# Extension of R&D Tax Credit to innovation expenditures : Evidence from France

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January 2019

*[Preliminary: please do not circulate]*

**Abstract**

The innovation tax credit (CII) is an extension of the research tax credit (CIR) intended to promote the incentive effect of the CIR among SMEs, so that they commit themselves in particular to the creation of new products via the development of prototypes. Established in 2013, it represented 155 millions euros in tax receivables in 2015, for almost 6,000 beneficiaries. We carry out the first impact assessment of the introduction of this public policy, over the 2013-2016 period, in response to a request from the European Commission. First, we highlight a significant effect of the introduction of the scheme on the employment of its beneficiaries in the short term, as well as on their turnover in the medium term. Then, we show that the tax credit has a positive impact on the number of products manufactured by the beneficiaries. This is, to our knowledge, the first time that such an effect is highlighted on a tax credit designed to help R&D or innovation in France.

**Codes JEL :** O32, O38, H25, C21
**Mots clés :** Innovation, Tax credit, products

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# Introduction

Research, development and innovation (RDI) is today one of the priorities of public authorities. The objective set by the European Union to devote 3% of GDP to R&D expenditure by 2020 is an example. This will is based on the underlying economic argument that innovation is the key factor to sustain long-term growth, and developed particularly in the context of endogenous growth theory (see Aghion *et al.* (1997) for an overview). Economic theory also justifies policies designed to support RDI through the existence of market failures related to innovation. On the one hand, innovation is a non-exclusive public good that overcomes positive externalities, producing higher social returns than private returns, especially through the diffusion of knowledge. On the other hand, the existence of information asymmetries inherent to innovative projects makes RDI financing risky and leads firms to underinvest (see Hall & Lerner (2010) for a review of these mechanisms).

While the need to implement RDI policies is now widely accepted, the way this policies should be design is still a matter of debate: some of the work aims to find the optimal distribution of direct support and tax incentives, but literature is not consensual on this subject. Currently, the share of tax incentives, such as tax credits, is growing strongly (OCDE, 2018). Tax schemes are often popular because of their simplicity of implementation, but their targeting of firms is less efficient. Many evaluations focus on the impact of tax incentives on RDI, and most suggest an effective impact in terms of R&D expenditures (see in particular Hall & Van Reenen (2000) and Becker (2015) for reviex of this literature). In particular, Bloom *et al.* (2002), by examining nine OECD countries over the period 1979-1997, find that lowering the R&D cost has a significant effect on R&D expenditures on the long run. However, the impact of these incentives depends on many factors, and their efficiency decreases, especially with the increase in direct support, or with the increase in the incentive itself (Guellec & Van Pottelsberghe De La Potterie, 2003). The impact of tax incentives has been assessed in many countries, such as Italy (Parisi & Sembenelli, 2003), the Netherlands (Lokshin & Mohnen, 2012), Taiwan (Yang *et al.* , 2012) and the United States (Rao, 2016). Most of these evaluations focus on the calculation of the multiplier effect of the R&D tax credit on R&D expenditures, but some go further, looking at the impact on innovation activity (Czarnitzki *et al.* , 2011).

In France, the Research Tax Credit (CIR), introduced in 1983, is the main RDI policy, representing around 6 billions euros in annual claim in 2015, i.e. about one third of total French RDI public support. Since 2008, this tax credit has been calculated based on the total volume of business R&D expenditures. Numerous evaluations of the CIR have been produced (see Salies (2017) for a recent literature review). The key question that these evaluations attempt to answer is the effect of the CIR in terms of R&D expenditures. To do this, some evaluations are based on structural models (?Mulkay & Mairesse, 2011, 2013; Lopez & Mairesse, 2019), or on methods of controlled matching (Duguet *et al.* , 2008; Lhuillery *et al.* , 2013). More recently, the impact of the reform of the policy in 2008 has been evaluated (Bozio *et al.* , 2014, 2019). These evaluations generally show that one more euro spent in CIR generates about one euro of additional R&D expenditure: there is no additionality or substitution effect. In 2010, Cahu *et al.* (2010) also estimated the impact of the CIR reform on R&D spending at 0.33 points of GDP.

Some of these studies have examined other impacts of the CIR. The effect on employment, qualified or not, has been estimated (Duguet *et al.* , 2008; Cahu *et al.* , 2010; Mulkay & Mairesse, 2011): these evaluations find a significant positive effect on employment in general, and researchers employment in particular. The impact of the CIR has also been modulated according to the amount of the claim (Lhuillery *et al.* , 2013; Marino *et al.* , 2016), highlighting in particular a lower impact for firms receiving a moderate level of support. The most recent studies have looked at more specific aspects of the impact of the CIR. On the one hand, no significant impact has been found on patents (Bozio *et al.* , 2014, 2019), but the period considered is still very short compared to the time needed to patenting. On the other hand, the impact in terms of productivity and in terms of innovation was measured according to the size of the company (Lopez & Mairesse, 2019), concluding a stronger impact on R&D expenditures for small firms, but an impact on productivity and innovation more important for larger firms.

Other French policies to RDI have been evaluated. First, the "young doctors" scheme included in the CIR has been subject of two specific evaluations (Margolis & Miotti, 2015; Giret *et al.* , 2019). These two studies find a positive effect of the policy on the employment of young doctors, but stronger for engineers (Margolis & Miotti, 2015) and without any impact in the end on the quality of employment (Giret *et al.* , 2019). The JEI policy has also been subject of three evaluations (Lelarge, 2008, 2009; S. Hallépée, 2012), which found a positive effect on employment in particular, but also a strong effect on wages (Lelarge, 2009). With regard to participation in competitiveness clusters, a positive impact on R&D expenditures was highlighted (Bellégo & Dortet-Bernadet, 2014), but this effect would be heterogeneous by type of cluster (Ben Hassine & Mathieu, 2017). More generally, other studies have focused on the overall impact of French R&D support. In particular Dortet-Bernadet & Sicsic (2015) show that R&D support have a positive effect on the qualified employment of SMEs.

In 2013, the CIR was extended to the innovation expenditures for small and medium-sized firms (SMEs) through the Innovation Tax Credit (CII). Its base consists of expenses for prototype design or pilot installation of new products, up to a limit of 400,000 euros per year per company, and its rate is 20%. In particular, staff costs and depreciation allowances are affected by this tax credit. This policy complements the CIR by promoting the economic valuation of a technology, where the CIR favored its experimental development. In its first two years of existence, the CII involved 6,261 firms, for a total amount of 203 millions euro of tax credit and an average annual claim of 22,000 euros. In 2015, it represented 155 million euros of claim.

The CII is a recent unevaluated policy. The purpose of this paper is to fill this gap, and responds to an obligation related to European legislation [1]. The evaluation mainly focuses on three types of impact. First, the initial objective of the CII is to support the development of RDI activities within firms and the creation of new products. Therefore, it is interesting to evaluate the performance of this policy on patent applications and on the number of new products manufactured by the companies, which is more difficult to identify for the CIR considering the delay between initiation of the R&D and marketing. Second, the direct impact of the CII in terms of RDI and new products should be reflected in the performance of the firms. We are therefore interested in the wider impact on business development, particularly on employment, turnover or investment. Finally, the positioning of this policy in the very dense panorama of French support to RDI is a key issue for the orientation of public policies. This is why we are interested in interactions with the CIR, in particular to study whether there has been a possible substitution between the two policies.

Section **??** describes the data used in this evaluation. Section 2 presents the policy and provides some elements relating to its evaluation; some descriptive statistics are then presented. Section 3 presents the methodology used in this evaluation: a counterfactual is constructed using propensity-score matching, and then the effect is estimated as a double difference. Finally, section 4 describes the results obtained in terms of the impact of the introduction of the CII.

## 1 Data

Our assessment is based on the use of five microeconomic databases produced by INSEE, the Ministry of National Education, Higher Education and Research (MESRI) and the Public Finance Administration (DGFIP). This section introduces them.

[1] RGEC

## 1.1 R&D tax credit data

The GECIR database, produced by the MESRI and the DGFiP, lists firms' CIR (including CII) declarations. It contains the firms that have benefited from the CIR or the CII since 2008 and the amount of the claim that has been granted each year, as well as all the information contained in the CIR declaration. Data refer to the period 2008-2014.

It is the main database of the evaluation because it defines the group of companies treated, distinguishing the companies receiving the CII, the CIR or neither. This makes it possible to build counterfactual groups in order to apply the econometric evaluation methods of the policy.

## 1.2 Firm-level accounting data

The Esane results-based file (FARE) collects statistical data on companies built by INSEE on the basis of the accounting information from the tax files and is consistent with information from annual sector surveys (ESA). These are annual data by company. In particular, they contain data relating to the balance sheet, the income statement, the investment, etc. They are available until 2016.

These data are needed for two reasons. First, they provide control variables to construct counterfactual groups with similar accounting characteristics, in accordance with standard matching procedures. Second, they provide variables of interest used in this assessment.

## 1.3 Firm-level employment data

The annual declaration of social data (DADS) is a document operated by INSEE and provided annually by each company employing employees in France. These statements include in particular detailed information on company employees: payroll, qualifications, socio-professional category, etc. These data are available until 2016.

This database is necessary in order to establish an effect of the CII on labor demand at firm level, in particular by occupations. Indeed, due to the technical nature of the R&D, one may expect a positive and significant effect on some occupations (scientific professions, engineers, technicians etc.).

## 1.4 Firm-level production survey (EAP)

Annual production surveys (EAP) have been produced by INSEE since 2008 and cover all companies in France whose main or secondary activity is manufacturing (excluding the agri-food industry). Every year, a rotating panel of about 35,000 companies is polled via the internet. These data include production volumes by product category and by firm. The term "production" refers to the quantity that a company has manufactured in a year for a given product, regardless of whether it has been sold, stored or integrated into another product.

This survey is of interest for the evaluation of the CII because it allows to determine the number of new products manufactured by a company (or by a subcontractor) each year. Yet, the aim of the CII is to help finalize the R&D (product development) process in order to commercialize it. A positive and significant effect on the number of products manufactured is therefore expected. In particular, the survey has four levels of product aggregation that allow us to refine the effect of CII on the production of new products.

## 1.5 French patent data

The *Patent atlas* is produced from raw data provided by the National Institute of Industrial Property (INPI) and derived from an extraction of the internal database of 2015 enriched by the Patstat database for European patents. Then, this database provides informations about patents applications and publications in France at the INPI (national route) and the European patent applications of the European

Patent Office (EPO) entering the French national phase. It covers the period 2003-2015 and contains information on both the applicant and the nature of the patent.

Although it does not capture all the outputs of the RDI process, the patent is an important element in understanding innovation activity, as a result of the R&D process. We used the number of patents as an indicator of business innovation activity.

# 2 Description of the CII

## 2.1 The tax-credit and its evaluation

The innovation tax credit (CII) is an extension of the research tax credit (CIR) only for SMEs, which takes into account innovation spendings related to the design of new products' prototypes. It complements the CIR by promoting the economic valorisation of a technology, where the CIR favored its experimental development. Firms may receive a tax credit of 20% on a tax-base limited at 400,000 Euros. This tax-base includes internal spending, in particular for employees and fixed assets, as well as outsourced spending. The declaration is made within the framework of the CIR.

The new product, resulting from the innovation process, must distinguish itself from reference products on the market by superior technical performances, functionalities, ergonomics or ecodesign, and this on the date of the beginning of the innovation process. In particular, process innovations or marketing innovations are excluded. Thus, the CII aims to help performance improvment of a product in order to lead it to the market, while the CIR aims to remove a technological gap by advancing the state of the art and technical knowledge. As a result, the CII appears later than the CIR in the innovation process, which plays a more upstream role. By construction, these two tax credits seem complementary.

The 2013 French Budget Bill[2] defines the CII major aim as follows: " Strengthen the competitiveness of innovative SMEs". This objective can be broken down in two ways: "to contribute to the creation of jobs by [SMEs]" and "to develop their efforts in research and innovation, which are a vector for growth and jobs". In particular, on this second point, the need for innovation efforts is illustrated by the 2011 Innovation Scoreboard of the European Union, according to which " less than a third of French SMEs have in place a product or process innovation, against 54% of German SMEs. Finally, concerning the evaluation of the tax-credit, it is mentioned that "the effect of the Innovation tax credit on firms innovative behaviour is not estimated; it is probably not estimable ex-ante."

The 2008 Treaty of Lisbon defines the concept of ***State aid*** as "state aids or using any form of State resources, that distort or threaten to distort competition by favoring some firms or productions" and declare them "incompatible with the internal market". May be exempted aids that aim a general economic development purpose, and in particular those designed to compensate market failures. That's why R&D tax-credits or subventions are concerned by the General block exemption Regulation (GBER). Nevertheless, the 2014 GBER stipulates an obligation for any State aid with an average annual budget of more than 150 millions €to define an evaluation plan, and communicate the results by 2020. Since the CII has exceeded this limit since 2015, an evaluation plan has been notified to the European Commission and this evaluation aims to comply with the European regulations.

## 2.2 Descriptive Statistics

The number of firms receiving the CII as well as the total amount of CII have increased sharply over the period 2013-2015 [3]. It reflects the gradual appropriation of the tax-credit by firms (table 1). The average claim amount is approximately 25 k€, while the median claim is 15 k€. The total amount of innovation spending declared is 635 million €in 2014: the proportion of firms reaching the innovation spending limit of 400 k€is low. Hence, the CII has an effective rate of tax credit of 19%.

[2] Examination of the first part of the draft budget law for 2013 - Volume II: General conditions of financial balance.

[3] For the year 2015, only the aggregated data are available.

Tableau 1: CII - Annual amounts of claim

| | **Number of beneficiaries** | **Total amount of claim (M€)** | **Mean claim (k€)** |
|---|---|---|---|
| 2013 | 4 094 | 83 | 20 |
| 2014 | 5 286 | 120 | 23 |
| 2015 | 5 942 | 155 | 26 |

In 2014, 94% of the CII beneficiaries and 94% of claims were concentrated in 4 sectors (table 2). Three types of activities seem to dominate: information and communication technologies, manufacturing and scientific and technical activities. Compared to the sectoral distribution of the CIR granted to SMEs, for which scientific and technical activities are the main sector (39% of the CIR granted to SMEs), ICT and manufacturing sectors are over-represented. These results are consistent with those of the CIS 2014 survey (Clement & Petrica, 2017), according to which ICT and manufacturing are the most innovative industries between 2012 and 2014.

Tableau 2: CII tax-credit in 2014 - By industry

| | **Number of beneficiaries** | **Claim** |
|---|---|---|
| ICT | 32 % | 38 % |
| Manufacturing | 30 % | 28 % |
| Scientific and technical activities | 22 % | 21 % |
| Retail | 8 % | 7 % |
| Others | 8 % | 6 % |

The total number of workers in firms that beneficiate of the CII is 119,000 in 2014. On average, these firms have 22 workers, and the median workforce is 11. This tax-credit mainly benefits SMEs with less than fifty employees, who concentrated 80% of the claim, and 46% of firms using CII have less than 10 workers. The average number of researchers and technicians reported by these firms is 4, and they represent 19% of the employment on average.

These beneficiaries have a total turnover of 18.6 billions €in 2014, almost a quarter of this turnover in realized on export (Table 3). The total value added in 2014 is 7.1 billion €.

Wages and salaries account for a relatively high share (22%) of operating spendings (this share is 17% for SMEs at national level). The markup (12%) and the investment rate (8%) are relatively low (compared to national rates by industries). The low markup can be explained by markets that are not mature enough because they are innovative, and the low investment rate by an intangible sectoral distribution. The debt ratio is relatively low (40%), which shows that these companies mainly finance themselves in equity, but the median financial profitability remains high (14%).

## 3 Methodology

In this section, we will describe the methodology we have set up, which draws on the classic methods of public policies evaluation ((Givord, 2014)).

Tableau 3: Accounting data (k€) for beneficiaries of the CII in 2014

| **Variable** | Mean | Median | Standard error |
|---|---|---|---|
| Turnover | 3 576 | 1 246 | 6 092 |
| EBITDA | 158 | 39 | 1 086 |
| Value Added | 1 366 | 593 | 2 217 |
| Net assets | 3 228 | 1 248 | 7 593 |
| Export rate | 22 % | 2 % | 0 |
| Markup | 12 % | 12 % | 55 |
| Investment rate | 8 % | 2 % | 4 |
| Debt ratio | 40 % | 21 % | 38 |
| Financial profitability | 6 % | 14 % | 35 |

## 3.1 Empirical strategy

When assessing the effect of a tax-credit on various outputs, the basic comparison of the evolution of these outputs for the beneficiaries and the non-beneficiaries is not sufficient. Indeed, the fact that a firm is a beneficiary of the tax-credit may reveal a bias: the most dynamic firms may be particularly inclined to look for a tax credit. In order to correct this selection bias, methods controlling the observable differences between beneficiaries and non-beneficiaries have been developed.

In this paper, treated firms ($T_i = 1$) are defined as those reporting CII in 2013 or 2014 and untreated ($T_i = 0$) as those which did not. We use accounting data, employment data, patent and CIR tax-credit data to control for observable differences between beneficiaries (treated) and non-beneficiaries (untreated), in order to identify a caucal effect of the CII tax-credit. Then, we want the conditional independence assumption to be verified:

$$Y_i^{T_i=1}, Y_i^{T_i=0} \perp T_i | X_i,$$

where $(X_i)_i$ is a vector of observables and $Y_i$ a variable of interest.

To do this, we use observable data matching methods, which allow us to build a control group that is statistically close to the treated firms. This control group will allow us to estimate the effect of the tax-credit on the treated firms, by comparing the difference in evolution of the variable of interest between the two groups after the implementation of the treatment. Because of the large number of different data and in order to use as much information as possible to create a control group, we use propensity score matching, as presented in (Rosenbaum & Rubin, 1983). The propensity score is defined as the probability of being treated, conditionally to the observable characteristics $p(X_i) = mathbbP(T_i = 1|X_i)$. Rosenbaum & Rubin (1983) shows that if the output variable $Y_0$ is independent of the access to the treatment $T$ conditionally to the observables $X$, then it is also independent of $T$ conditionally to the propensity score $p(X)$. The matching method then consists of matching treated firms with untreated firms with similar propensity scores.

## 3.2 Construction of the control group

The CII is a tax-credit with the specificity to be intended for firms likely to carry out an innovation activity. This ability to easily enter into an innovation process can not be observed empirically. In order to constitute a counterfactual group of firms of this type, we limit our pool of potentially selected firms to CIR beneficiaries at least once between 2009 and 2012 and / or appearing in the *R&D survey* at least once between 2004 and 2012. The *R&D survey* is built to select only firms carrying out R&D activities by identifying them via the aid schemes to which they are attached (CIR, ANR, JEI, etc.). The presence of a firm in this survey reflects its proximity to the innovation process.

The propensity score is estimated from a logit model:

$$\hat{p}(X) = \frac{1}{1 + e^{-\hat{\beta}X - \hat{\Gamma}}}.$$

We enrich the specification of the model by a set of interaction terms between the observable variables $X_i$ in level in 2012 and in evolution over the period 2009-2012. This allows us to add a dynamic dimension to the construction of the control group, the firms benefiting from the tax credit being SMEs likely to have dynamic changes in their activity or their workforce. More precisely, for a set of $N$ observable variables $X_i$, if $\Delta_i$ represents the evolution of the variable $X_i$ over the period 2009-2012:

$$\hat{\Gamma} = \left( \sum_{i=1}^{N} \hat{\gamma}_i^1 \Delta_i + \sum_{i=1}^{N} \hat{\gamma}_i^2 X_i \Delta_i + \sum_{i \neq j} \hat{\gamma}_{ij}^3 X_i X_j \Delta_i \Delta_j \right)$$

The set of control variables used is detailed in the table 4. These controls include traditional variables relating to employment, accounting data and intrinsic characteristics (sector, age) of firms. Because the CII is an extension of the CIR, the propensity to report an CII may be strongly related to reporting the CIR, which is why we control by the amount of CIR reported and an indicator identifying firms reporting the CIR. Finally, we also control the number of patents filed and membership of a multi-firm entity (tax group).

Tableau 4: Control variables for propensity score estimation

| **Variable** | **Specification** | **Source** |
|---|---|---|
| Employment | Level 2012 and increase 2009-2012 | DADS |
| Share of R&D employment | Level 2012 and increase 2009-2012 | DADS |
| Turnover | Level 2012 and increase 2009-2012 | FARE |
| Liabilities | Level 2012 and increase 2009-2012 | FARE |
| Debt ratio | Level 2012 and increase 2009-2012 | FARE |
| Investment rate | Level 2012 and increase 2009-2012 | FARE |
| EBITDA | Level 2012 and increase 2009-2012 | FARE |
| Industry | qualitative variable | FARE |
| Year of creation | quantitative variable | FARE |
| tax group | dummy variable | LIFI |
| Number of patents | Mean and increase 2009-2012 | MESRI |
| CIR amount | Total amount over 2009-2012 | GECIR |
| Beneficiary of the CIR | Dummy variable | GECIR |

Once the propensity score is calculated, the control group includes, for each treated firm, the untreated firm with the nearest propensity score in absolute value (other matching methods, associating more than one unprocessed firm to a treated company, have been tested). Balance tests allow us to check the quality of the matching. Quantin (2018) refers in particular to the standardized difference in means between treated and counterfactual groups before and after pairing:

$$\frac{\overline{X_t} - \overline{X_c}}{\sqrt{\frac{s_t^2 + s_c^2}{2}}}$$

where $\overline{X_t}$ and $\overline{X_c}$ correspond respectively to the means of the variable $X$ in the treated group and the counterfactual group, while $s_t^2$ and $s_c^2$ are the variances within these two groups for the $X$ variable. The standardized difference in means is implemented in particular because it does not depend on the size of the sample, unlike the statistical tests on the average difference. Matching significantly reduces the size of the counterfactual, so a measure to get away from the sample size seems essential. Quantin (2018) also suggests comparing pre- and post-match variance ratios to more closely analyze covariate distributions. The thresholds of 0.2 and 2 are often retained to consider the balancing property as verified, respectively for the standardized difference in means and the ratio of variances (Rubin, 2001).

## 3.3 Estimations

Once the groups are built, we use the difference difference method. The specification adopted is:

$$\log Y_{it} = \alpha + \beta_t T_{it} + \mu_t + \lambda_i + \epsilon_{it}, \tag{1}$$

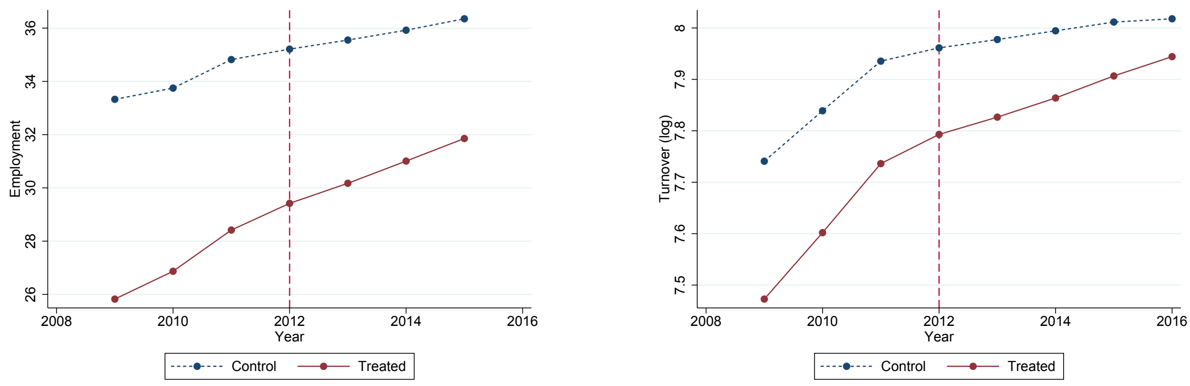
where $T_{it}$ corresponds to the fact that the firm $i$ belongs to the treated group and that the observation is taken in the year $t$. In order to measure the cumulative effect with respect to the year of implementation of the $t_0$ treatment, the variable $T_{i,t_0-1}$ is omitted from the regression. This specification has two interests. First, it makes it possible to estimate the average effect of the treatment on the treaties each year: one can thus identify delays for the effects of the device over time. Secondly, it makes it possible to verify that the treatment has no effect before the implementation of the tax-credit, and thus to verify the common trend, important hypothesis in the differences of difference models. In addition, the term $\lambda_i$ controls unobservable and time-stable characteristics for each firm, and the temporal fixed effect $\mu_t$ controls the temporal and unobservable heterogeneity that could affect all firms. The coefficient $\beta_t$ thus measures the causal effect of the treatment in the year $t$.

## 3.4 Data processing

In order to avoid firms dynamics effects (creation or destruction of firms during the study period), we focus on the treated firms for which we can obtain a panel over 2009-2015 made up of these variables. The choice of 2009 as the first year of our panel results from an balance between a number of years before the creation of the CII (i) sufficient to test the hypothesis of common tendency between the group treated and the counterfactualand (ii) small enough to keep a sufficiently large number of treated. We thus finally obtain a balanced panel over the period 2009-2015, with one more year for tax data, as DADS 2016 is not available.

Strictly positive variables (employment, turnover) are considered in logarithmic, just like the total amount of CIR between 2009 and 2012. Intensive variables (share of R&D employment, debt ratio , investment rate) are used without reprocessing. R&D employment is defined as Engineers and technical managers and Technicians. Only firms with a positive (or equal to 0) investment rate and debt ratio are considered. EBITDA takes positive or negative values. In this case, annual deciles are constructed. Finally, other variables (year of creation, tax group, industry, number of patents, CIR between 2009 and 2012) are used without reprocessing.

Graphique 1: Évolution des variables dans les deux groupes




(a) Employment (b) Turnover

Figure 1 shows the evolution of employment and turnover for treated group (in red) and in the counterfactual *pool* described above (in blue). While the common trend seems almost respected for turnover, a selection of a better counterfactual seems necessary regarding employment.

# 4 Impact of the CII

## 4.1 Impact on economic development

Before attempting to estimate the impact, we will describe the matching. First of all, the preparation of the data is not without consequences. The table 5 describes the companies that before (Raw data) and after (Final data) cleaning process. Cleaning process reduces the number of treated firms from 6003 to 2929. The selected firms are on average older. In addition, all the economic characteristics presented in the table have a greater magnitude in the final sample than in the raw sample. Finally, the average amount of CIR in 2012 is slightly larger in the final sample than in the raw sample.

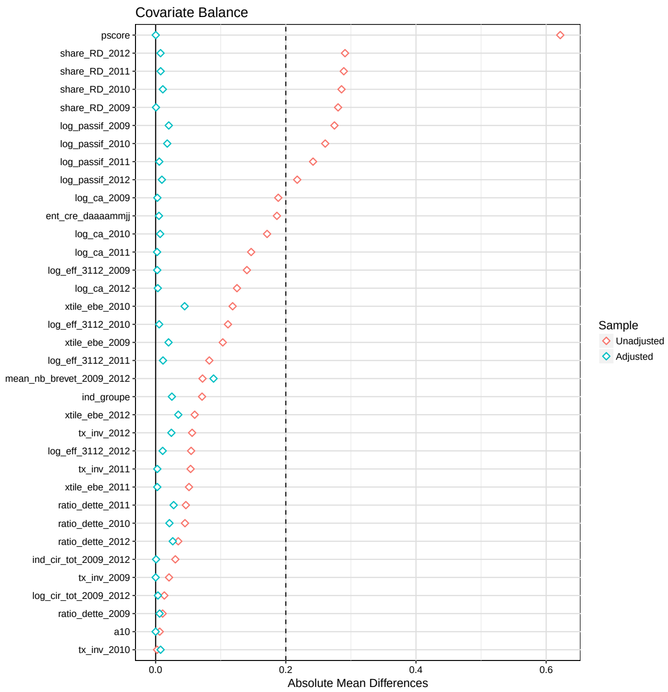
Tableau 5: Descriptive statistics for the treated

| | (1) *Raw data* | | | | (2) *Final data* | | | |
|---|---|---|---|---|---|---|---|---|
| | Obs. | Mean | SE | Median | Obs. | Mean | SE | Median |
| Turnover | 6003 | 3545 | 6381 | 1197 | 2929 | 4922 | 6279 | 2509 |
| EBITDA | 6003 | 178 | 924 | 44 | 2929 | 357 | 813 | 129 |
| Employment | 6003 | 22 | 33 | 10 | 2929 | 29 | 34 | 17 |
| Debt | 6003 | 507 | 1637 | 99 | 2929 | 519 | 1017 | 150 |
| Equity | 6003 | 1324 | 5869 | 362 | 2929 | 1684 | 2707 | 751 |
| Investment | 6003 | 107 | 577 | 12 | 2929 | 139 | 389 | 27 |
| Year of creation | 6003 | 1998 | 14 | 2003 | 2929 | 1993 | 15 | 1997 |
| Amount of CIR | 6003 | 53 | 137 | 17 | 2929 | 55 | 101 | 24 |

Notes : Data for 2012.

A 1:1 matching is performed on the estimated propensity score, with an additional condition of strict equality of industries. The assumption of common support before matching is verified (see the graph 6 in appendix). The figure 2 presents the balance checks of the matching for all the variables described in the table 4, for 2009-2012. Absolute mean differences between the two groups is presented for each variable before and after matching. Balance for all observables pre-treatment is well verified.

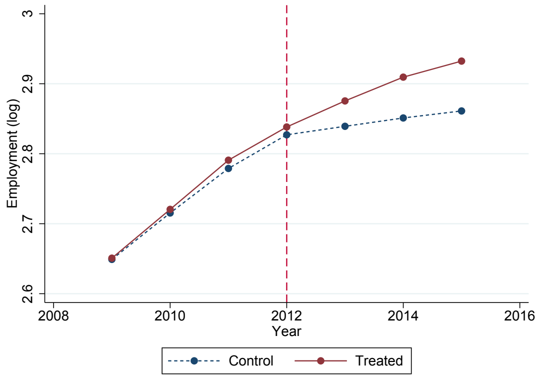
Graphique 2: Absolute mean differences before and after matching



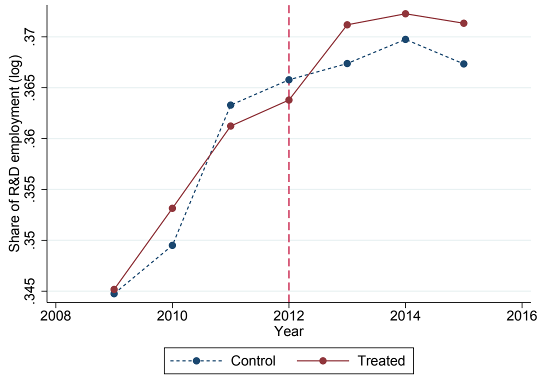

**Notes**: For each variable, the absolute mean differences between treated and counterfactual groups are in red before matching, and for blue after. The dotted line at 0.2 corresponds to the maximum difference recommended by Rubin (2001).

We can now focus on the effect of the tax-credit on variables of interest, using the methodologies described in section 3.3. The table 6, which refers to the regression equation 1, and the figure 3, present these results.

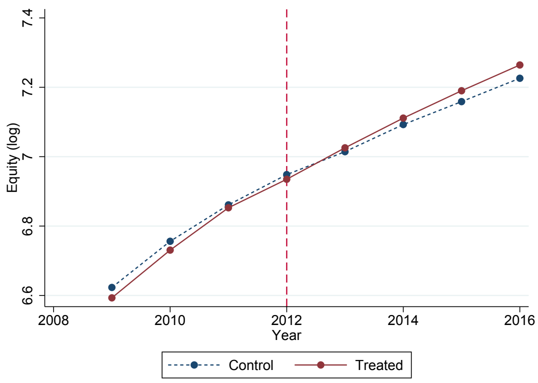
Graphique 3: Evolution of output variables



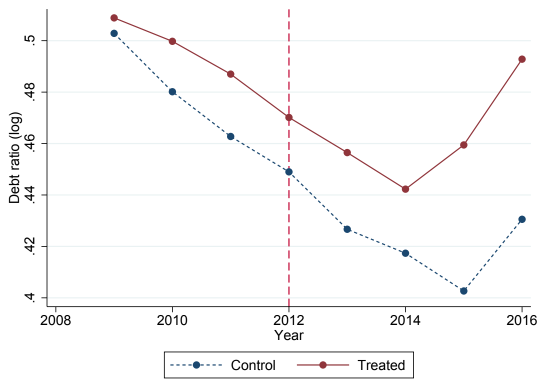

(a) Employment



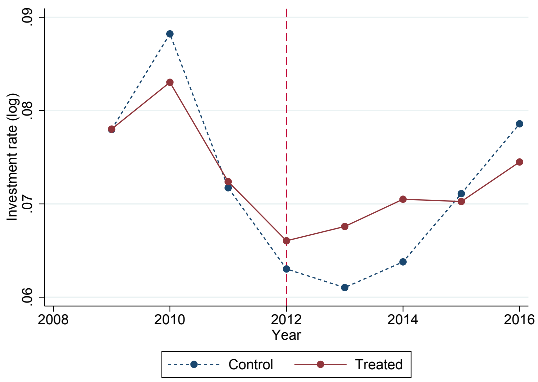

(b) Share of R&D employment



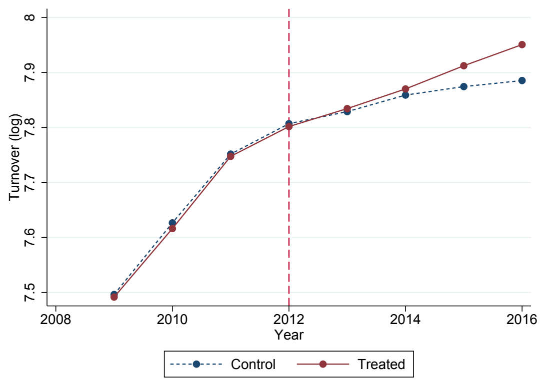

(c) Liabilities




(d) Debt ratio




(e) Investment rate




(f) Turnover

Each column corresponds to a different variable of interest: employment, share of R&D employment, liabilities, debt ratio, investment rate and turnover. It is recalled that these regressions take into account year and firms fixed effects. The coefficients presented correspond to the ATT, for a given year $t$. The last year before the implementation of the treatment (2012), used as a reference, is therefore absent from the table presented. The first three rows of this table are used to test the common pre-treatment trend hypothesis on the six variables of interest. The non-significance of the coefficients $T_{i,2009}$ that the common pre-treatment trend hypothesis on 2009-2012 is well respected between treated and counterfactual groups. We also note that this common trend hypothesis is also verified for 2010-2012 and 2011-2012.

Tableau 6: Economic Impact

| | (1) Employment | (2) Share of R&D employment | (3) Liabilities | (4) Debt ratio | (5) Investment rate | (6) Turnover |
|---|---|---|---|---|---|---|
| $T_{i,2009}$ | -0.00941 | 0.00241 | -0.0166 | -0.0151 | -0.00298 | 0.000534 |
| | (0.0116) | (0.00516) | (0.0155) | (0.0236) | (0.00845) | (0.0131) |
| $T_{i,2010}$ | -0.00600 | 0.00563 | -0.0121 | -0.00155 | -0.00821 | -0.00513 |
| | (0.00883) | (0.00462) | (0.0115) | (0.0214) | (0.0193) | (0.00976) |
| $T_{i,2011}$ | 0.000657 | -0.0000703 | 0.00497 | 0.00309 | -0.00237 | 0.00111 |
| | (0.00649) | (0.00356) | (0.00823) | (0.0168) | (0.00612) | (0.00654) |
| $T_{i,2013}$ | 0.0251*** | 0.00580* | 0.0245*** | 0.00866 | 0.00352 | 0.0108* |
| | (0.00619) | (0.00339) | (0.00765) | (0.0171) | (0.00390) | (0.00632) |
| $T_{i,2014}$ | 0.0472*** | 0.00451 | 0.0320*** | 0.00376 | 0.00369 | 0.0164* |
| | (0.00842) | (0.00386) | (0.0105) | (0.0203) | (0.00528) | (0.00857) |
| $T_{i,2015}$ | 0.0601*** | 0.00599 | 0.0447*** | 0.0356* | -0.00387 | 0.0432*** |
| | (0.0102) | (0.00425) | (0.0131) | (0.0215) | (0.00513) | (0.0112) |
| $T_{i,2016}$ | | | 0.0516*** | 0.0411 | -0.00711 | 0.0706*** |
| | | | (0.0150) | (0.0253) | (0.00606) | (0.0144) |
| Constant | 2.833*** | 0.365*** | 6.942*** | 0.460*** | 0.0645*** | 7.804*** |
| | (0.00231) | (0.00124) | (0.00318) | (0.00613) | (0.00189) | (0.00260) |
| Observations | 40152 | 40152 | 45888 | 45888 | 45888 | 45888 |
| $R^2$ | 0.100 | 0.007 | 0.254 | 0.002 | 0.001 | 0.164 |

Standard errors in parentheses.

$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

First, we are interested in effects on employment. Indeed, 93 % of the expenditure declared under the CII in 2014 are personnel costs. Column (1) of the table 6 focuses on the impact in terms of total employment. A significant effect on employment is observed in the first year of implementation of the tax-credit. This average cumulative effect on employment, however, increases over time, from 2.5% in 2013 to 4.7% in 2014 and 6.0% in 2015. Column (2) describes the evolution of the share of R&D employment. There is also an immediate effect for CII beneficiaries, with an increase of 0.6 percentage points as of 2013. The effect for 2014 and 2015 is no longer significant. We therefore seem to observe an increase in the share of R&D employment in very short terms, which is not maintained over time. Then, R&D employment growth at the same rate as total employment.

If this effect on employment was expected, what about other variables of economic development of firms, and in particular financial variables? Column (3) shows the effect on the liabilities. As with employment, there is an immediate and progressive effect over time, rising from 2.5% in 2013 to 5.2% in 2016. This increase in business resources can reflect different economic realities: an increase the debt of the treated firms, an increase in their equity, or a joint increase in debt and equity. We return in more detail on this point thereafter. In order to decide between these three possibilities, the column (4) concerns precisely the debt ratio, defined as the ratio between debt and equity. We observe a significant effect on this variable for the year 2015 and not significant for the other years. This leads us to the third hypothesis: the increase in the size of the liabilities of the beneficiaries reflects a joint growth in the level of debt and equity.

So far, the effects presented have been immediate effects that have amplified over time. Finally, let us focus on two variables on which an eventual effect is expected in the long term: the investment rate and the turnover. Column (5) presents the estimate on the investment rate. There is no effect on this variable. The investments considered in the numerator are gross tangible investments, intended to be used by the company over the long term for its production (technical installations, equipment, tools, etc.). The fact of not observing any effect on this variable suggests that the CII does not generate investment, either in the short term or in the long term, regarding the means of production of the treated.

Finally, column (6) concerns the effects on turnover. As for employment, we note a positive and progressive effect in its magnitude. From 1.1% in 2013, this effect increases to 7.1% in 2016. It seems that the beneficiaries of the CII increase their sales volume of goods and services. The increase in the magnitude of the effect over time can come from the time required to make a prototype, and then to the placing on the market of a new product.

**Robustness**

The estimates presented in the table 6 have the advantage of being carried out on a balanced panel over the period 2009-2015 for the employment variables, and 2009-2016 for the accounting variables. This dataset was obtained by making two concessions: (i) significantly reducing the number of observations processed, as shown in the table 5, and (ii) looking at some of the intensive variables (rate indebtedness, investment rate) rather than monetary variables (debt, investment). In order to test the robustness of our results, we will focus directly on the variables of interest. We will therefore consider total employment, debt, equity, investment and turnover. All these variables are considered in logarithm, which has the consequence of translating an effect to the intensive margin only. For example, a beneficiary company with zero pre-pay debt but a loan from CII will not be considered in the regression. We are simply imposing a condition on the presence of total employment data and turnover for 2009-2015. From this database, we perform the matching again to obtain the counterfactual group. Balance checks are presented in the figure 7. The table 10 shows the results.

Another way to test the robustness of the results obtained is to match each treated firm, not with a counterfactual company but with several counterfactual firms. The tables 11 and 12 correspond respectively to the results obtained by performing matching on 2 and 3 nearest neighbors for each treated firm. The common trend tests on 2009-2012 on the six variables of interest are verified. The results obtained are very similar to those presented in the table 6, which reflects a robustness of the results presented previously. It should be noted, however, that with 2 or 3 nearest neighbors, we observe a positive effect on the share of R&D employment, in addition to the positive effect on employment.

Finally, we add in the matching process a strict condition on the fact that a company has been a beneficiary of the CIR at least once between 2009 and 2012, in addition to the strict matching condition on industry. This condition makes it possible to clearly differentiate the intensive margin of the tax-credit, that is to say the beneficiaries already present in the tax-credit before the extension to innovation spending (CII), of the extensive margin of the tax-credit, that is to say the new firms that enter the tax-credit via the CII. The results of the regressions, always obtained from the equation 1, are presented in the table 13 in the appendix. Again, the results are similar to those presented above.

## 4.2 Impacts on innovation

The previous section examined the effects of CII on broad economic development variables. With the exception of R&D employment, these variables are not directly related to the implementation of an innovation process within companies. This is why we are now interested in the impact of the CII on the RDI activity of its beneficiaries.

Patenting is a possible output for the innovation activity promoted by the CII, and as such, patent defense spending are eligible. If it does not capture all the innovation activity of a company, it still remains an interesting indicator. As we saw earlier, the average annual number of patents filed over the period 2009-2012 is one of the variables used in the calculation of the propensity score allowing the realization of matching. Patent filing is a one-time event that does not necessarily happen every year for many companies, and in particular for CII beneficiaries that are SMEs. We keep the same matching as in the part 4.1. The number of application of patents is considered directly in level in the regression equation, which is written:

$$Y_{it} = \ alpha + \ beta_t T_{it} + \ mu_t + \ lambda_i + \ epsilon_{it},$$

where $Y_{it}$ is the number of applications of patents by the firm $i$ in $t$.

Tableau 7: Impact on patents

| | Brevets |
|---|---|
| $T_{i,2007}$ | -0.00771 |
| | (0.0131) |
| $T_{i,2008}$ | -0.00354 |
| | (0.0121) |
| $T_{i,2009}$ | -0.00528 |
| | (0.0114) |
| $T_{i,2010}$ | 0.00312 |
| | (0.0115) |
| $T_{i,2011}$ | 0.0244** |
| | (0.0117) |
| $T_{i,2013}$ | 0.00905 |
| | (0.0118) |
| $T_{i,2014}$ | 0.00662 |
| | (0.0128) |
| $T_{i,2015}$ | 0.0143 |
| | (0.0129) |
| Constant | 0.0870*** |
| | (0.00412) |
| Observations | 51624 |
| $R^2$ | 0.002 |

Erreur type entre parenthèses.
$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

The results of this regression are shown in the table 7. The common trend assumption is observed over the periods 2007-2012, 2008-2012, 2009-2012 and 2010-2012, since no coefficient is statistically significant. However, there is no impact of the CII on patent applications after 2013. This lack of effect must be put into perspective because many treated firms do not make patent applications during the period. Of the 2929 beneficiary companies presented in the final sample of the table 5, only 24%, made at least one patent application between 2007 and 2015.

Graphique 4: Evolution of patents

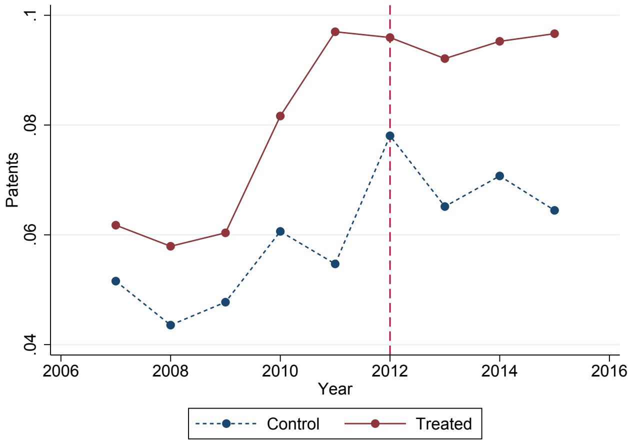



Figure 4 presents the evolution of the number of patent applications for treated and counterfactual groups between 2007 and 2015.

## 4.3 Impact on products

The 2013 French Budget Bill, introducing the CII, insists on the importance of *"strengthening the competitiveness of innovative SMEs [...] by a targeted measure allowing them to benefit from the CIR as expenditure for prototype realization of new product design"*. Beyond the expected effect on employment, the intended purpose of the CII was the development of new products by the treated firms.

In order to focus on the production of new products by firms, we mobilize the data of the *Annual Production Surveys (EAP)*, described above. The EAP survey data covers several levels of product information. Namely, the nomenclature in which the products manufactured are classified has four levels of reading, of which we study the three finest (product, class of products and group of products), from the finest to the most aggregated. Let us illustrate these different levels by an example: where the finest level of the nomenclature, the level ( textsl Product), will distinguish the *"Linen fabrics containing> = 85 % by weight of linen"* from *"Linen fabrics containing <85% by weight of linen"*, the level of aggregation directly above, the level (*Class of products*), will not differentiate fabrics made from linen fabrics made from wool or cotton by grouping them in the class *"Fabrics"*. The *Group of product* level will be very close to the *Class of products* level. We tested an indicator of new products at the three levels of the classification. In addition, in order to carry out a homogeneous monitoring of the products, we constitute stable product envelopes at the finest possible level, to abstract us from the PRODFRA nomenclature evolutions issues. In fact, the nomenclature has to change from year to year, and we have formed groups of products to avoid being skewed by these nomenclature changes.

Since EAP surveys only concern firms in manufacturing, we focus on manufacturing, which naturally reduces our number of observations in the treated group. In addition, we impose the condition of presence of companies every year between 2009 and 2016 in order to obtain, as in the previous sections, a balanced panel. These beneficiary companies are described in the table 8. Among the companies treated in general, and presented in the table 5, their economic characteristics are globally of greater magnitude. For example, the average employment in industry is 49, when it is 31 in all industries. The treated firms have an average of 2 products in 2012.

Tableau 8: Descriptive statistics for treated - Manufacturing

| | Obs. | Moy. | Éc-typ. | Méd. |
|---|---|---|---|---|
| Chiffre d'affaires | 820 | 8563 | 7123 | 6399 |
| Excédant brut d'exploitation | 820 | 598 | 1088 | 282 |
| Emploi | 820 | 49 | 38 | 39 |
| Endettement | 820 | 923 | 1274 | 460 |
| Capitaux propres | 820 | 2976 | 3486 | 1764 |
| Investissement | 820 | 272 | 500 | 106 |
| Date de création | 820 | 1983 | 19 | 1988 |
| Montant de CIR | 820 | 61 | 96 | 32 |
| Nombre de produits | 820 | 2 | 2 | 2 |
| Nombre de classes de produits | 820 | 2 | 1 | 1 |
| Nombre de groupes de produits | 820 | 2 | 1 | 1 |

Notes : Données comptables et d'emploi pour l'année 2012.

As in the previous sections, we perform a matching on all the economic variables presented in the 4.1 section and described in the table 4, to which we add the number of products manufactured by the firm. Balance check before and after matching is presented in the figure **??** in appendix. As with the impact assessment on patents, we then estimate the effect via the following equation:

$$Y_{it} = \alpha + \beta_t T_{it} + \mu_t + \lambda_i + \epsilon_{it}$$

where $Y_{it}$ is the number of products manufactured by the firm $i$ in $t$.

The results of these regressions are presented in the table 9. Each column examines the effect on the products, but at three different levels of definition of the product concept. Above all, whatever the level of aggregation considered, we can see that the common trend hypothesis between treated group and counterfactual group is well verified for 2009-2012, 2010-2012 and 2011-2012. Column (1) shows the effect at the *Product* level. A significant effect is observed in 2014, which disappears in 2015, and again in 2016, by 0.12 additional products manufactured on average by the beneficiary companies. Columns (2) and (3) present the results for aggregation levels *Class of products* and *Group of products*, respectively. The effect is significant in 2014, 2015 and 2016 to reach respectively 0.09 additional class of products and 0.08 additional group of products for treated firms.

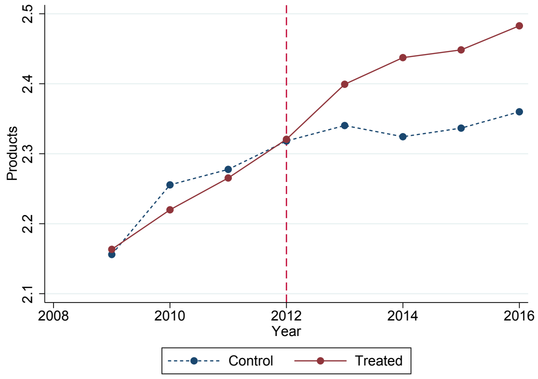
Tableau 9: Impact on products

| | (1) Products | (2) Classes of products | (3) Groups of products |
|---|---|---|---|
| $T_{i,2009}$ | 0.00491 | 0.00614 | 0.0147 |
| | (0.0588) | (0.0282) | (0.0267) |
| $T_{i,2010}$ | -0.0381 | -0.0172 | -1.81e-16 |
| | (0.0433) | (0.0257) | (0.0239) |
| $T_{i,2011}$ | -0.0147 | -0.0160 | 0.00369 |
| | (0.0294) | (0.0202) | (0.0194) |
| $T_{i,2013}$ | 0.0565 | 0.0246 | 0.0172 |
| | (0.0489) | (0.0252) | (0.0224) |
| $T_{i,2014}$ | 0.111* | 0.0553* | 0.0455* |
| | (0.0569) | (0.0293) | (0.0268) |
| $T_{i,2015}$ | 0.109 | 0.0872*** | 0.0737** |
| | (0.0667) | (0.0326) | (0.0300) |
| $T_{i,2016}$ | 0.120* | 0.0897** | 0.0762** |
| | (0.0705) | (0.0358) | (0.0331) |
| Constant | 2.319*** | 1.604*** | 1.548*** |
| | (0.0165) | (0.00864) | (0.00805) |
| Observations | 13024 | 13024 | 13024 |
| $R^2$ | 0.012 | 0.028 | 0.028 |

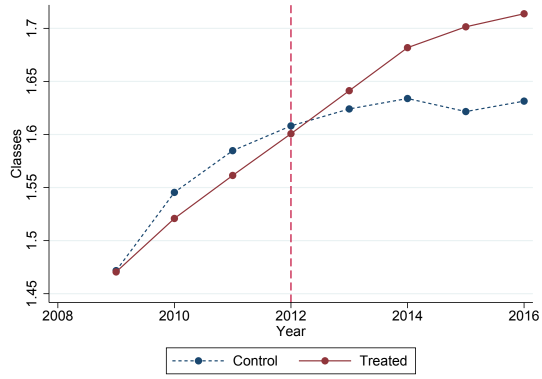
Standard errors in parentheses.
$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Finally, beyond the presence of an effect on the number of products at the lowest nomenclature level, columns (2) and (3), which group the products at a more aggregated level have a significant and persistent effect over 2014-2016. This effect reflects the ability of treated firm to offer additional products quite different from the products they offered before the introduction of the tax-credit, otherwise we would observe only an effect at the finest level. Finally, this last result table suggests that the CII did have an effect on the manufacture of new products, which was the initial objective of the tax-credit. This is, to our knowledge, the first time that such an effect is highlighted on a R&D or innovation tax-credit.

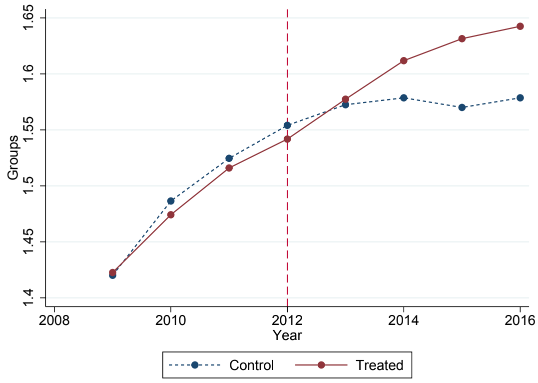
Graphique 5: Number of products evolution




(a) *Products*




(b) *Class of products*




(c) *Group of products*

The figure 5 shows the evolution of the number of products according to the three levels described above. A break in the trend for the treated group before and after the tax-credit is clearly observed, regardless of the level studied in the nomenclature.

## Conclusion

The extension of the CIR to innovation spending (CII) aims to promote the marketing of new products by SMEs. Its evaluation has specific features: in particular, it is not necessarily expected a direct effect on R&D spending, but more on indicators of innovation activity of companies. We estimate the effect of the introduction of CII using propensity score matching methods.

We considered three kinds of impact. First, we showed that the introduction of the CII had a significant positive impact on employment, total and R&D, in the short term and on long-term turnover. These effects were relatively expected, given that the share of labor costs among innovation expenditure reported under the CII is preponderant, and that the introduction of new products on the market should generate turnover growth. The introduction of the CII also had a positive impact on debt and equity of treated firms, which shows that they sought to finance the expansion of their activity. However, no impact on the investment was found.

Next, we looked at indicators that directly measure the innovation activity of companies: patents and new products. If we do not find a significant positive effect of the introduction of CII on the number of patent applications, we observe an effect on the number of products manufactured by its beneficiaries. This is, to our knowledge, the first time that such an effect is highlighted on a tax credit designed to help innovation.

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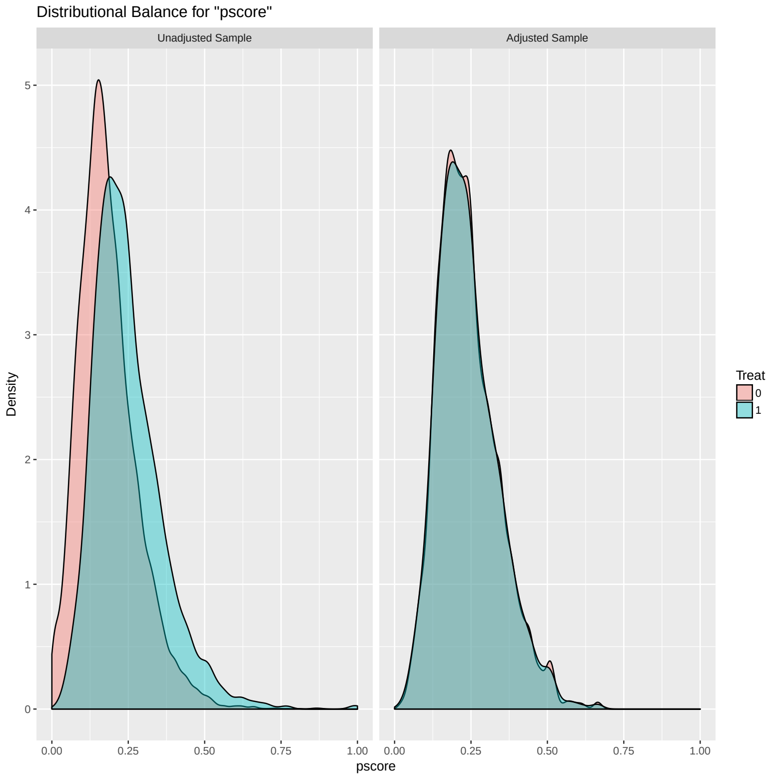
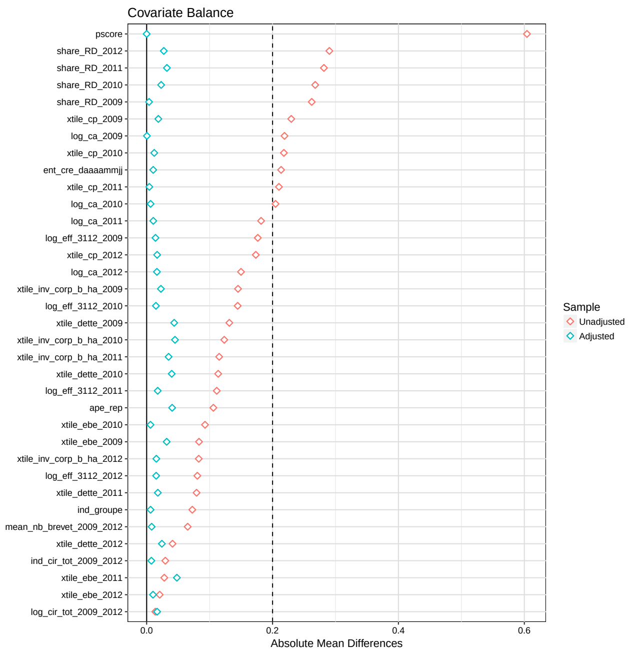
# A Additional figures

Graphique 6: Propensity score distribution



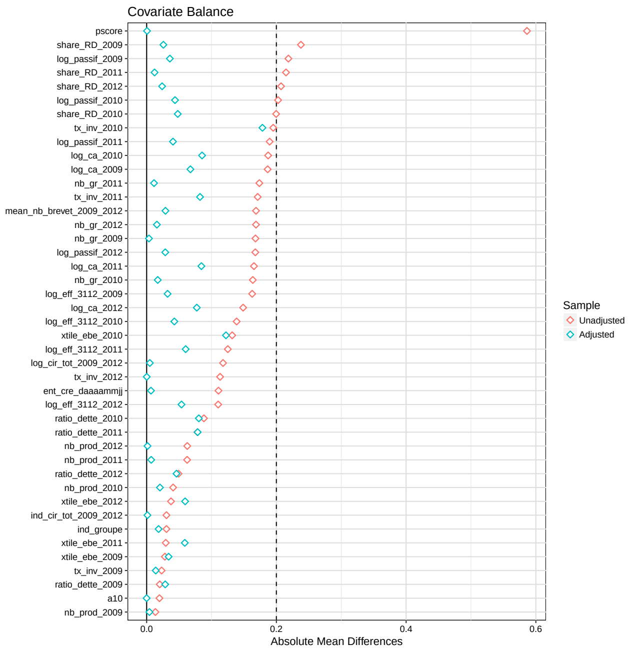

**Notes**:

Graphique 7: Balance check




**Notes**:

Graphique 8: Balance check - Products




**Notes**:

# B Additional tables

Tableau 10: Estimations

| | (1) Employment | (2) Debt | (3) Equity | (4) Investment | (5) Turnover |
|---|---|---|---|---|---|
| $T_{i,2009}$ | -0.000609 | -0.0670 | 0.00256 | -0.0131 | -0.0223 |
| | (0.0111) | (0.0448) | (0.0203) | (0.0411) | (0.0144) |
| $T_{i,2010}$ | -0.000349 | -0.0386 | -0.0226 | 0.0216 | -0.0126 |
| | (0.00872) | (0.0403) | (0.0197) | (0.0398) | (0.0108) |
| $T_{i,2011}$ | 0.00280 | 0.0114 | -0.0132 | -0.0151 | -0.00724 |
| | (0.00628) | (0.0325) | (0.0129) | (0.0362) | (0.00771) |
| $T_{i,2013}$ | 0.0295*** | 0.124*** | 0.0704*** | 0.0963*** | 0.0217*** |
| | (0.00598) | (0.0317) | (0.0190) | (0.0358) | (0.00684) |
| $T_{i,2014}$ | 0.0462*** | 0.163*** | 0.0542*** | 0.0516 | 0.0234** |
| | (0.00808) | (0.0392) | (0.0152) | (0.0385) | (0.00915) |
| $T_{i,2015}$ | 0.0608*** | 0.221*** | 0.0402** | 0.00942 | 0.0274** |
| | (0.0108) | (0.0438) | (0.0177) | (0.0406) | (0.0116) |
| $T_{i,2016}$ | | 0.274*** | 0.0672*** | -0.0229 | 0.0298** |
| | | (0.0491) | (0.0200) | (0.0434) | (0.0140) |
| Constant | 2.771*** | 4.951*** | 6.482*** | 3.369*** | 7.673*** |
| | (0.00228) | (0.0123) | (0.00488) | (0.0125) | (0.00281) |
| Observations | 52584 | 55088 | 56121 | 53268 | 60005 |
| $R^2$ | 0.070 | 0.022 | 0.113 | 0.012 | 0.128 |

Standard errors in parentheses.

$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Tableau 11: Estimations - 2 nearest neighbors

| | (1) Employment | (2) Share of R&D employment | (3) Liabilities | (4) Debt ratio | (5) Investment rate | (6) Turnover |
|---|---|---|---|---|---|---|
| $T_{i,2009}$ | -0.0124 | 0.0000869 | -0.0174 | -0.00825 | 0.000963 | 0.00367 |
| | (0.00987) | (0.00446) | (0.0132) | (0.0205) | (0.00684) | (0.0112) |
| $T_{i,2010}$ | -0.00728 | 0.00146 | -0.0164* | 0.0131 | -0.0111 | -0.00877 |
| | (0.00751) | (0.00400) | (0.00992) | (0.0184) | (0.0179) | (0.00837) |
| $T_{i,2011}$ | -0.00178 | 0.00224 | -0.00407 | 0.00115 | -0.00516 | 0.00114 |
| | (0.00547) | (0.00316) | (0.00692) | (0.0148) | (0.00592) | (0.00562) |
| $T_{i,2013}$ | 0.0244*** | 0.00826*** | 0.0300*** | 0.00744 | 0.00239 | 0.00951* |
| | (0.00535) | (0.00299) | (0.00655) | (0.0135) | (0.00361) | (0.00544) |
| $T_{i,2014}$ | 0.0462*** | 0.00867** | 0.0406*** | 0.00670 | 0.00690 | 0.0186** |
| | (0.00715) | (0.00341) | (0.00888) | (0.0167) | (0.00496) | (0.00740) |
| $T_{i,2015}$ | 0.0603*** | 0.00725* | 0.0519*** | 0.0178 | -0.00142 | 0.0434*** |
| | (0.00865) | (0.00377) | (0.0112) | (0.0186) | (0.00474) | (0.00959) |
| $T_{i,2016}$ | | | 0.0635*** | 0.0194 | -0.00121 | 0.0706*** |
| | | | (0.0129) | (0.0220) | (0.00538) | (0.0119) |
| Constant | 2.848*** | 0.363*** | 6.954*** | 0.453*** | 0.0655*** | 7.819*** |
| | (0.00180) | (0.00100) | (0.00261) | (0.00478) | (0.00159) | (0.00215) |
| Observations | 59297 | 59297 | 67768 | 67768 | 67768 | 67768 |
| $R^2$ | 0.093 | 0.005 | 0.237 | 0.002 | 0.001 | 0.155 |

Standard errors in parentheses.
$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Tableau 12: Estimations - 3 nearest neighbors

| | (1) Employment | (2) Share of R&D employment | (3) Liabilities | (4) Debt ratio | (5) Investment rate | (6) Turnover |
|---|---|---|---|---|---|---|
| $T_{i,2009}$ | -0.00730 | -0.000956 | -0.0130 | -0.00297 | -0.00602 | 0.00203 |
| | (0.00930) | (0.00423) | (0.0125) | (0.0195) | (0.00735) | (0.0103) |
| $T_{i,2010}$ | -0.00544 | 0.000228 | -0.0195** | 0.0133 | -0.00677 | -0.0101 |
| | (0.00713) | (0.00379) | (0.00935) | (0.0175) | (0.0169) | (0.00787) |
| $T_{i,2011}$ | -0.00123 | 0.000961 | -0.0102 | 0.00602 | -0.00332 | -0.000283 |
| | (0.00520) | (0.00301) | (0.00644) | (0.0141) | (0.00578) | (0.00528) |
| $T_{i,2013}$ | 0.0243*** | 0.00629** | 0.0287*** | 0.00519 | -0.00346 | 0.00952* |
| | (0.00514) | (0.00286) | (0.00614) | (0.0125) | (0.00570) | (0.00511) |
| $T_{i,2014}$ | 0.0467*** | 0.00873*** | 0.0433*** | -0.00142 | 0.00790 | 0.0179** |
| | (0.00676) | (0.00323) | (0.00834) | (0.0159) | (0.00487) | (0.00698) |
| $T_{i,2015}$ | 0.0608*** | 0.00692* | 0.0525*** | 0.0215 | -0.00134 | 0.0395*** |
| | (0.00819) | (0.00357) | (0.0105) | (0.0175) | (0.00463) | (0.00901) |
| $T_{i,2016}$ | | | 0.0649*** | 0.0224 | -0.00439 | 0.0677*** |
| | | | (0.0122) | (0.0207) | (0.00537) | (0.0109) |
| Constant | 2.835*** | 0.361*** | 6.950*** | 0.454*** | 0.0665*** | 7.809*** |
| | (0.00156) | (0.000864) | (0.00226) | (0.00414) | (0.00148) | (0.00185) |
| Observations | 78519 | 78519 | 89736 | 89736 | 89736 | 89736 |
| $R^2$ | 0.089 | 0.005 | 0.230 | 0.001 | 0.001 | 0.150 |

Standard errors in parentheses.
$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Tableau 13: Impact économique - Strict condition on CIR before 2012

| | (1) Employment | (2) Share of R&D employment | (3) Liabilities | (4) Debt ratio | (5) Investment rate | (6) Turnover |
|---|---|---|---|---|---|---|
| $T_{i,2009}$ | -0.00929 | 0.00728 | -0.00734 | -0.0136 | 0.00407 | -0.00113 |
| | (0.0114) | (0.00509) | (0.0152) | (0.0235) | (0.00689) | (0.0128) |
| $T_{i,2010}$ | -0.00957 | 0.00842* | -0.00289 | 0.00417 | 0.00580 | -0.0128 |
| | (0.00876) | (0.00460) | (0.0114) | (0.0213) | (0.0175) | (0.00963) |
| $T_{i,2011}$ | 0.00240 | 0.00288 | 0.00487 | 0.0154 | -0.00160 | -0.00233 |
| | (0.00648) | (0.00358) | (0.00807) | (0.0159) | (0.00614) | (0.00659) |
| $T_{i,2013}$ | 0.0261*** | 0.00722** | 0.0294*** | -0.00349 | 0.00156 | 0.0103 |
| | (0.00601) | (0.00339) | (0.00764) | (0.0173) | (0.00415) | (0.00635) |
| $T_{i,2014}$ | 0.0471*** | 0.00807** | 0.0303*** | -0.00890 | 0.00448 | 0.0167** |
| | (0.00849) | (0.00389) | (0.0105) | (0.0201) | (0.00540) | (0.00846) |
| $T_{i,2015}$ | 0.0600*** | 0.00535 | 0.0426*** | 0.0111 | 0.000223 | 0.0418*** |
| | (0.0102) | (0.00429) | (0.0132) | (0.0220) | (0.00517) | (0.0111) |
| $T_{i,2016}$ | | | 0.0492*** | 0.0249 | -0.00340 | 0.0696*** |
| | | | (0.0153) | (0.0257) | (0.00648) | (0.0145) |
| Constant | 2.832*** | 0.363*** | 6.944*** | 0.453*** | 0.0654*** | 7.806*** |
| | (0.00230) | (0.00122) | (0.00313) | (0.00602) | (0.00183) | (0.00260) |
| Observations | 39704 | 39704 | 45376 | 45376 | 45376 | 45376 |
| $R^2$ | 0.101 | 0.008 | 0.256 | 0.001 | 0.000 | 0.162 |

Standard errors in parentheses.

$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$