Crowding in or Crowding Out? Evidence from Discontinuity in the Assignment of Business R&D Subsidies

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INTRODUCTION

In OECD economies alone, **government funding of business R&D exceeds USD 100 billion per year**, about half of which is due to direct support in the form of subsidies, loans and public procurement (OECD, 2023).

Do business R&D subsidies merely crowd out private funds or do they translate into additional R&D expenditure and even crowd in additional R&D expenditure from private sources?

Answering this is challenging because it requires

- **A strategy for separating the causal effects** of subsidies from the influence of other factors – previous studies largely relying on controlling for observable firm characteristics in a regression or matching framework (e.g. Czarnitzki et al.,2007; Gorg and Strobl, 2007; Berube and Mohnen, 2009).
- **Data on firms' R&D expenditure** – previous quasi-experimental studies not observing R&D expenditure (e.g. Bronzini and Iachini, 2014; Howell, 2017; Santoleri et al., 2022).
- **Examining effects not only during the subsidies but also in the longer term** – most previous studies only looking at contemporaneous or short-term effects.

To address these challenges, we analyse a **flagship Czech business R&D subsidy programme** in **a regression discontinuity design**, exploring its effects both **during and after the subsidised projects**.

THE ALFA PROGRAMME

The ALFA programme was administered by the Technology Agency of the Czech Republic (TA CR) and provided R&D subsidies to private firms during the period **2011–2018**, in total worth about EUR 340 million. The typical project duration was 3-4 years, and the **average subsidy size per project and firm** was **approx. EUR 200,000**.

NUMBER OF PROJECT PROPOSALS BY CALL

	Call 1 2010	Call 2 2011	Call 3 2012	Call 4 2013	Total 2010-2013
Total					
Supported	114	107	101	102	424
Unsupported	211	297	496	447	1451
Binary criteria affirmatory					
Supported	114	107	101	102	424
Unsupported	54	113	278	297	742
Bandwith of 5.5 points around cutoff					
Supported	20	57	75	88	240
Unsupported	38	52	130	128	348

Each project proposal was assessed by two or three external reviewers and one rapporteur from the panel. In the first step, several binary criteria were used to eliminate ineligible proposals. In the second step, each evaluator awarded 0 to 100 points to each project based on set criteria.

DATA

The paper exploits the following datases, linked at the firm level:

- **Administrative records on project proposals** including the composition of the project consortium, project scores and ranks and indicators of meeting the binary criteria and receiving support
- **R&D survey** covering the entire population of R&D-performing firms in the Czech Republic
- **Administrative R&D tax relief** records from the CZSO
- **Administrative data on publicly-supported R&D projects** from the Research, Development and Innovation Information System
- **Patent** records
- **Structural business statistics** firm data
- **Business census** demographic data
- **Financial statements** from MagnusWeb

The resulting panel data include 1,183 firm-project combinations and years 2007-2021, so we observe >4 years before and >8 years after the start of each project

ESTIMATION

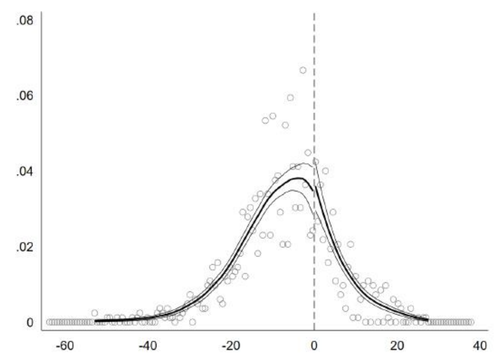
We employ an **RD estimator that compares firms whose projects received scores just below or just above the threshold for obtaining support**. We estimate the following stacked RD regression:

$$Y_{ipt} = \beta T_p + \gamma_-(1-T_p)X_p + \gamma_+ T_p X_p + \sum_{j=1}^{J} \delta_j Z^j_{ipt_0} + \theta_c + \theta_t + \epsilon_{ipt}.$$

- Y_{ipt} = the outcome in year t for firm i participating in project p submitted to call c (e.g. log R&D expenditure, log number of patents, log sales)
- T_p = a dummy variable marking whether project p received a subsidy
- X_p = project score
- Z_{ipt0} = pre-treatment control variables
- θ_c = call fixed effects
- θ_t = year fixed effects

We estimate the regression using weighted least squares and report bias-corrected RD estimates and robust standard errors clustered at the firm level (Calonico et al., 2014).

DENSITY OF PROJECT SCORES AROUND THE CUTOFF

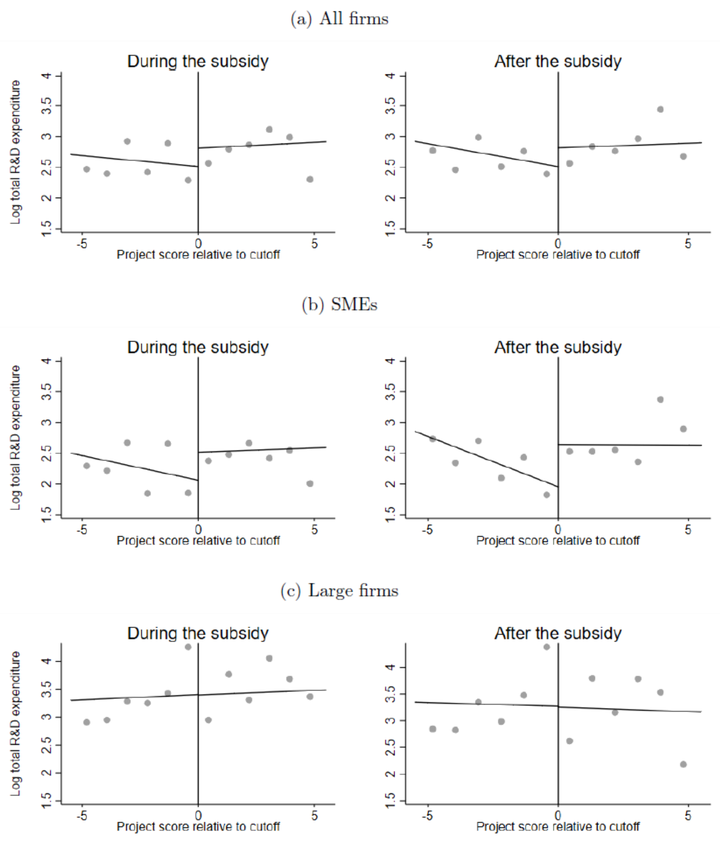


Notes: The figures plot the density of project proposals along the scores received around the cut-off, following McCrary (2008). Panel (a) plots the density separately for each call of the ALFA programme. Panel (b) plots the density for data combining calls 1, 3 and 4.

MAIN RESULTS

Our results indicate that R&D subsidies in the ALFA programme had **strong positive effects on** both **total and privately-funded R&D expenditures** of the supported firms, but the effects differed strongly between small and medium-sized enterprises (SMEs) and large firms. In the SMEs, we find **strong evidence of crowding-in** of private R&D investment. The estimated effects are positive for both total and privately funded R&D and imply that **1 unit of public subsidy** was **associated with about 2.5 units of additional R&D expenditure**.

EFFECTS OF ALFA ON TOTAL R&D EXPENDITURE



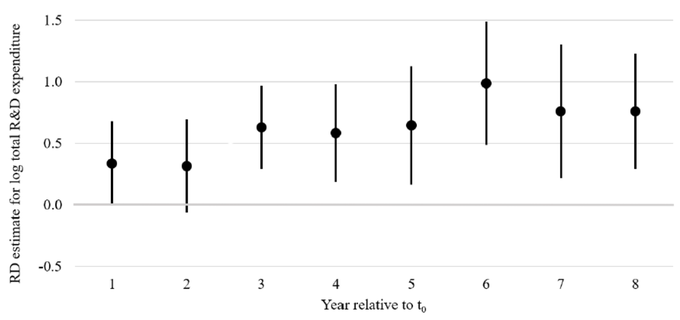
Notes: The figures show RD plots comparing the log total R&D expenditure below and above the cutoff, separately during the subsidy (t_0+1 to t_T) and after the subsidy (t_T+1 to t_T+4). The results are based on estimating Equation 1 using weighted least squares (with weights given by a triangular kernel function), for a bandwidth of 5.5 points around the cutoff, controlling for pre-treatment firm characteristics and year and call fixed effects.

In contrast to SMEs, **on large firms**. Further analysis suggests an **important role of financing constraints** in explaining this heterogeneity.

SHORT-TERM VS. LONG-TERM

We find evidence of a strong persistence in the positive impact of ALFA on R&D expenditure by SMEs, up to 8 years after the award competition. We find that this persistence is associated with subsequent funding from the specific funding provider in charge of the ALFA programme, but not from other sources of public support.

EFFECTS ON TOTAL R&D EXPENDITURE BY YEAR RELATIVE TO T_0 (SMES)



Notes: The figure displays results of RD estimates of the effect of the subsidies on total R&D expenditure separately for each year relative to t_0, together with their 90% confidence intervals based on standard errors clustered at the firm level. The results are based on estimating Equation 1 using weighted least squares (with weights given by a triangular kernel function), for the baseline bandwidth of 5.5 points around the cutoff, controlling for pre-treatment firm characteristics and year and call fixed effects.

ECONOMIC EFFECTS

We are unable to detect effects on patenting, sales, employment and labour productivity in the full sample of SMEs. However, in a subsample of SMEs that received comparatively large subsidies relative to their pre-treatment sales, we document positive effects on these outcomes, although not on labour productivity.

PATENTING AND ECONOMIC EFFECTS (SMES WITH LARGE SUBSIDY-TO-SALES RATIO)

Band.	During the subsidy: Infinite	Wide	Baseline	Narrow	After the subsidy: Infinite	Wide	Baseline	Narrow
	Outcome: Log patent applications							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimate	0.10	0.20***	0.21**	0.17*	0.11*	0.17**	0.09	0.00
	(0.07)	(0.08)	(0.10)	(0.10)	(0.07)	(0.07)	(0.09)	(0.09)
N (left)	1035	752	451	348	894	647	389	303
N (right)	259	203	122	104	227	181	112	97
	Outcome: Log sales							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimate	0.07	0.17*	0.22**	0.24**	0.03	0.21	0.26*	0.20
	(0.09)	(0.09)	(0.10)	(0.10)	(0.14)	(0.14)	(0.15)	(0.14)
N (left)	1019	742	445	342	850	614	373	293
N (right)	247	197	117	99	202	163	97	82
	Outcome: Log employment							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimate	0.10***	0.12***	0.10*	0.10**	0.06	0.16**	0.20**	0.14
	(0.04)	(0.04)	(0.05)	(0.05)	(0.07)	(0.07)	(0.08)	(0.09)
N (left)	992	735	442	339	720	523	320	251
N (right)	227	183	107	95	160	136	75	68
	Outcome: Log labour productivity							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimate	0.01	-0.05	0.01	0.05	0.05	-0.02	-0.02	-0.03
	(0.06)	(0.07)	(0.08)	(0.08)	(0.06)	(0.07)	(0.09)	(0.09)
N (left)	994	732	439	341	732	527	324	260
N (right)	211	174	103	90	159	131	77	67

Notes: *** 1%, ** 5%, * 10%. The table reports RD estimates of the effect of the subsidies on patenting and economic performance, separately during the subsidy (t_0+1 to t_T) and after the subsidy (t_T+1 to t_T+4). The results are based on estimating Equation 1 using weighted least squares (with weights given by a triangular kernel function), for an infinite bandwidth and bandwidths of 10, 5.5 and 4 points around the cutoff, controlling for pre-treatment firm characteristics and year and call fixed effects. Standard errors are clustered at the firm level.

KEY TAKE-AWAYS

- We employ a regression-discontinuity design to analyse a flagship Czech business R&D subsidy programme.
- In SMEs,
  - the subsidies managed to crowd in additional private R&D expenditure.
  - 1 unit of public subsidy was associated with about 2.5 units of additional R&D expenditure.
  - the positive effects were sustained after the original projects ended.
  - the subsidies resulted in increased patenting, sales and employment.
- In large firms, we do not find any evidence of positive effects of the programme.
- The heterogeneous effects by firm size appear related to financing constraints.