

Science and Technology Parks and their effects on innovative performance

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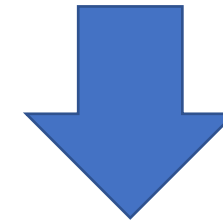
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STPs are **policy-driven** agglomerations which are:

- designed to **encourage the formation and growth of knowledge-based businesses** and other organizations normally resident on site
- have a **management function** that is actively engaged in the transfer of technology and business skills to these organizations
- have a **specific perimeter**, the lack of which is a well-known problem in agglomeration studies

Over the past 15 years, **SP activity worldwide has approximately doubled** (Lecluyse et al., 2019):

- over 400 STPs in Europe
- 300 in North America
- more than 1,500 STPs in China and India
- and a great number of STPs in emerging economies in South America, Asia and Africa



STPs are **one of the main innovation policy** in many countries (Albahari et al., 2018)

- Previous research has evaluated STP's effect mainly on:
 - i) **Research inputs** (R&D investments intensity and workforce quality)
 - ii) **Innovative outputs** (**patents**, sales from new products) and
 - iii) **R&D productivity**
- Several studies show a positive impact on the **number of patents** (Siegel et al, 2003; Squicciarini, 2008)

Proxy of innovative performance ???

- **DRAWBACK:** patent count does not take into account patent quality! (Griliches, 1998)
- Patent quality is skewed: there are patents with high value and patents with little or no value (Scherer and Harhoff, 2000)

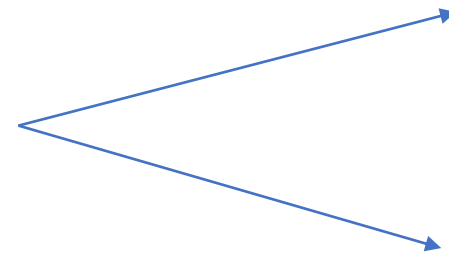
Estimating the **STP's effect**
on tenant's **innovation**
performance



Patent quality as proxy

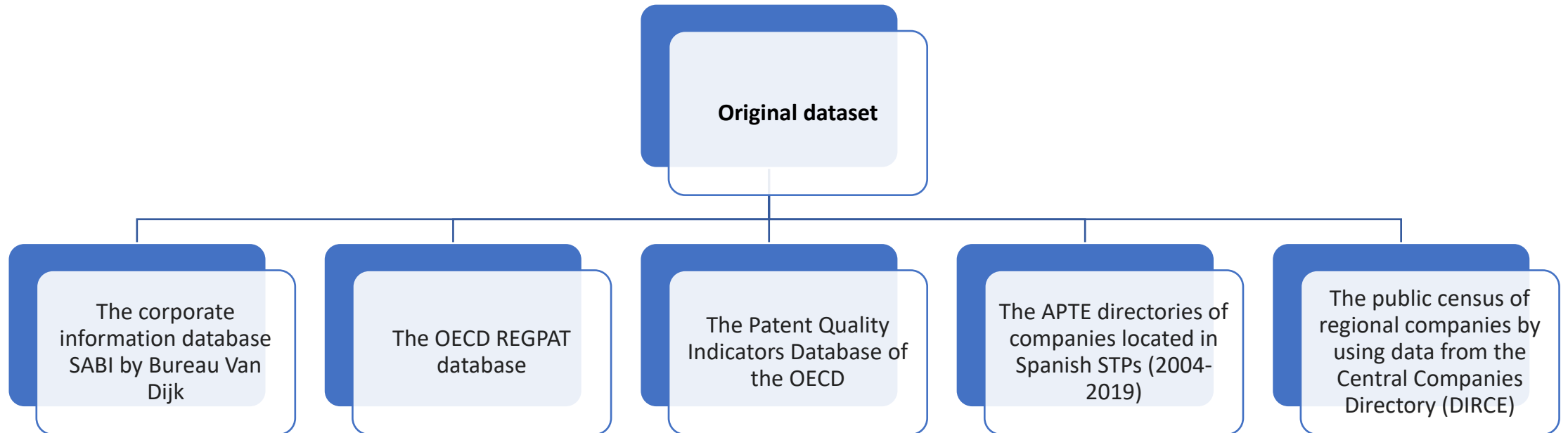
Channels through which the
effect takes place

Contributions



1. Estimating the effect of the on-park
location on patent quality

2. Investigating the channels through which
the effect takes place



Final Sample

- 9,012 patents for firms on-park and off-park
 - 1,415 patents for STP's firms

- Model:

$$y_i = \beta_0 + \beta_1 Patpark + \sum_k \beta_k x_{ik} + u_i$$

- We use different types of regressions to obtain more robust results: OLS, Poisson regressions and instrumental variable method (IV).

- Instrumental variable



Number of companies located in an STP as a percentage of total companies (Vásquez-Urriago et al., 2014)

$$Patpark = \alpha_0 + \alpha_1 instrument + \sum_k \alpha_k x_{ik} + v_i$$

Variables

Characteristics	Label	Description
<i>Dependent variables</i>		
Forward citations	Fwd_cits5	Number of patent citations received up to 5 years after publication (normalized by technology field and patent application year)
Renewal	Renewal	Life duration of the granted patent, in number of years
<i>Independent variable</i>		
Patent located in STP	Patpark	1 if the patent is own by a tenant, 0 otherwise
<i>Channels for STP effect</i>		
Number of inventors	Inv_number	Number of inventors of the patent
Family size	Family_size	Number of patent offices where a certain invention has been protected
Non-patent-literature citations	NPL_cits	Number of non-patent literature (NPL) references of prior knowledge on which the invention is based
University role	University	1 if any of the applicants is an university, 0 otherwise
<i>Control variables</i>		
Firm age	Firm_age	Age of firm in patent application year
Firm size	Firm_emp	Number of employees of firm in patent application year
	Firm_sales	Sales of firm in patent application year
Firm sector	CNAE_code	Numerical Code referring to National Classification of Economic Activities (CNAE). 22 dummies.
Firm location	Reg_code	Indicates the region which the applicant's address is located. 10 dummies.
Patent application year	App_year	Indicates the year in which the EPO patent application is made. 13 dummies.
Patent technology field	Tech_field	Indicates the technological field of the patent, based on Schmoch (2008), 2011 rev. 30 dummies.

The indicators of the dimensions of patent quality chosen are forward citations (5-years) and renewals.

- **Forward citations** reflect the technological importance of the patent (Trajtenberg, 1990; Harhoff et al., 2003)
- Number of **renewals** is an indicator of the economic value of the patent (Griliches, 1990; Lanjouw et al., 1998).

The selected channels through which STPs carry out their effect:

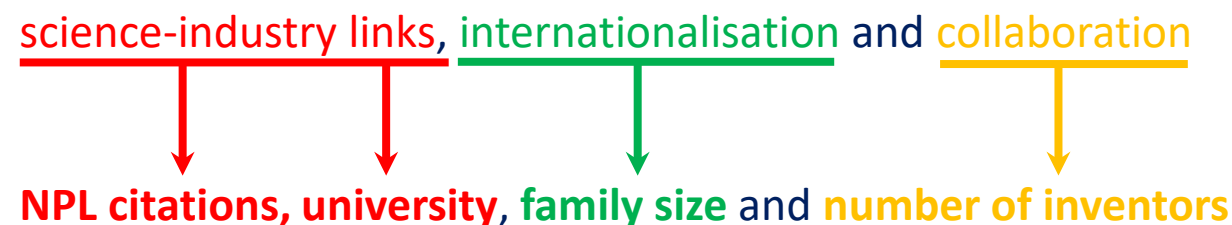


Table 1. STP's effect on tenants' innovative performance

	OLS regression model		Poisson regression model		IV method regression	
	(1)	(2)	(3)	(4)	(5)	(6)
	log(Fwd_cits5)	log(Renewal)	Fwd_cits5	Renewal	log(Fwd_cits5)	log(Renewal)
Patent Park	0.049*** [0.017]	0.038** [0.015]	0.202*** [0.067]	0.049*** [0.017]	0.191*** [0.061]	0.028 [0.055]
log(Firm_age)	-0.045*** [0.007]	-0.035*** [0.007]	-0.183*** [0.029]	-0.036*** [0.007]	-0.035*** [0.008]	-0.036*** [0.008]
log(Firm_emp)	0.002 [0.006]	0.007 [0.006]	0.012 [0.029]	0.009 [0.007]	-0.005 [0.007]	0.007 [0.007]
log(Firm_sales)	0.017*** [0.005]	0.006 [0.004]	0.072*** [0.021]	0.008* [0.005]	0.018*** [0.005]	0.006 [0.004]
Year dummies	YES	YES	YES	YES	YES	YES
Technology dummies	YES	YES	YES	YES	YES	YES
Industry dummies	YES	YES	YES	YES	YES	YES
Region dummies	YES	YES	YES	YES	YES	YES
Constant	0.116** [0.048]	1.864*** [0.052]	-1.542*** [0.296]	1.845*** [0.060]	0.101** [0.049]	1.865*** [0.053]
<i>N</i>	9012	9012	9012	9012	9012	9012

Marginal effects; Standard errors in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Columns (1) and (2) show results of OLS regression model, Columns (3) and (4) show results of Poisson regression model and Columns (5) and (6) show results of IV method regression.

- **On-park patents have higher quality**
 - ✓ Patents obtained by firms located in STPs are **more cited**
 - ✓ **Same trend** regarding patent **renewal**
- Our findings support several studies which have found evidence of **positive STP effects** on innovative performance of their tenants (Siegel et al., 2003b; Squicciarini, 2008).
- Regarding covariates:
 - ✓ **younger firms** obtain **higher quality patents** (Vásquez-Urriago et al., 2016).
 - ✓ variables related to **firm size, amount of sales and number of employees** show **different** results and are **not statistically significant**

Table 2. Forward citation results

	(1)	(2)	(3)	(4)	(5)	(6)
	log(Fwd_cits5)	log(Fwd_cits5)	log(Fwd_cits5)	log(Fwd_cits5)	log(Fwd_cits5)	log(Fwd_cits5)
Patent Park	0.049*** [0.017]	0.044** [0.017]	0.054*** [0.017]	0.049*** [0.017]	0.043** [0.017]	0.039** [0.017]
log(Firm_age)	-0.045*** [0.007]	-0.044*** [0.007]	-0.042*** [0.007]	-0.045*** [0.007]	-0.045*** [0.007]	-0.044*** [0.007]
log(Firm_emp)	0.002 [0.006]	0.001 [0.006]	0.003 [0.006]	0.001 [0.006]	0.002 [0.006]	0.001 [0.006]
log(Firm_sales)	0.017*** [0.005]	0.017*** [0.005]	0.016*** [0.005]	0.017*** [0.005]	0.017*** [0.005]	0.017*** [0.005]
Inv_number		0.008** [0.003]				0.007** [0.003]
Family_size			0.018*** [0.001]			
NPL_cits				0.000 [0.001]		
University					0.147** [0.058]	0.135** [0.058]
Year dummies	YES	YES	YES	YES	YES	YES
Technology dummies	YES	YES	YES	YES	YES	YES
Industry dummies	YES	YES	YES	YES	YES	YES
Region dummies	YES	YES	YES	YES	YES	YES
Constant	0.116** [0.048]	0.102** [0.048]	0.052 [0.048]	0.116** [0.048]	0.110** [0.048]	0.098** [0.049]
<i>N</i>	9012	9012	9012	9012	9012	9012

 Marginal effects; Standard errors in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Renewals results

	(1)	(2)	(3)	(4)	(5)	(6)
	log(Renewal)	log(Renewal)	log(Renewal)	log(Renewal)	log(Renewal)	log(Renewal)
Patent Park	0.038** [0.015]	0.029* [0.015]	0.045*** [0.014]	0.038** [0.015]	0.038** [0.015]	0.030* [0.015]
log(Firm_age)	-0.035*** [0.007]	-0.034*** [0.007]	-0.030*** [0.007]	-0.035*** [0.007]	-0.035*** [0.007]	-0.034*** [0.007]
log(Firm_emp)	0.007 [0.006]	0.006 [0.006]	0.009 [0.006]	0.007 [0.006]	0.007 [0.006]	0.007 [0.006]
log(Firm_sales)	0.006 [0.004]	0.006 [0.004]	0.004 [0.004]	0.006 [0.004]	0.006 [0.004]	0.006 [0.004]
Inv_number		0.012*** [0.003]				0.013*** [0.003]
Family_size			0.026*** [0.001]			
NPL_cits				-0.000 [0.001]		
University					-0.003 [0.043]	-0.026 [0.043]
Year dummies	YES	YES	YES	YES	YES	YES
Technology dummies	YES	YES	YES	YES	YES	YES
Industry dummies	YES	YES	YES	YES	YES	YES
Region dummies	YES	YES	YES	YES	YES	YES
Constant	1.865*** [0.052]	1.843*** [0.053]	1.770*** [0.051]	1.865*** [0.052]	1.865*** [0.052]	1.844*** [0.053]
<i>N</i>	9012	9012	9012	9012	9012	9012

Marginal effects; Standard errors in brackets; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- **On-park patents** involve **larger teams** of inventors and **rely more on science-industry links** (fwd_citations)
- Part of park effect is delivered by facilitating **greater collaboration** and a **closer science-industry links**
- Tenants' patents have **smaller patent families**, which indicates that they are **less international** (not a channel)

- **On-park** patents have **higher quality**
- Part of park effect is delivered by facilitating **greater collaboration** and a **stronger science-industry links**

- Next steps:
 - Does this effect extend to firms located outside the STP's perimeters? That is, does STPs generate **knowledge spillovers in their proximity?**
 - *Taking into account the distance among firms and STPs*

- Griliches, Z. (1998). Introduction to " R&D and Productivity: The Econometric Evidence". In R&D and productivity: The econometric evidence (pp. 1-14). University of Chicago Press.
- Scherer, F. M., & Harhoff, D. (2000). Technology policy for a world of skew-distributed outcomes. *Research policy*, 29(4-5), 559-566.
- Siegel, D. S., Westhead, P., & Wright, M. (2003). Assessing the impact of university science parks on research productivity: exploratory firm-level evidence from the United Kingdom. *International journal of industrial organization*, 21(9), 1357-1369

Feedbacks are more than welcome!!

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