

### **Title**

Reliance on public knowledge in technology: the impact of national characteristics

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### **Abstract**

This paper explores country-specific determinants of backward patent citations as measure of reliance on public knowledge. Using data from the European Patent Office we find that the stronger the business-orientation the lower the level of knowledge flows. We also find that national characteristics indicating the quality of an innovation system do have a positive effect.

### **Keywords**

Keywords: knowledge flows, innovation systems, patents.

This paper analyses institutional determinants of patents' backward references. Despite well-known limitations (see e.g. Jaffe et al. 1993) patent citations are still considered to be reliable to the effect of capturing knowledge flows, that is, the extent to which inventors and examiners acknowledge state-of-the-art (Narin et al, 1997). This principle is operationalized in different context by various streams of literature on the sources, the effects and the meaning of knowledge flows across both organizations and geographical boundaries (see Jaffe et al, 2002). The majority of these works focus on issues like systematic measurement errors that may undermine the use of patent citations to study knowledge flows. A less debated aspect is what influences backward references, and the connections of the latter with the broader institutional environment. Following the widely accepted notion that resource endowment and patterns of technological specialization bring to bear on the particular configuration of knowledge generation and diffusion (Antonelli, 2005; 2008), we seek to uncover empirical regularities between country-specific characteristics and knowledge flows.

In particular, we aim to test hypotheses of the following kind (likely to be better formulated):

**Hypothesis 1.** Patents whose applicants come from national systems with higher business expenditure on R&D, relative to other institutional sectors, will have a lower presence of the public knowledge base (i.e. larger number of backward references in the patent).

**Hypothesis 2.** Patents whose applicants come from 'better' national systems will have a higher presence of the public knowledge base (i.e. larger number of backward references in the patent).

Figure 1 helps visualising the construction of our sample.

{Figure 1 around here}

This is the model to be estimated:

$$nref_{ijkt} = f(\text{epopct}_{it}, \text{appy}_{it}, \text{IPC}_{it}, \text{institutional sector}_{jt}, \\ \text{sBERD}_{k,t-2}, \text{sHTE}_{k,t-2}, \text{timereq}_{k,t-2})$$

i=patent, j=applicant, k= country of applicant, t=year of application

Table 1 shows the list of variables and their description. Variable sBERD will allow testing Hypothesis 1, sHTE and timereq will do for Hypothesis 2. The rest are control variables.

{Table 1 around here}

Table 2 presents some descriptive statistics for the whole sample. The average patent has almost 5 backward references. Countries in the sample have a share of 65 percent of BERD over GERD, 18 percent of high-tech exports over total exports and it takes an average of 33 days to start a business in them.

{Table 2 around here}

In Table 3, Column 1, with control variables only, we see that EPO-PCT patents have more references than direct EPO patents. More recent patents have larger numbers of references. There is variation according to the technology class of the patent: being in A, B, C, F and G increases the number of references, being in E has no effect and being in D and H decreases the number. Patents applied for by applicants from institutional sectors other than companies have more references.

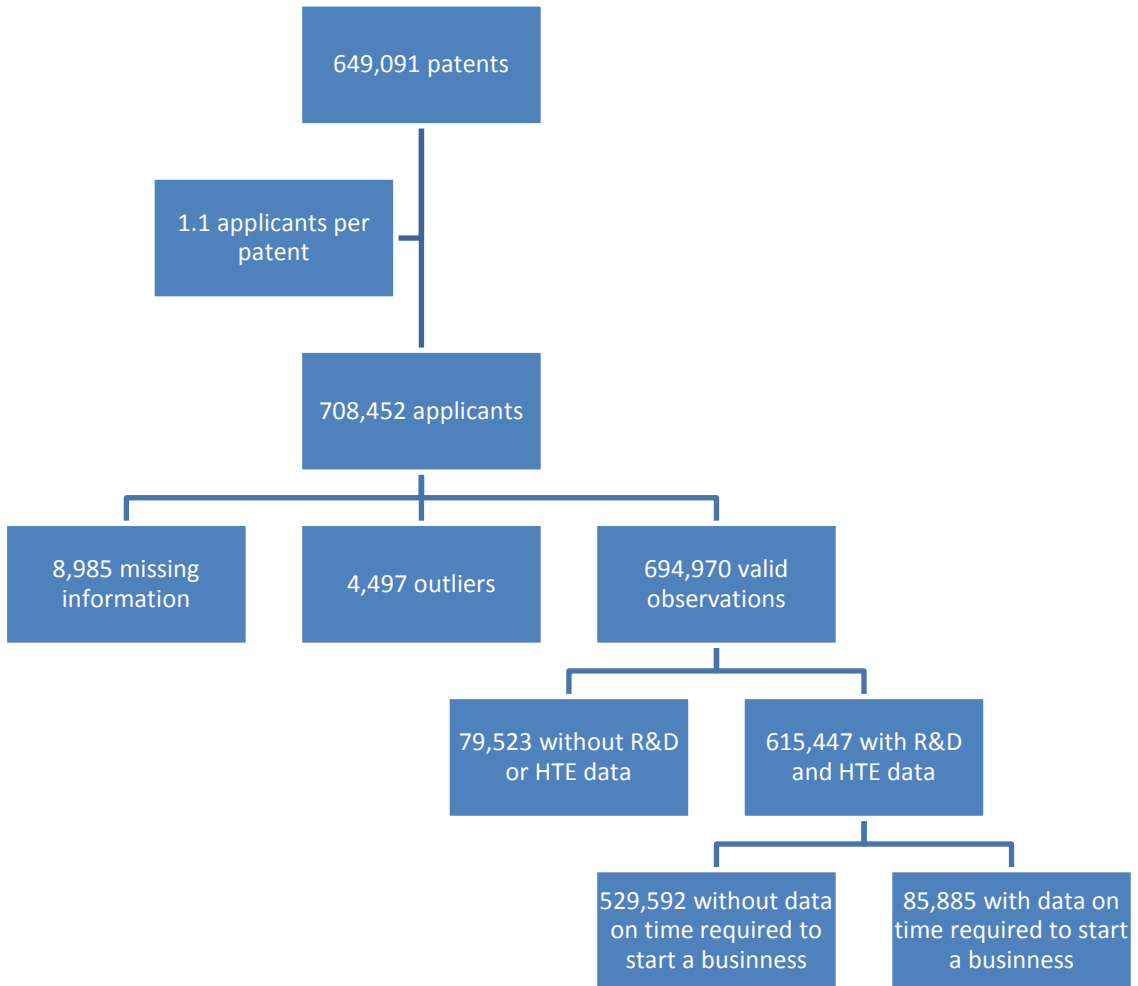
{Table 3 around here}

Regarding applicant country characteristics, we can see in Column 2 that the average patent has fewer references if the applicant comes from countries with higher shares of business over total expenditure on R&D. This supports Hypothesis 1.

More references are found if the country has larger shares of high-tech exports. In And Column 3 we see that the longer it takes for individuals in a country to start a business, the fewer the number of backward references. These two findings verify Hypothesis 2.

**Figures**

Figure 1  
EPO patents in 1990-2007 from Patstat



## Tables

Table 1  
List of variables

Variable	Description
<b>Patent characteristics</b>	
ref	Number of backward references
appshare	1/Number of applicants
epopct	Dummy=1 if EPO-PCT patent, 0 if direct EPO patent
appy	Application year
IPC: A, B, C, D, E, F, G, H	Dummy=1 if patent classified in a given IPC
<b>Applicant characteristics</b>	
Institutional sector: company, individual, university, hospital	Dummy=1 if applicant classified in a given institutional sector
<b>Applicant country characteristics</b>	
sBERD	Business R&D expenditure (BERD): Share of Gross R&D expenditure (GERD)
sHTE	High-technology exports: Share of manufactured exports
timereq	Time required to start a business: Days

Table 2  
Descriptive statistics

Variable	Full sample (n=694,970)				R&D and THE sample (n=615,447)				Time required to start a business sample (n=85,885)			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
ref2	4.90	2.69	0	19	4.93	2.71	0	19	4.92	2.85	0	19
epopct	0.44	0.50	0	1	0.44	0.50	0	1	0.42	0.49	0	1
appy	1,999.01	4.67	1,990	2,007	1,999.57	4.36	1,990	2,007	2,005.46	0.64	2,003	2,007
A	0.20	0.40	0	1	0.20	0.40	0	1	0.19	0.39	0	1
B	0.28	0.45	0	1	0.28	0.45	0	1	0.26	0.44	0	1
C	0.20	0.40	0	1	0.19	0.39	0	1	0.14	0.35	0	1
D	0.03	0.18	0	1	0.03	0.17	0	1	0.03	0.16	0	1
E	0.06	0.24	0	1	0.06	0.24	0	1	0.06	0.24	0	1
F	0.14	0.35	0	1	0.14	0.35	0	1	0.15	0.36	0	1
G	0.19	0.39	0	1	0.19	0.39	0	1	0.18	0.39	0	1
H	0.20	0.40	0	1	0.20	0.40	0	1	0.19	0.39	0	1
Company	0.88	0.33	0	1	0.88	0.33	0	1	0.88	0.32	0	1
Individual	0.09	0.28	0	1	0.08	0.28	0	1	0.07	0.26	0	1
Nonprofit	0.01	0.12	0	1	0.02	0.12	0	1	0.01	0.12	0	1
University	0.01	0.10	0	1	0.01	0.10	0	1	0.02	0.12	0	1
Government	0.01	0.11	0	1	0.01	0.11	0	1	0.01	0.11	0	1
Hospital	0.00	0.02	0	1	0.00	0.02	0	1	0.00	0.02	0	1
sBERD					0.64	0.07	0	1	0.65	0.08	0	1
sHTE					18.28	6.64	1	60	18.42	5.93	3	35
timereq									32.71	19.10	6	114

Weight variable: share of number of applicants

Table 3  
Negative binomial estimation of the determinants of number of backward references

	1 Baseline regression	2 +R&D-HTE variables	3 +Time to start a business variable
epopct	0.15*** (0.00)	0.15*** (0.00)	0.18*** (0.00)
appy	0.00*** (0.00)	0.00*** (0.00)	-0.04*** (0.00)
A	0.14*** (0.00)	0.14*** (0.00)	0.17*** (0.01)
B	0.02*** (0.00)	0.02*** (0.00)	0.05*** (0.01)
C	0.14*** (0.00)	0.15*** (0.00)	0.16*** (0.01)
D	-0.03*** (0.00)	-0.02*** (0.00)	0.03** (0.01)
E	0.00 (0.00)	-0.00 (0.00)	-0.06*** (0.01)
F	0.06*** (0.00)	0.06*** (0.00)	0.07*** (0.01)
G	0.06*** (0.00)	0.06*** (0.00)	0.07*** (0.01)
H	-0.01*** (0.00)	-0.01*** (0.00)	-0.01 (0.01)
Individual	0.03*** (0.00)	0.03*** (0.00)	0.02*** (0.01)
Nonprofit	0.16*** (0.01)	0.15*** (0.01)	0.17*** (0.02)
University	0.26*** (0.01)	0.25*** (0.01)	0.26*** (0.01)
Government	0.16*** (0.01)	0.15*** (0.01)	0.14*** (0.02)
Hospital	0.30*** (0.03)	0.30*** (0.04)	0.23*** (0.09)
sBERD		-0.12*** (0.01)	-0.06** (0.03)
sHTE		0.00*** (0.00)	0.00*** (0.00)
timereq			-0.00** (0.00)
Constant	-7.23*** (0.29)	-3.34*** (0.34)	73.52*** (7.06)
Ln $\alpha$	-2.77*** (0.01)	-2.76*** (0.01)	-2.40*** (0.02)
Observations	694,970	615,447	85,855

\*\*\* Significant at 1%. \*\* Significant at 5%. \*Significant at 10%. Standard errors below coefficients. *Company* is the benchmark for institutional types. Weight variable: share of number of applicants.