# Are you spending enough? A dose-response analysis of regional R&D subsidies

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# Outline

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# A preamble: The reasons for market failures
And their solution

## The innovation process of firm is costly, uncertain and not fully appropriable:

- Firm private innovation investments can never be fully appropriated (other firms have the opportunity to free ride)

This leads to:

- Underinvestment in individual R&D activities

## At aggregate level:

The R&D expenditure will be below the socially desirable level

## Public intervention aims at:

- Let some socially desirable R&D projects valuable for private investors to a level at which it becomes profitable for companies to invest

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# Introduction

The economic rationale behind the subsidies to Innovation activity

Common justification for government intervention to engender innovation (Lundvall and Borras, 2005):

- Enhance economic activity and stimulate growth,
- Upgrade the quality of human resources, and
- Promote firm competitiveness (especially wrt local contexts)

What is still contended, however, is the ability of policy makers

- To provide effective incentives to spur welfare-enhancing innovations, and
- Avoid the introduction of additional distortions in the competitive arena
- To rectify **market failures**,

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# Empirical evidence

Additionality of R&D subsidies

Results on additionality for R&D programs in Italy:

1. Caloffi, Mariani and Sterlacchini (2016): "[...] Several types of programmes yield non-negligible probability of success and that the outcome variable used to measure programme impact matters. If there exist any differential in probability of success between the government levels that may deliver the programmes, **this differential is favourable to regional governments**"

The last observation is the starting point of the present analysis!

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# Empirical evidence II

Additionality of R&D subsidies across countries

There exists a rich stream of literature summarized by Meta Analysis:

1. Garcia-Quevedo, J. (2004)
2. Negassi and Sattin (2014)
3. Castellacci and Mee Lie (2015)
4. Gaillard-Ladinska et al. (2015)

**Recent studies:** Aristei, D., Sterlacchini, A., Venturini, F. (2016) provide evidence about European countries: no crowding out, but no additionality
In general: Mixed results
(read: there conditions that enable additionality to be taken into account...)

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# What about R&D subsidies intensity?

Empirical evidence using Dose-Response

Few studies:

1. Marino, M., Lhuillery, S., Parrotta, P., Sala, D. (2016): *either no additionality or substitution effects between public and private R&D expenditure. Crowding-out effects appear to be more pronounced for medium-high levels of public subsidies*

2. Dai and Cheng (2015): *there exists a saturation point beyond which a further increase in public subsidies does not yield an increase of firm's total R&D investment. Moreover, a minimum threshold value of public subsidies is required to induce the firm's private R&D spending*

*obs: data requirements are a binding constraint*

## We would contribute to this stream of literature

To provide to the policy maker finer results and more precise indications

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# Research question(s) and objective of the study

Context:

Trentino (Italy) Provincial Law 6/99

Scope and time window of evaluation:

R&D subsidies granted to firms from year 2002 to 2007

Research questions:

1. Do different intensities of subsidies imply different effects on additionality?
2. What kind of R&D investments present evidence of additionality and for "which doses of the treatment"?

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# The advantages of our study

## Exhaustive information about subsidies:

Detailed informations about all the direct financial incentives granted to Trentino firms

## No confounding effects:

- No overlapping among the different levels of industrial policy
- We exactly know if and when each firm was subsidized and the timing of their expenses

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# The context of study: The PL 6/99 in Trentino
Some key details

## The procedure to get financed:

- Submit a Research project to APIAE
- A technical committee decides whether the project can be financed or not
  *If yes:*
- A financial committee decides whether the financial and economic requests are adequate for the project

## Timing of expenses:

" [...] Le spese relative alle domande esaminate con procedura valutativa devono essere effettuate dal giorno successivo la domanda di agevolazione ed entro tre anni dalla data di concessione dell'agevolazione"

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# The distribution of grants intensity

Years 2002-2007
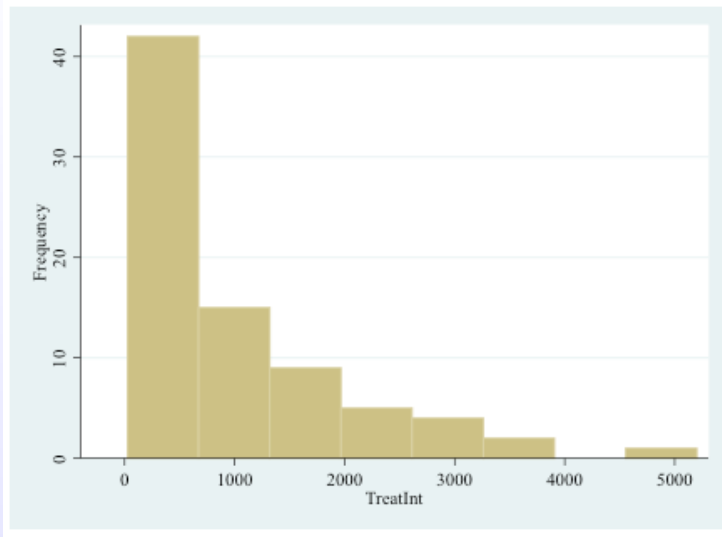
# Data

The collection of information for the evaluation exercise

## The database:

- It is the results from the merge of three archives:
    - Administrative data from APIAE
    - AIDA data (BvD) + Pitagora + Telemaco (for integrations)[1]
    - ASIA data (ISTAT)
- It covers the years 2001-2008 and

[1]: We solved many problems of different formats and conventions.

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# Variables

we consider the following outcome variables to study additionality:

1. Employment dynamics (Empl) - the number of employees;
2. Total labor costs (TC);
3. Unit labor costs (ULC) - the ratio between net labor costs and the total number of employees;
4. Capital expenses (FA) - the net tangible assets expenses;
5. Intangible intensity (IA) - the net intangible assets expenses.

what does it mean "net"...

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# Controls

The exogenous confounders included in our models are all lagged one year and comprise:

- unit labor costs;
- size of firm as measured by the number of employees;
- rescaled cashflow as a proxy of the financial constraints that firms face, measured as the ratio between cash flow and total sales;
- capital intensity
- a control variable (year) for controlling business cycle effects;

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# A regression approach

We start from a specific population generating process for the two exclusive potential outcome

$w = 1 : y_1 = \mu_1 + g_1(\mathbf{x}) + h(t) + e_1$

$w = 0 : y_0 = \mu_0 + g_0(\mathbf{x}) + e_0$

It can be shown using the Rubin framework that:

$y_i = \mu_0 + w_i ATE + x_i \delta_0 + w_i(x_i - \mathbf{x})\delta + w_i(h(_{t_i}) - \bar{h})\eta_i$

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# Estimation

Starting from the previous linear relationship we aim at estimating:
$E(y_i|w_i, h_{ti}, x_i) = \mu_0 + w_i ATE + x_i \delta_0 + w_i(x_i - \bar{x})\delta + w_i(h(t_i) - \bar{h})$ (a)

- Ordinary Least Squares (OLS) can be used to get consistent estimation of all parameters of interest in (a)
- h(t) is specified as follow:
  $h(t) = at + bt^2 + ct^3$

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# The model implementation
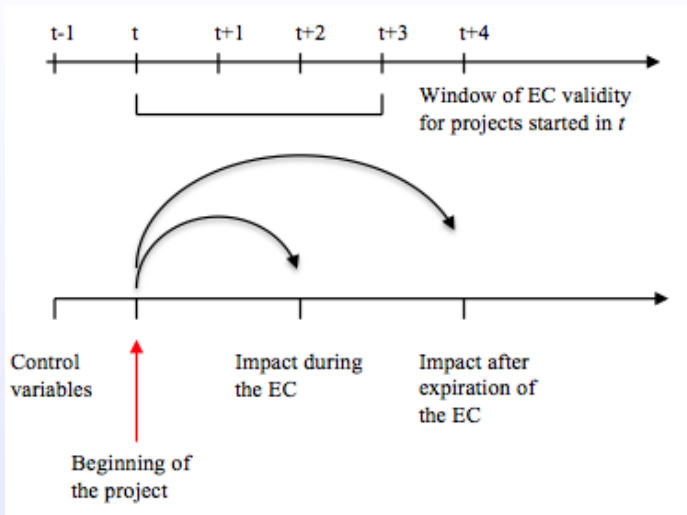
# The model implementation II

1. What is the "dose"?
2. (example a firm that receives 1,500€ as a subsidy for a project that costs 2000€, 75% of percentage of subsidization)
3. Options:
4. S level: S=1500
5. Total expenses of project: P=2000
6. P percentage Pp=75

We have chosen S level
nonetheless to be clear:
1500 is 75% of 2000, but also 10% of 15000 for instance!
**Different measures give different answers!**

# Impact on labour

Impact on employment level

| Models: | (1) | (2) |
|---|---|---|
| *Dep. variable:* | | |
| *Employment level* | *Empl(t+2)* | *Empl(t+4)* |
| *Average effect of treatment* | | |
| *ATE* | 14.3641*** | 11.9223** |
| | (3.966) | (4.701) |
| *Non.linear effect of doses* | | |
| *Tw* | -2.5694*** | -2.6341*** |
| | (0.500) | (0.594) |
| *T2w* | 0.0739*** | 0.0795*** |
| | (0.014) | (0.016) |
| *T3w* | -0.0005*** | -0.0005*** |
| | (0.000) | (0.000) |

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# Impact on labour
## Impact on employment level

| Controls | | |
|---|---|---|
| *age* | -0.0300 | -0.0637** |
| | (0.020) | (0.026) |
| *Unit labor cost* | 0.0842*** | 0.1020** |
| | (0.032) | (0.040) |
| *Employment level* | 1.0418*** | 1.0785*** |
| | (0.010) | (0.013) |
| *Employment level$^2$* | -0.0001*** | -0.0002*** |
| | (0.000) | (0.000) |
| *Cashflow (rescaled)* | -0.0013 | -0.0019 |
| | (0.007) | (0.022) |
| *Capital intensity* | 0.0882 | -0.2739 |
| | (0.567) | (0.654) |
| *Capital intensity$^2$* | -0.0014 | 0.0117 |
| | (0.033) | (0.030) |
| Constant | 1.6313 | 3.7618** |
| | (1.195) | (1.510) |
| *Year dummies* | yes | yes |
| Observations | 2,103 | 1,862 |
| N_treated used | 78 | 78 |
| N_untreated used | 2025 | 1784 |

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# Impact on labour

Impact on employment level



(a)                    (b)

# Impact on labour

Impact on employment level



(a)                                                (b)
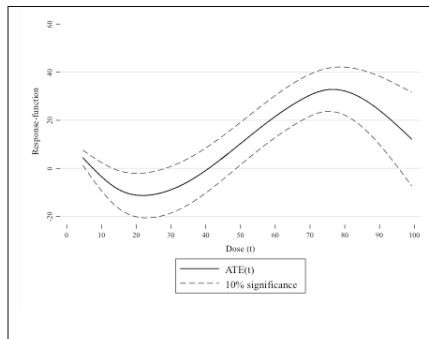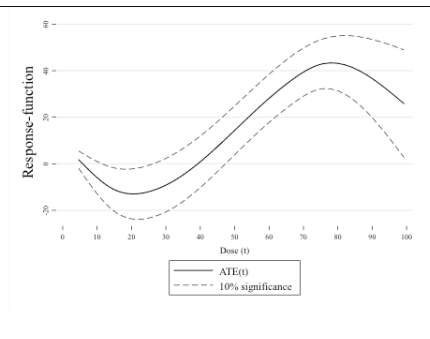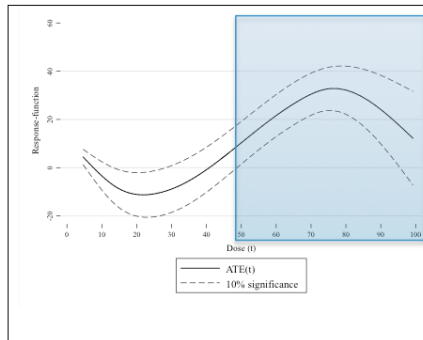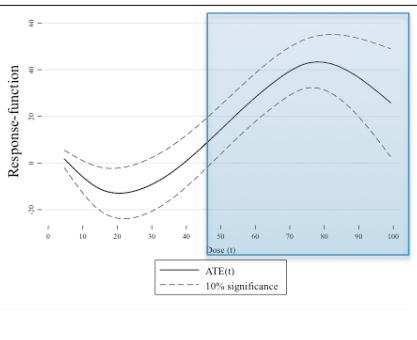
# Impact on labour

Impact on wage costs
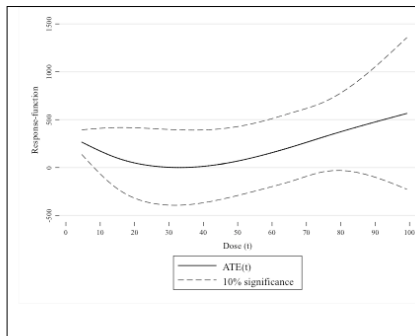


(a)

(b)

# Impact on labour

Impact on wage costs

# Impact on labour

Impact on unit labor costs
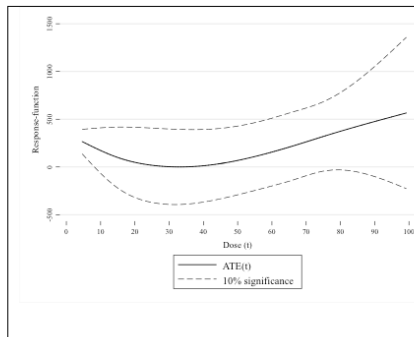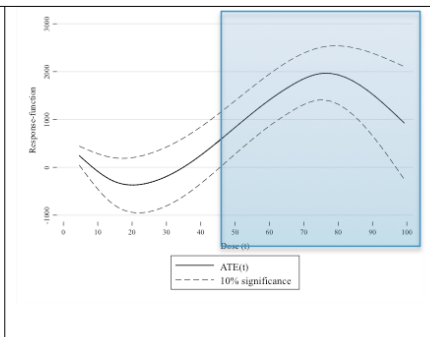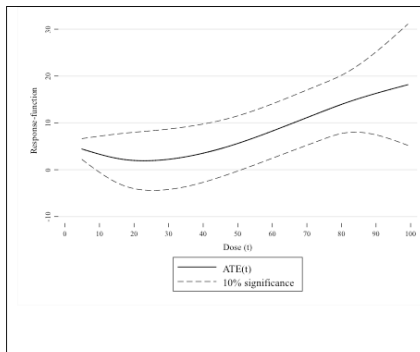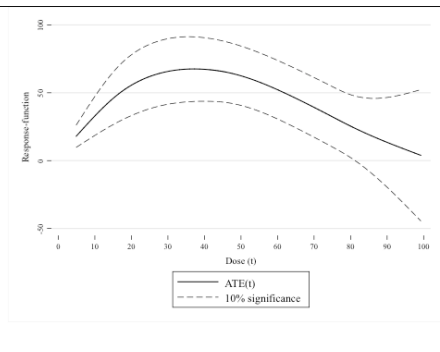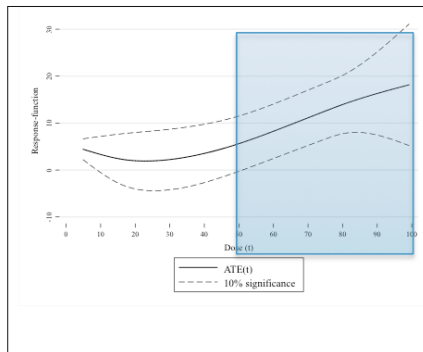
# Impact on labour

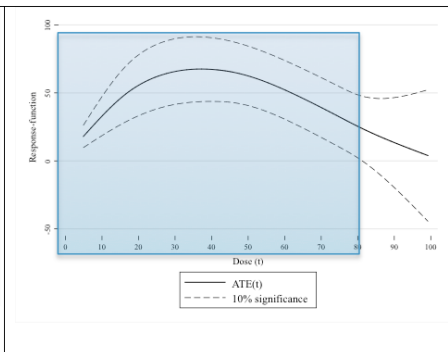Impact on unit labor costs
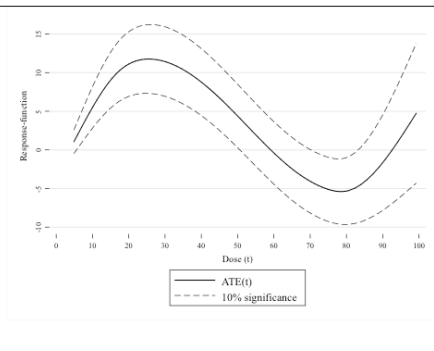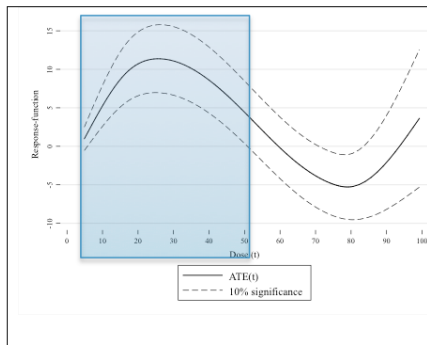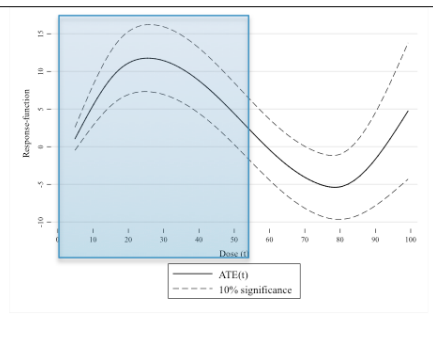


(a)                                              (b)

# Impact on capitalized expenses
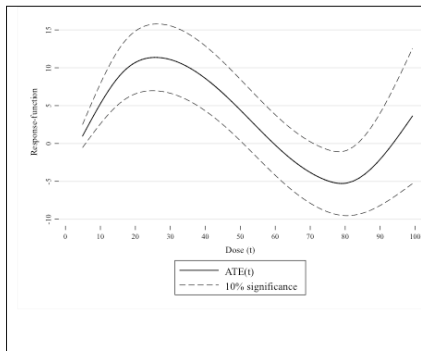
Impact on fixed assets investment

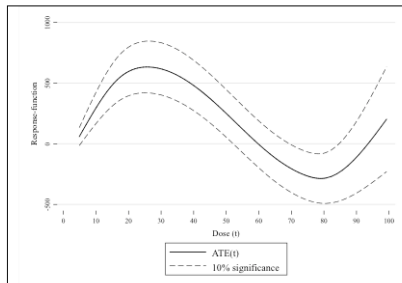# Impact on capitalized expenses

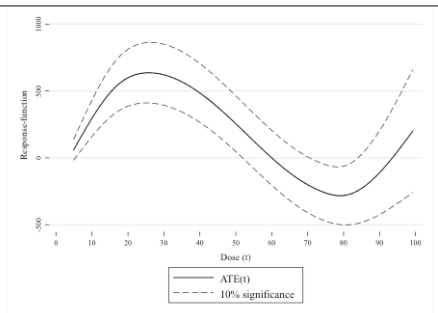Impact on fixed assets investment



(a)    (b)

# Impact on capitalized expenses
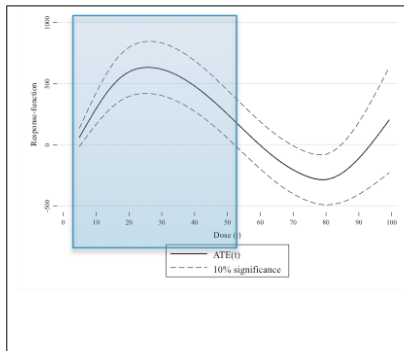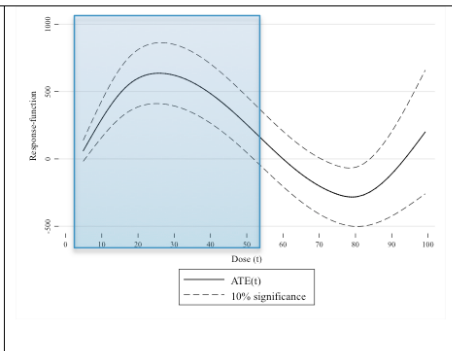
Impact on intangible assets investment



(a)

(b)

# Impact on capitalized expenses

Impact on intangible assets investment

# Discussion of results

## Major results

There is evidence of additionality of innovative efforts:

- on fixed assets and intangibles intensity
- on employment levels and on composition of human resources (higher skill employed)

Moreover:

- higher doses are associated with employment related effects
- smaller doses are associated with capitalized investments

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# Future research agenda

## Results extensions:

- Use longer time series to see the effect of crisis
- Take into consideration longer lags to evaluate the impact on performances
- merge data about R&D workers (difficult to obtain)

from methodological point of view:
deepen the robustness checks of results

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# Thanks for your attention

For further information:

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