around 6% of ME firms get the subsidy and these firms are significantly bigger (labor, number of establishments and average distance) than non-beneficiary firms, as is common (Criscuolo et al. (2019)), reflecting the high fixed cost of applications more easily amortized by large firms, creating selection. However, 34% of our ME sample beneficiaries have less than 50 employees so it is not exclusively large firms (in 2012).

Related CIR Studies

Some papers have examining the impact of the R&D subsidies include: the unitary cost of R&D, patent demand (Bozio et al. (2019) for France and Dechezleprêtre et al. (2016) for the UK), the number of researchers (Salies, 2017) and productivity. Studies focusing on France have mainly exploited the major reform implemented in 2008, such as Mulkay and Mairesse (2013) and Salies (2017). One exception is Bunel et al. (2019), where they evaluate the 2013 reform, implemented through a different innovation targeting subsidy for Small and Medium-sized Enterprises (SME) only, the Crédit d'Impôt Innovation. Using a DiD design and propensity score matching, they find a positive relationship between the SMEs beneficiaries of the innovation subsidy and their level of employment, balance sheet total, turnover and patent application. Yet, they do not find any significant impact

[16]See https://www.economie.gouv.fr/files/files/directions_services/dgfip/controle_fiscal/prevention/dossier_justificatif_cir.pdf for a help file when completing an application.

[17]It is important to keep in mind that other schemes are available for smaller firms: Credit d'Impôt Innovation (CII), a product-based development subsidy is available for firms with less than 250 workers, with a turnover inferior to 50 million euros. CIFRE is a scheme that financially helps firms to hire PhD students.

[18]Among the 4662 firms having CIR in 2009, 2793 receive it each year from 2009 to 2014.

[19]Relatively same amounts means 90% of amount.

on mean wages and investment. Less explored are the effects of R&D subsidies on the composition of the workforce within firms and industries. Castillo et al. (2014) use a fixed effect model to look at the Argentinian program for promoting innovation within SMEs. They find that the program increased employment and wages within the participant firms. Researchers find mixed conclusions when looking at R&D specific outcomes, often showing that large firms are not creating new R&D activities but reimbursing already on-going projects, whereas smaller firms take the decision to start new R&D. Most of the literature is limited to the analysis of inputs where they compare the R&D returns to the CIR. They tend to conclude that SMEs are more efficient in transforming R&D tax credit into R&D investments or patents. Those findings inform the recommendations in Aghion et al. (2022), who suggest the French tax credit focus on small and medium firms (Howell (2017)). Much less is known on the effect of R&D subsidies on the structure of internal R&D inputs (e.g. workforce composition) and on the structure/organization of firms and the externalities they can create, which is the focus here. Lately, the CIR has faced questions about its efficiency, and a study by Aghion et al. (2022) proposes various updates that would make it closer in structure to other developed countries.

2.2.1 CIR Descriptive statistics

Here we provide statistics on the balanced sample of firms and the ME sample of firms with an emphasis on characteristics that characterize the ME firm sample, including firm coverage, and distribution of the subsidy. Table 3 describes the number of ME firms by year, the average subsidy claimed, and the interquartile range. Firms number around 5000, while the average subsidy varies, reaching a maximum of 698K euros in 2014. Notably, the mean is higher than the 75$^{\text{th}}$ percentile, showing a few firms receive large amounts.

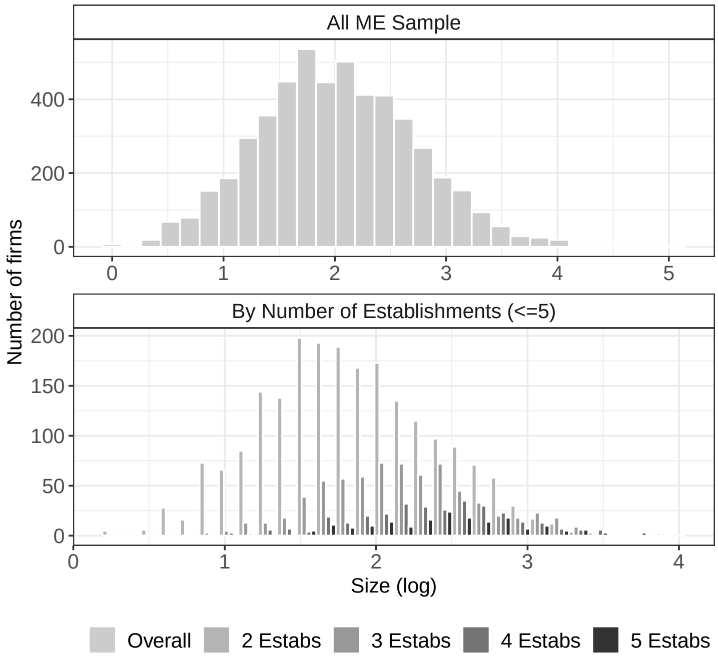
The top panel of Figure 3 depicts the employment size distribution of the ME firm sample who claim the CIR in 2012, showing that ME firms cover a range of sizes, including smaller firms. The bottom Panel breaks this down by the number of establishments, showing each establishment number bin still covers small and large firms. In the 3 establishment sample, 19% of ME firms have 50 or less employees and 47% have 150 employees or more. Comparing those numbers to the full ME sample, 30 percent of firms have 50 or less employees and 40% have more than 150 employees. This size distribution is specific to

Table 3: CIR Claim Distributions (in thousands) and Recipients

Year	Mean	Q1	Q3	ME Recipients
2009	629.9	43.9	287.1	4662
2010	611.3	43.0	268.0	5068
2011	585.2	36.2	250.4	5150
2012	625.4	38.1	265.7	5107
2013	638.4	36.2	273.3	5030
2014	698.3	40.5	308.3	4592

Notes: ME recipients stands for our sample, please note that not all firms have strictly more than 1 establishment per year. Mean is the average CIR award. Q1 and Q3 are the lower and upper quartile. Reported in thousands of euros.
Sources: DGFiP-Mesri, base GECIR ; Insee.

Figure 3: Size Distribution of CIR Recipients



Notes: Top Panel uses the sample of firms with at least 1 establishment in addition to an HQ over the period 2009-2014, i.e. some firms can be single establishment in 2012 and plotted here. Bottom Panel uses subsamples of firms with 2, 3, 4 and 5 establishments.
Sources: DGFiP-Mesri, base GECIR ; Insee, base DADS.

ME firms and reflects the strategic behavior of opening plants not solely driven by worker capacity constraints, as underscored by the establishment choices of relatively small firms.

Table 4 presents the industrial composition of subsidy awards for the balanced sample in columns 1-2 and the ME sample in columns 3-4. For ME firms, three sectors received 90 percent of the total amount of the subsidy: the manufacturing industry accounts for 54%, 24% for the scientific and technical activities and 12% for information and communication, similar to the balanced sample.

Considering the number of beneficiaries, Table 5 shows that the industrial composition

Table 4: Industrial Composition of Subsidies in Billions of Euros: 2012

Samples	Balanced Sample		ME Sample	
Industry label	Amount	Shares	Amount	Shares
Manufacturing	2.29	48.95	1.73	54.06
Scientific and Technical Activities	1.30	27.66	0.77	24.19
Information and Communication	0.69	14.73	0.39	12.37
Wholesale and Retail Trade	0.31	6.61	0.24	7.39
Others	0.10	2.06	0.06	1.99
Total	4.69	100	3.19	100

Notes: The two first columns are based on the balanced sample of firms and the two last columns on ME firms. For each sample, the first column tells us the subsidy amount by industry, the second column is the share. Sources: DGFiP-Mesri, base GECIR ; Insee.

is similar since more than 85% of CIR beneficiaries (ME or full sample) belong to one of these three sectors. Reassuringly, the industrial composition is close in both the balanced sample of firms and the multi-establishment sample.[20] However, ME firms account for 33% of firms (5,105 vs 15,327 in 2012), but a large share of the R&D subsidy bill (3.19 vs 4.69, 67%). The policy concentration of the policy for ME firms has remained rather stable during 2009-2014. The columns "All" in Table 5 compare the industrial composition of the two samples getting the R&D subsidy and the overall samples. First, the industrial composition of the overall balanced sample and the ME sample are very similar. Second, R&D subsidy receivers are over-represented in manufacturing (45%), while nearly half of them (40%) are in wholesale and retail trade for the overall sample.

Table 5: Industrial Composition of Firms by Sample: 2012

	Balanced Sample				Balanced ME			
	CIR		All		CIR		All	
Industry	Total	%	Total	%	Total	%	Total	%
Manufacturing	6849	45	61181	12	2411	47	10246	15
Scientific and Technical	3250	21	80399	16	966	19	11532	17
Information/Communication	2973	19	16640	3	912	18	2901	4
Wholesale and Retail Trade	1447	9	201002	40	546	11	29137	43
Others	808	5	145597	29	270	5	13777	20
Total	15327	100	504819	100	5105	100	67593	100

Notes: The table reports the industry composition of firms receiving the CIR in 2012. The two first columns are based on the balanced sample of firms and the two following columns on ME firms. The 2 last columns on the right are the overall sample of ME firms. Sources: DGFiP-Mesri, base GECIR ; Insee.

Having laid out the data, policy and descriptions of ME firm features, we now turn to estimating the impact of the CIR at the firm level, which will provide industry level employment shifts for spillovers in the last section.

[20] Bunel et al. (2019) show the same three sectors are the most represented in the SME sample.

3 Subsidies and Firm Level Outcomes

This section estimates the effect of firm subsidies on employment and establishment growth. Our estimates show that firms open new establishments and their footprint expands to new CZs, while hiring occupations at different rates with techies being the most responsive. We first define and validate our Firm-CZ shift-share instrument for firm level subsidy awards. We then estimate firm responses and analyze heterogeneous effects.

3.1 Specification and Firm-CZ Shift-Share IV

Our baseline estimation specification is as follows:

$$y_{f,t} = \beta \, \text{Subsidy}_{f,t} + \gamma x_{f,t} + \alpha_f + \alpha_{i,t} + \alpha_{l(f),t} + \epsilon_{f,t} \tag{1}$$

where $y_{f,t}$ is an outcome such as establishment scope or employment. $\text{Subsidy}_{f,t}$ is the cumulative subsidy claimed by the firm and the specification includes an indicator for belonging to a Business Group, $x_{f,t}$ and fixed effects for firm α_f, industry by year $\alpha_{i,t}$ and HQ-CZ by year $\alpha_{l(f),t}$. Since the IV treatment will follow shocks across firm branches which are highly heterogeneous, we have followed a robust error clustering strategy throughout the paper as the 'cell' of treatment is not obvious. Clustering at the HQ CZ-time level to capture the largest component of the treat provides larger errors but broadly similar conclusions.[21]

To address endogeneity, we develop a shift-share instrumental variable (SSIV) design to identify β following Borusyak et al. (2021) with Firm-CZ shifts and shares computed using initial firm employment across commuting zones. The intuition behind the instrument is that we can isolate the amount of subsidy given to firms by analyzing regional level subsidy trends and look for their effects across firms with different levels of shock exposure.

This strategy reflects two main considerations. First, shifts in all areas a firm operates in matter for outcomes as in Giroud and Mueller (2019) and specialized activities like R&D are likely concentrated in establishments strategically located outside of HQs.[22] Second,

[21] Notably, for some results the standard errors of estimates are actually smaller under our IV versus OLS estimates under this strategy. While this is statistically possible in the heteroskedastic (but not homoskedastic) case, it generated critiques. We are happy to cluster at the reader's pleasure.

[22] Among firms headquartered in Paris with at least 30% of its workforce outside of Paris, 75% have a larger share of non-HQ employment in areas with *high* levels of R&D subsidy. We define a Commuting

we wish to control for advancing or declining CZs and this multi-establishment estimation strategy allows controlling for CZ-time effects, unlike specifications using treatments only at the firm HQ location.

Instrument and Specification

The shifts are cumulative subsidy amounts, $\Delta\text{CZ Subsidy}_{l,f,t}$, computed as the increase in the (log) amount of subsidy in commuting zone l in year t since 2009. Because we want shifts that arise from trends exogenous to the firm, we use a "Leave-One-Out" correction for the firm's industry. Therefore $\Delta\text{CZ Subsidy}_{l,f,t}$ is high where innovation is promoted in a CZ outside a firm's industry. Thanks to the equivalence in Borusyak et al. (2021) showing that it is sufficient to have exogeneity only in one of the two components of a shift-share design, we characterize the Leave-One-Out shifts as exogenous, and regard the initial location shares as endogenous to the subsidy.

Each firm f's initial employment share in CZ l in 2009, $s_{f,l,0}$, determines its exposure to shifts.[23] The instrument for cumulative firm subsidies is defined as a shift-share of cumulative shifts $\Delta\text{CZ Subsidy}_{l,f,t}$ and exposure shares $s_{f,l,0}$:

$$\text{BranchExposure}_{f,t} = \sum_{l=1}^{L} \Delta\text{CZ Subsidy}_{l,f,t} \times s_{f,l,0} \tag{2}$$

We use $\text{BranchExposure}_{f,t}$ as an instrument in the following specification:

$$\text{Subsidy}_{f,t} = \beta_1 \text{BranchExposure}_{f,t} + \gamma_1 x_{f,t} + \alpha_f + \alpha_{i,t} + \alpha_{l(f),t} + \epsilon_{1,f,t} \tag{3}$$

$$Y_{f,t} = \beta_2 \widehat{\text{Subsidy}}_{f,t} + \gamma_2 x_{f,t} + \alpha_f + \alpha_{i,t} + \alpha_{l(f),t} + \epsilon_{2,f,t} \tag{4}$$

Equation 3 is the first-stage estimation, with the same set of covariates from our baseline regression.

Zone as a high-R&D subsidy area if its total R&D subsidy amount received in 2009 is above the median.

[23] We use the initial period, as contemporaneous shares might be a result of diffusing resources to high subsidy locations, implying reverse causality. Our shares reflect the idea predicted by Giroud and Mueller (2019) that "establishments of multi-region firms should be less sensitive to (their own) local shifts than single-region firms". In our framework, their prediction translates as multi-location firms are affected by shifts from all regions where the firm operates.

Instrument Validation

Here we confirm the different shift-share IV assumptions as recommended in Assumptions 1 and 2 in Borusyak et al. (2021) to establish SSIV consistency. First, the standard identification assumption needs to hold. Table A2 in the Appendix reports the first-stage regression from Equation 3 with cumulative R&D subsidy amount of firm f in year t as the outcome on our instrument. Our preferred specification is Column (1) and shows that it is strongly predicted by our instrumental variable, with a F-statistic of 22,663. Moreover, in Column (3) we compute the shares $s_{f,l,0}$ using techie employment and Column (4) uses equal shares across CZ where firms operate. Using labour shares works as well as techie shares (Column (2)), but allows us to keep the full sample of firms as not all firms employ techie workers. However, using equal shares turns out be a bad predictor, we can see a significantly smaller coefficient and F-Statistic. Firms that comply with the instrument are firms awarded the subsidy, and whose timing of obtaining the grant are sensitive to regional time-varying waves.

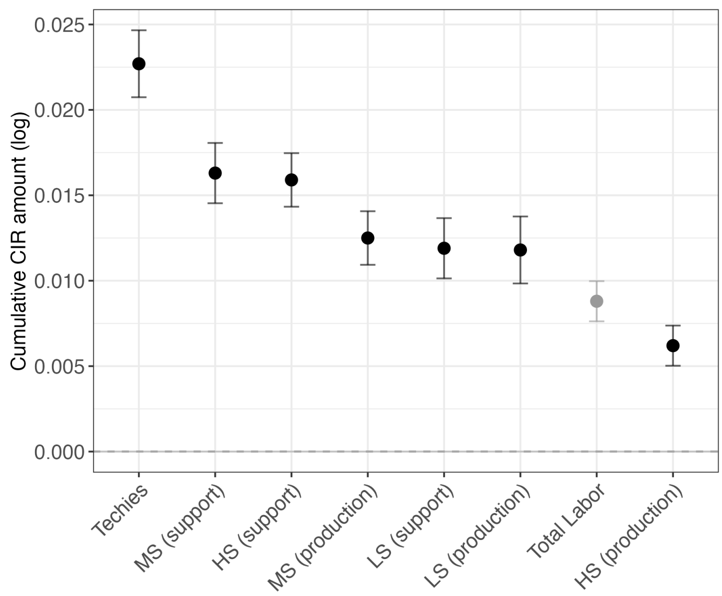
Moreover, we show in the descriptives that firm subsidy levels are persistent overtime, suggesting that the source of variation is plausible. To further test Assumption 1 of Borusyak et al. (2021), we regress the shifts on the shares and results are shown in Table A1. We find a correlation and R^2 close to zero, suggesting no economic relevance. This result implies that firms' location choices do not anticipate regional leave-one-out shifts, or at least not in a meaningful way. Assumption 2, stating that "the number of observed shifts grows with the sample" is met since firms' employment is relatively spread across CZs, and the effective sample size is large. If a few shocks drive our empirical analysis, then our results could be biased. Therefore, we check that the effective number of shocks is large by computing the inverse of the Herfindahl index of shock importance weights $1/\sum_l s_l^2$. Where s_l is the average CZ employment share across firms. We find this is close to 0, implying the effective number of shocks is large.

Additionally, we run a specification to predict lagged intensive and extensive margins outcomes on $\text{BranchExposure}_{f,t}$ including the same set of controls as a pre-trend falsification test in Appendix Table A3. The estimates show no correlation on extensive margin outcomes, alleviating concerns about other shifts correlated with we want to identify. We do find small correlations on intensive margins outcomes, but they are not robust to clustering standard errors at the HQ CZ-time level while our results are, suggesting no pre-trends.[24]

3.2 Occupational Hiring and Subsidies (Spillover Shifts)

Next we estimate firm responses to subsidies through Equations 3 and 4. First, we estimate an intensive margin of occupational hiring that will allow us to aggregate subsidy effects to industry level employment shifts. Second, we explore establishment extensive margin outcomes to understand where this increased employment might be allocated besides overall historical patterns as for Opening Employment spillovers. We find evidence that much of the hiring due to subsidies is in new establishments outside the CZ of a firm's HQ. The intensive margin outcomes are log of cumulative employment for the occupational categories of Table 2. Figure 4 shows that all labor types have a positive elasticity with respect to the subsidy.[25]

Figure 4: Employment Elasticities w.r.t. Subsidies (IV)



Notes: The graph plots the estimated coefficients from the 2SLS specification in Equation 4. Each labour type is a separate regression, where the outcome is the log of cumulative labour and the dot stands for the employment elasticity with 95% confidence intervals. The full table can be found in Table A4 in the Appendix.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Techie employment is the most responsive in line with the R&D targeting of the subsidy. The elasticity estimate is substantively higher than that of production workers, and the results support the idea that Medium/High Skill Support workers are complementary to

[24]We use 2 years because of the timing in the tax credit.

[25]We report the corresponding table (IV and OLS) in Table A4 in the Appendix. For all our results, the OLS estimates are larger consistent with subsidy awards being associated with higher growth firms.

Techies. An increase of the cumulative subsidy of 100% (an additional year receiving the same amount) translates into an increase in techies of 2.3% and in employment of 0.9% (Figure 4). Overall, estimated policy effects suggest that firm labor composition tilts towards R&D activities. In the Appendix (Section A1.0.1), we find similar with a long difference specification, so they are robust to timing considerations.

Furthermore, the IV estimates of Table 6 show that while subsidies increase firm employment, the average establishment size effect is about half, highlighting the importance extensive margin growth.[26] This suggests that a fundamental way that firms expand employment due to subsidies is through hiring in new establishments.

Table 6: Subsidies and Firm Employment (OLS and IV)

	OLS		IV	
	Cumulative Employment (1)	Average Employment (2)	Cumulative Employment (3)	Average Employment (4)
Cumulative Subsidy	0.0102*** (0.0009)	0.0047*** (0.0005)	0.0088*** (0.0006)	0.0046*** (0.0005)
Firm FE	Yes	Yes	Yes	Yes
HQ CZ × Year FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes
Observations	337,965	337,965	337,965	337,965
R^2	0.9940	0.0.9925	0.9940	0.9925

Notes: The table reports results from the OLS specification (Equation 1) in the first 2 columns and the 2SLS specification in the last 2 columns (Equation 4). Outcomes are in log. Columns (1) and (3) are cumulative and Column (2) and (4) are the average employment in establishments. Robust standard-errors in parentheses. All specifications include fixed effects for BG, firm, HQ location by year and industry by year.. Significance codes: ***: 0.01, **: 0.05, *: 0.1. Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Next, we explore the establishment extensive margin by using different measures of firms' expansion and geographic dispersion. Our IV results are presented in Table 7, with corresponding OLS estimates in Table A5 of the Appendix. In Columns (1) and (2) we estimate the impact of the subsidy on the firm's number of establishments and CZs. In columns (3) and (4), we estimate a linear probability model of opened or closed establish-

[26] These results are in line with other studies on the CIR using different identification strategies. Bach et al. (2021) study the 2008 policy reform and find that beneficiary firms increase employment of techies and intangible investments. Our results on investments are available in Section A1.0.1 in the Appendix. Most studies (Salies (2021)) focus on the effect of R&D outcomes, and their results suggest moderate increases in R&D intensity: technicians increase, but not their share or patenting. There is also a size heterogeneity effect (also CNEPI, 2021; CPO, 2022, see Aghion et al. (2022) for a summary).

ments. In Column (5), we estimate a linear probability model of openings with techies and in Column (6) (log) cumulative openings outside the HQ-CZ. In all specifications, we include fixed effects for firm, HQ-CZ-year, Industry-year and business group affiliation.

Table 7: Effect of the R&D subsidy on the extensive margin of firms: IV

	Log Estab. (1)	Log CZ (2)	Opening Dummy (3)	Closing Dummy (4)	Opening Techies (5)	Cum. Open non-HQ CZ (6)
Cumulative Subsidy	0.0042*** (0.0006)	0.0030*** (0.0005)	-0.0004 (0.0008)	-0.0014* (0.0009)	0.0143*** (0.0010)	0.0120*** (0.0013)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
HQ CZ × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337,965	337,965	337,965	270,372	337,965	337,965
R^2	0.9214	0.9465	0.2728	0.3143	0.8042	0.8380

Notes: The table reports the 2SLS results of Equation 4. Each column is a separate regression with outcomes from (1) to (6): log number of establishments, log number of distinct CZ, indicator for new openings, closings, opening with techie, and log cumulative number of openings in CZ different than HQ. Robust standard-errors in parentheses. All specifications include fixed effects for BG, firm, HQ CZ*year and industry*year fixed effects. The CIR variable is the cumulative amount of CIR firms get. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1. Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Initially aimed at fostering R&D activities by incumbent establishments, the subsidy expands firms' extensive margin of establishments. Column (1) of Table 7 shows that an increase in the cumulative subsidy increases the number of establishments while Column (2) shows expansion across CZs. Columns (3) and (4) show weak churn in establishment openings and closings. Columns (5) and (6) explore the types of openings firms are likely to open by looking at establishments with techies or the openings outside the HQ-CZ, and both are positive and significant. Overall, the coefficients for the subsidy are in line with firms' tactical expansion and geographic dispersion.[27]

To further support the claim that much of the subsidy hiring response is in new establishments, we estimate cumulative employment effects where we include an effect for continually open establishments in Table 8. The effect on continually existing establishments is negative for all labor categories. This again suggests that the expansion of firms due to the subsidy is largely driven by new establishments.

[27] One mechanism we explore with the 7% of ME firms in a production data sample is the relationship between opening/closing establishments and adding/dropping products. We find no significant effect of the policy on adding or dropping new products, and a weak positive relationship with product scope, which is slightly stronger for firms opening new establishments, which we found uncompelling.

Table 8: Total Firm Employment vs Continual Establishments

	Production			Support			Techies
	Low	Middle	High	Low	Middle	High	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cum. Subsidy	0.0114***	0.0203***	0.0104***	0.0089***	0.0226***	0.0242***	0.0328***
	(0.0010)	(0.0008)	(0.0006)	(0.0009)	(0.0010)	(0.0009)	(0.0009)
Cum. Subsidy × Continual Estab.	-0.0080***	-0.0141***	-0.0090***	-0.0016***	-0.0150***	-0.0177***	-0.0241***
	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Continual Estab.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry ×Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HQ CZ×Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	561,770	561,770	561,770	561,770	561,770	561,770	561,770
R^2	0.96844	0.95443	0.88926	0.96094	0.95724	0.95696	0.96946

Notes: The table reports results from the 2SLS specification in Equation 4 on the pooled sample including a dummy for incumbents and its interaction with the fitted cumulative subsidy We pool data where each firms have an observation for employment in the full sample and for the incumbents only (establishments always exist). Robust standard-errors in parentheses. Significance codes: ***: 0.01, **: 0.05, *: 0.1. The reported standard errors are robust to correlation in the errors among firms.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

3.3 Robustness and Heterogeneity

Here we provide evidence that the employment changes we estimate are in fact new employment by showing there is little reallocation of occupations in response to the subsidy. We also examine heterogeneous effects of the subsidy across firm characteristics, finding that large and small firms both respond, but smaller firms more strongly.

Employment Reallocation

We further verify that these results are not driven by reallocation effects from moving occupations across establishments. We measure reallocation for firm f, for each occupation category o by:

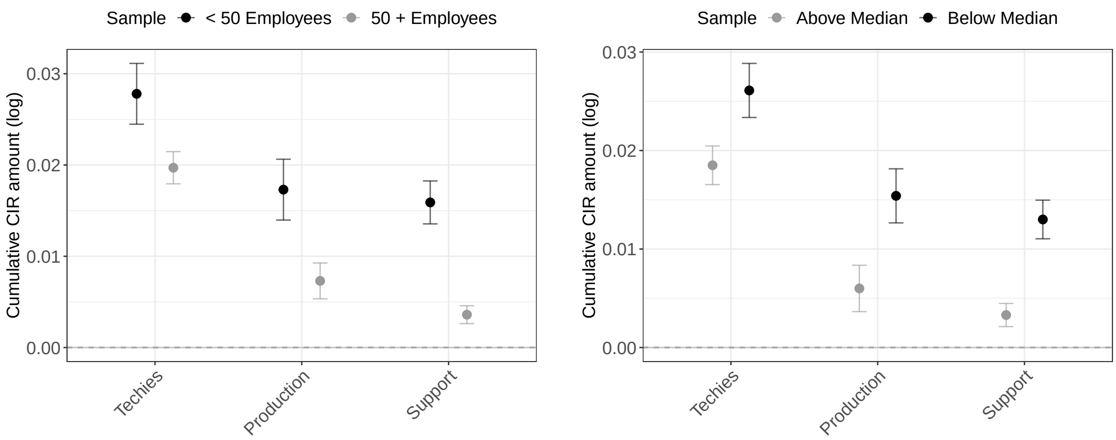
$$R_{o,f,t} = \sum_e |L_{o,e,t} - L_{o,e,t-1}| - |L_{o,f,t} - L_{o,f,t-1}| \tag{5}$$

where the first term is the absolute change in employment over all establishments e and the second term is the absolute change at the firm level. If $R_{o,f,t} = 0$, there are no signs of reallocation within the firm since every establishment level hire or fire is matched at the firm level. However, if $R_{o,f,t} > 0$, it means that the firm has more movements of jobs between establishments than the absolute change at the firm level. Results are presented in Table A6 in the Appendix, showing no significant relationship between the cumulative R&D subsidy amount reallocation for most occupation categories.[28]

Responses by Size

Numerous studies point to the differential behavior of large, productive firms, and here we examine heterogeneity by firm size.[29] Because our computation of Industry shifts in the next section rely on estimated labor elasticities, we want to understand if those results are driven by particular firms. We use the same framework as in Section 3.1 and contrast estimates across an initial size threshold of 50 employees and median number of establishments (two). First, we split the sample between firms that have less than 50 employees (34% of the receivers in the base year) and over as legal frameworks in France have been documented to cause size bunching at this level.[30] Second, we split the sample by having 2 or fewer and 3 or more establishments in the base year.

Figure 5: Firm level analysis on different sub-samples of firms



(a) Size (50 employees) (b) Number of Establishments

Notes: The error bars show the 95% confidence interval using robust standard errors. All panels compare the estimates for two different sub-samples: panel (a) splits firms smaller than 50 employees. Panel (b) splits firms if they have strictly more than the median number (2) of establishments in the initial period. Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Figure 5 displays the results graphically (see Section A1.0.1). The point estimates come from separate regressions as in Equation 4 for techie workers and aggregated categories of production and support workers across sub-samples. Panel (a) cuts the sample across the 50 employee threshold, while Panel (b) cuts across the median number of establishments.

[28]Only High Skilled Support workers are significant at the 5% level out of seven coefficients estimated.

[29]Firm size is important in measuring the efficiency of the R&D subsidies and the likelihood of getting subsidies (Criscuolo et al. (2019)), also the innovative capacity of firms (Acemoglu et al. (2018)).

[30]We repeat this exercise using firm geographic dispersion, finding no differences and small differences on the extensive margin results (Section A1.0.1).

The results show stronger effects for smaller firms in both cases, especially for support occupations and hold in long differences. We further explore if firm size matters for extensive margin outcomes, finding strong effects for smaller firms while larger firms are more likely to expand to new CZs (see Table A11). All the results show that the CIR induces small and large firms to expand with new establishments and often to new CZs.[31]

We now use the firm level employment elasticities just established to predict labor demand shifts and estimate spillover effects.

4 Spillovers from Subsidies

In the previous section we showed that the subsidy has a hiring effect that varies by occupation, and drives techie intensive expansion in CZs besides that of the HQ. Following this logic of hiring associated with R&D intensive activities and resources, we aggregate the predicted subsidized hiring to industry labor demand shifts. To then look for spillovers, we 'distribute' industry demand shifts in two different ways based on historical hiring patterns from firm branch data. First, by past employment across firm branches and second, by past hiring excluding each firm's HQ CZ. This is similar to instruments that allocate migration flows based on past patterns, with the second method emphasizing the structural expansion estimated in the last section. Both methods provide an instrument for local hiring within subsidized firms, based on different resource allocation assumptions. We then use instrumented employment predictions to estimate local spillovers to non-subsidized firm employment.

4.1 Industry Labor Demand Shifts

Here we describe how we aggregate subsidy induced hiring and examine the employment incidence of the policy. Let $L_{o,f,t}$ be the number of workers of occupation o in firm f at time t and $L_{f,t}$ total firm employment. Using the firm level occupational elasticity for type o w.r.t. the subsidy $\varepsilon_{o,f,t}$:[32]

$$\varepsilon_{o,f,t} \equiv \Delta \ln L_{o,f,t} / \Delta \ln \text{Subsidy}_{f,t}.$$

[31] Clustering at HQ CZ-time makes this difference statistically, but not not quantitatively, insignificant.

[32] In principal this could be done at the establishment level, but in practice, some occupations are sparsely employed at the establishment level, creating zeros and selection issues when estimating growth.

For brevity, we assume that across all firms and periods that $\varepsilon_{o,f,t} = \varepsilon_o$ where estimates of $\widehat{\varepsilon_o}$ appear above in Figure 4. The total employment elasticity of firm f w.r.t. the subsidy, given last period occupational employment $\{L_{o,f,t-1}\}$ is:

$$\widehat{\varepsilon}_{f,t} \approx \sum_o \widehat{\varepsilon}_{o,f,t} \frac{L_{o,f,t-1}}{L_{f,t-1}} = \sum_o \widehat{\varepsilon_o} \frac{L_{o,f,t-1}}{L_{f,t-1}} \approx \frac{\Delta \ln L_{f,t}}{\Delta \ln \text{Subsidy}_{f,t}}$$

where we use the approximation $\Delta \ln L_{o,f,t} \approx (L_{o,f,t} - L_{o,f,t-1})/L_{o,f,t-1}$ at the occupation and firm level. Then for each firm, additional employment induced by the subsidy is

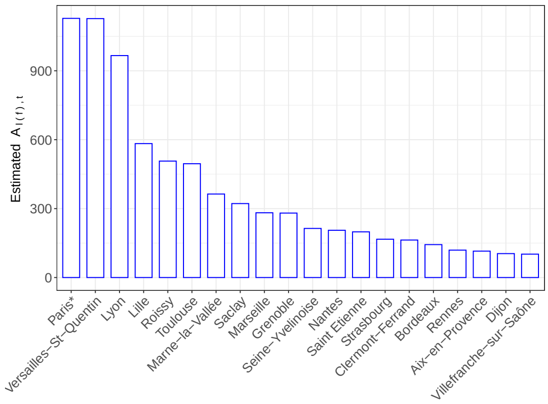
$$\widehat{A}_{f,t} = \sum_{t=2009}^{T=2014} \widehat{\varepsilon_o} L_{o,f,t-1} \cdot \Delta \ln \text{Subsidy}_{f,t}.$$

The total industry employment shift for industry i is then given by $\widehat{A}_{i,t} \equiv \sum_{f \text{ in industry } i} \widehat{A}_{f,t}$.

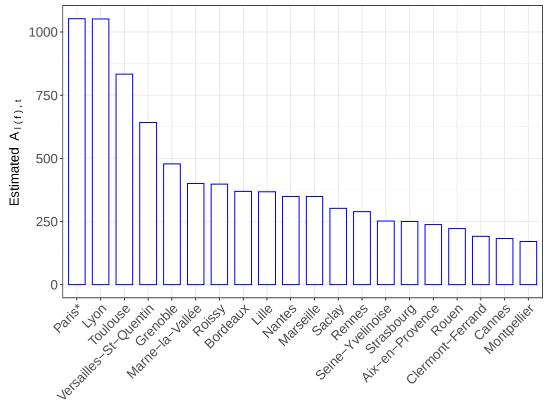
HQ vs ME Policy Incidence

The importance of establishment location, rather than just HQ location data, is striking. Figure 6 plots the 20 CZs with the most predicted hires from the subsidy in 2012 using predicted employment from the subsidy. Panel (a) maps this to each firm's HQ only, while Panel (b) uses each firm's branches. Even though Paris remains the CZ with the largest number of predicted hires in both cases, the 20 largest CZs are different and in a different order. For example, Toulouse has few HQs but high non-HQ employment, so is low ranked in Panel (a) but ranks in the top 10 in Panel (b). Moreover, the Panel (b) distribution is less skewed towards large cities. Similarly Panel (c) attributes employment in openings to each firm's HQ while Panel (d) locates the employment in the opening CZ. Again, Toulouse stands out as it becomes the top CZ when we consider the actual location of new establishments.

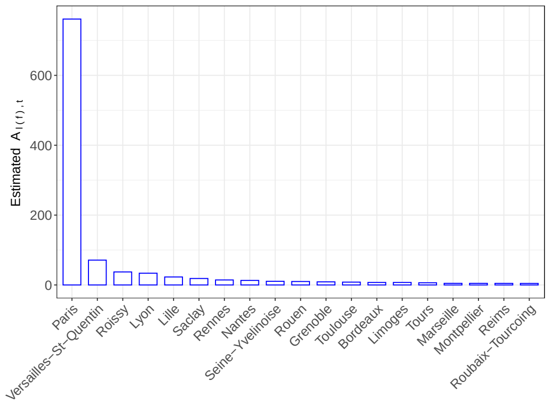
Figure 6: Predicted Hiring from Subsidies across Commuting Zones, 2012



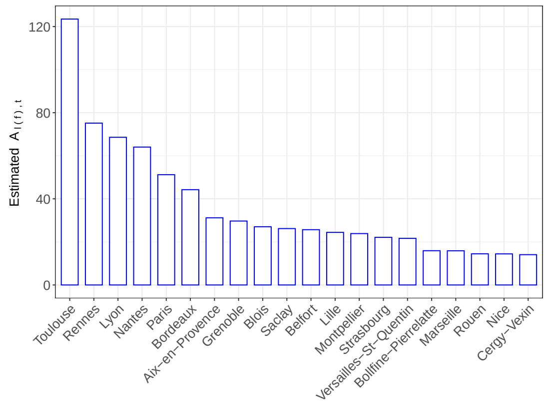
(a) Headquarters Location: All CIR



(b) All Establishments' Location: All CIR



(c) Headquarters Location: Openings

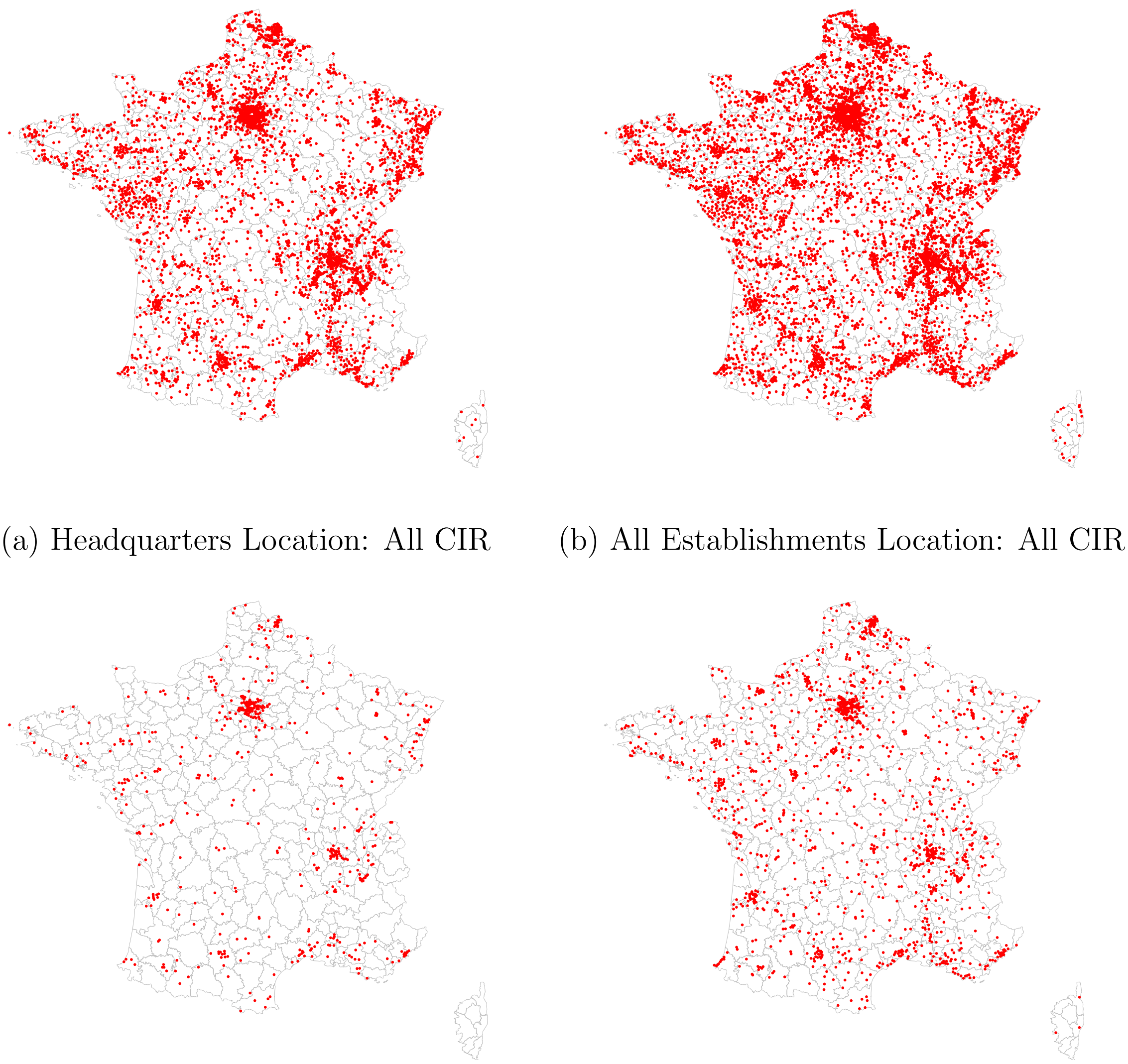


(d) All Establishments' Location: Openings

Notes: The bars represent predicted hirings from the subsidy by CZ. Panel (a) aggregates over HQ locations only and Panel (b) aggregates over establishments. For openings in a CZ different than HQ, Panel (c) aggregates over HQ locations only and Panel (d) aggregates over establishments. Paris is scaled to the second maximum value for representation, from 4200 in panel (a) and 8600 in panel (b). Sources: DGFiP-Mesri, base GECIR ; Insee, DADS postes etablissements, 2009-2014.

A second comparison is Figure 7 where colored postcodes have a positive number of predicted hiring from the subsidy in 2012. Again, in Panel (a), we plot only hiring in HQs and in Panel (b) we use establishment locations. The bottom panels repeat the same for new establishments in non-HQ CZs. In both cases, not only do the colored dots expand to treated areas around French cities when considering the true location of establishments, they also reach remote locations such as Bordes (Figure 1). These Figures demonstrate that establishment expansion is key to understanding the reach of the subsidy.

Figure 7: Positive Additional workers



(a) Headquarters Location: All CIR (b) All Establishments Location: All CIR

(c) Headquarters Location: Openings (d) All Establishments Location: Openings

Notes: The maps display the location of predicted hiring from the subsidy at the postcode level. The red dots stand for postcodes where there is a positive prediction. For all CIR employment, Panel (a) considers only HQ locations and Panel (b) is all establishment locations. For CIR openings in a CZ different than HQ, Panel (c) considers only HQ locations and Panel (d) is all establishment locations.
Sources: DGFiP-Mesri, base GECIR ; Insee, DADS postes etablissements, 2009-2014.

4.2 Instrument and Specification

From above, the total industry employment shift for industry i from the subsidy is defined by $\widehat{A}_{i,t}$. The intuition of our instrument is that $\widehat{A}_{i,t}$ is distributed by historical employment patterns. This implicitly puts multiple dimensions together. First, R&D does not spread equally in the branches of firms because of a distance to headquarter effect (Adams and Jaffe (1996)) as reflected in the sizes of firm branches. Second, industries have different areas of concentration across France as is well known. Third, other omitted variables that determine firm location choices for branches are contained in the historical shares.

We define the historical industry employment shares as observed for CIR firms in 2008 in industry i and location l as $s_{i,l,2008}$. We define the corresponding share excluding firm HQ CZ employment as $\mathring{s}_{i,l,2008}$. These shares sum to one at the industry level, and correspond to instruments for cumulative subsidy induced hiring in location l at time t, defined as

$$\text{SubsidyEmp}_{i,l,t} = \sum_{j=2009}^{t} \widehat{A}_{i,j} \times s_{i,l,2008} \tag{6}$$

$$\text{SubsidyOpen}_{i,l,t} = \sum_{j=2009}^{t} \widehat{A}_{i,j} \times \mathring{s}_{i,l,2008} \tag{7}$$

We use the first instrument of Equation (6) in the following specification:

$$\text{OverallEmp}_{i,l,t} = \beta_1 \text{SubsidyEmp}_{i,l,t} + \gamma_1 \text{Openings}_{i,l,t} + \alpha_{i,t} + \alpha_{l,t} + \epsilon_{1,l,t}, \tag{8}$$

$$\text{IncumbentEmp}_{i,l,t} = \beta_2 \text{OverallEmp}_{i,l,t} + \gamma_2 \text{Openings}_{i,l,t} + \alpha_{i,t} + \alpha_{l,t} + \epsilon_{2,l,t}, \tag{9}$$

Where Openings is employment in opening of non-CIR firms as an Industry-CZ-time control for local effects not otherwise captured, and $\alpha_{i,t}$ and $\alpha_{l,t}$ are Industry-time and CZ-time fixed effects, with errors clustered at the CZ and year level. The effect of employment changes from the subsidy on incumbent employment in the same CZ and Industry is β_2. Similarly we use the second instrument of Equation (7) in this specification:

$$\text{OpeningEmp}_{i,l,t} = \beta_3 \text{SubsidyOpen}_{i,l,t} + \gamma_3 \text{Openings}_{i,l,t} + \alpha_{i,t} + \alpha_{l,t} + \epsilon_{3,l,t}, \tag{10}$$

$$\text{IncumbentEmp}_{i,l,t} = \beta_4 \text{OpeningEmp}_{i,l,t} + \gamma_4 \text{Openings}_{i,l,t} + \alpha_{i,t} + \alpha_{l,t} + \epsilon_{4,l,t}. \tag{11}$$

In Equation 11, β_4 tells us the effect of employment changes on the extensive margins from the subsidy on incumbent employment in the same CZ and Industry.

4.3 Spillover Estimates

We now analyze spillovers from subsidized to non-subsidized firms. We start by estimating the first stage regressions of Equation (8) and (10) in Table 9. The coefficients in the table are positive and significant, with the Openings control positive and significant. The F-statistics are all far above 10, showing these are strong instruments. In the case of employment in openings of subsidized firms, we lose over half of the observations due to zeros in many industry-CZ-time cells. We also see that the Openings control is stronger here as common factors might induce firms in the same industry to open establishments in an area.[33]

Table 9: Employment Spillovers from Subsidies: First Stage

	OverallEmp (1)	OpeningEmp (2)	OverallEmp (3)	OpeningEmp (4)
SubsidyEmp	0.5535***		0.4759***	
	(0.0056)		(0.0067)	
SubsidyOpen		0.2550***		0.2392***
		(0.0115)		(0.0127)
Openings			0.1137***	0.1678***
			(0.0076)	(0.0189)
CZ × Year	Yes	Yes	Yes	Yes
Industry × Year	Yes	Yes	Yes	Yes
Observations	27,995	9,504	18,835	8,139
F-Stat	9,722.47	492.62	4545.25	351.803
R^2	0.7209	0.4543	0.7486	0.4970

Notes: Robust standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Table 10 shows the second stage estimates of Equations (9) and (11). The coefficients in the table are positive and significant, consistent with local industry spillovers, with the Openings control positive and significant. Columns (3) and (4) suggest that local industry spillovers from subsidized firms are stronger in openings. We caution though that interpretation of the total effect would require accounting for displacement with a general equilibirum model, such as in exciting new approaches such as Ottaviano and Schmitz (2024) who provide structural means of accounting for these effects.

A second issue in interpretation arises due to sample selection since Opening Employment is necessarily less common than employment across all establishments, Columns 2 and 4 have a more restricted sample. For comparison, we replicate these results on a sub-sample with strictly positive industry-location cells in Table A12 of the Appendix,

[33]Exploring heterogeneity by CZ-Industry characteristics such as size, economic activity show no differences in first stage instrument compliance so we have omitted these results.

Table 10: Employment Spillovers from Subsidies: Second Stage

	Incumbent Employment by Industry-CZ			
	(1)	(2)	(3)	(4)
OverallEmp	0.2889***		0.2596***	
	(0.0078)		(0.0089)	
OpeningEmp		0.4785***		0.3533***
		(0.0316)		(0.0300)
Openings			0.1274***	0.1373***
			(0.0067)	(0.0139)
CZ × Year	Yes	Yes	Yes	Yes
Industry × Year	Yes	Yes	Yes	Yes
Observations	27,995	9,504	18,835	8,139
R^2	0.7644	0.7908	0.8333	0.8440

Notes: Robust standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

showing that the difference between openings and overall employment remains statistically significant.[34]

4.4 Within Firm Spillover Effects

The first stage regressions of Equation (8) and (10) in Table 9 are also instruments to estimate within firm effects across branches by replacing workers in incumbent establishments in different locations rather than aggregated locations. Changing Equations (9) and (11) to Equations (12) and (13) gives a within firm specification:

$$\text{IncumbentEmp}_{i,e,t} = \beta_5 \text{OverallEmp}_{i,l,t} + \gamma_5 \text{Openings}_{i,l,t} + \alpha_{f(e),t} + \alpha_l + \alpha_i + \epsilon_{5,e,t}, \quad (12)$$

$$\text{IncumbentEmp}_{i,e,t} = \beta_6 \text{OpeningEmp}_{i,l,t} + \gamma_6 \text{Openings}_{i,l,t} + \alpha_{f(e),t} + \alpha_l + \alpha_i + \epsilon_{6,e,t}. \quad (13)$$

Where Openings is employment in non-CIR openings as a control for local effects not otherwise captured. Fixed effects include $\alpha_{f,t}$ for Firm-time, α_l for CZ and α_i for industry, with robust errors. In Table 11, the specification compares spillover effects within firm. The estimated coefficients are positive and significant, with Columns 3 and 4 including Openings as a control. This shows that even within firms, branches exposed to more

[34]First-stage results are similar to Table 9: highly significant and strong.

spillovers grow faster, although here the magnitude of spillover effects are similar for CIR and non-CIR employment, even on the harmonized sample of Column 5 on a comparable sample.

Table 11: Employment Spillovers from Subsidies on firms' branches: Second Stage

	Firm-CZ Incumbent Employment (Branches)				
					Same Sample
	(1)	(2)	(3)	(4)	(5)
OverallEmp	0.0584***		0.0484***		0.0389***
	(0.0068)		(0.0071)		(0.0101)
OpeningEmp		0.0786***		0.0583***	
		(0.0155)		(0.0168)	
Openings			0.0426***	0.0595***	0.0662***
			(0.0050)	(0.0084)	(0.0074)
Firm × Year FE	Yes	Yes	Yes	Yes	Yes
CZ FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	266,783	205,673	266,783	205,673	205,673
R^2	0.7098	0.7338	0.7101	0.7347	0.7354

Notes: Robust standard-errors in parentheses. OLS and first stage results for the IV regressions are in Appendix Table A13 and Table A14. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1. Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

In a second exercise, we want to understand how spillovers at the branch level aggregate within the firm to spur growth overall. We repeat the branch specification at the firm level, with local spillovers weighted by initial CZ employment shares, over establishments that are always open. Firms are treated by a sum of spillovers weighted by initial CZ labor composition. Results in Table 12 show that non-CIR firms indeed do 'collect' spillovers through branches in a similar magnitude as the branch level, but only from subsidized firm employment spillovers in line with positive externalities from the subsidy.

Table 12: Employment Spillovers from Subsidies on firms: OLS and IV

	Firm Level Incumbent Employment			
	OLS		IV	
	(1)	(2)	(3)	(4)
OverallEmp	0.0120***		0.0734***	
	(0.0013)		(0.0093)	
OpeningEmp		0.0008		0.0342***
		(0.0005)		(0.0071)
Openings	0.0043***	0.0062***	-0.0031**	-0.0008
	(0.0008)	(0.0012)	(0.0013)	(0.0018)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	1,419,161	1,038,820	1,419,161	1,038,820
R^2	0.9628	0.9647	0.9627	0.9645

Notes: Robust standard-errors in parentheses. Corresponding first stage results for the IV regressions can be found in Table A15 in the Appendix.
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

5 Conclusion

In this paper, we estimate the impact of a large R&D targeted subsidy on multi-establishment firms in between 2009 and 2014. Our estimates use a Firm-CZ shift-share instrumental variable strategy of firm employment shares across commuting zones and local subsidy shifts outside the firm's industry. The subsidy induced firms to hire more workers, especially techies and to restructure by opening establishments in commuting zones outside their headquarters. We also find evidence that a substantive adjustment margin is through the extensive margin of new establishments, rather than reallocation and that small firms have a higher employment response than large firms.

Using the estimated industry employment shifts and past employment shares by commuting zone to create a labor demand instrument, we show that non-beneficiary establishments in the same industry benefit from local spillovers. Furthermore the spillover estimates are larger for Subsidized Openings outside of the headquarter commuting zone. While smaller in magnitude, these positive local spillover effects persist at the firm branch level. Aggregating these branch effects at the firm level again shows positive spillovers, but only for subsidy induced employment. In sum, firm subsidies diffuse though openings outside of historically HQ concentrated areas to spread growth.

The rich results we obtain for the impact of subsidies on firm structure raise questions for future research, such as how policy interacts with establishment location choice and composition. Identifying which firms generate large externalities would also allow more targeted measures towards sectors and regions, making policies more effective. How these forces interact within business groups, with national labor markets or across borders within multinational firms may also be key in understanding policy impacts. In total, taking the multi establishment rather than headquarter only view of the firm shows promise in better understanding the ultimate reach of economic policies.

References

Acemoglu, D., U. Akcigit, H. Alp, N. Bloom, and W. Kerr (2018, November). Innovation, reallocation, and growth. *American Economic Review 108*(11), 3450–91.

Adams, J. D. and A. B. Jaffe (1996). Bounding the effects of r&d: An investigation using matched establishment-firm data. *The RAND Journal of Economics 27*(4), 700–721.

Aghion, P. (2022). Modern manufacturing capital, labor demand, and product market dynamics: Evidence from france. *Energy 22*.

Aghion, P., N. Chanut, and X. Jaravel (2022). Renforcer l'impact du credit d'impot recherche.

Akcigit, U., J. G. Pearce, and M. Prato (2020). Tapping into talent: Coupling education and innovation policies for economic growth. Technical report, National Bureau of Economic Research.

Atalay, E., A. Hortaçsu, M. Runyun, C. Syverson, and M. F. Ulu (2023). Micro-and macroeconomic impacts of a place-based industrial policy. Technical report, National Bureau of Economic Research.

Autor, D. H., D. Dorn, and G. H. Hanson (2013, October). The china syndrome: Local labor market effects of import competition in the united states. *American Economic Review 103*(6), 2121–68.

Bach, L., A. Bozio, A. Guillouzouic, C. Malgouyres, and N. Serrano-Velarde (2021). Les impacts du crédit impôt recherche sur la performance économique des entreprises. *Rapport IPP* (33), 146.

Bergeaud and Guillouzouic (2024). PROXIMITY OF FIRMS TO SCIENTIFIC PRODUCTION. *Annals of Economics and Statistics* (153), 105.

Bilir, L. K. and E. Morales (2020). Innovation in the Global Firm. *Journal of Political Economy 128*(4), 1566–1625.

Bloom, N., M. Schankerman, and J. Van Reenen (2013). Identifying technology spillovers and product market rivalry. *Econometrica 81*(4), 1347–1393.

Borusyak, K., P. Hull, and X. Jaravel (2021). Quasi-Experimental Shift-Share Research Designs. *The Review of Economic Studies 89*(1), 181–213.

Bozio, A., S. Cottet, and L. Py (2019). *Évaluation d'impact de la réforme 2008 du crédit impôt recherche*. Ph. D. thesis, Institut des politiques publiques (IPP).

Bunel, S., B. Hadjibeyli, et al. (2019). Évaluation du crédit d'impôt innovation. Technical report, Institut National de la Statistique et des Etudes Economiques.

Cao, D., E. Sager, H. Hyatt, and T. Mukoyama (2019). Firm Growth through New Establishments. 2019 Meeting Papers 1484, Society for Economic Dynamics.

Card, D. (2001). Immigrant inflows, native outflows, and the local labor market impacts of higher immigration. *Journal of Labor Economics 19*(1), 22–64. Publisher: The University of Chicago Press.

Castillo, V., A. Maffioli, S. Rojo, and R. Stucchi (2014). The effect of innovation policy on smes' employment and wages in argentina. *Small Business Economics 42*, 387–406.

Charnoz, P., C. Lelarge, and C. Trevien (2018). Communication costs and the internal organisation of multi-plant businesses: Evidence from the impact of the french high-speed rail. *The Economic Journal 128*(610), 949–994.

Cowgill, B., A. Prat, and T. Valletti (2021). Political power and market power. *arXiv preprint arXiv:2106.13612*.

Criscuolo, C., R. Martin, H. G. Overman, and J. Van Reenen (2019, January). Some causal effects of an industrial policy. *American Economic Review 109*(1), 48–85.

De Souza, G. (2023). R&D Subsidy and Import Substitution: Growing in the Shadow of Protection. Technical report, Federal Reserve Bank of Chicago.

Dechezleprêtre, A., E. Einiö, R. Martin, K.-T. Nguyen, and J. Van Reenen (2016). Do tax incentives for research increase firm innovation? an rd design for r&d. Technical report, National Bureau of Economic Research.

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. Publisher: Elsevier.

Dortet-Bernadet, V. and M. Sicsic (2017). The effect of R&D subsidies and tax incentives on employment: an evaluation for small firms in France. *Economie et Statistique / Economics and Statistics* (493), 5–22.

Duhautois, R., C. Erhel, M. Guergoat-Larivière, and M. Mofakhami (2022). More and better jobs, but not for everyone: Effects of innovation in french firms. *ILR Review 75*(1), 90–116.

Duranton, G. and D. Puga (2004). Chapter 48 - micro-foundations of urban agglomeration economies. In J. V. Henderson and J.-F. Thisse (Eds.), *Cities and Geography*, Volume 4 of *Handbook of Regional and Urban Economics*, pp. 2063–2117. Elsevier.

Fazio, C., J. Guzman, and S. Stern (2019, July). The Impact of State-Level R&D Tax Credits on the Quantity and Quality of Entrepreneurship. Technical Report w26099, National Bureau of Economic Research, Cambridge, MA.

Fons-Rosen, C., V. Scrutinio, and K. Szemeredi (2017). Colocation and knowledge diffusion: evidence from million dollar plants. *Working Paper*. Publisher: London School of Economics and Political Science. Centre for Economic . . . .

Gathmann, C., I. Helm, and U. Schönberg (2020). Spillover effects of mass layoffs. *Journal of the European Economic Association 18*(1), 427–468. Publisher: Oxford University Press.

Giroud, X. (2013). Proximity and investment: Evidence from plant-level data. *The Quarterly Journal of Economics 128*(2), 861–915.

Giroud, X., S. Lenzu, Q. Maingi, and H. Mueller (2021, July). Propagation and Amplification of Local Productivity Spillovers. NBER Working Papers 29084, National Bureau of Economic Research, Inc.

Giroud, X., E. Liu, and H. Mueller (2024). Innovation Spillovers across US Tech Clusters. Technical report, National Bureau of Economic Research.

Giroud, X. and H. M. Mueller (2019, October). Firms' internal networks and local economic shocks. *American Economic Review 109*(10), 3617–49.

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

Griliches, Z. (1992). The search for r&d spillovers. *The Scandinavian Journal of Economics 94*, S29–S47.

Gumpert, A., H. Steimer, and M. Antoni (2021, 12). Firm Organization with Multiple Establishments*. *The Quarterly Journal of Economics 137*(2), 1091–1138.

Harrigan, J., A. Reshef, and F. Toubal (2021). The march of the techies: Job polarization within and between firms. *Research Policy 50*(7), 104008.

Helm, I. (2020). National industry trade shocks, local labour markets, and agglomeration spillovers. *The Review of Economic Studies 87*(3), 1399–1431.

Howell, S. T. (2017). Financing innovation: Evidence from r&d grants. *American economic review 107*(4), 1136–1164.

Ioramashvili, C. (2024). Technological invention and local labour markets: Evidence from france, germany and the uk. *Working Paper*.

Jaffe, A. B. (1986). Technological opportunity and spillovers of r&d: Evidence from firms' patents, profits, and market value. *The American Economic Review 76*(5), 984–1001.

Jiang, X. (2021). Information and communication technology and firm geographic expansion.

Kalnins, A. and F. Lafontaine (2013). Too far away? the effect of distance to headquarters on business establishment performance. *American Economic Journal: Microeconomics 5*(3), 157–79.

Keller, W. and S. R. Yeaple (2013, June). The gravity of knowledge. *American Economic Review 103*(4), 1414–44.

Kleinman, B. (2022). Wage inequality and the spatial expansion of firms.

Koenig, P., F. Mayneris, and S. Poncet (2010). Local export spillovers in france. *European Economic Review 54*(4), 622–641.

Mayer, T., F. Mayneris, and L. Py (2017, July). The impact of Urban Enterprise Zones on establishment location decisions and labor market outcomes: evidence from France. *Journal of Economic Geography 17*(4), 709–752.

Moretti, E. (2010, May). Local multipliers. *American Economic Review 100*(2), 373–77.

Moretti, E. and P. Thulin (2013, February). Local multipliers and human capital in the United States and Sweden. *Industrial and Corporate Change 22*(1), 339–362.

Mulkay, B. and J. Mairesse (2013). The r&d tax credit in france: assessment and ex ante evaluation of the 2008 reform. *Oxford Economic Papers 65*(3), 746–766.

Myers, K. R. and L. Lanahan (2022). Estimating spillovers from publicly funded r&d: Evidence from the us department of energy. *American Economic Review 112*(7), 2393–2423.

Navarra, E. (2023). The effects of corporate subsidies along the value chain. *Available at SSRN 4337015*.

Salies, E. (2017, April). Etudes d'impact du crédit d'impôt recherche (CIR). Research report, OFCE.

Salies, E. (2021). The impact of france's cir tax credit on employment in private sector r&d: A critical review. Volume 175, pp. 67–104.

Tian, L. and Y. Yu (2022). Geographic spillovers and firm exports: Evidence from china.

van der List, C. (2024). How do Establishments Choose their Location? Taxes, Monopsony, and Productivity. *Working Paper*.

Van Dijk, J. J. (2017). Local employment multipliers in US cities. *Journal of Economic Geography 17*(2), 465–487. Publisher: Oxford University Press.

Vernon Henderson, J. (2007). Understanding knowledge spillovers. *Regional Science and Urban Economics 37*(4), 497–508. Regional Science and Urban Economics at 35. A Retrospective/Prospective Special Issue.

What Works Centre for Local Economic Growth (2019). Local multipliers toolkit. Technical report.

A1 Appendix: Shift Share Instrument

Instrument

A1.0.1 Long-Difference Specification

To alleviate concerns about the timing of the events, we implement the IV design with long differences between 2009 and 2014. The results for all different outcomes on the intensive and extensive margins with this specification are in line with the standard IV

Table A1: Establishment Level Regression of the Shocks on Shares

	Shocks
	(1)
Constant	-2.13e^{-}14
	(0.0027)
Shares	0.0307***
	(0.0027)
Observations	135,954
R^2	0.0009

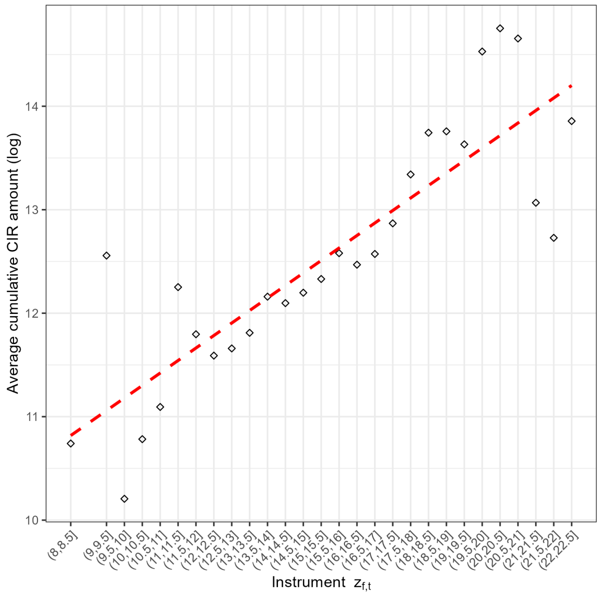
Notes: The table reports the results of a regression of our shocks ΔCZ Subsidy$_{l,t}$ at the CZ level on the shares $s_{f,l,0}$ from Equation 2 at the establishment level. All variables are standardised and robust standard-errors in parentheses. Significance codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Table A2: First Stage Estimations

	Cumulative Subsidy (log)			
	"True shares" Preferred	"True shares" Techie sample	Techies shares	Equal shares
	(1)	(2)	(3)	(4)
Instrument (log)	0.5334***	0.5400***	0.5360***	0.0132***
	(0.0035)	(0.0038)	(0.0038)	(0.0018)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
HQ CZ × Year	Yes	Yes	Yes	Yes
Industry × Year	Yes	Yes	Yes	Yes
F-Statistic	22,663	20,621	19,780	55.109
Observations	337,965	135,715	135,715	337,965
R^2	0.99359	0.99348	0.99333	0.96620

Notes: The table reports the first stage results of Equation 3. The outcome variable is the cumulative amount of CIR firms get (endegenous variable). The instrument in Columns (1) and (2) uses the employment shares of firms in different CZ, Column (3) uses techie employment shares, and Column (4) uses shares which are equal across CZ where firms operate. All specifications include a dummy variable for BG, firm, HQ CZ*year and industry*year fixed effects. Robust standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Figure A1: Correlation between the instrumental variable and the endogenous variable



Notes: The figure plots the correlation between the instrumental variable and the endogenous variable. We report the correlation using a binscatter plot of average cumulative CIR amount in log (endogenous variable) against the instrument $Z_{f,t}$. The dashed red line is a linear fit.
Source: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Table A3: Lagged firm level outcomes (IV)

	Log Employment (1)	Log Tech (2)	Log S3 (3)	Log Estab. (4)	Log CZ (5)	Closing Dummy (6)	Cum. Open non-HQ CZ (7)
Instrument	0.0013***	0.0054***	0.0046***	0.0002	8.64×10^{-5}	0.0010	0.0023**
	(0.0004)	(0.0007)	(0.0006)	(0.0004)	(0.0004)	(0.0009)	(0.0009)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HQ CZ × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	202,779	202,779	202,779	202,779	202,779	202,779	202,779
R^2	0.9962	0.9909	0.9890	0.9496	0.9666	0.5186	0.8636

Notes: The table reports a regression results of 2-year lagged outcomes on our instrument. Each column is a separate regression with outcomes from (1) to (7): log total cumulative employment, log cumulative techies, log cumulative S3, log number of establishments, log number of distinct CZ, dummy for closings, and log cumulative number of openings in CZ different than HQ. Robust standard-errors in parentheses. All specifications include a dummy variable for BG, firm, HQ CZ*year and industry*year fixed effects. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

specification. They confirm the positive impact of the subsidy, inducing ME firms to open new establishments and expand their footprint, while hiring occupations at different rates.

The outcomes and endogenous variable are log changes across the six years period.[35]

[35] For example, the employment outcome we will be computed as $\Delta L_f = \log(1 + L_{f,2014}) - \log(1 +$

Table A4: Effect of the R&D subsidy on Cumulative Employment (OLS and IV)

	Employment Log Total	Production Low	Production Middle	Production High	Support Low	Support Middle	Support High	Techies
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OLS	0.0102***	0.0140***	0.0181***	0.0095***	0.0146***	0.0205***	0.0208***	0.0280***
	(0.0009)	(0.0010)	(0.0008)	(0.0006)	(0.0008)	(0.0009)	(0.0007)	(0.0010)
IV	0.0088***	0.0118***	0.0125***	0.0062***	0.0119***	0.0163***	0.0159***	0.0227***
	(0.0006)	(0.0010)	(0.0008)	(0.0006)	(0.0009)	(0.0009)	(0.0008)	(0.0010)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HQ CZ×Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337,965	337,965	337,965	337,965	337,965	337,965	337,965	337,965

Notes: The table reports results from the 2SLS specification in Equation 4. Regressions include a control for BG, Firm, HQ CZ*year and industry*CZ fixed effects. The coefficient is the effect of the cumulative R&D subsidy on the different cumulative labour categories in log. Two-way (CZ and year) standard-errors in parentheses. Significance codes: ***: 0.01, **: 0.05, *: 0.1. The reported standard errors are robust to correlation in the errors among firms.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Table A5: Effect of the R&D subsidy on the extensive margin of firms: OLS

	Log Estab.	Log CZ	Opening Dummy	Closing Dummy	Opening Techies	Cum. Open non-HQ CZ
	(1)	(2)	(3)	(4)	(5)	(6)
Cumulative Subsidy	0.0056***	0.0043***	0.0013	-1.08×10^{-5}	0.0187***	0.0156***
	(0.0005)	(0.0004)	(0.0007)	(0.0008)	(0.0009)	(0.0012)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
HQ CZ × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337,965	337,965	337,965	270,372	337,965	337,965
R^2	0.92143	0.94653	0.27279	0.31433	0.80422	0.83805

Notes: The table reports the OLS results of Equation 1. Each column is a separate regression with outcomes from (1) to (6): log number of establishments, log number of distinct CZ, dummy for new openings, dummy for closings, dummy for opening with techie, and log cumulative number of openings in CZ different than HQ. Robust standard-errors in parentheses. All specifications include a dummy variable for BG, firm, HQ CZ*year and industry*year fixed effects. The CIR variable is the cumulative amount of CIR firms get. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

The endogenous variable is the log change in the cumulative amount of the R&D subsidy, denoted $\Delta\text{Subsidy}_f$, across firms indexed by f. Denoting by ΔY_f log changes in firm-level outcomes, we estimate the following specification by 2SLS:

$$\text{Subsidy}_f = \beta_1 \text{BranchExposure}_f + \gamma_1 x_{f,0} + \alpha_i + \alpha_{l(f)} + \epsilon_{1,f} \tag{14}$$

$L_{f,2009}$).

Table A6: Effect of the R&D subsidy on the *role reallocation* within firms (IV)

	Role Reallocation (log)						
	P1	P2	P3	S1	S2	S3	Techie
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cumulative Subsidy	-0.0001	0.0009	-0.0001	-0.0007	-0.0002	0.0045**	0.0027
	(0.0020)	(0.0010)	(0.0005)	(0.0021)	(0.0017)	(0.0021)	(0.0024)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HQ CZ × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	337,965	337,965	337,965	337,965	337,965	337,965	337,965
R^2	0.63767	0.72545	0.61540	0.63487	0.67495	0.63566	0.66639

Notes: The table reports results from our 2SLS specification in Equation 4 of outcomes computed in Equation 5 on log cumulative R&D subsidy at the firm level. Each column is a different labour category: Columns (1) to (3) for low, middle and high skilled support workers, respectively. And Columns (4) to (6) for low, middle and high skilled production workers, respectively. Column (7) is for tech workers. And All outcomes are in log. Robust standard-errors in parentheses. All specifications include a dummy variable for BG and year, firm and HQ location by year fixed effects. Significance codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

$$Y_f = \beta_2 \widehat{\text{Subsidy}}_f + \gamma_2 x_{f,0} + \alpha_i + \alpha_{l(f)} + \epsilon_{2,f} \tag{15}$$

The shift-share instrument is the combination of the cumulative shifts ΔCZ Subsidy$_{l,f,t}$ in subsidy between 2009 and 2014 and exposure shares $s_{f,l,0}$ as in Equation 16:

$$\text{BranchExposure}_f = \sum_{l=1}^{L} \Delta\text{CZ Subsidy}_{l,f,t_{2009-2014}} \times s_{f,l,0} \tag{16}$$

Using this design forces us to restrict the set of fixed effects to industry α_i and HQ CZ $\alpha_{l(f)}$ fixed effects. Following the literature, we add controls for the firm being in a business group and beginning of the period financial indicators (total revenues, Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA), total debt, balance sheet, value added and investment ratio). Our results are fairly stable across specifications controls. The results on the main extensive and intensive outcomes of firms are in Table A7. These results are in line with the previous specification: firms grow in establishments (Column 1) and in employment (Column 2). The results also document heterogeneity along occupational responses. The estimated coefficients show a significant and positive impact of the subsidy, with point estimates ranging from 0.007 for low-skill production workers to 0.032 for techies. These results confirm our findings using the time-varying specification. Firms restructure by adding establishments and hiring occupations at different rates.

Table A7: Long-Differences: Subsidies and Labour Responses

	Δ_5 Nb Estab (1)	Δ_5 L (2)	Δ_5 Techies (3)	Δ_5 S3 (4)	Δ_5 S2 (5)	Δ_5 S1 (6)	Δ_5 P3 (7)	Δ_5 P2 (8)	Δ_5 P1 (9)
$\Delta Y_{2009-2014}$	0.0080***	0.0366***	0.0324***	0.0157***	0.0211***	0.0211***	0.0274***	0.0172***	-0.0072***
	(0.0014)	(0.0044)	(0.0024)	(0.0022)	(0.0025)	(0.0020)	(0.0020)	(0.0023)	(0.0025)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HQ CZ FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	41,551	41,590	41,551	41,551	41,551	41,551	41,551	41,551	41,551
R^2	0.04332	0.07858	0.54139	0.38776	0.32958	0.11245	0.25934	0.47308	0.36293
Within R^2	0.02158	0.05105	0.25260	0.24042	0.19749	0.05543	0.12848	0.27035	0.06710

Notes: The table reports results from the specification in Equation 15. All regressions include industry and CZ fixed effects. We include controls such as a dummy variable for the BG and beginning of the period financial indicators (total revenues, EBITDA, total debt, balance sheet, value added, investment ratio). Columns (1) and (2) are the number of establishments and total labour, and Columns (3) to (9) are the 7 categories of employment: techies; high skilled support (S3), middle skilled support (S2), low skilled support (S1), high skilled production (P3), middle skilled production (P2) and low skilled production (P1). Robust standard-errors in parentheses. Significance codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

R&D Outcomes and Investments

In this section we explore the role of the R&D subsidy on intangible investments. Bach et al. (2021) study the 2008 reform of the policy and find that beneficiary firms face an increase in employment (we also find this result), and in intangible investments. While it is not the focus of the study to evaluate the efficiency of the subsidy, we provide results for both the OLS specification as in Equation 1 and the IV strategy as in Equation 4 where outcomes are cumulative amount of investment variables from the FARE financial data. There is a lower number of observations relative to the main results of the paper due to some missing variables in the financial indicators.

Results are as expected (see Table A8), all positive and highly significant suggesting that the R&D subsidy is positively correlated with investments. The effect is considerably stronger for intangibles, in line with the R&D targeting subsidy. The literature already documented that the R&D subsidy is moderately increasing the R&D intensity of firms (the number of technicians is increasing, but not their share, nor does the probability of filing a patent). However, our results in the main text showing that the most responsive occupations are techies and the strong result on intangible investment, thus suggest that the subsidy seem to generate *some* R&D activities at the firm level. Moreover, we perform some descriptives on the sample of firms opening new establishments and we find strong

Table A8: Relationship of the R&D Subsidy and Investments

	OLS Cumulative Investment			IV Cumulative Investment		
	Intangibles (1)	Tangibles (2)	Overall (3)	Intangibles (4)	Tangibles (5)	Overall (6)
Cumulative Subsidy	0.0679***	0.0298***	0.0221***	0.0536***	0.0217**	0.0188***
	(0.0031)	(0.0023)	(0.0023)	(0.0033)	(0.0025)	(0.0024)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
HQ CZ × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	334,017	334,310	333,740	334,017	334,310	333,740
R^2	0.89042	0.94916	0.93791	0.89040	0.94916	0.93791

Notes: The table reports results from the OLS and IV specification in Equation 1 and Equation 4 for various investment and R&D investment outcomes. All regressions include a control for BG, Firm, HQ CZ by year and industry by year fixed effects. The coefficient is the effect of the cumulative R&D subsidy on the different investment outcomes in logs: Columns (1) and (4) are intangible investments, Columns (2) and (5) are tangible investments and Columns (3) and (6) are gross investments. Robust standard-errors in parentheses. Significance codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

positive correlations on the share of investment towards R&D activities. This is intuitive as those openings are populated by techies and high skilled workers as found in the main text.

Heterogeneity Tables

Table A9: Heterogeneity Corresponding Table: Firms below 50 employees.

	Support (1)	Prod (2)	Techies (3)
Cumulative Subsidy	0.0159***	0.0173***	0.0278***
	(0.0012)	(0.0017)	(0.0017)
Firm FE	Yes	Yes	Yes
HQ CZ × Year FE	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes
Observations	316,690	316,690	316,690
R^2	0.98936	0.98762	0.98068

Notes: The table reports results from the 2SLS specification in Equation 4 for the sample of firms below 50 employees in 2009, the estimated coefficients are plotted in Panel (a) of Figure 5. Regressions include a control for BG, Firm, HQ CZ by year and industry by year fixed effects. The coefficient is the effect of the cumulative R&D subsidy on the different labour categories in cumulative. Column (1) is support workers (low, middle and high skilled), Column (2) production workers (low, middle and high skilled), and Column (3) is techie workers. Robust standard-errors in parentheses. Significance codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Table A10: Heterogeneity Corresponding Table: Firms above 50 employees

	Support (1)	Prod (2)	Techies (3)
Cumulative Subsidy	0.0036***	0.0073***	0.0197***
	(0.0005)	(0.0010)	(0.0009)
Firm FE	Yes	Yes	Yes
HQ CZ × Year FE	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes
Observations	323,375	323,375	323,375
R^2	0.99146	0.98970	0.98693

Notes: The table reports results from the 2SLS specification in Equation 4 for the sample of firms above 50 employees in 2009, the estimated coefficients are plotted in Panel (a) of Figure 5. Regressions include a control for BG, Firm, HQ CZ by year and industry by year fixed effects. The coefficient is the effect of the cumulative R&D subsidy on the different labour categories in cumulative. Column (1) is support workers (low, middle and high skilled), Column (2) production workers (low, middle and high skilled), and Column (3) is techie workers. Robust standard-errors in parentheses. Significance codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Spillover

Table A11: Extensive margins outcomes: 50 employees threshold

Model:	Nb. Estab (1) Below 50	Nb. Estab (2) Above 50	Nb. CZ (3) Below 50	Nb. CZ (4) Above 50	Opening New CZ (5) Below 50	Opening New CZ (6) Above 50
Cumulative Subsidy	0.0065*** (0.0009)	0.0021*** (0.0007)	0.0045*** (0.0008)	0.0018*** (0.0006)	0.0105*** (0.0016)	0.0149*** (0.0019)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
HQ CZ × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	316,690	323,375	316,690	323,375	316,690	323,375
R^2	0.90976	0.92426	0.93860	0.94944	0.83344	0.84114

Notes: The table reports results from the 2SLS specification in Equation 4 for the sample of firms below 50 employees in odd Columns and above 50 employees in even Columns. The coefficient is the effect of the cumulative R&D subsidy on extensive margin outcomes: number of establishments, number of distinct CZ and cumulative number of openings in a CZ different than the HQ. Regressions include a control for BG, Firm, HQ CZ by year and industry by year fixed effects. Robust standard-errors in parentheses. Significance codes: ***: 0.01, **: 0.05, *: 0.1.
Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Table A12: Employment Spillovers from Subsidies: Second Stage (same sample)

	Incumbent Employment by Industry-CZ (1)	(2)
OverallEmp	0.2750*** (0.0151)	
Openings	0.1412*** (0.0115)	0.1373*** (0.0139)
OpeningEmp		0.3533*** (0.0300)
CZ × Year	Yes	Yes
Industry × Year	Yes	Yes
Observations	8,139	8,139
R^2	0.89314	0.84403

Notes: Robust standard-errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1. Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Table A13: OLS of Employment Spillovers from Subsidies on Firm-CZ Level Employment (branches)

	Firm-CZ Incumbent Employment (Branches)			
	(1)	(2)	(3)	(4)
OverallEmp	0.0486***		0.0412***	
	(0.0038)		(0.0038)	
OpeningsEmp		0.0190***		0.0141***
		(0.0030)		(0.0030)
Openings			0.0444***	0.0728***
			(0.0048)	(0.0072)
Firm × Year FE	Yes	Yes	Yes	Yes
CZ FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	266,783	205,673	266,783	205,673
R^2	0.70985	0.73494	0.71008	0.73531

Notes: Robust standard-errors in parentheses. Corresponding OLS results for the regressions in Table 11. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1. Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Table A14: First Stage of Employment Spillovers from Subsidies on Firm - CZ Level Employment (Branches)

	OverallEmp	OpeningsEmp
	(1)	(2)
SubsidyEmp	0.3998***	
	(0.0027)	
SubsidyOpen		0.2329***
		(0.0049)
Openings	0.1557***	0.2381***
	(0.0041)	(0.0088)
Firm × Year FE	Yes	Yes
CZ FE	Yes	Yes
Industry FE	Yes	Yes
Observations	266,783	205,673
R^2	0.94488	0.83837
F-Statistic	22,519.9	2,252.42

Notes: Robust standard-errors in parentheses. Corresponding first stage results for the IV regressions in Table 11. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1. Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.

Table A15: First Stage of Employment Spillovers from Subsidies on Firm Level Employment

	OverallEmp (1)	OpeningsEmp (2)
SubsidyEmp (IV)	0.0390***	
	(0.0007)	
SubsidyOpen (IV)		0.0586***
		(0.0010)
Openings	0.1160***	0.1982***
	(0.0020)	(0.0041)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	1,419,161	1,038,820
R^2	0.98817	0.90911
F-Statistic	3,397.53	3,721.22

Notes: Robust standard-errors in parentheses. Corresponding first stage results for the IV regressions in Table 12. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1. Sources: DGFiP-Mesri, base GECIR ; Insee, 2009-2014.