Impact evaluation of science-industry transfer policy on large companies using synthetic control method: An application to two French Technological Research Institutes (TRIs)

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Impact of R&I Policy at the Crossroads of
POLICY DESIGN
IMPLEMENTATION
EVALUATION

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Outline

1. Introduction

2. Empirical strategy

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1. Introduction

1.1. Context (1)

- In the aftermath of the 2008 crisis, the French government sought to transit to a new model of growth by moving beyond conjunctural responses to the conduct of structural actions.

- For that, the government commissioned several studies at the OECD in order to analyze its national innovation system.

- These studies revealed that France suffers from the lack of efficiency in innovation despite relatively high levels of public and private research.

- This context illustrates one of the criticisms often addressed to the European Union, commonly called **"European paradox".**

1. Introduction
1.2. Context (2)

- In 2010, French government launched a vast investment program called *"***Programme d'Investissement d'Avenir***"*.

- The **objective** is to accelerate the transition of the French economy towards a new model of growth, based on the knowledge economy and sustainable development.

- With a budget of **57 billion Euros** today, this program focuses on several major areas.

- More specifically, this program is based on many actions including the creation of the **Technological Research Institutes** in 2012

1. Introduction

1.3. Technological Research Institutes (1)

- An interdisciplinary thematic research institute that brings together higher education and research institutions, major groups and SMEs around a common program of technological research (2012 – 2019).

- They are based on **technological platforms** and **multilateral cooperation**.

- The creation of the TRIs is based on the **principle of territoriality** (8 TRIs were established in 8 different French territories).

- **Co-investment logic:** 50% of activities are financed by private actors and 50% by the public actors.

1. Introduction

1.3. Technological Research Institutes (2)

- The private actors consist of **large firms**. They bring equipment, cash and R&D workforce.

- In this context, the substantial benefits are expected from these large companies.

- Beyond this, generally large firms benefit more from R&D support than SMEs in France.

- **Empirical literature:** There no impact evaluation studies that only focus on large companies.

- **Issue:** It is very difficult to quantify the impact of a policy on large companies for many reasons.

1. Introduction

1.3. Methodological issues of large firms evaluation

- The difficulty to find a counterfactual for large companies.
- Large companies benefit from a multitude of R&D support schemes: **The difficulty to identify the effect of TRIs.**
- The performance of large firms is strongly influenced by their strategic behavior (merger, acquisition, etc.) changing over time.
- In the case of the TRIs, public policy support for large firms is not a financial issue and is more complex to observe, resulting in a more complex measure of the existence of potential effects.
- **How do we identify if the large firms would have undertaken the same R&D projects in the absence of the TRIs ?** .

2. Empirical strategy

2. Empirical strategy

2.1. Synthetic control method

- **Principle: C**onstitute a synthetic counterfactual by the linear combination of weighted averages of the variables of "untreated" units over the pre-treatment period.

- **The underlying idea:** if the synthetic control is able to closely follow the trend of treated unit over a long period before the treatment, then, any extraordinary gap after treatment can be attributed to the treatment.

- **The objective:** To find the weight (or proportion) that minimizes the distance between the values of the variables of the "treated" unit and the values of the same variables of the other units of the “donor pool”.

2. Empirical strategy
2.2. Evaluation framework

- J+1 Large companies whose the first is treated.
- T periods including T_0 first pre-treatment period.
- Y_{1t}: Performance indicator of treated « 1 ».
- Y_{jt}: Performance indicator for potential controls, j=2,,,,J+1
- $Y_{1t} = \begin{cases} Y_{1t}^{1} \\ Y_{1t}^{0} \end{cases} \quad t = 1, 2, \ldots T_0, T_0 + 1, T_0 + 2, \ldots . T$
- The **objective** is to estimate $\delta_{1T_0+1}, \delta_{1T_0+2}, , , , , , \delta_{1T}$ with
- δ_{1t}= Y_{1t}^{1} - Y_{1t}^{0} for t > T_0
- For that, we must be able to estimate the conterfactual $\boldsymbol{Y_{1t}^{0}}$

2. Empirical strategy
2.3. Conterfactual construction

- We look for a vector of « optimal » weights (J x 1)

- $W = (w_2^*, w_3^*, , , , , , , w_{J+1}^*)$ allowing to find:
  - Previous situations of treated large firm:
  - $Y_{1t} = \sum_{j=2}^{J+1} w_j^* Y_{jt}, \quad for \;\; t = 1, , , , T_0$

  - The same characteristics of treated large firm:
  - $X_1 = \sum_{j=2}^{J+1} w_j^* X_j$

- The program is to determine W* that minimizes $X_1 - X_j W^*$

2. Empirical strategy

2.4. Average treatment effect estimator

- Once weights are determined,

- $\widehat{\delta_{1t}} = Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt},\ for\ \ t = T_0 + 1,,,,,,,T$

- The estimator of the "overall" average effect of treatment for the treated:

- $\widehat{\delta_1} = \frac{1}{T-T_0} \sum_{t=T_0+1}^{T} [\, Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt}]$

2. Empirical strategy
2.4. Data & variables (1)

i) **Data:**

- Annual panel data at the firm level
- Study period: 1998 – 2015.
- Pre-treatment period : 1998 - 2011 (14 years of pre-treatment).
- Post-treatment period : 2012 - 2015 (4 years of post-treatment).
- Sample of 26 firms: 4 treated firms and 22 untreated firms.
- Number of observations: 468.

ii) **Sources:**

- Fare & Ficus (Ministry of finance).
- DADS (Insee).
- R&D survey (MENESR).
- Gecir (Ministry of finance).
- Technological Research Institutes: “Nanoélec” & “Bioaster”.

2. Empirical strategy
2.4. Data & variables (2)

iii) Outcome variables: R&D input indicators:

- Net total R&D expenditures
- Internal R&D expenditures
- External R&D expenditures
- R&D self-financing
- R&D intensity
- R&D workforce

3. Results

3. Results

3.1. Descriptive statistics (1)

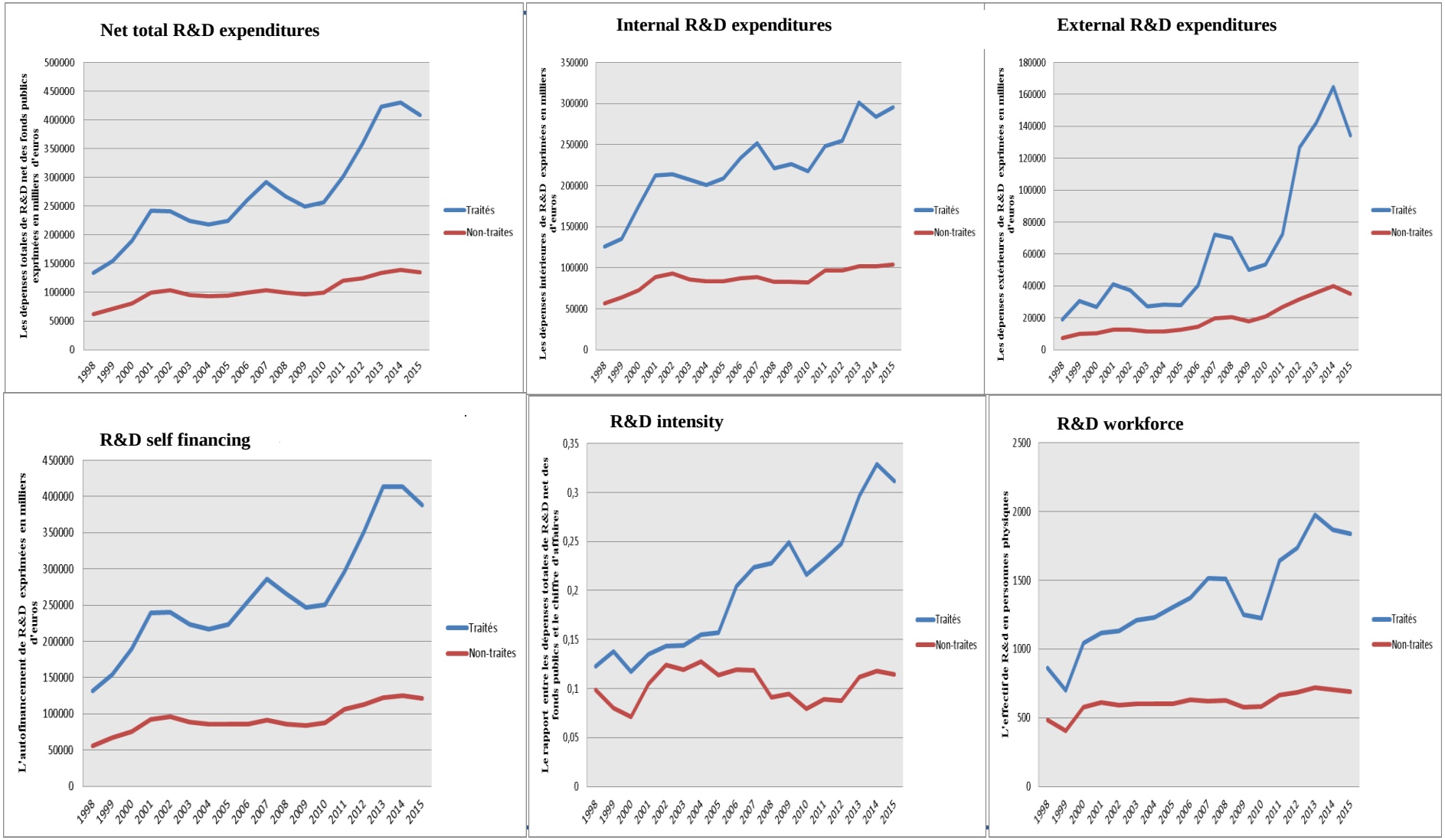
Table 1: Comparison treated and control firms over the pre-treatment period (1998-2011)

Variables	Treated group	Control group	Difference test
Dependent variables			
Net total R&D expenditures	232,476	68,815	163,661***
Internal R&D expenditures	205,468	59,352	146,116***
External R&D expenditures	42,590	9,792	32,798***
R&D self financing	229,819	58,517	171,302***
R&D intensity	0.17595	0.08874	0.08721***
R&D workforce	1,222	468	754***
Independent variables			
Turnover	1,591,081	1,326,125	264 956
Workforce	6,419	5,261	1,158*
Equity	1,540,272	781,748	758,524***
Public financing	15,582	299	15,283***
Private financing	2,657	10,044	-7,387***
Capital R&D expenditures	39,079	7,571	31,508***
Share of managers	0.289	0.272	0.017
Share of exports	0.711	0.566	0.144***
Number of plants	18	19	-1
Number of firms	4	22	

3. Results

3.1. Descriptive statistics (2)

Figure 1: Trends in R&D indicators: treated vs untreated firms



3. Results

3.1. Descriptive statistics (3)

Table 2: Comparison before & after treatment

	Treated group	Treated group	Control group	Control group
Dependent variables	**Mean (Before)**	**Mean (After)**	**Mean (Before)**	**Mean (After)**
Net total R&D expenditures	232,476	404,912	68,815	83,529
Internal R&D expenditures	205,468	283,691	59,352	67,554
External R&D expenditures	42,590	141,835	9,792	16,307
R&D self financing	229,819	391,776	58,517	70,718
R&D intensity	0.17595	0.296	0.089	0.074
R&D workforce	1,222	1,853	468	490
Independent variables				
Turnover	1,591,081	1,684,976	1,326,125	1,326,125
Workforce	6,419	4,629	5,261	4,670
Equity	1,540,272	2,705,468	781,748	1,213,799
Public financing	15,582	20,615	299	332
Private financing	2,657	13,136	10,044	12,811
Capital R&D expenditures	39,079	142,230	7,571	26,798
Share of managers	0.289	0.374	0.273	0.336
Share of exports	0.711	0.801	0.567	0.530
Number of plants	18	8	19	16

3. Results

3.1. Descriptive statistics (4)

- There exists a gap in mean between treated firms and untreated firms: **Untreated firms do not constitute an appropriate counterfactual group for the treated group**.

- Trends in R&D input indicators between treated and untreated firms are not parallels: **Difference-in-difference method is not appropriate.**

- Observation of peaks and valleys common to both trajectories : **The presence of temporal fixed effects**.

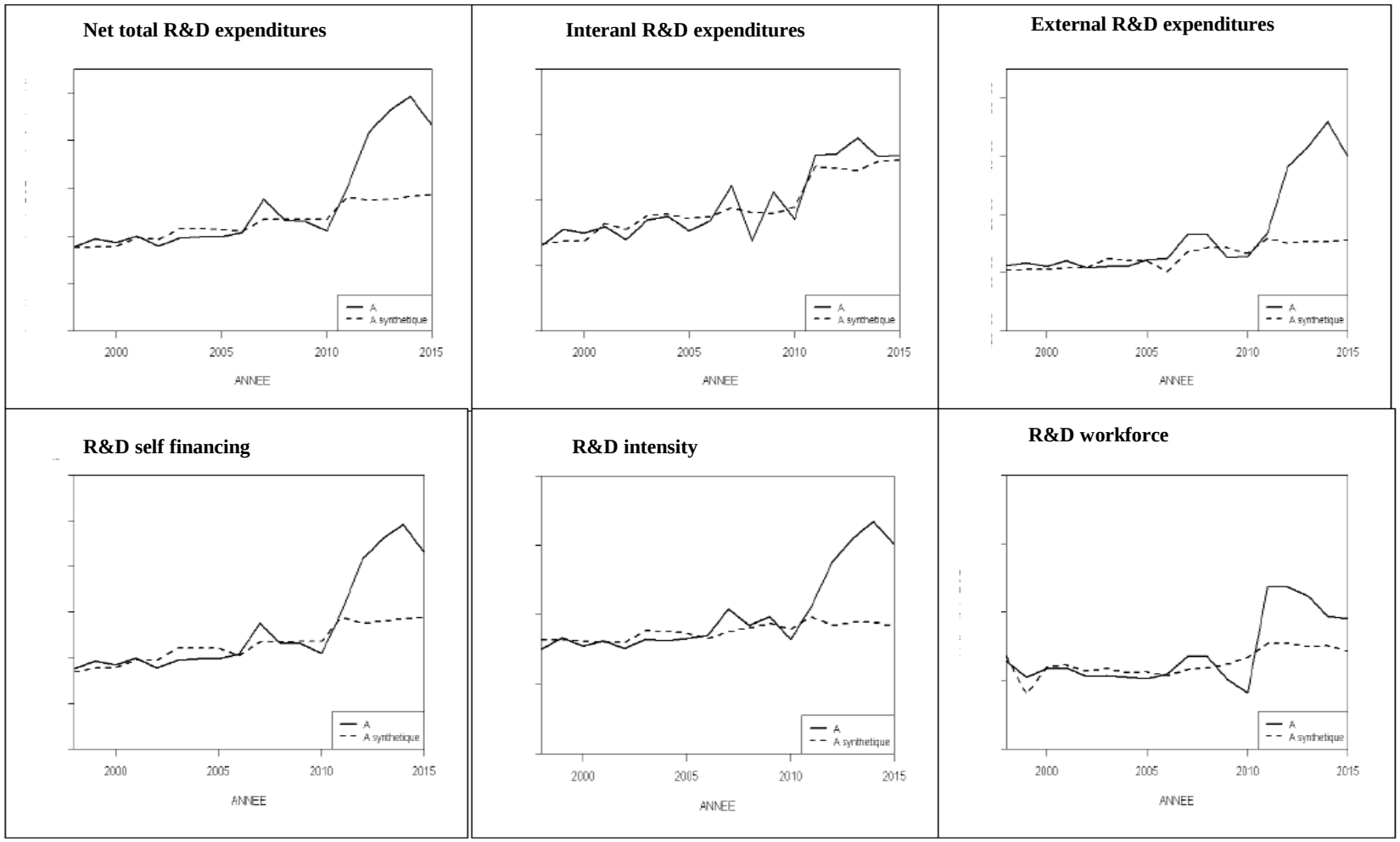
- Observation of peaks and valleys very specific to the each group, which seems to imply the existence of individual trends.

- **Consequence :** Implement other traditional counterfactual evaluation methods such as **fixed effects model** & **random trend model**.

3. Results

3.1. Results: Company « A »

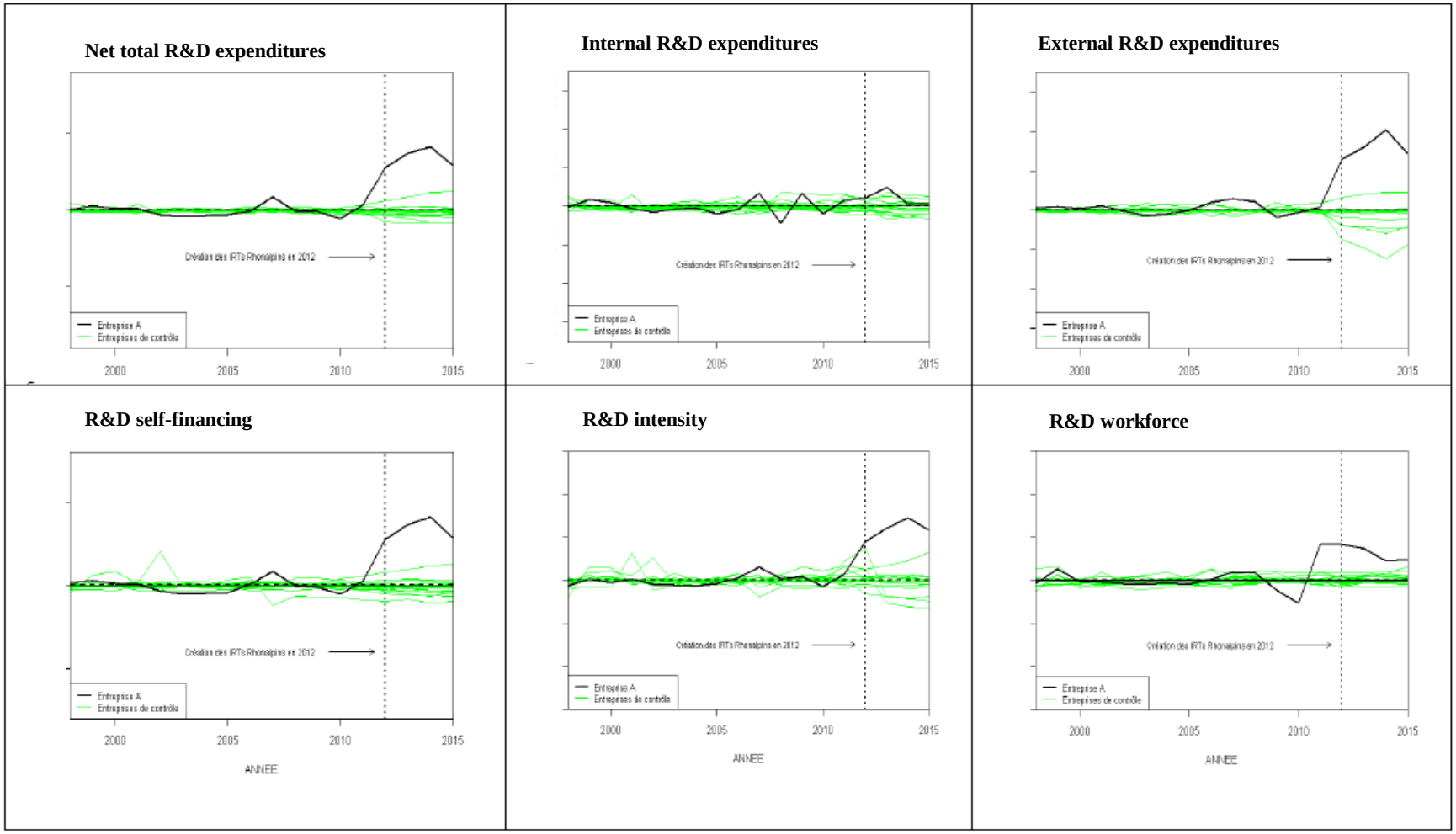
Figure 2: Trends in R&D indicators: Company "A" vs Synthetic version



3. Results

3.1. Results: Company « A »

Figure 3 : Gaps between company "A" and placebos of control companies



3. Results

3.1. Results: Company « A »

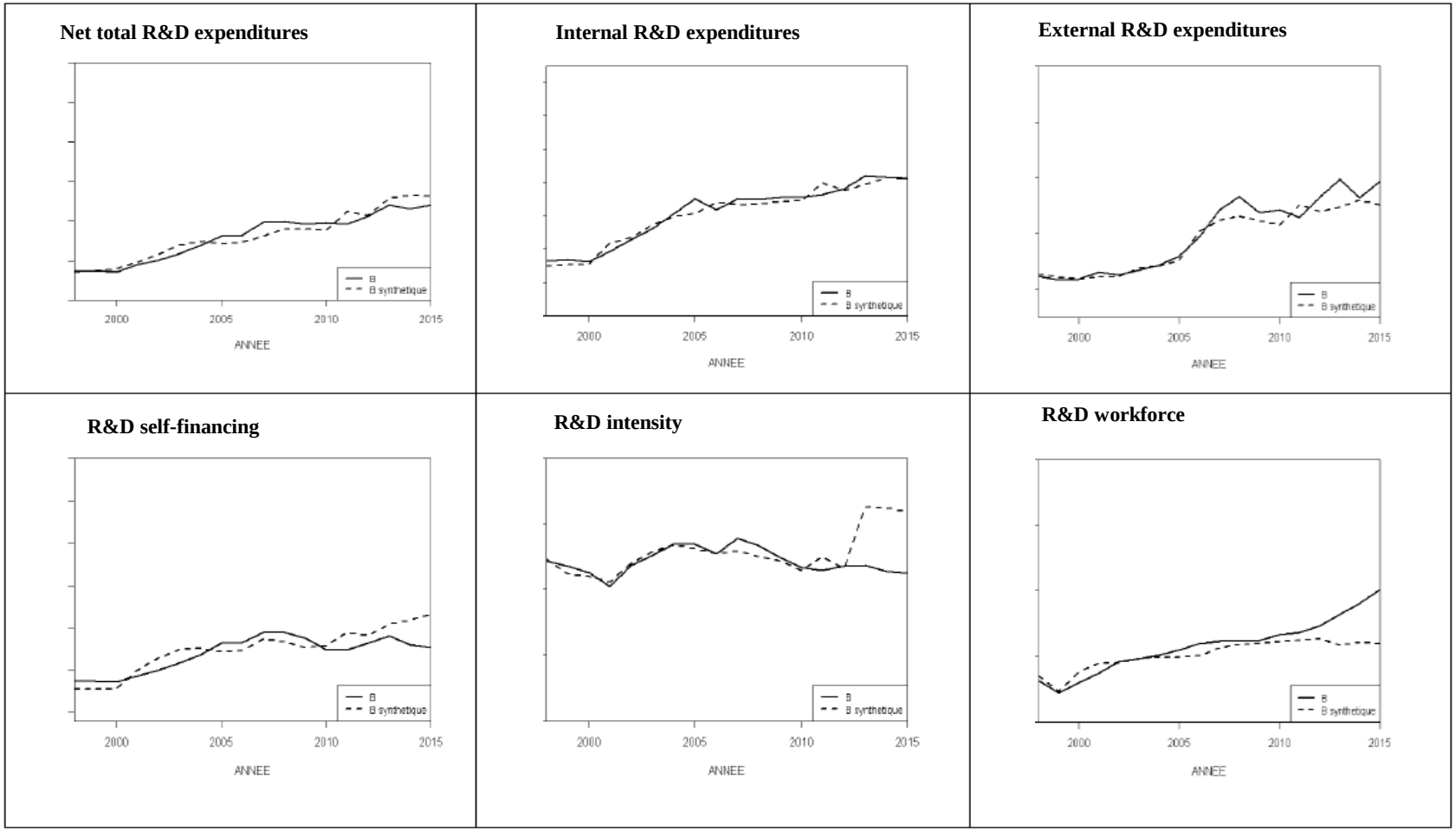
Table 3: Annual average effect estimated

R&D input indicators	2012	2013	2014	2015	Annual mean effect
Net total R&D expenditures	281,855	374,272	416,921	294,860	341,977
Internal R&D expenditures	24,159	11,084	13,313	8,468	14,256
Internal R&D expenditures	261,056	324,351	410,998	286,983	320,847
R&D self financing	277,134	364,922	411,248	285,936	334,810
R&D intensity	9%	12%	15%	12%	12%
R&D workforce	829	739	437	477	620

3. Results

3.2. Results: Company « B »

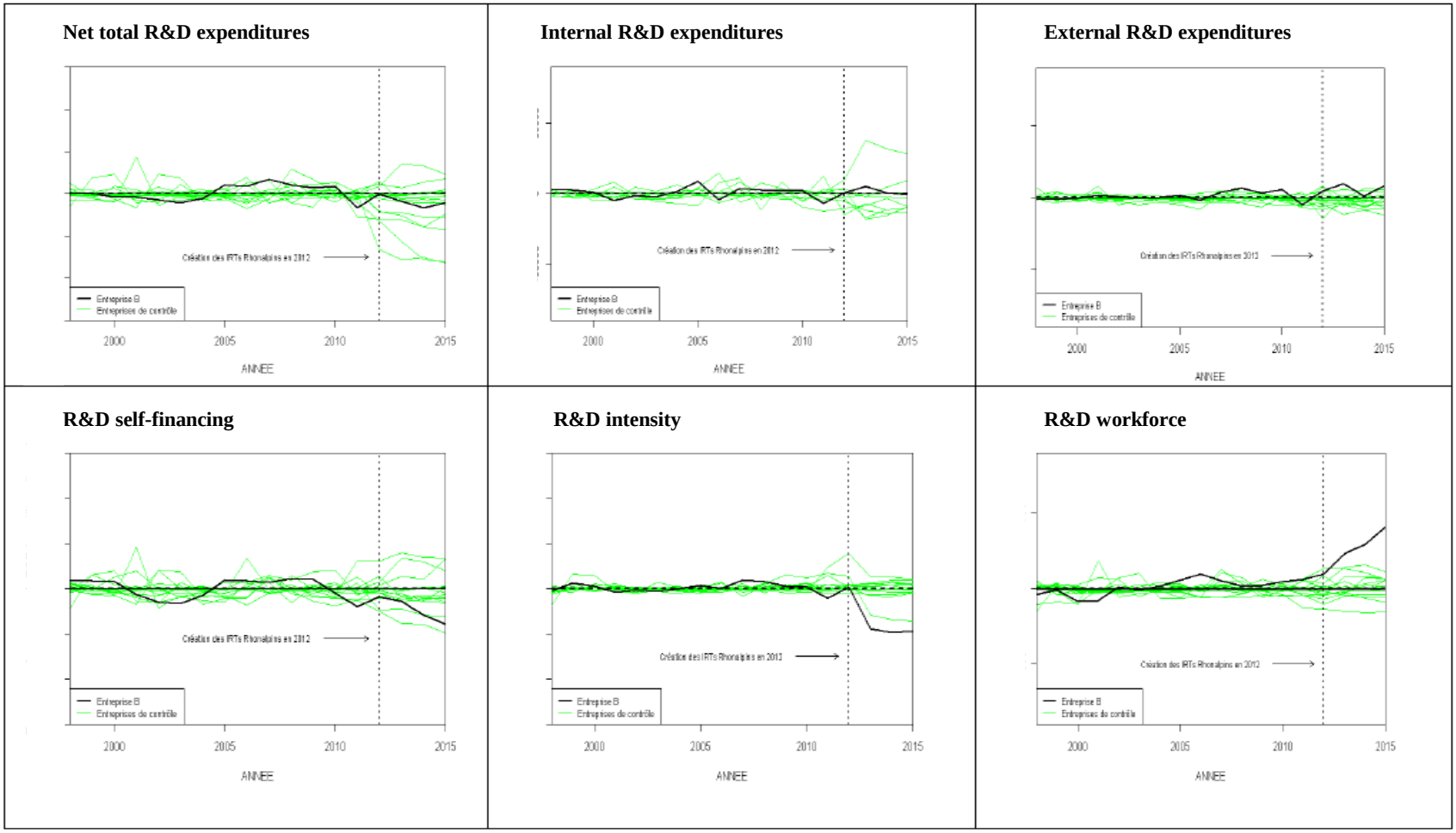
Figure 4 : Trends in R&D indicators: Company "B" vs synthetic version



3. Results

3.2. Results: Company « B »

Figure 5 : Gaps between company "B" and placebos of control companies



3. Results

3.2. Results: Company « B »

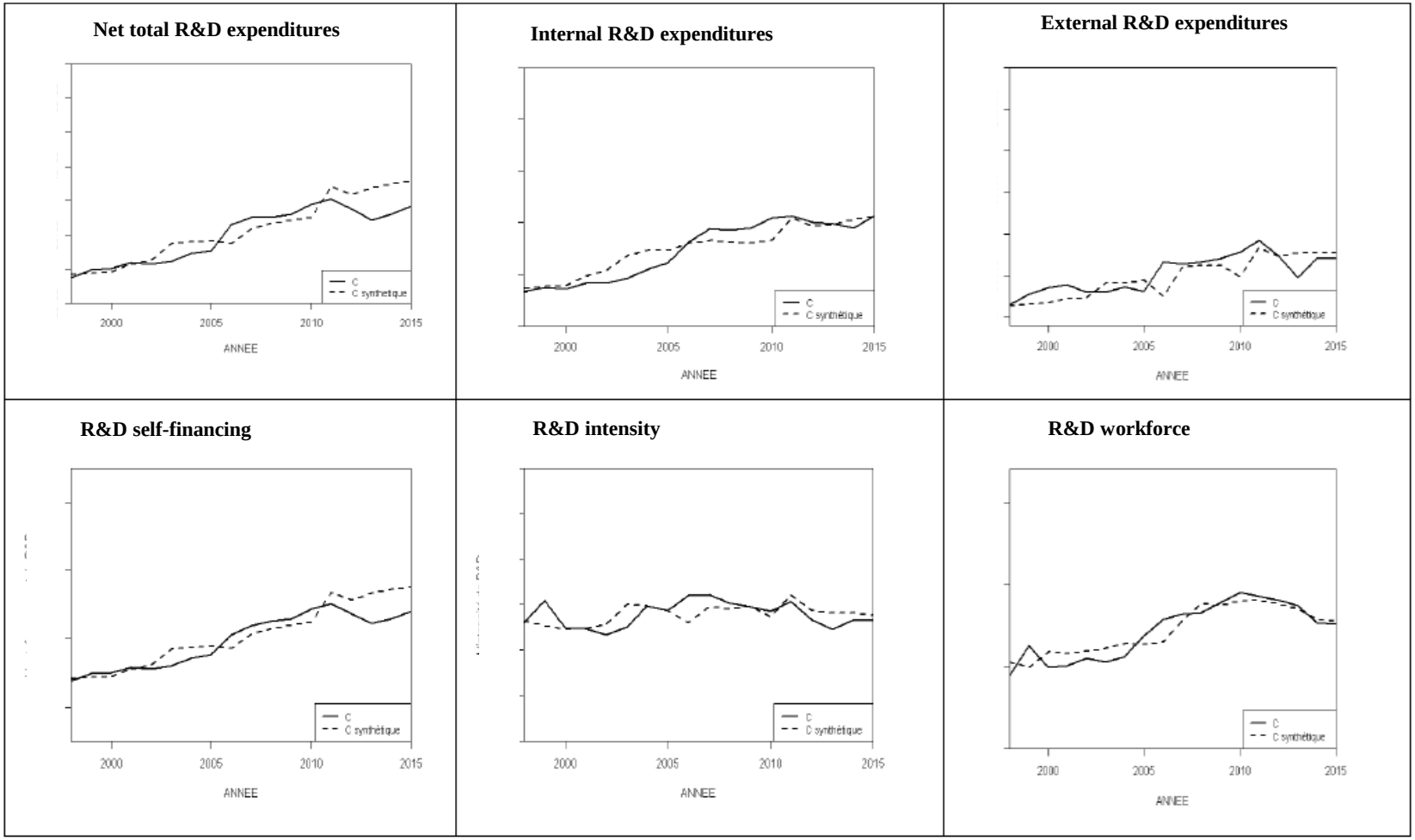
Table 4 : Annual average effect estimated

R&D input indicators	2012	2013	2014	2015	Annual mean effect
Net total R&D expenditures	-792	-9,114	-16,367	-10,448	-9,180
Internal R&D expenditures	746	5,033	505	-1,036	2,448
Internal R&D expenditures	4,982	9,884	968	8,448	6,071
R&D self financing	-9,086	-14,023	-28,922	-39,110	-22,785
R&D intensity	0.34%	-9%	-10%	-9%	-7%
R&D workforce	99	233	296	409	259

3. Results

3.3. Results: Company « C »

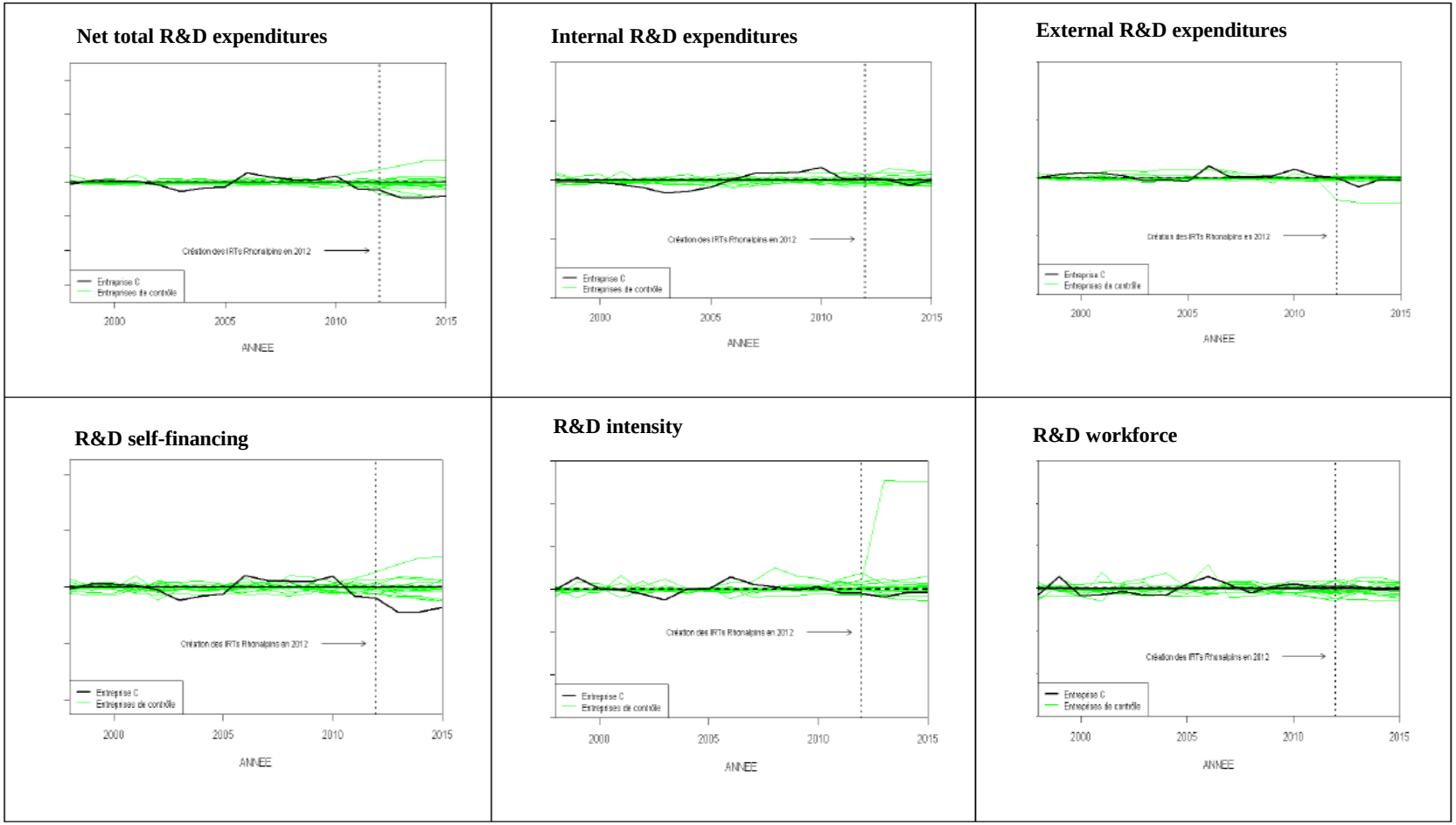
Figure 5: Trends in R&D indicators: Company "C" vs synthetic version



3. Results

3.3. Results: Company « C »

Figure 6 : Gaps between company "C" and placebos of control companies



3. Results

3.3. Results: Company « C »

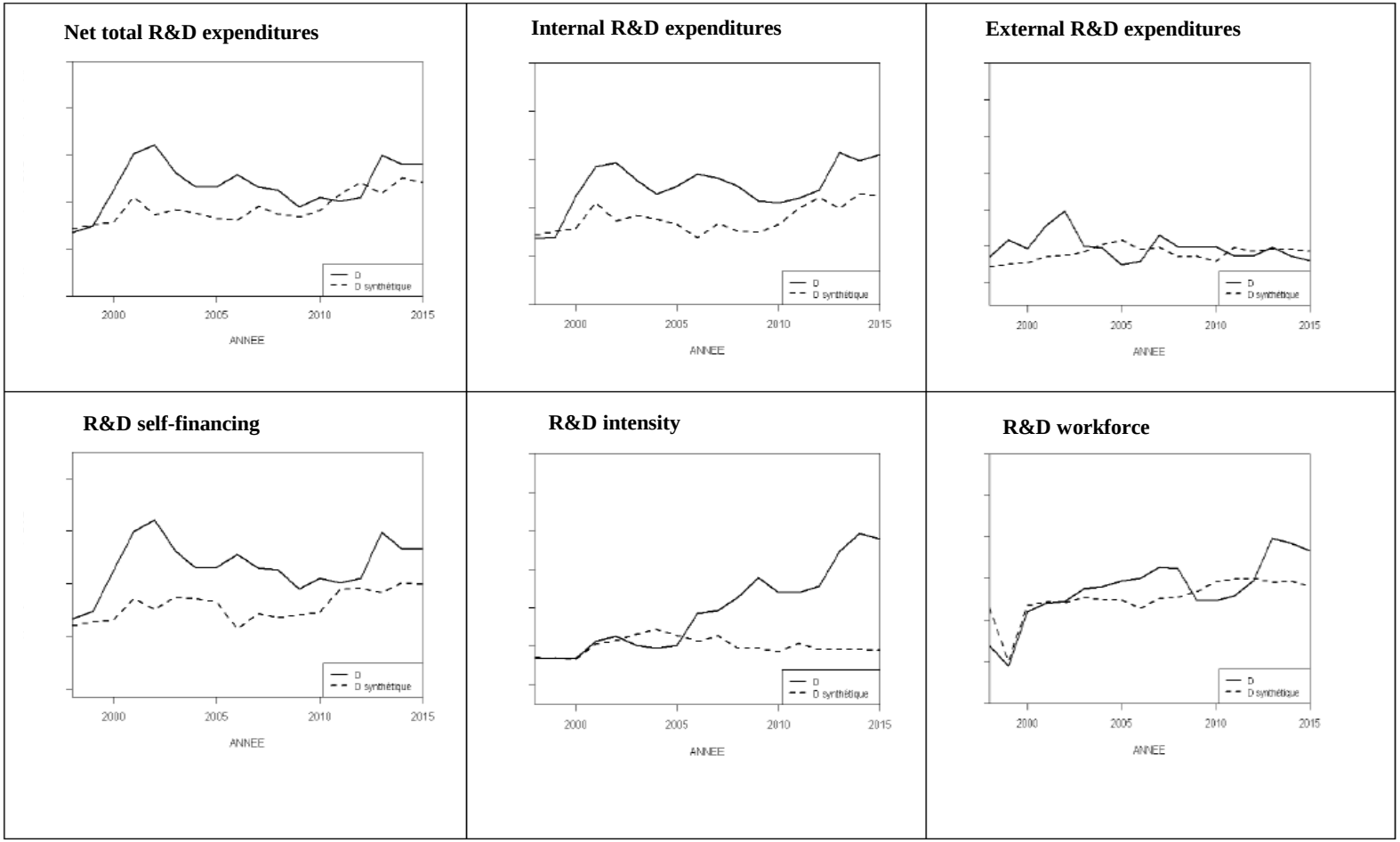
Table 7 : Annual mean effect estimated

R&D input indicators	2012	2013	2014	2015	Annual mean effect
Net total R&D expenditures	-43,634	-92,563	-89,955	-75,293	-75,361
Internal R&D expenditures	6,969	430	-17,756	784	-2,393
External R&D expenditures	734	-30,521	-6,533	-7,406	-10,932
R&D self financing	-40,525	-88,842	-86,453	-72,537	-72,089
R&D intensity	-2%	-4%	-2%	-1%	-2%
R&D workforce	27	17	-18	-17	2

3. Results

3.3. Results: Company « D »

Figure 7: Trends in R&D indicators: Company "D" vs Synthetic version



3. Results

3.3. Results: Traditional evaluation methods

	Diff-in-diff	Fixed effects model	Random trend model
Net total R&D expenditures	157.722***	115.860***	59.533***
Internal R&D expenditures	70.020	46.105***	6.415
External R&D expenditures	92.731***	70.460***	53.142***
R&D self-financing	149.757***	113.826***	59.462***
R&D intensity	0.135	0.099***	0.012
R&D workforce	609	418***	166

Expenditures in thousands euros

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4. Conclusion

4. Conclusion

- The TRI policy seems to be effective for large companies.

- According to the SCM, all the companies do not benefit from TRIs. Only one company has the systematic effects (Company A).

- Methodologically, the SCM is very interesting for the large companies but has some limitations, notably the problem of interpolation bias.

- Convergence of the traditional evaluation methods: DiD, fixed effects model and random trend model.

- The effects seem to be focused on net total R&D expenditures, external R&D expenditures and R&D self financing.

- The additional total R&D expenditures are largely executed outside the company through collaborations and subcontracting and are self-financed.

4. Conclusion

- Traditional counterfactual methods especially the DiD method and fixed effects model are not suitable for assessing the impact on large firms.

- The classical DiD method and the fixed effects model tend to **overestimate** the effect of TRIs on large firms analyzed.

- The SCM and random trend model provide relatively similar results and seem to be **suitable** for evaluating very large firms.

- **Warning:** Although significant direct effects may not be observed, there can exist indirect effects due to the interactions between large companies and SMEs.

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Thank you for your attention !