An Evaluation of the Innovation Tax Credit

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Abstract – The Innovation tax credit (*crédit d'impôt innovation*, CII) is an extension of the Research tax credit (*crédit d'impôt recherche*, CIR) intended to boost the incentive effect of the latter on SMEs to encourage them to engage in the creation of new products *via* the development of prototypes or pilot plants. Introduced in 2013, it represented €120 million of tax credit in 2014 for some 5,300 recipients. This article seeks to measure the impact of the introduction of this scheme on its beneficiaries over the period from 2013 to 2016. Using a difference-in-differences method following propensity score matching, we find a greater increase in employment in the short term for firms benefiting from the scheme, along with a more pronounced increase in their turnover in the medium term. A greater increase in the number of new products produced by the beneficiaries is also observed. Finally, the introduction of the CII went along with a reduction in the research expenditure reported under the CIR.

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Research, development and innovation (RDI) is now a priority for public authorities, as shown by the EU's target of devoting 3% of GDP to R&D and innovation and the launch of the "Innovation Union" initiative as part of the Europe 2020 strategy. Economic theory suggests that RDI activities should be supported since they have a positive impact on growth and multiple market failures result in firms under-investing in these activities. Nevertheless, there is much debate about how supportive policies can be implemented. In particular, the question as to the optimal balance between direct support and tax incentives remains central.

In France, tax incentives account for more than two-thirds of the 10 billion euros worth of RDI support granted annually. The Research tax credit (CIR, *Crédit d'impôt recherche*), which was introduced in 1983 and substantially reformed in 2008, is the principal scheme in this regard (around 6 billion euros worth of tax credits each year). Numerous evaluations of the CIR have been produced (for a summary, see Cnepi, 2019). The main question that these evaluations seek to answer relates to the impact of the CIR on R&D expenditure. The most recent studies, whether they be based on structural models (Lopez & Mairesse, 2018; Mulkay & Mairesse, 2018) or on difference-in-differences methods (Bozio *et al.*, 2019), converge on the fact that the firms that were already benefiting from the CIR before the 2008 reform have increased their R&D expenditures by an amount equal to or slightly above the amount of tax support received. The impact on employment appears to be more moderate (Bozio *et al.*, 2019). Some studies (Bozio *et al.*, 2019; Lopez & Mairesse, 2018) also looked at the impact of the CIR reform on innovation, revealing an increase in the probability of filing patents, but no increase in the number of patents conditional on having filed a patent in the past, together with an increase in the likelihood to innovate. Finally, Lopez & Mairesse (2018) looked at the impact in terms of productivity, showing that, while the impact on the probability of innovating is smaller for large firms, the impact on productivity increases with the size of the firm.

Other French RDI support schemes have also been evaluated. Firstly, the "young doctors" (*jeunes docteurs*) scheme, which forms part of the CIR, has been the subject of two specific evaluations (Margolis & Miotti, 2015; Giret *et al.*, 2018). These two studies reveal a positive impact on the employment of young doctors, but no impact on the quality of employment. The "young innovative firm" (*jeunes entreprises innovantes*, JEI) scheme has also been evaluated three times (Lelarge, 2008, 2009; Hallépée & Houlou-Garcia, 2012; Bunel *et al.*, 2020). In particular, these evaluations point to a positive impact on employment. As regards participation in competitiveness clusters (*Pôles de compétitivité*), it has been shown that this has a positive impact on R&D expenditures (Bellégo & Dortet-Bernadet, 2014) using a matching method and a difference-in-differences estimation, but this impact is expected to differ depending on the type of cluster (Ben Hassine & Mathieu, 2017). More generally, other studies have focused on the overall impact of French R&D support schemes. By combining a labour demand model with a matching method, Dortet-Bernadet & Sicsic (2015) show that R&D support has a positive impact on skilled employment within SMEs. Other evaluations of French innovation support schemes have also been carried out as part of the evaluation plan of the French RDI state aids (see Charpin, 2020), including those of Bpifrance's innovation support or R&D projects support.

In 2013, the CIR was extended to include innovation expenditures by SMEs through the innovation tax credit (CII). The CII tax base is made up of expenditure on prototypes design or pilot plants for new products up to a limit of 400,000 euros per firm per year; it has a rate of 20%. In particular, this tax credit covers personnel costs and depreciation expenses linked to these activities. However, the tax bases considered for the CIR and the CII are disjointed, as they refer to different types of activities: one further upstream in the RDI process and the other further downstream. The purpose of the CII is to supplement the CIR by promoting the economic development of a technology once the CIR has promoted its experimental development. During its first two years of existence, the CII reached 6,574 SMEs with a total amount of 203 million euros in tax credits and an average annual claim of 22,000 euros.

Since the CII is a recent scheme, as far as we are aware it has not yet been evaluated. This evaluation aims to fill this gap. We start by looking at the broader economic development of the beneficiary firms by comparing them to similar SMEs that have not benefited from the CII. We study the effects of the introduction of the scheme on aspects such as employment, turnover and investment. Since the aim of the CII is to contribute to the development of the innovation activities of firms and the introduction of new products onto the markets, we go on to analyse

the differences in the changes in the number of products produced by firms that benefited from the scheme and comparable firms that did not benefit from it. To the best of our knowledge, an empirical study looking at the impact of a public R&D and innovation support scheme on the introduction of new products onto the market is the first of its kind within the literature. Looking beyond the methodological innovation, which is based on the use of product data, this aspect is particularly important for studying the CII, which is aimed at encouraging its beneficiaries to create new products. Finally, the question as to the position of this scheme within the very dense panorama of French RDI support is essential for guiding public policies. That is why we are interested in the way in which it interacts with the CIR, in particular to measure whether there has been a possible substitution effect between the two schemes.

Section 1 describes the scheme and provides a few descriptive statistics. Section 2 describes the methodology used in this evaluation: difference-in-differences after matching. Finally, Section 3 describes our findings.

1. Description of the Scheme

1.1. Measurement

The innovation tax credit (CII) is an extension of the research tax credit (CIR) aimed at SMEs;[1] its base is made up of innovation expenditure relating to prototypes design or pilot plants for new products up to a limit of 400,000 euros per firm per year and at a rate of 20%. This tax base includes internal expenditures, particularly in relation to employment and fixed assets, as well as subcontracted expenditures. The declaration to the tax authorities is made alongside the CIR one, but the tax bases for the eligible expenditures of the two schemes are separate. In addition, if the tax credit received under the CIR or the CII exceeds the amount of corporate tax, the surplus (or the entire amount if the SME is exempt from paying tax) gives rise to a refund by the Directorate-General for Public Finance (*Direction Générale des Finances Publiques*, DGFiP). This refund can be paid immediately if the beneficiary SME applies to the tax authorities.[2]

The new product that is the result of the innovation process entitling the firm to the CII must be distinguishable from reference products on the market (the firm's competitors) by virtue of its superior performance in terms of technology, functionality, ergonomics or eco-design at the date on which work began. Innovations with regard to services, processes, organisation or marketing methods are excluded from the scheme. The aim of the CII is therefore to help to improve the performance of a product with a view to launching it on the market, while the CIR aims to remove a technological barrier by advancing the state of scientific and technical knowledge available at the start of the work. The CII therefore supplements the CIR by promoting the economic development of a technology once the CIR has promoted its experimental development. As a result, the CII appears to come into play further downstream of the innovation process, while the CIR is more upstream. By design, these two tax credits are therefore, *a priori*, complementary. However, although positive externalities seem to be brought about by the CIR, via the conditioning of the eligibility of expenditure on the objective of progressing scientific and technical knowledge of a technology, the existence of these externalities seems more difficult to envisage in the case of the CII, which is aimed at the design of a prototype or a pilot plant for a new product within a firm. Overall, the CII is an original support scheme for R&D and innovation, from the point of view of its main objective of product development, the nature of the expenditures that are eligible, which arises relatively late in the R&D process, and the small number of positive externalities generated around the beneficiaries.

The main objective of the CII, as expressed in the French Finance Act for 2013, by means of which the scheme was introduced,[3] is to "boost the competitiveness of innovative SMEs" by encouraging the creation of new products and thereby promoting the economic value of research and development (R&D) activities. In particular, on this second point, the need to develop innovation efforts was illustrated by the 2011 Innovation Scoreboard within the European Union, according to which "fewer than one third of French SMEs have implemented a product or process innovation, compared with 54% of German SMEs", a gap that remains significant to this day. This gap can be partly explained by sectoral considerations, since the German economy is more heavily weighted towards the manufacturing industry when compared with

1. The CII is reserved for firms that meet the definition of micro, small and medium-sized firms given in Annex I to Commission Regulation (EU) No 800/2008, i.e. firms that employ fewer than 250 people and that have an annual turnover of no more than 50 million euros or an annual balance sheet total not exceeding 43 million euros.

2. 70% of those who benefited from the CII in 2013 or 2014 made use of this immediate repayment option.

3. Review of the first part of the draft French Finance Act for 2013 – Volume II: General conditions for financial balance.

other European countries, and manufacturing is a highly innovative sector. Although, for example, Balcone & Schweitzer (2019) show that sectoral composition has a strong impact on the level of R&D expenditures, sectoral composition seems less relevant to explain differences in terms of innovation, as suggested by Duc & Ralle (2019). Indeed, German firms are generally more innovative and introduce more new products than those in other European countries, but the sectoral structure only seems to explain a small part of this gap, as does the structure in terms of firm size. The propensity of SMEs to launch new products is therefore more likely to be explained by factors related to the innovation process. Supporting innovation expenditures with a tax incentive remains a peculiarity, even if some countries have introduced similar schemes, particularly Spain, which provides a tax credit of 12% on technological innovations.

1.2. Data

We have the list of firms that have benefited from the CIR or the CII and the amount of the tax credit granted to them each year, as well as all of the information contained within their CIR declarations (CIR management database, Gecir). This allows us to identify the beneficiaries of the CII, as well as the SMEs that have benefited from the CIR but did not apply for the CII following its creation. The R&D survey also allows us to identify firms that were likely to conduct innovation activities prior to the creation of the CII. We match these data with the firm's annual accounting data (turnover, total assets, gross operating surplus, investment, debt, etc.) taken from the Fare files in order to study the effects of the scheme on these variables. These data are enriched by the annual social data declarations (DADS), which provide data on employment and wages for each firm. Possible group membership is taken into account by making use of the financial links between firms (Lifi). Finally, the use of data from the *Atlas des brevets* (Patent atlas) allows us to study the innovation activity of firms, and the *Enquête annuelle de production* (Annual production survey) allows us to study the change in the number of products manufactured by categories of products and by firm within the manufacturing industry. These various data sources are described in more detail in the Online Appendix C1 (link at the end of the article).

1.3. Descriptive Statistics

The annual amount of the CII increased between 2013 and 2014, as did the number of beneficiaries (Table 1), reflecting the gradual appropriation of the scheme by firms. The increase in the total amount of CII granted can be explained by both the increase in the number of beneficiaries and the increase in the average amount: the total amount increased by 40% between 2013 and 2014, yet the number of beneficiaries only increased by 29%, while the average amount increased by 12% over the same period. The total amount of innovation expenditures declared was 635 million euros in 2014; the proportion of firms reaching the cap for innovation expenditures of 400,000 euros was low (3%), which resulted in an effective average tax credit rate of 23%. It is therefore mainly small SMEs that benefit from the CII, for which the amount received is economically significant: for SMEs with fewer than 5 employees, which represented 27% of the beneficiaries in 2014, the amount of the CII represents 8% of their turnover on average.

In 2014, three industries received 87% of the total amount of the CII (Table 2): information and communication (38% of the total amount of the CII), manufacturing (28%) and professional, scientific and technical activities (21%). If we look at the number of beneficiaries, 84% of them belong to one of these three industries: 32% belong to information and communication, 30% to manufacturing and 22% to professional, scientific and technical activities. These three industries are also the ones that have the highest proportion of innovative firms according to Insee's Innovation survey (Clément & Petricã, 2017). Although the three industries receiving the greatest amounts from the CII are also the ones that receive the greatest amounts from the CIR, their weightings differ depending on the type of tax credit considered. Indeed, in the case of the CIR, the professional, scientific and technical activities industry receives 37% of the CIR granted to SMEs, while the information and communication industry receives 27% and the manufacturing industry 25%.

Table 1 – **Number of beneficiaries and annual amounts of CII**

	Number of beneficiaries	Total tax credit granted (€ million)	Average tax credit granted (€ thousand)
2013	4,092	83	20
2014	5,286	120	23

Sources: DGFiP-MESRI, GECIR database (2013-2014).

Table 2 – **Sectoral distribution of beneficiaries of the CII and amounts of CII and CIR granted to SMEs in 2014 (as a %)**

	Number of beneficiaries of the CII	Amount of CII granted	Amount of CIR granted to SMEs
Information and communication	32	38	27
Manufacturing	30	28	25
Professional, scientific and technical activities	22	21	37
Wholesale and retail trade, repair of motor vehicles and motorcycles	8	7	5
Other	8	6	5
Total	100	100	100

Sources: DGFiP-MESRI, GECIR database, Insee, FARE database.

In 2014, the average amount of tax credit received by each firm benefiting from the CII was 23,000 euros (Table 3). These beneficiary firms have a median workforce of 10 employees and are generally larger than other SMEs. In comparison, firms with fewer than 10 employees represent 93% of the SMEs across the whole French economy. Across the economy as a whole, the total workforce employed by the firms benefiting from the CII is 106,000. The median age of a firm benefiting from the CII is 10 years.

Of the firms benefiting from the CII, 57% also declare R&D expenditures within the scope of the CIR, which corresponds to an average amount of 82,000 euros for the CIR. All in all, these SMEs that combine the CIR with the CII account for 15% of the amount of the CIR granted to SMEs. They have a higher level of employment than those that benefit solely from the CII. SMEs that benefit solely from the CII are smaller than those that benefit solely from the CIR.

The firms that benefited from the CII in 2014 had an average turnover of 3.6 million euros (Table 4), which represents a total turnover of 18.6 billion euros. Almost a quarter (22%) of that total turnover is achieved through exports. Those same firms generate a total value added of 7.1 billion euros, corresponding to 0.33% of GDP. Of those firms, 64% have a positive gross operating surplus and 91% generate positive value added. These figures are slightly higher than those for SMEs benefiting solely from the CIR in 2014, 58% of which had a positive gross operating surplus and 87% generated positive value added.

The average investment ratio[4] was 6%. The aggregated investment ratio for all beneficiaries of the CII was 8%, compared to 9% if all of the SMEs benefiting from the CIR are taken into account. These figures are lower than the investment ratio for all business sector in 2014,

4. The investment ratio is defined as the ratio of gross tangible investments excluding contributions to value added.

Table 3 – **Main characteristics of SMEs benefiting from the CIR or the CII in 2014**

	Number of beneficiaries	Age (years)	Number of employees (FTE)		Amount of CIR granted (€ thousand)	Amount of CII granted (€ thousand)
	Total	Median	Mean	Median	Mean	Mean
CII	5,286	10	21	10	47	23
of which CII only	*2,272*	*10*	*16*	*7*	-	*24*
of which CIR and CII combined	*3,014*	*11*	*25*	*13*	*82*	*22*
CIR only	12,992	10	22	9	107	-

Sources and Coverage: DGFiP-MESRI, GECIR database, Insee, DADS, FARE, SIRUS. SMEs benefiting from the CIR or the CII in 2014.

Table 4 – **Accounting data and financial ratios of firms benefiting from the CII in 2014**

	Mean	Median	Standard deviation
Turnover (€ thousand)	3,576	1,246	6,092
Export sales (€ thousand)	784	15	2,542
Gross operating surplus (€ thousand)	158	39	1,086
Value added (€ thousand)	1,367	593	2,217
Debt (€ thousand)	566	139	1,742
Equity (€ thousand)	1,405	427	5,233
Investment rate (%)	6.2	1.9	12.0

Sources: DGFiP-MESRI, GECIR database, Insee, FARE. SMEs benefiting from the CII in 2014.

which stood at 18% (Insee, 2016). However, this difference can probably be explained by the fact that those benefiting from CII are SMEs, which generally invest less than intermediate-sized firms and large firms. In 2014, 61% of firms with between 1 and 9 employees had non-zero investment, compared with 96% of firms with 250 or more employees (Insee, 2016). This low investment ratio could also be explained by investments that are more targeted on intangibles for the less advanced stages of product development. Finally, it should be noted that 30% of those benefiting from the CII in 2014 belonged to a fiscal group.

2. Methodology

This section details the methodology applied in our evaluation, which is based on usual public policy evaluation methods (Givord, 2014).

2.1. Empirical Approach

When assessing the effect of a scheme on various indicators, it is not enough to simply compare the changes in these indicators for beneficiaries of the scheme to the changes for those that did not benefit, since the very fact of benefiting from the scheme is often not random: it is often the most dynamic firms that have the greater probability to ask for a tax credit. In order to correct for this selection bias, methods have been developed to control for observable differences between beneficiaries and non-beneficiaries.

In this evaluation of the CII, the treated firms ($T_i = 1$) are defined as those that benefited from the CII in 2013 or 2014 and the non-treated firms ($T_i = 0$) are those that did not benefit. We have accounting and employment data, as well as data relating to patents or CIR, which allows us to control for observable differences between the beneficiaries (treated firms) and non-beneficiaries (non-treated firms) in an attempt to identify a causal effect of the CII on the beneficiary firms. This requires that the following conditional independence assumption be met:

$$Y_i^0 \perp T_i \mid X_i$$

where Y_i^0 is the variable Y when firm i is not treated and X_i is a vector of observables relating to firm i. This means that, conditionally on the observable characteristics X, the evolution of firms that have not benefited from the scheme provide a good prediction of the potential evolution of the beneficiaries, had they not benefited of the scheme. This is a strong assumption. It reflects the fact that, apart from the observable characteristics X, there are no other characteristics that influence both future developments and the choice of treatment.

In order to control for observable characteristics, we use observable matching methods, which allow us to establish a control group that is close, in statistical terms, to the treated firms. This will allow us to evaluate the impact of the scheme on the treated firms by comparing the differences in the evolutions of the variables of interest in the two groups following the treatment. Due to the vast array of data and in order to make the best use of the information in order to create a control group, we have chosen to use propensity score matching methods (Rosenbaum & Rubin, 1983). The propensity score is defined as the probability of being treated depending on the observable characteristics $p(X_i) = \mathbb{P}(T_i = 1 \mid X_i)$. Rosenbaum and Rubin (1983) show that if the outcome variable Y^0 is independent of the treatment T conditionally on the observable characteristics X, it is also independent from T conditionally on the propensity score $p(X)$. The matching method therefore consists of matching treated firms with non-treated firms that have similar propensity scores.

2.2. Control Group and Data Cleaning

The CII is a tax credit aimed at SMEs that are likely to engage in innovative activities; however, this ability to engage in innovation cannot be observed empirically. In order to build a control group of firms *a priori* of this type, before matching, we restrict ourselves to SMEs that benefited from the CIR at least once between 2009 and 2012 and/or that appeared in the R&D survey at least once between 2004 and 2012. Since the sampling frame for the R&D survey was established in such a way as to only select firms that undertake R&D activities by identifying them on the basis of the public support that they receive (CIR, ANR, JEI, etc.), the inclusion of a firm within that survey reflects its proximity to the innovation process.

In order to study the effect of the scheme, we need to follow the evolution of a set of variables, both among the beneficiaries (treated firms) and non-beneficiaries (non-treated firms). As a result, the overall sample is limited to firms for which data are available for each year of the period from 2009 to 2016. The choice of 2009 as the first year of our panel results from a trade-off between having a number of years before the introduction of the CII that is *(i)* sufficient to test the assumption that there is a common trend between the treated group and the control group, and *(ii)* small enough to still include a

large enough number of beneficiaries. We therefore finally end up with a balanced panel for the period from 2009 to 2016 with one fewer year for employment data (2009-2015). This restriction is not without consequence for the sample of beneficiary SMEs actually studied in the rest of this article. Indeed, according to tax data, 6,574 SMEs benefited from the CII at least once in 2013 or 2014. Of those 6,574 SMEs, 5,594 appear in the DADS and Fare databases for the year 2012. By applying the condition of the availability of data relating to 2009-2016, the number is limited to 2,908 beneficiary SMEs. These latter two sub-samples of treated firms are described in Table 5. The firms that are ultimately selected are older on average, with the year of creation shifting from 1998 in the raw sample to 1993 in the cleaned sample. With the exception of debt and the amount of the CIR, all of the economic characteristics set out in the table are greater in magnitude in the final sample than in the raw sample: employment, turnover, gross operating surplus, equity and investment. As regards the non-recipient firms, these conditions reduce the size of the sample from 24,295 to 12,844 units.

Nevertheless, the condition of proximity to the innovation process referred to above is not adequate to ensure a similar dynamic between the treated group and the control group established in this manner prior to the introduction of the CII. Indeed, Figure I shows the changes in employment and turnover within the group of CII beneficiaries and in the control group before matching. It can quite clearly be seen that, prior to the introduction of the CII, the characteristics of the two groups do not follow the same trend, which justifies the need to make use of a matching method.

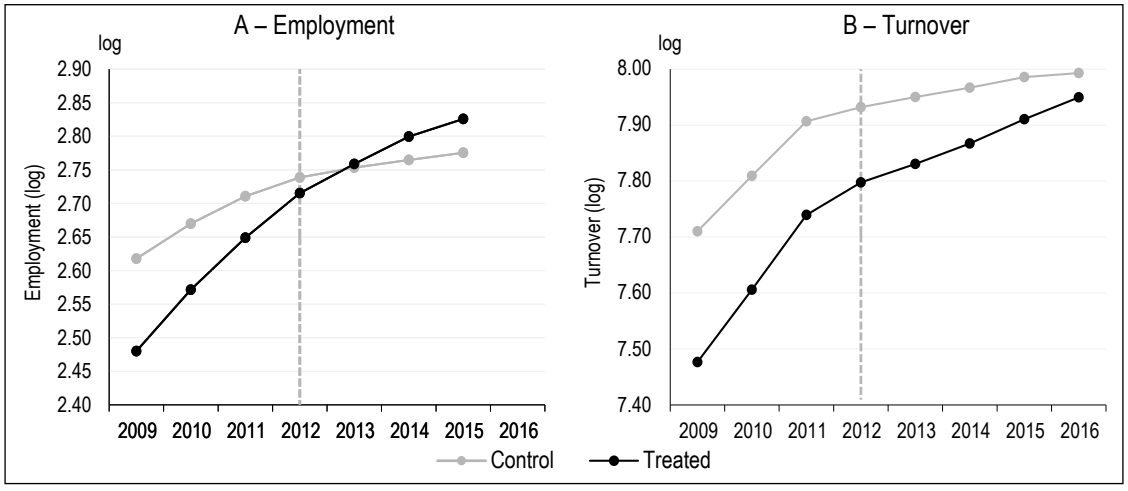
In order to calculate the propensity score, we use level variables, calculated over the year 2012, and change variables, over the period 2009-2012. The control variables used are listed in Table 6. These controls include standard variables relating to employment, accounting data and the intrinsic characteristics (sector, age) of the firms. Since the CII is an extension of the CIR,

Table 5 – **Descriptive statistics for the beneficiaries**

	Raw data			Final data		
	Mean	Standard deviation	Median	Mean	Standard deviation	Median
Turnover (€ thousand)	3,766	6,532	1,374	4,937	6,294	2,521
Gross operating surplus (€ thousand)	189	954	52	358	814	129
Workforce (FTE)	21	30	10	27	31	15
Debt (€ thousand)	525	1,598	113	521	1,020	151
Equity (€ thousand)	1,370	5,812	404	1,687	2,713	751
Investment (€ thousand)	113	595	14	140	390	27
Date of creation	1998	14	2002	1993	15	1997
Amount of CIR granted (€ thousand)	56	141	21	55	101	24
Number of observations	5,594			2,908		

Notes: Gross tangible investments, excluding contributions are taken into consideration here.
Sources: DGFiP-MESRI, GECIR database, Insee, FARE (2012).

Figure I – **Changes in variables in the treated and control groups**



Sources and Coverage: DGFiP-MESRI, GECIR database; Insee, DADS, FARE. SMEs that are and are not benefiting from the CII before matching.

Table 6 – **Control variables for estimating the propensity score**

Variable	Specification	Source
Employment	2012 level and change from 2009 to 2012	DADS
Share of technical employment	2012 level and change from 2009 to 2012	DADS
Turnover	2012 level and change from 2009 to 2012	FARE
Total assets	2012 level and change from 2009 to 2012	FARE
Debt ratio	2012 level and change from 2009 to 2012	FARE
Investment ratio	2012 level and change from 2009 to 2012	FARE
Gross operating surplus	2012 level and change from 2009 to 2012	FARE
Business sector	Categorical variable	FARE
Year of creation	Quantitative variable	FARE
Fiscal group membership	Indicator for fiscal group membership 2009-2012	LIFI
Number of patents	Mean and change from 2009 to 2012	*Atlas des brevets*
Amount of CIR granted	Total amount for 2009-2012	GECIR
Beneficiary of the CIR	Indicator for beneficiaries of the CIR 2009-2012	GECIR
Exposure to the CICE	Share of wages below 2.5 times the minimum wage in 2012	DADS

the propensity to benefit from the CII risks being strongly linked to the fact of benefiting from the CIR, which is why we control for the amount received from the CIR and an indicator for firms benefiting from the CIR. Finally, we also control for the number of patents filed, whether or not the firm belongs to a group, and exposure to the tax credit for competitiveness and employment (*crédit d'impôt pour la compétitivité et l'emploi*, CICE; exposure is defined as the share of the wage bill that corresponds to jobs for which the salary is below 2.5 times the minimum wage as of 2012). The interactions between these variables are incorporated into the model used to estimate the propensity score.

More precisely, the propensity score is estimated using a linear *logit* model:

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

Once the propensity score has been estimated for each SME, there are several methods that can be used to establish a control group that is effectively comparable to the treated group (Quantin, 2018). For each treated firm, we select the non-treated firm with the nearest propensity score, with a strict condition that it belongs to the same business sector as the treated firm. In order to test the robustness of our results, we will propose other matching methods that link more than one non-treated firm to a treated firm. Balance tests allow us to verify the quality of matching. Rosenbaum & Rubin (1985) introduce in particular the standardised difference in mean values between the treated group and the control group:

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

where $\overline{X_t}$ and $\overline{X_c}$ correspond to the means for the variable X respectively within the treated group and the control group, while s_t^2 and s_c^2 are the variances within these two groups for the variable X. The standardised difference in the mean values is used in particular as, unlike statistical tests on the difference in mean values, no account is taken of the size of the sample. Since matching significantly reduces the size of the control group, a measure that allows us to disregard the sample size seems indispensable. Quantin (2018) also suggests comparing the variance ratios before and after matching in order to more closely analyse the distribution of the covariates. The thresholds of 0.2 and 2 are often used to consider the balancing property to be verified for the standardised difference in means and the variance ratio, respectively (Rubin, 2001).

The level variables that are strictly positive (employment, turnover) are considered in logarithmic form, as is the total amount of CIR received between 2009 and 2012. The intensive variables (share of technical employment, debt ratio, investment ratio) are considered directly in the matching. Technical employment is defined as the sum of the number of employees in the "engineers and firm technical executives" (38) and "technicians" (47) socio-professional categories. The debt ratio is defined as the ratio of total debt to the firm's equity, while the investment ratio is defined as the ratio of gross tangible investments excluding contributions to value added. The sample of 2,908 beneficiary SMEs referred to above only includes those firms that have investment and debt ratios that are positive or zero. Observations for which the debt ratio has not been defined (zero equity) are also removed. The gross operating surplus variables take on positive or negative values.

Annual deciles are therefore constructed for this variable. Finally, other variables (year of creation, fiscal group membership, business sector, number of patents, share of technical employment, beneficiary of the CIR between 2009 and 2012, exposure to the CICE) are used without adjustment.

Each beneficiary firm is matched with a non-beneficiary firm via the estimated propensity score, with an additional condition that the business sectors are strictly equal at NACE level A10. The assumption of common support prior to matching is verified (cf. Figure A-I in the Appendix). If there are no SMEs within the control group that belong to the same business sector and have a propensity score that is sufficiently similar to that of a treated unit (difference of less than 0.05 times the standard error of the propensity score), the beneficiary SME is not retained. In addition, in the event that several SMEs within the control group have propensity scores that are extremely close (difference of less than 10^{-20}), the close units are selected and weighted by the inverse of the number of units within the control group selected for the same firm within the beneficiary group. We end up with 2,860 beneficiary firms compared with 2,870 within the control group, 20 of which are weighted at 0.5.

Figure II shows the checks carried out on the balancing property of matching for all of the variables described in Table 6, in levels for 2009-2012. The standardised difference in mean values between the two groups is presented for each variable, before and after matching. The balancing property for all of the pre-treatment observable variables is verified.[5]

2.3. Estimation of the Effects of the Scheme

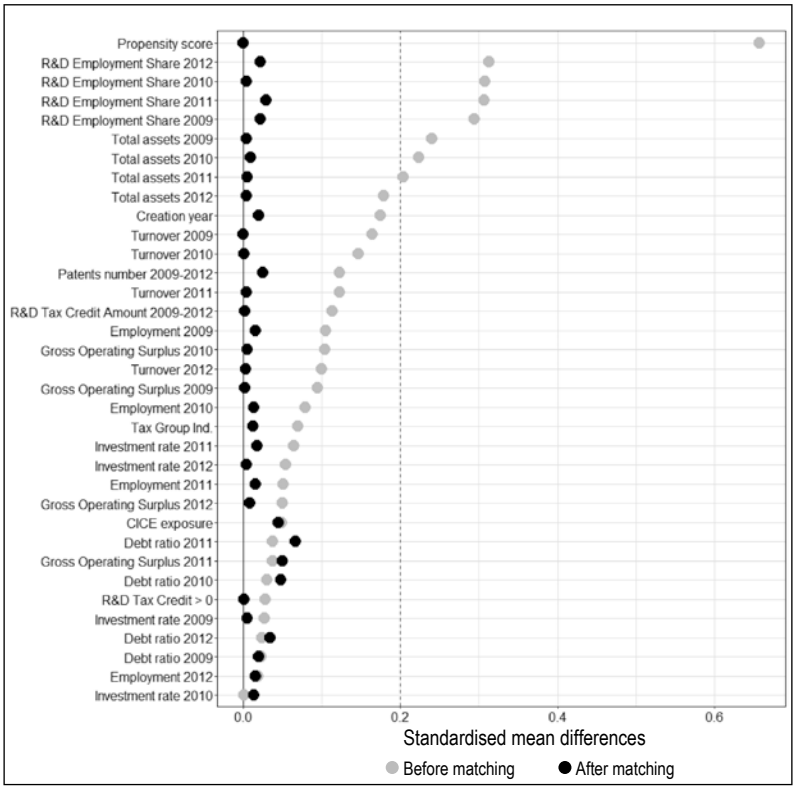
Once the control group has been built, an estimate is made of the differences in the changes in the variables of interest between beneficiaries and non-beneficiaries using the difference-in-differences method. The specification used is as follows:

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

where T_{it} corresponds to the fact that the firm i belongs to a treated group and that the observation is taken at year t. In order to measure the cumulative impact with respect to the year in which the treatment was implemented (2013), the variable T_{i2012} is omitted from the regression.

5. We have also verified the similarity of the distributions of the two groups after matching by means of Kolmogorov-Smirnov tests. For all of the variables shown in Figure II, the similarity between the distributions of the two groups can never be rejected, except for the debt ratio.

Figure II – **Standardised difference in mean values before and after matching**



Notes: The dotted line at 0.2 corresponds to the maximum value of the differences recommended by Rubin (2001).
Sources: DGFiP-MESRI, GECIR database; Insee, FARE.

This specification serves two purposes. Firstly, it allows us to estimate an average impact of the treatment on the treated firms for each year: we can therefore identify different dynamics depending on the variable of interest under consideration. Secondly, it allows us to verify that the treatment does not have any impact prior to the introduction of the scheme and therefore to verify that the common trend assumption, which is central to difference-in-differences models, is duly verified. In addition, the term λ_i allows us to control for characteristics that are non-observable and remain stable over time for each firm, and the time fixed effect μ_t allows us to control for temporal and non-observable heterogeneity that could affect all firms in t, in so far as the assumptions inherent in the propensity score matching methods are verified. The coefficient β_t therefore represents the effect of the treatment on the beneficiaries for the year t.

As we have previously mentioned, the estimates are only based on a sub-sample of firms benefiting from the scheme. The firms that are excluded are young firms created between 2009 and 2012, which represent 22% of all those benefiting from the CII, or firms that ceased to exist before the end of the period (cessation of activity, buyout),[6] which represent 4.8% of all those benefiting from the CII, or firms created after the introduction of the CII, which represent 0.8% of all those benefiting from the CII. The other firms are excluded from the analysis due to a one-off lack of data. As a result, the data cleaning mainly leads to the exclusion of firms less than 3 years old created prior to the introduction of the CII from the analysis.

3. Results

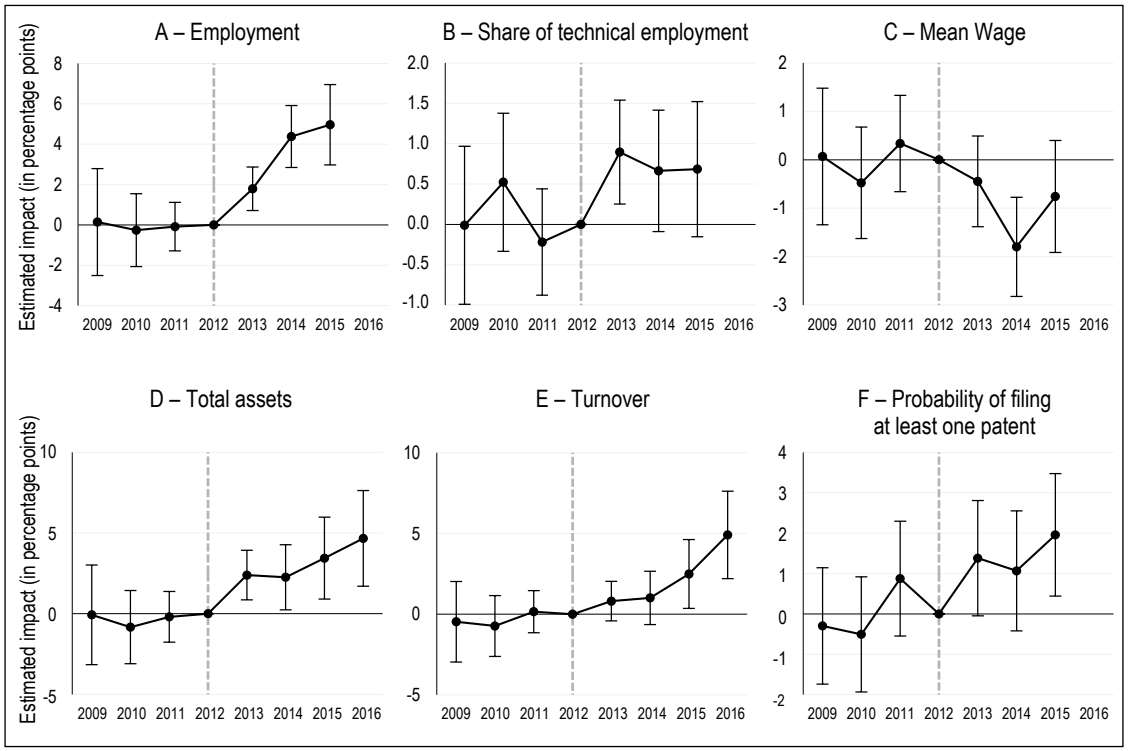
In this section, we present our findings with regard to the various indicators selected and the associated robustness checks.

3.1. Economic Development of Beneficiary Firms

We start by looking at the economic development of the firms benefiting from the scheme in the broad sense. The differences between the treated group and the control group are estimated based on the regression equation (1). Figure III shows the estimates obtained. The coefficients correspond to the mean impact of treatment on the treated firms for a given year t. The coefficients for 2009, 2010 and 2011 are statistically non-significant and allow us to test the assumption of

6. Our criterion for this point is that the firm no longer appears in the Fare file with effect from a given year, any time after 2012.

Figure III – **Estimation of the effects**



Reading note: The vertical bars represent the 95% confidence intervals. The vertical dotted line indicates the last year before the introduction of the CII (2013).
Sources and Coverage: DGFiP-MESRI, GECIR database; Insee, DADS, FARE; MESRI, Atlas des Brevets, authors' calculations. SMEs benefiting from the CII and comparable non-beneficiaries.

a common pre-treatment trend for the variables of interest. Figure A-II in the Appendix shows the development of six variables of interest in the treatment group and the control group and Table A-1 shows the results of the regression.

As 93% of the expenditure declared within the scope of the CII in 2014 was linked to personnel costs (cf. Figure A-III in the Appendix), we start by looking at the impact on employment. Figure III-A shows the estimates regarding the change in the employment gap between the matched beneficiary and non-beneficiary firms. A higher level of employment is observed from the first year of the scheme for the beneficiary firms. The gap between the two groups widens over time, increasing from 1.8 percentage point in 2013 to 4.4 percentage points in 2014 and 5.0 percentage points in 2015.

Figure III-B shows the estimates for the change in the share of technical employment, i.e. the proportion of employees likely to undertake RDI activities (technicians, engineers and firm technical executives). This proportion increases more rapidly for the group that benefited in 2013. This difference between the beneficiary group and the non-beneficiary group becomes insignificant at the 5% threshold from 2014 onwards, although the magnitude of the coefficient remains the same. Conversely, the mean wage (Figure III-C) increases more slowly in beneficiary firms than it does in the others, with a significant gap in 2014 of around 1.8 percentage points. Knowing that the beneficiary firms demonstrated a greater increase in employment than the others; that lower increase in wages may stem from the fact that the new employees hired have lower average wages than existing employees.

As regards the financial development of the firms, Figure III-D shows the change in the total assets. As with employment, an immediate, stronger change can be observed within the beneficiary group, which increases over time from 2.4 percentage points in 2013 to 4.7 percentage points in 2016.

We observed a greater increase in the turnover of the beneficiary firms, which increases in magnitude over time: insignificant in 2013 and 2014, it increased to 2.5 percentage points in 2015 and then to 4.9 percentage points in 2016 (Figure III-E). In the medium term, it therefore appears that those benefiting from the CII are experiencing greater increases in their sales. The slow emergence of the gap between the two groups could be the result of the time needed to produce a prototype and then bring a new product to market.

With the exception of the share of technical employment, the variables studied so far are not *a priori* directly linked to the implementation of an innovation process within the firms. For that reason, we will now turn our attention to the interaction between the CII and RDI activity. The filing of patents is a possible outlet for the innovation activity promised by the CII and, as such, expenditure on filing and defending patents is included in the eligible expenditures under the CII. Although the filing of patents does not capture all of a firm's innovation activity, it is still an interesting indicator. Figure III-F shows that the change in the probability of filing at least one patent between 2012 and 2015 is slightly higher for the beneficiary firms when compared with matched non-beneficiary firms.

3.2. Robustness

We saw in Section 2.2 that the sectoral matching was carried out at level A10 of the NACE classification of activities. Although the choice of classification level may seem coarse, it results from a trade-off between having sufficient sectoral similarity between beneficiaries and non-beneficiaries and having a sufficient number of non-beneficiary firms within each sector that have a propensity score that is close enough to each beneficiary for the two groups to be effectively comparable. In order to ensure that the findings presented are not solely due to this choice of classification level, we repeat our estimates taking into consideration a stricter matching at the finest level of the NACE in each case. The findings (presented in the Appendix in Table A-2) are very close to those obtained in Table A-1. However, we still see a positive impact on the investment ratio in the short term. Since the nature of investments is specific to each business sector, it is possible that the overly coarse classification level leads to a failure to highlight an impact on the investments made by beneficiary firms in the short term. A second way to test the robustness of the findings obtained is to match each treated firm with several firms from the control group. We therefore perform matching on the closest 2 and 3 neighbours for each firm that benefited from the CII (Tables A-3 and A-4 in the Appendix). The assumptions of a common trend from 2009 to 2012 are verified, with the exception of the probability of filing a patent in 2011-2012 in the matching with 3 closer neighbours. Once again, the findings obtained are broadly similar to those presented in Table A-1; however, there is a gap, which in this case persists over time, between the beneficiary

and non-beneficiary groups with regard to the share of technical employment.

As mentioned above, the CII is an extension of the CIR to cover innovation expenditure. Although an indicator showing participation in the CIR is present in the calculation of the propensity score, there is no *a priori* guarantee that the matched SMEs actually behaved in the same way as regards the CIR prior to 2012. We therefore add a strict condition to the matching regarding the fact of benefiting from the CIR at least once between 2009 and 2012 (Appendix, Table A-5). The assumptions of a common trend from 2009 to 2012 are verified, and the estimates obtained are similar with, once again, a slight difference regarding the continuing effect of the share of technical employment.

We then use an alternative matching method to the nearest neighbours on the basis of propensity scoring, namely the weighted adjustment method (Quantin, 2018). This approach makes use of all of the non-treated units within the control group, i.e. all of the non-beneficiary SMEs for which the propensity score has been estimated. For this approach, the units within the control group are weighted by $p(X)/(1-p(X))$ in order to estimate the impact of the treatment. With this specification, the common trend assumption is no longer verified for employment, the total assets and the investment ratio (see Appendix, Table A-6). The findings obtained for the other variables remain close to those presented in Section 3.1 with a few exceptions: once again, a significant positive difference remains between the treated group and the control group as regards the share of technical employment and the likelihood of filing a patent. The difference in the mean wage is negative and significant across the entire period from 2013 to 2015.

As we saw in Section 2.2, the fact that we studied the period from 2009 to 2015 significantly reduced our sample of beneficiary firms, which fell from 5,594 units to 2,908. In order to increase the number of beneficiary SMEs taken into account, we slightly relaxed this condition and worked only with the period from 2011 to 2015. For this period, we only require the existence of the employment variables, the total assets, the turnover, the creation date and the business sector. Our sample of beneficiary SMEs increases by around 1,000 units, growing to 3,821 SMEs, 3,808 of which are effectively matched. For this new sub-population of beneficiaries, the common trend assumption for 2011-2012 is verified for all of the variables (Appendix, Table A-7). In this case, the difference in employment growth between the treated group and the control group during the period from 2012 to 2015 is 7.3 percentage points, compared with 5.0 percentage points in the main specification (see Table A-1). Once again, the gap in the share of technical employment persists over time. No significant difference is observed between the treated group and the control group in connection with the probability of filing a patent. The positive and significant differences in the total assets and the turnover are observed once again. The estimated impact is slightly greater than for the main specification, which confirms the assumption that it underestimates the relative impact on all of the beneficiary firms since it is restricted to larger firms.

3.3. New Products

The evaluation prior to the introduction of the CII[7] stresses the importance of "boosting the competitiveness of innovative SMEs [...] by means of a targeted measure allowing them to benefit from the CIR in respect of expenditure on the creation of prototypes or pilot plants for new products". Therefore, looking beyond the overall economic development of the beneficiary firms, an expected purpose of the CII is the development of new products by the beneficiary firms.

In order to examine this angle, we make use of data from the *Enquêtes Annuelles de Production* (Annual Production Surveys, EAP). A product can be defined at different levels of the PRODFRA nomenclature. More specifically, the nomenclature in which the products manufactured are recorded comprises four levels; we are studying the finest three of these levels. It is possible to illustrate these different levels using an example: the finest level of the nomenclature, the Product level (hereinafter referred to as the fine level) will distinguish between "Terracotta floor and wall tiles" and "Earthenware floor and wall tiles", the products classes level (hereinafter referred to as the intermediate level) will group them together into the "Ceramic tiles" class. The products groups level (hereinafter referred to as the aggregated level) will consider "Terracotta construction materials" as a whole. In order to monitor the products in a homogeneous manner, we establish stable product envelopes at each nomenclature level. During the period from 2009 to 2016, this amounts to 4,429 distinct products at the fine level, 243 at the intermediate level and 98 at the aggregated level.

7. *Preliminary evaluations of the Articles of the draft French Finance Act for 2013 – Article 55.*

In accordance with the coverage of the EAP surveys, we limit ourselves to the industrial sector, which, of course, reduces the number of observations in the treated group. In addition, we impose the condition that the firms must be present every year from 2009 to 2016 in order to obtain a balanced panel, as we did for the previous sections. These beneficiary firms are described in Table 7. It can be seen, for example, that the average level of employment among beneficiary firms in the manufacturing sector is 45, compared with 27 for beneficiaries in all sectors considered together. The firms benefiting from the CII manufactured an average of 2 products in 2012, regardless of the nomenclature level considered.

As before, we perform matching across all of the economic variables presented in Section 2.2 and described in Table 6, before then adding the number of different products manufactured by the firm. The verification of the balancing property before and after matching is shown in the Appendix (Figure A-IV). As was the case in Section 3.1, we then estimate the impact using the equation (1).

The findings of these regressions are presented in Figure IV and in Table A-8 in the Appendix. Regardless of the aggregation level considered, it can be seen that the common trend assumption is duly verified. At the fine level (Figure IV-A), the difference is never significant at 5%. For the intermediate and aggregated levels of the product definition (Figures IV-B and IV-C, respectively), the difference is positive and significant from 2015 onwards and remains so until 2016, when it reaches 0.0977 more products at the intermediate level and 0.0827 more products at the aggregate level among the beneficiaries of the CII. By using the alternative weighting adjustment method (Appendix, Table A-9), the estimated coefficients remain significant at the intermediate and aggregated product definition levels, but not at the fine level.

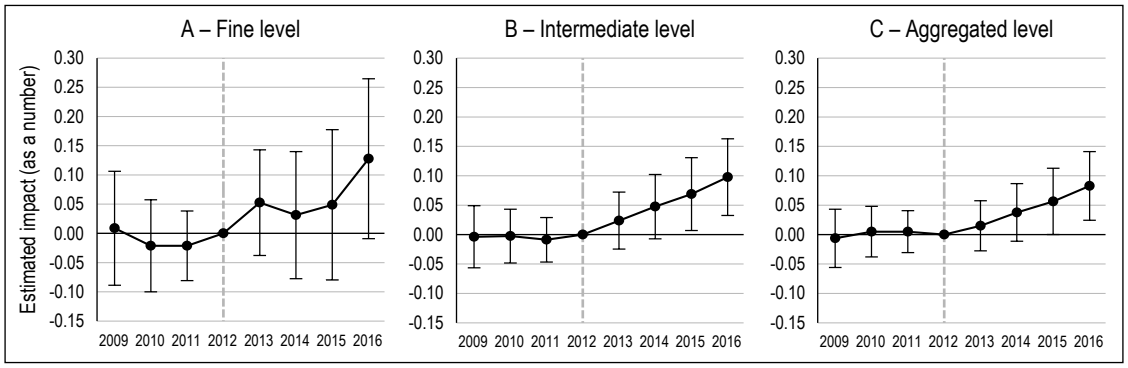
These results reflect the ability of the beneficiary firms to offer additional products that are fairly different (within the meaning of the nomenclature used) from the products they offered prior to the introduction of the CII. Indeed, the gap remains and even increases in magnitude at the lowest level of aggregation, which suggests that

Table 7 – **Descriptive statistics for the beneficiaries – Industrial Sector (2012)**

	Mean	Standard deviation	Median
Turnover	8,566	7,131	6,392
Gross operating surplus	599	1,089	284
Employment	45	35	35
Debt	924	1,275	458
Equity	2,980	3,489	1,769
Investment	272	501	106
Date of creation	1,983	19	1,988
Amount of CIR granted	61	96	32
Number of products – fine level	2	2	2
Number of products – intermediate level	2	1	1
Number of products – aggregated level	2	1	1
Number of observations	818		

Sources: DGFiP-MESRI, GECIR; Insee, DADS, FARE, EAP.

Figure IV – **Estimation of the number of products**



Reading note: The vertical dotted line indicates the last year before the introduction of the CII (2013).
Sources and Coverage: DGFiP-MESRI, GECIR database; Insee, DADS, FARE, EAP; authors' calculations. SMEs benefiting from the CII and comparable non-beneficiaries.

it is not simply variations of existing products that are being introduced, but products that are substantially different.

The use of the EAP survey therefore makes it possible to highlight a different change in the number of products. This is a new finding within the economic literature on the subject of RDI support schemes. However, the significantly higher number of new products among CII beneficiaries since 2015 may come as a surprise, since one would expect to have to wait longer before any impact would be seen on the number of products. The interpretation of these differences as a causal effect of the CII on the creation of new products, or on other economic variables, is not fully established due to the unobserved differences that remain between beneficiary and non-beneficiary firms. While we discuss this point again in the conclusion, an instrumental variable approach has also been implemented (see Online Appendix C2). The questions raised in this section as to the validity of the instrument lead us to consider this approach as an extension of the thinking relative to the endogeneity of the treatment rather than being fully a result of the study.

3.4. Interactions between CII and CIR

Unlike the CIR, the CII is aimed solely at SMEs. Nevertheless, although the CIR and CII declarations are submitted at the same time, the SMEs receiving the CIR do not necessarily also receive the CII and vice versa: in 2014, 43% of those benefiting from the CII were not benefiting from the CIR, as was discussed earlier. Since the CIR and CII are two *a priori* complementary schemes, we will now look at the interaction between these two schemes.

In order to study the consequences of the introduction of the CII, we will take into consideration those SMEs that benefited from the CIR in 2011 and 2012. The total amount of research expenditures declared under the CIR by all SMEs is constantly increasing; however, due to an attrition effect, it falls when we limit ourselves to this sub-group of firms: indeed, the total amount of research expenditures declared by SMEs increases thanks to new firms using the scheme, but for a fixed set of firms this expenditure decreases since some of them stop using it. When a distinction is made depending on whether a firm is benefiting from the CII, behaviours can be observed that appear to be different: of the SMEs that benefited from the CIR in 2011 and 2012, those that went on to benefit from the CII in 2013 experienced a drop in the amount of research expenditures they declared of 12% during that same year, while those that did not receive the CII experienced a smaller drop of 6%. As a result, the introduction of the CII is reflected by a fall in the declared research expenditure under the CIR for those firms that also declare innovation expenses under the CII.

This first descriptive statistic cannot guarantee that the observed differences cannot be simply explained by distinct dynamics between the two samples. Indeed, as we saw earlier, the two populations do present some intrinsic differences, with those that benefit from the CII generally being smaller than those that benefit from the CIR, as well as belonging to different sectors. We therefore perform matching again, using a method similar to that described in Section 2, by limiting ourselves to just those SMEs that benefited from the CIR in the past; due to the smaller number of observations, our study period prior to the introduction of the CII is also reduced to 2011-2012. Following this matching, the sample contains 2,070 SMEs that benefited from the CII. The balancing property is duly verified for all of the pre-treatment variables. A negative and statistically significant difference can be observed with regard to research expenditure between the group that benefited from the CII after 2013 and the group that did not benefit (see Table 8). In addition, the coefficient, which is not significant for the year 2011, shows that the common trend assumption is duly verified (Figure V).

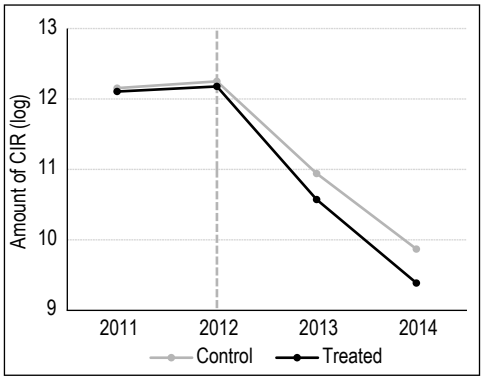
A first possible interpretation of this finding could be that the R&D process may come to an end to make way for a market launch phase, thereby replacing the research expenditures supported by the CIR with innovation expenditure supported by the CII. This seems all the more plausible

Table 8 – **Estimation of the mean impact on treated firms**

	Research expenditure declared for the CIR
$T_{i,2011}$	0.0302
	(0.0186)
$T_{i,2013}$	-0.290**
	(0.118)
$T_{i,2014}$	-0.408***
	(0.150)
Constant	12.21***
	(0.0291)
Observations	16,560
R^2	0.161

Notes: Standard error shown in brackets. Estimation with cluster at the level of the firms. * : p < 0.1, ** : p < 0.05, *** : p < 0.01.

Figure V – **Amount of CIR - estimates**



Reading note: The dotted vertical line corresponds to the last year before the introduction of the CII (2013).
Sources and Coverage: DGFiP-MESRI, GECIR database; Insee, DADS, FARE, EAP; authors' calculations. SMEs benefiting from the CII and comparable non-beneficiaries.

given that the beneficiaries of the CII are SMEs, which are undoubtedly working on fewer projects in parallel than intermediate-sized firms and large firms. A second interpretation would be that a share of the research expenditures is being relabelled as innovation expenditures. In reality, it would actually be the innovation expenditures that is relabelled: since the rate of the CII (20%) is lower than that of the CIR (30%), there is no financial incentive for firms to relabel their expenditures as innovation expenditures if that is not what the money has actually been spent on.

* *
*

This article provides the first evaluation of the CII. This scheme, which is an extension of the CIR, aims in particular to encourage SMEs to launch new products onto the market.

Using propensity score matching methods, we have looked at three groups of variables of interest. First, as regards economic development in the broad sense, we observe a greater increase in employment among the firms that benefited from the scheme, coupled with an increase, at least in the short term, in the share of technical positions. A negative change is observed with regard to mean wages after two years, but this is not statistically significant after three years. As regards the accounting variables, the total assets show a greater increase among beneficiaries of the scheme from the first year onwards; turnover also shows a more pronounced increase among the beneficiaries, but from two years after the introduction of the scheme, whereas no difference is observed in the investment ratio. Next, as regards the innovation activity of the firms, a greater increase is seen in the probability of filing a patent among beneficiaries of the scheme. If we limit ourselves to looking at firms within the manufacturing industry, an increase can also be seen in the number of products manufactured by the beneficiaries.

Nevertheless, the interpretation of these results as causal effects of the CII on the variables presented must be qualified. Indeed, matching methods allow for the correction of observable pre-treatment differences, but they do not provide any guarantee as to the balance of non-observable variables. Persistent differences in the latter could lead to a misinterpretation of the findings presented above. Moreover, it is important to keep in mind that there is a significant risk of endogeneity with regard to the use of the CII, since these are the firms that have chosen to use it. In this respect, and even if many observables are taken into account during matching to limit this risk, the possibility that some firms may make use of the scheme on the pretext of eligible innovation expenditures that would have taken place with or without the existence of the CII cannot be completely ruled out.[8] As a result, the absence of certainty regarding the balance of non-observable variables coupled with the potential existence of a partial deadweight effect suggests that the estimates presented should be interpreted as an upper bound of the impact of the CII on the beneficiary firms.

Lastly, we highlight a fall in the amount of research expenditures declared under the CIR, which is linked to the introduction of the CII. This fall could be interpreted either in terms of the cyclical nature of innovation activities, or in terms of the relabelling of research expenditures as innovation expenditures.

Finally, the most significant changes observed for the beneficiary firms across the majority of the variables of interest investigated in this study seem to combine a causal effect from the CII, which induces certain firms to engage in an innovation process and a self-selection process among the most dynamic firms under the CII, for which these greater changes in the variables of interest would have been seen regardless of whether or not the CII was introduced. □

8. See Online Appendix C2, which shows an attempt at an instrumental variable approach.

Link to the Online Appendix:
https://www.insee.fr/en/statistiques/fichier/5430852/ES-526-527_Bunel-Hadjibeyli_Online-Appendix.pdf

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APPENDIX

ADDITIONAL FIGURES AND ESTIMATIONS

Figure A-I – **Propensity Score Distribution**

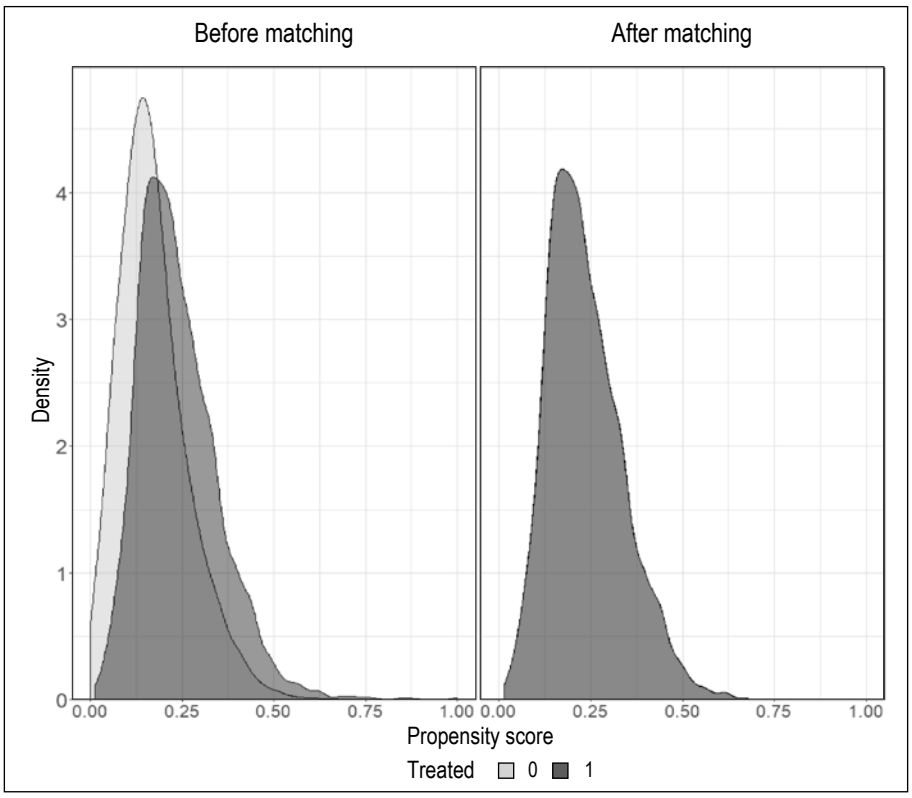
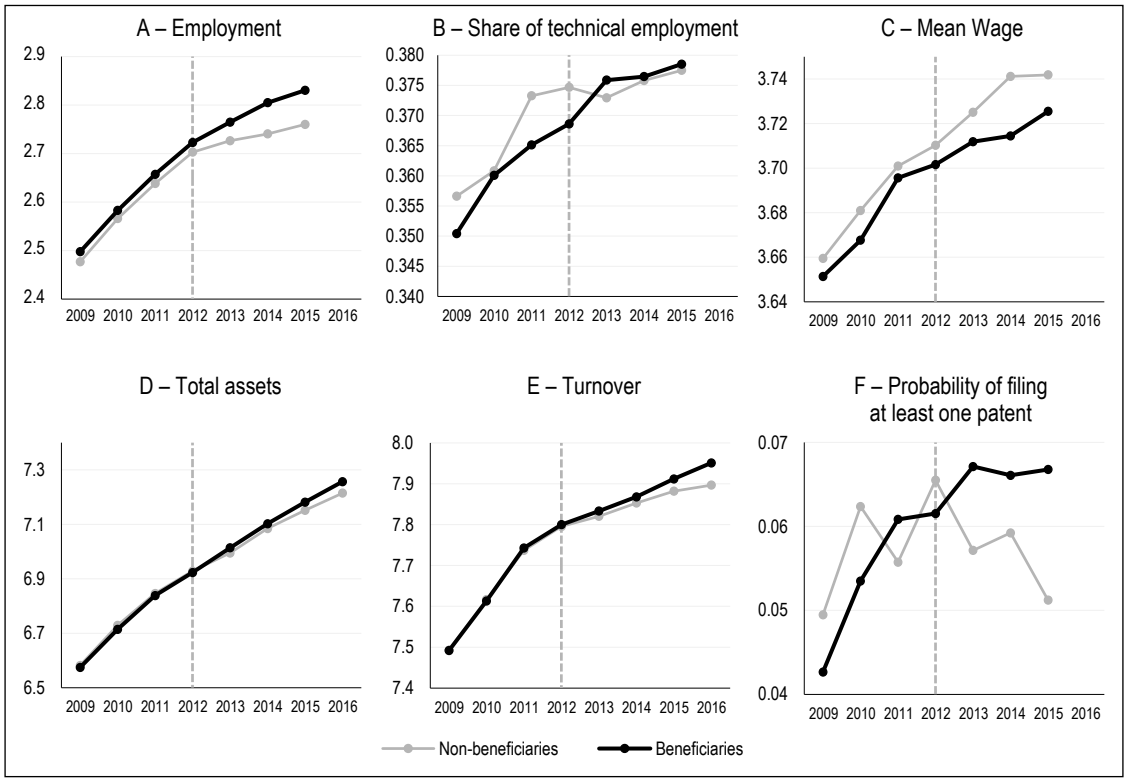
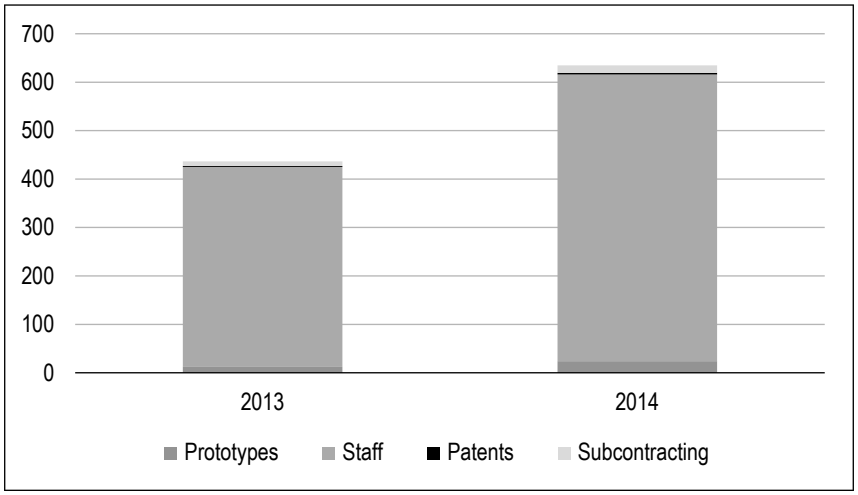


Figure A-II – **Changes in the variables of interest**



Sources and Coverage: DGFiP-MESRI, GECIR database; INSEE, DADS, FARE; MESRI, Atlas des Brevets. SMEs benefiting from the CII and comparable non-beneficiaries.

Figure A-III – **Nature of the expenditure declared under the CII**



Sources and Coverage: DGFiP-MESRI, GECIR database. SMEs benefiting from the CII.

Figure A-IV – **Balancing Property – Products**

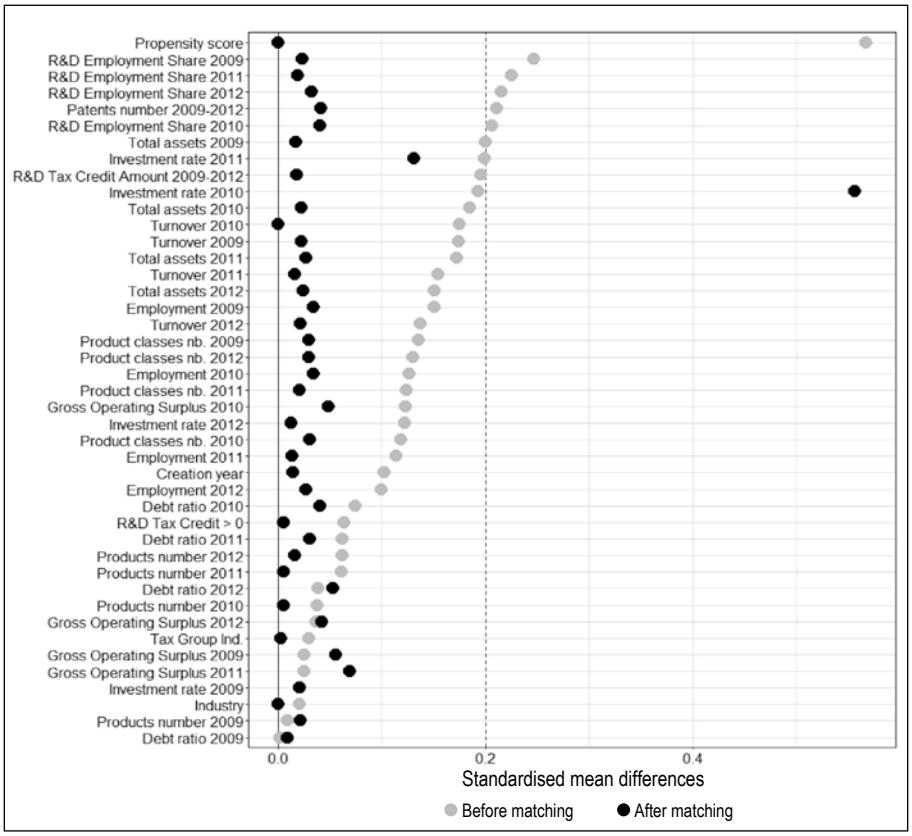


Table A-1 – **Estimates on the overall economic variables**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Employment	Share of technical employment	Mean wage	Total assets	Investment ratio	Turnover	Probability of filing a patent
T_{i2009}	0.00140	-0.000113	0.000670	-0.000708	0.00470	-0.00470	-0.00297
	(0.0135)	(0.00499)	(0.00720)	(0.0157)	(0.00653)	(0.0127)	(0.00735)
T_{i2010}	-0.00264	0.00522	-0.00476	-0.00832	0.0102	-0.00730	-0.00507
	(0.00920)	(0.00436)	(0.00588)	(0.0116)	(0.0156)	(0.00960)	(0.00727)
T_{i2011}	-0.000862	-0.00219	0.00336	-0.00197	-0.00324	0.00157	0.00874
	(0.00614)	(0.00336)	(0.00507)	(0.00802)	(0.00542)	(0.00666)	(0.00725)
T_{i2013}	0.0179***	0.00895***	-0.00447	0.0239***	0.00173	0.00809	0.0138*
	(0.00550)	(0.00329)	(0.00478)	(0.00783)	(0.00413)	(0.00625)	(0.00728)
T_{i2014}	0.0438***	0.00663*	-0.0180***	0.0226**	0.00649	0.0101	0.0107
	(0.00783)	(0.00384)	(0.00522)	(0.0103)	(0.00540)	(0.00843)	(0.00759)
T_{i2015}	0.0496***	0.00684	-0.00757	0.0344***	-0.00519	0.0249**	0.0196**
	(0.0102)	(0.00427)	(0.00590)	(0.0130)	(0.00593)	(0.0109)	(0.00774)
T_{i2016}				0.0467***	-0.00415	0.0491***	
				(0.0151)	(0.00607)	(0.0138)	
Constant	2.713***	0.372***	3.706***	6.926***	0.0650***	7.798***	0.0635***
	(0.00221)	(0.00119)	(0.00163)	(0.00309)	(0.00166)	(0.00256)	(0.00242)
Observations	40,110	40,110	40,110	45,840	45,840	45,840	40,110
R^2	0.130	0.006	0.028	0.261	0.000	0.176	0.001

Notes: Standard error shown in brackets. Estimates with clusters at the level of the firms. * p < 0.1, ** p < 0.05, *** p < 0.01.
Reading note: The difference in the changes in employment between the treated group and the counterfactual group over the period from 2012 to 2015 is 4.96 percentage points.

Table A-2 – **Estimates – strict sectoral matching at the finest level of NACE classification**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Employment	Share of technical employment	Mean wage	Total assets	Investment ratio	Turnover	Probability of filing a patent
T_{i2009}	-0.00754	-0.00254	0.00364	-0.0127	-0.00175	-0.0112	0.00264
	(0.0148)	(0.00561)	(0.00823)	(0.0172)	(0.00513)	(0.0145)	(0.00699)
T_{i2010}	-0.0103	0.00453	-0.00108	-0.0202	0.0206	-0.0122	-0.00309
	(0.0102)	(0.00495)	(0.00681)	(0.0127)	(0.0193)	(0.0106)	(0.00718)
T_{i2011}	-0.0105	0.00310	0.00789	-0.0112	0.00134	-0.00524	-0.00309
	(0.00666)	(0.00390)	(0.00561)	(0.00888)	(0.00647)	(0.00721)	(0.00731)
T_{i2013}	0.0209***	0.00667*	0.000811	0.0248***	0.00850*	0.00922	0.0141**
	(0.00631)	(0.00360)	(0.00564)	(0.00883)	(0.00461)	(0.00749)	(0.00719)
T_{i2014}	0.0481***	0.00804*	-0.00809	0.0450***	0.0135**	0.0122	0.0141*
	(0.00885)	(0.00449)	(0.00581)	(0.0119)	(0.00639)	(0.00979)	(0.00766)
T_{i2015}	0.0594***	0.00532	-0.00742	0.0611***	0.00462	0.0363***	0.0198***
	(0.0113)	(0.00493)	(0.00659)	(0.0150)	(0.00589)	(0.0120)	(0.00761)
T_{i2016}				0.0720***	0.00570	0.0652***	
				(0.0173)	(0.00683)	(0.0155)	
Constant	2.674***	0.405***	3.727***	6.852***	0.0589***	7.714***	0.0421***
	(0.00252)	(0.00134)	(0.00194)	(0.00358)	(0.00210)	(0.00294)	(0.00235)
Observations	31,766	31,766	31,766	36,304	36,304	36,304	31,766
R^2	0.117	0.007	0.028	0.240	0.000	0.165	0.002

Notes: Standard error shown in brackets. Estimates with clusters at the level of the firms. * p < 0.1, ** p < 0.05, *** p < 0.01.

Table A-3 – **Two nearest neighbours**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Employment	Share of technical employment	Mean wage	Total assets	Investment ratio	Turnover	Probability of filing a patent
T_{i2009}	-0.00241	-0.00208	0.00255	-0.00453	0.00112	-0.00312	-0.00142
	(0.0116)	(0.00435)	(0.00650)	(0.0135)	(0.00664)	(0.0110)	(0.00614)
T_{i2010}	-0.00936	0.00327	-0.00396	-0.00641	0.00782	-0.0106	-0.000709
	(0.00800)	(0.00386)	(0.00511)	(0.00988)	(0.0160)	(0.00811)	(0.00625)
T_{i2011}	-0.00528	0.000664	0.00433	-0.00571	-0.00553	-0.00340	0.00910
	(0.00541)	(0.00296)	(0.00451)	(0.00690)	(0.00525)	(0.00565)	(0.00628)
T_{i2013}	0.0147***	0.0103***	-0.00248	0.0237***	0.00126	0.00735	0.0155**
	(0.00482)	(0.00288)	(0.00427)	(0.00671)	(0.00365)	(0.00538)	(0.00633)
T_{i2014}	0.0375***	0.0106***	-0.0156***	0.0208**	0.00251	0.00941	0.0121*
	(0.00672)	(0.00334)	(0.00440)	(0.00890)	(0.00508)	(0.00740)	(0.00657)
T_{i2015}	0.0405***	0.0119***	-0.00762	0.0360***	-0.00517	0.0234**	0.0191***
	(0.00867)	(0.00367)	(0.00515)	(0.0112)	(0.00488)	(0.00942)	(0.00669)
T_{i2016}				0.0507***	-0.00543	0.0428***	
				(0.0146)	(0.00557)	(0.0113)	
Constant	2.706***	0.374***	3.708***	6.921***	0.0646***	7.791***	0.0586***
	(0.00177)	(0.000977)	(0.00135)	(0.00264)	(0.00139)	(0.00211)	(0.00195)
Observations	59,255	59,255	59,255	67,720	67,720	67,720	59,255
R^2	0.122	0.004	0.031	0.225	0.000	0.170	0.001

Notes: cf. Table A-2.

Table A-4 – **Three nearest neighbours**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Employment	Share of technical employment	Mean wage	Total assets	Investment ratio	Turnover	Probability of filing a patent
T_{i2009}	-0.00381	-0.00164	0.00134	-0.00113	-0.00141	0.00106	0.000803
	(0.0107)	(0.00409)	(0.00600)	(0.0126)	(0.00644)	(0.0102)	(0.00575)
T_{i2010}	-0.0109	0.00225	-0.00309	-0.00767	0.00497	-0.00728	-0.000862
	(0.00750)	(0.00367)	(0.00482)	(0.00923)	(0.0160)	(0.00755)	(0.00586)
T_{i2011}	-0.00630	-0.000461	0.00439	-0.00482	-0.00597	-0.00137	0.0108*
	(0.00514)	(0.00281)	(0.00441)	(0.00645)	(0.00507)	(0.00527)	(0.00593)
T_{i2013}	0.0141***	0.00813***	-0.0000262	0.0243***	0.0000421	0.0107**	0.0173***
	(0.00457)	(0.00272)	(0.00408)	(0.00628)	(0.00333)	(0.00498)	(0.00598)
T_{i2014}	0.0391***	0.00827***	-0.0115***	0.0312***	0.00297	0.0176**	0.0139**
	(0.00633)	(0.00315)	(0.00408)	(0.00838)	(0.00482)	(0.00690)	(0.00620)
T_{i2015}	0.0473***	0.0107***	-0.00690	0.0467***	-0.00506	0.0316***	0.0217***
	(0.00816)	(0.00345)	(0.00490)	(0.0105)	(0.00450)	(0.00883)	(0.00635)
T_{i2016}				0.0604***	-0.00387	0.0531***	
				(0.0131)	(0.00522)	(0.0106)	
Constant	2.720***	0.372***	3.706***	6.927***	0.0637***	7.803***	0.0584***
	(0.00154)	(0.000840)	(0.00116)	(0.00229)	(0.00118)	(0.00184)	(0.00166)
Observations	78,463	78,463	78,463	89,672	89,672	89,672	78,463
R^2	0.115	0.004	0.030	0.222	0.000	0.160	0.001

Notes: cf. Table A-2.

Table A-5 – **Strict condition concerning CIR prior to 2012**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Employment	Share of technical employment	Mean wage	Total assets	Investment ratio	Turnover	Probability of filing a patent
T_{i2009}	-0.00399	0.000398	0.00347	0.0134	0.00734	0.000831	0.000705
	(0.0134)	(0.00496)	(0.00803)	(0.0156)	(0.00679)	(0.0128)	(0.00735)
T_{i2010}	-0.00919	0.00485	-0.00588	0.00124	0.0105	-0.00431	-2.79e-15
	(0.00911)	(0.00443)	(0.00605)	(0.0115)	(0.0157)	(0.00980)	(0.00721)
T_{i2011}	-0.00688	-0.00133	0.00492	0.00188	-0.00813	0.00307	0.00829
	(0.00620)	(0.00343)	(0.00523)	(0.00794)	(0.00596)	(0.00666)	(0.00719)
T_{i2013}	0.0139**	0.0105***	-0.000511	0.0206***	0.00105	0.0163**	0.0187***
	(0.00545)	(0.00327)	(0.00464)	(0.00757)	(0.00455)	(0.00639)	(0.00725)
T_{i2014}	0.0356***	0.00831**	-0.0122**	0.0261**	0.00935*	0.0180**	0.0120
	(0.00774)	(0.00378)	(0.00499)	(0.0103)	(0.00525)	(0.00867)	(0.00763)
T_{i2015}	0.0466***	0.00919**	-0.00820	0.0456***	-0.00245	0.0313***	0.0197**
	(0.0102)	(0.00414)	(0.00598)	(0.0131)	(0.00594)	(0.0112)	(0.00767)
T_{i2016}				0.0567***	0.00478	0.0585***	
				(0.0151)	(0.00550)	(0.0142)	
Constant	3.046	0.417	4.169	6.934	0.0653	7.791	0.0822
	(128019.7)	(47648.6)	(153458.4)	(15660.9)	(2858.9)	(21974.3)	(27908.4)
Observations	39,725	39,725	39,725	45,400	45,400	45,400	39,725
R^2	0.128	0.006	0.025	0.262	0.000	0.168	0.002

Notes: cf. Table A-2.

Table A-6 – **Inverse probability weighting of the treatment**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Employment	Share of technical employment	Mean wage	Total assets	Investment ratio	Turnover	Probability of filing a patent
T_{i2009}	-0.00591	-0.000590	-0.00134	-0.00507	0.00259	-0.00710	-0.000650
	(0.0117)	(0.00427)	(0.00654)	(0.0135)	(0.00793)	(0.0113)	(0.00619)
T_{i2010}	-0.0120	0.00324	-0.00384	-0.0148	0.0000190	-0.0134	0.00191
	(0.00795)	(0.00378)	(0.00513)	(0.00989)	(0.0159)	(0.00828)	(0.00608)
T_{i2011}	-0.0102**	-0.000328	0.00226	-0.0132**	-0.00908*	-0.00606	0.00953
	(0.00521)	(0.00291)	(0.00435)	(0.00668)	(0.00513)	(0.00545)	(0.00618)
T_{i2013}	0.0211***	0.00684**	-0.00697*	0.0202***	-0.00685	0.00848	0.0197***
	(0.00454)	(0.00274)	(0.00407)	(0.00649)	(0.00481)	(0.00537)	(0.00618)
T_{i2014}	0.0449***	0.00744**	-0.0158***	0.0366***	-0.000966	0.0168**	0.0182***
	(0.00643)	(0.00322)	(0.00410)	(0.00858)	(0.00492)	(0.00723)	(0.00641)
T_{i2015}	0.0539***	0.00750**	-0.0106**	0.0503***	-0.00688	0.0341***	0.0225***
	(0.00828)	(0.00356)	(0.00484)	(0.0107)	(0.00454)	(0.00936)	(0.00654)
T_{i2016}				0.0613***	-0.00792	0.0530***	
				(0.0125)	(0.00538)	(0.0108)	
Constant	2.716***	0.369***	3.702***	6.923***	0.0662***	7.798***	0.0661***
	(0.00190)	(0.00102)	(0.00142)	(0.00261)	(0.00170)	(0.00219)	(0.00206)
Observations	110,264	110,264	110,264	126,016	126,016	126,016	110,264
R^2	0.133	0.006	0.025	0.253	0.000	0.174	0.002

Notes: cf. Table A-2.

Table A-7 – **Period from 2011 to 2015**

	(1)	(2)	(4)	(6)	(7)
	Employment	Share of technical employment	Total assets	Turnover	Probability of filing a patent
T_{i2011}	-0.00794	-0.00149	0.00511	-0.00214	-0.00446
	(0.00578)	(0.00326)	(0.00973)	(0.00799)	(0.0112)
T_{i2013}	0.0299***	0.00992***	0.0204**	0.0237***	0.00131
	(0.00545)	(0.00295)	(0.00855)	(0.00692)	(0.0112)
T_{i2014}	0.0577***	0.0165***	0.0436***	0.0354***	0.00643
	(0.00814)	(0.00363)	(0.0114)	(0.00930)	(0.0111)
T_{i2015}	0.0725***	0.0167***	0.0596***	0.0458***	0.0185
	(0.0108)	(0.00397)	(0.0147)	(0.0117)	(0.0113)
Constant	2.620***	0.371***	6.795***	7.656***	0.0923***
	(0.00224)	(0.00106)	(0.00324)	(0.00257)	(0.00351)
Observations	38,180	38,180	38,180	38,180	38,180
R^2	0.044	0.002	0.096	0.040	0.000

Notes: cf. Table A-2.

Table A-8 – **Products**

	(1)	(2)	(3)
	Fine level	Intermediate level	Aggregated level
T_{i2009}	0.00877	-0.00376	-0.00627
	(0.0497)	(0.0269)	(0.0252)
T_{i2010}	-0.0213	-0.00251	0.00501
	(0.0402)	(0.0233)	(0.0220)
T_{i2011}	-0.0213	-0.00877	0.00501
	(0.0304)	(0.0193)	(0.0181)
T_{i2013}	0.0526	0.0238	0.0150
	(0.0461)	(0.0247)	(0.0217)
T_{i2014}	0.0313	0.0476*	0.0376
	(0.0554)	(0.0279)	(0.0250)
T_{i2015}	0.0489	0.0689**	0.0564**
	(0.0655)	(0.0316)	(0.0287)
T_{i2016}	0.128*	0.0977***	0.0827***
	(0.0698)	(0.0332)	(0.0298)
Constant	2.231***	1.560***	1.496***
	(0.0159)	(0.00806)	(0.00737)
Observations	12,776	12,776	12,776
R^2	0.015	0.029	0.028

Notes: cf. Table A-2.

Table A-9 – **Inverse probability weighting of the treatment**

	(1)	(2)	(3)
	Fine level	Intermediate level	Aggregated level
T_{i2009}	-0.0153	-0.0144	-0.0225
	(0.0521)	(0.0268)	(0.0252)
T_{i2010}	-0.0318	-0.0246	-0.0194
	(0.0385)	(0.0233)	(0.0218)
T_{i2011}	-0.0199	-0.0106	0.000838
	(0.0274)	(0.0180)	(0.0170)
T_{i2013}	0.0562	0.0218	0.0159
	(0.0427)	(0.0219)	(0.0193)
T_{i2014}	0.0813	0.0554**	0.0455**
	(0.0509)	(0.0258)	(0.0230)
T_{i2015}	0.0702	0.0633**	0.0535**
	(0.0607)	(0.0290)	(0.0261)
T_{i2016}	0.0976	0.0668**	0.0614**
	(0.0644)	(0.0306)	(0.0275)
Constant	2.315***	1.600***	1.529***
	(0.0148)	(0.00765)	(0.00702)
Observations	35,472	35,472	35,472
R^2	0.013	0.029	0.029