The impact of R&D subsidies in different institutional frameworks

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This paper

- We assess the impact of public support to business R&D (subsidies) in heterogeneous regional institutional contexts

- Pilot project on a sample Spanish manufacturing firms
  → Extension to CIS data for all EU countries [ongoing]

- Preliminary investigation → Take with care all the results and related recommendations for policy

Why R&D subsidies

- Market failure argument (Nelson 1959, Arrow 1962)
- Economic benefits (see surveys in Becker 2015, Dimos and Pugh 2016)
  - No crowding out
  - More innovation
- Market creation beyond market failure (Mazzucato 2015)
  - Promoting radical innovations (Beck et al. 2015)

Responses to R&D policies

- Firms have different reactions to R&D subsidies
- Heterogeneity in firms characteristics (David, Hall, and Toole 2000; Dosi 2007, Wallsten 2000, Becker 2015, Dimos and Pugh 2016)
  - Size, age, and industry
  - Absorptive capacity
  - Network embeddedness

Institutions?

- Not only firm-level characteristics but also heterogeneity in the institutional framework

"Institutions are the humanly devised constraints that structure political, economic and social interactions. [..] They have been devised to create order and reduce uncertainty in exchange" (North 1991)

"[t]hey define the choice set and hence determine transaction and production costs" (North 1990)

What we know

- In general, good institutions increase the easiness of doing business (van Elk et al. 2015, Pelkmans & Renda 2016)
- Macro studies support the view that institutions do matter for innovation (Acemouglu and Robinson 2012, Rodriguez-Pose & Di Cataldo 2014, Rodriguez-Pose & Garcilazo 2015)
- Not effective property right protections, bad legal framework, corruption, low delivery of public services, etc. → The worse the institutional quality the lower R&D investments and innovative performance

Institutions and R&D subsidies

- Theoretical indeterminacy!!
- The impact of public support is higher in the case of firms acting in environments with higher quality of institutions (Rodriguez-Pose & Garcilazo 2015)
  - High quality of public services, goods and infrastructures, low clientelism, lower transaction costs
- The more constrained the economic actors, the higher the impact of public R&D subsidies; coherent with theory of bottlenecks (Hausmann et al. 2008)
  - Relax constraints, decreasing marginal returns

In this paper

- We assess the impact of public support to business R&D in heterogeneous regional institutional contexts
  - Do different sub-national institutional frameworks affect the impact of R&D subsides on firms' behaviour and investments?

- Pilot on an exhaustive sample Spanish firms

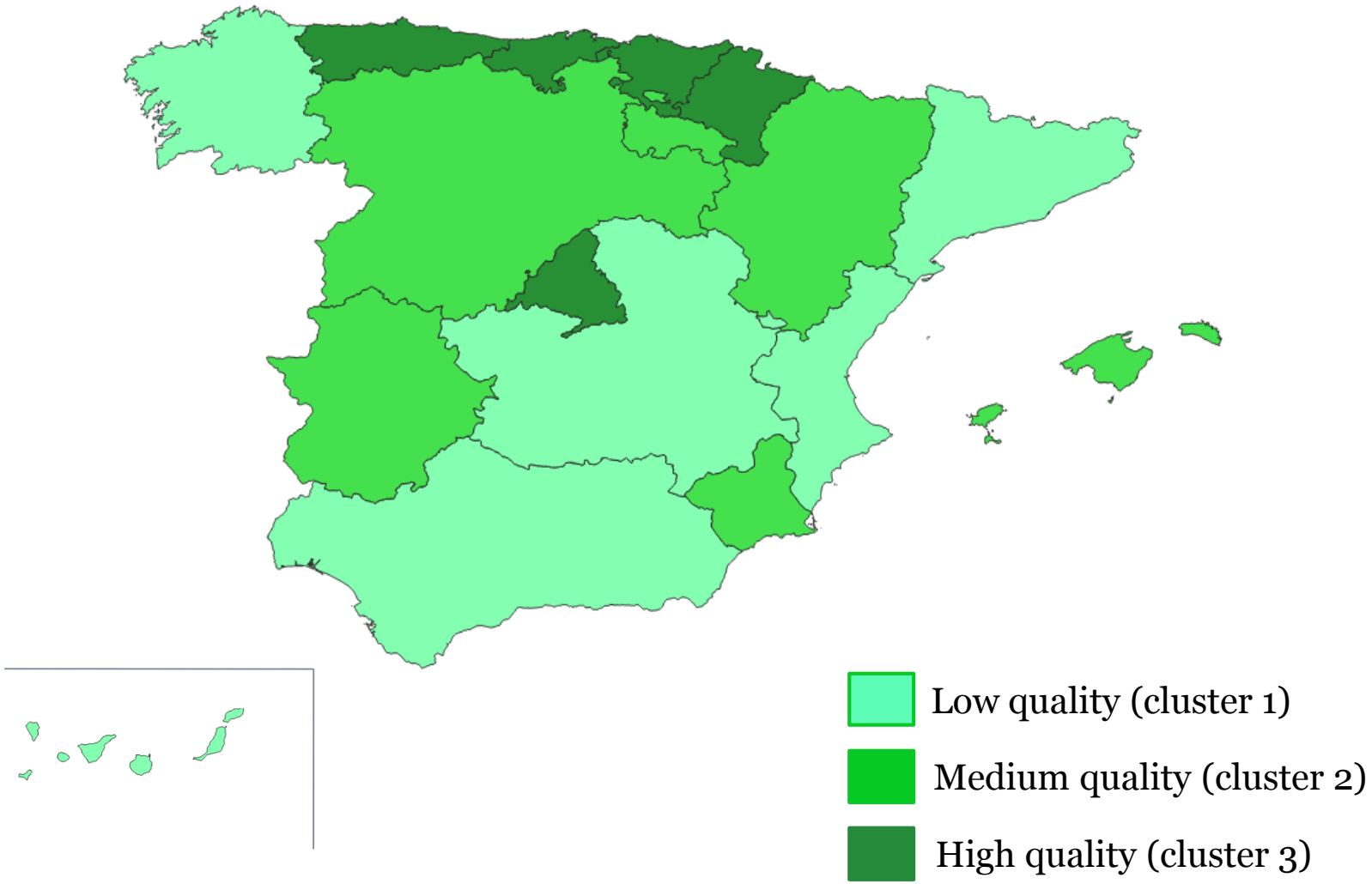
- Quasi-experimental design (matching)

Defining institutional framework

- Spanish regions - NUTS 2 level
- Aggregate indicator of institutional framework
  - Institutional quality (EU regional Social Progress Index, 2011 – 2014)
  - Dimensions of the original indicator that are relevant for innovation: (i) absorption capacity; (ii) generalized property rights
- Range [1, 100]

	Dimension	Component	Indicator
Institutional Index	Absorption Capacity	Access to Basic Knowledge	Secondary Enrolment rate
			Lower secondary completion rate
			Early school leaving
		Access to Information and Communications	Internet at home
			Broadband at home
			Online interaction with public authorities
		Access to Advanced Education	Tertiary education attainment
			Tertiary enrolment
			Lifelong learning
	Generalised Property Rights	Opportunity and Quality of Government	Young people not in education, employment or training
			Corruption
		Quality and Accountability of Government Services	Quality and accountability of government services
		Impartiality of Government Services	Impartiality of government services

Clustering of Spanish regions (NUTS 2), by institutional quality



Firm-level data

- ESEE (Encuesta Sobre Estrategias Empresariales)
- Manufacturing sector – 20 sectors, 10+ workers
- Unbalanced panel (1991 – 2012)
- 21.294 observations - 4.009 firms
- Main variables of interest
  - Public R&D subsidy ("average effect over different schemes")
  - Total and private R&D intensity
  - Patent applications
  - Product innovation

R&D subsidies, by source and cluster

Methodology

- Quasi-experimental design: Matching estimator
  - Bias-Corrected-Nearest-Neighbor matching estimator → control group ("counterfactual")

- Pooled and by cluster:
  - Step 1: Selection equation: probability of receiving R&D subsidies conditional to a set of covariates [*backup slides*]
  - Step 2: Matching algorithm [*backup slides*]
  - Step 3: Average Treatment effect on the Treated (ATT)

The variables

Variable	Mean	Sd	Min	Med	Max
R&D total	0.0092	0.0362	0	0	0.9871
R&D private	0.0066	0.0211	0	0	0.6078
Patents	0.1229	1.2178	0	0	46
Product innovation	0.0552	0.2283	0	0	1
R&D dummy	0.3538	0.4781	0	0	1
R&D subsidy	0.1067	0.3087	0	0	1
No. of employees	224.39	685.94	1	46	24,268
Age	26.38	20.56	0	21	262
Foreign shareholding	0.1661	0.3589	0	0	1
Market share	0.1136	0.1971	0	0	1
Export intensity	0.1763	0.2563	0	0.0337	1
Investment in capital goods [million €]	1.6319	11.7190	0	0.0694	592.8100
Debt on equity	0.0394	0.1947	0	0.0133	9.3788

Descriptives, by cluster

Variable	R&D (yes)	Patents (yes)	Subsidies (yes)	All firms			R&D performers		
				R&D total	R&D private	Patents	R&D total	R&D private	Patents
Cluster 1	26.78%	4.77%	7.98%	0.0059	0.0039	0.2009	0.0224	0.0145	0.6337
				(0.0347)	(0.0159)	(1.7197)	(0.0643)	(0.0282)	(3.2092)
Cluster 2	39.76%	6.74%	9.67%	0.0096	0.0066	0.3137	0.0240	0.0166	0.6801
				(0.0387)	(0.0194)	(2.0573)	(0.0585)	(0.0279)	(3.0592)
Cluster 3	38.51%	6.91%	14.51%	0.0142	0.0087	0.3421	0.0368	0.0225	0.7385
				(0.0539)	(0.0259)	(2.2060)	(0.0820)	(0.0379)	(3.1553)
Pooled	36.06%	6.29%	10.65%	0.0100	0.0065	0.2931	0.0277	0.0180	0.6895
				(0.0430)	(0.2931)	(2.0236)	(0.0680)	(0.6895)	(3.1184)

Note : standard deviations in parenthesis

The higher the institutional quality, the higher R&D investments and innovative performance … but the impact of subsidies?

R&D subsidies effect (aggregate)

Variable	Treated	Controls	ATT	T-stat
Total R&D intensity	0.0531	0.0135	0.0396	17.80**
Private R&D intensity	0.0294	0.0135	0.0159	9.82**
Patents	0.6205	0.3028	0.3177	3.83**
Product innovation	0.1696	0.1412	0.0284	1.96*
No. of treated firms (on support)	2,759			
No. of treated firms (off support)	18			
No. of controls	23,260			

Note : significant at * 5%, ** 1% level

Mean values for firms receiving subsidies

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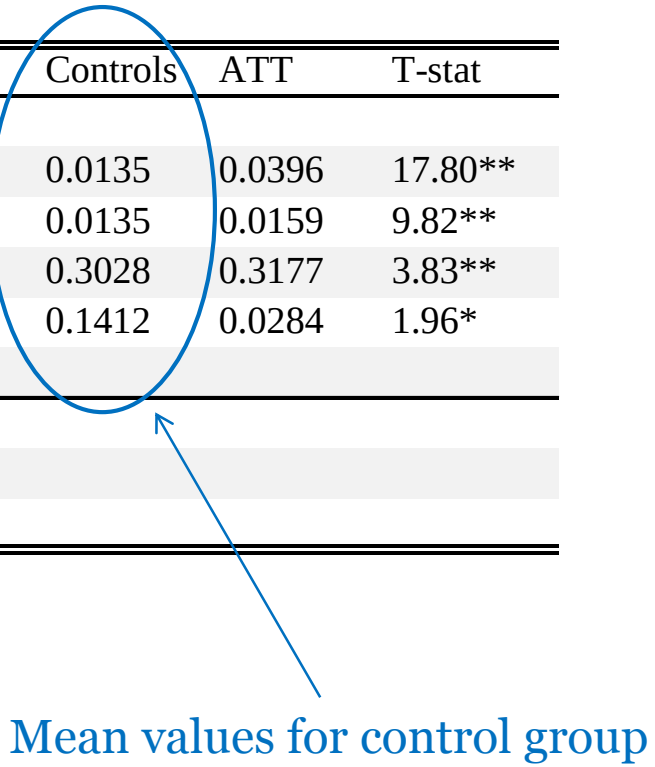

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Net impact of R&D subsidies

- R&D additionality
- Positive impact on output

R&D subsidies effect (by cluster)

Variable	*Cluster 1* Treated	Controls	ATT	T-stat	*Cluster 2* Treated	Controls	ATT	T-stat
Total R&D intensity	0.0462	0.0137	0.0325	11.53**	0.0470	0.0096	0.0374	9.93**
Private R&D intensity	0.0262	0.0137	0.0124	7.85**	0.0243	0.0096	0.0146	8.09**
Patents	0.7691	0.3264	0.4427	3.33**	0.3799	0.2322	0.1477	1.43
Product innovation	0.1790	0.1335	0.0455	2.21*	0.1679	0.0962	0.0717	3.11**
No. of treated firms (on support)	966				679			
No. of treated firms (off support)	10				8			
No. of controls	9,680				6,943			

Note : significant at * 5%, ** 1% level

Variable	*Cluster 3* Treated	Controls	ATT	T-stat
Total R&D intensity	0.0623	0.0188	0.0434	8.19**
Private R&D intensity	0.0348	0.0188	0.0160	3.41**
Patents	0.5887	0.3467	0.2420	1.63
Product innovation	0.1601	0.1486	0.0115	0.42
No. of treated firms (on support)	1,099			
No. of treated firms (off support)	15			
No. of controls	6,637			

Note : significant at * 5%, ** 1% level

Low and mid instit. quality

- R&D additionality
- Positive impact on output

R&D subsidies effect (by cluster)

	Cluster 1				*Cluster 2*			
Variable	Treated	Controls	ATT	T-stat	Treated	Controls	ATT	T-stat
Total R&D intensity	0.0462	0.0137	0.0325	11.53**	0.0470	0.0096	0.0374	9.93**
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Note : significant at * 5%, ** 1% level

High institutional quality

- R&D additionality
- No impact on output

(Preliminary) conclusions

- No evidence of crowding-out → Input additionality in all clusters
- Ceteris paribus, innovation effect for firms embedded in low quality institutional frameworks

Next evaluation steps:

- Impact of different funding schemes
- Refine econometrics
- Before-after the crisis

Backup: Selection equation

Dependent Variable: R&D subsidy	Coeff.	S.E.
R&D subsidy (t-1)	1.5239**	(0.0432)
R&D dummy (t-1)	0.8013**	(0.0449)
ln No. of employees (t-1)	0.2178**	(0.0153)
ln Age (t-1)	0.0080	(0.0233)
Foreign shareholding (t-1)	-0.3604**	(0.0451)
Market share (t-1)	-0.0928	(0.0757)
Export intensity (t-1)	0.2200**	(0.0632)
Investment in capital goods (t-1)	-0.0016	(0.0010)
Debt on equity (t-1)	-0.0088	(0.0628)
Industry, regional, and time dummies	yes	
No. of firms	3,675	
No. of observations	26,037	
Wald Chi2	4,127.67**	
Pseudo R2	0.4710	
Totally correctly classified	93.29%	
Correctly predicted Ones	70.26%	
Correctly predicted Zeros	95.77%	

Note : significant at * 5%, ** 1% level

Backup: The counterfactual

Variable	Matched	Treated	Control	% bias	T-stat
R&D subsidy (t-1)	no	0.6781	0.0402	178.0	120.74**
	yes	0.6781	0.6776	0.2	0.04
R&D dummy (t-1)	no	0.9355	0.2882	177.7	68.16**
	yes	0.9355	0.9320	1.0	0.49
ln No. of employees (t-1)	no	5.6191	4.0177	118.2	52.72**
	yes	5.6161	5.5783	3.0	1.09
ln Age (t-1)	no	3.3798	3.0671	43.9	20.01**
	yes	3.3798	3.3486	4.4	1.49
Foreign shareholding (t-1)	no	27.332	15.471	30.4	15.13**
	yes	27.332	24.982	6.0	1.91
Market share (t-1)	no	16.198	10.953	25.1	12.17**
	yes	16.198	16.320	-0.6	-0.19
Export intensity (t-1)	no	0.3457	0.1591	68.6	34.10**
	yes	0.3457	0.3454	0.1	0.04
Investment in capital goods (t-1)	no	5.2889	1.2022	25.7	18.35**
	yes	5.2889	4.4521	5.3	1.63
Investment in intangible assets (t-1)	no	37.132	16.196	7.0	2.54*
	yes	37.132	31.352	1.9	1.31

Panel(a)

	Cluster 1				*Cluster 2*				*Cluster 3*			
Variable	Treated	Controls	ATT	T-stat	Treated	Controls	ATT	T-stat	Treated	Controls	ATT	T-stat
Total R&D intensity	0.0489	0.0169	0.0320	9.18**	0.0477	0.0117	0.0360	7.00**	0.0678	0.0064	0.0614	7.13**
Private R&D intensity	0.0298	0.0169	0.0129	6.38**	0.0266	0.0117	0.0149	5.73**	0.0376	0.0214	0.0162	2.85**
Patents	1.0308	0.3508	0.6800	3.75**	0.4387	0.2574	0.1813	1.48	0.6742	0.4258	0.02484	1.23
Product innovation	0.1929	0.1353	0.0576	2.32*	0.1887	0.1340	0.0547	1.68	0.1781	0.1405	0.0376	1.31
No. of treated firms (on support)	648				408				887			
No. of treated firms (off support)	10				7				15			
No. of controls	4,022				2,684				3,316			

Note : significant at * 5%, ** 1% level

Panel(b)

	Cluster 1				*Cluster 2*				*Cluster 3*			
Variable	Treated	Controls	ATT	T-stat	Treated	Controls	ATT	T-stat	Treated	Controls	ATT	T-stat
Total R&D intensity	0.0420	0.0077	0.0343	7.06**	0.0460	0.0063	0.0397	7.35**	0.0404	0.0093	0.0311	6.82**
Private R&D intensity	0.0193	0.0077	0.0116	6.78**	0.0208	0.0063	0.0146	7.07**	0.0233	0.0093	0.0140	5.65**
Patents	0.2237	0.1327	0.0910	1.29	0.2926	0.1889	0.1037	0.69	0.2378	0.2378	0.0000	0.00
Product innovation	0.1579	0.0976	0.0603	2.11*	0.1333	0.0642	0.0691	2.44*	0.0825	0.1489	-0.0663	-1.47
No. of treated firms (on support)	304				270				206			
No. of treated firms (off support)	14				2				6			
No. of controls	5,658				4,259				3,321			

Note : significant at * 5%, ** 1% level

Impact of R&D subsidies, by cluster and industry. Panel (a) MHT and HT sectors. Panel (b) LT sectors