Prolific inventors: who are they and where do they locate? Evidence from a five countries US patenting data set.

Christian Le Bas (LEFI, Université Lyon 2)

Conference

"Regional Innovation Policies and SMEs : Promoting Technology Transfer, Fostering Entrepreneurship, Nurturing Start-Ups to Support Regional Dynamics"

Tokyo, 3-5 Feb. 2010

Why prolific inventors are important

- A significant quantity of converging empirical evidence :
- Ernst *et al*. (2000) show that very productive inventors are associated with more valuable patents
- The characteristics of the inventor, in particular ***his own past number of patents***, is the main determinant of the private economic value of invention, ***more important*** than the characteristics of the organization in which he is employed (Gambardella *et al.*, 2005)
- Prolific inventors (those with more than 12 patents) tend to produce inventions having more value (Gay *et al.*, 2008)

Prolificness

- "Prolificness" is the characteristic of a single inventor who produces many patents (an alternative term is "prolificacy").

- Prolificness transforms the effects of the accumulation of inventing experiences by one inventor (a particular form of learning) into higher values of inventions.

- Prolificness = accumulation of talented technological human capital embodied in inventions in such a way that prolific inventors' inventions are of higher than average value.

- The transformation due to prolificness is dynamic and may exhibit increasing returns.

Previous studies confirm the importance of prolificness and the relationship with the *quality* of inventions

- **For *highly productive scientists* (Lotka, 1926),**
- For "***highly prolific inventors***" (Narin and Breitzman, 1995),
- For ***great inventors*** (Kahn and Sokoloff, 2004 ; Jones, 2005)
- For ***key inventors*** (Ernst, 1999; Pilkington *et al.*, 2009)
- For ***star inventors*** (Marx *et al.*, 2007)
- For ***star scientists*** (Zucker and Darby,1996, 2001, 2002)
- But no study on a large scale.....

Aims of the research

Short term : Construct a database that reveals the "scale and scope" of prolific inventor populations in five countries (Germany, Japan, France, United Kingdom, and USA):

(1) their numbers

(2) their significant characteristics

(3) the factors that explain their numbers of patents.

Long term : Test the hypothesis that the mobility of prolific inventors *has a positive impact on the value of inventions at the firm level* (mobility may increase experience more rapidly than stationnarity)

The raw material : the US patent

- **United States Patent 4,820,631**
  Lacal , et al. April 11, 1989
  Deletion mutants and monoclonal antibodies against ras proteins
  Abstract

- Specific deletion mutants of ras p21 gene and specific monoclonal antibodies which recognize specific regions of the ras p21 protein have been prepared. A kit for detecting the presence of specific ras p21 proteins and their levels in a body sample has been described.
  Inventors: **Lacal;Juan C.** (Bethesda, MD), **Aaronson ; Stuart A .** (Vienna, VA)

- Assignee:**The United States of America as represented by the Secretary of the** (Washington, DC)
  Appl. No.: **06/890,510**
  Filed: **July 30, 1986**
  Current U.S. Class:435/6 ; 435/5; 435/7.23; 435/810; 435/975; 436/548; 436/808; 436/813; 530/387.7; 530/387.9
  Current International Class: C07K 16/18 (20060101); C07K 16/32 (20060101); C07K 14/82 (20060101); C12Q 001/68 (); G01N 033/53 (); G01N 033/577 (); C12N 005/00 ()
  Field of Search: 435/172.1,172.2,6,849,7,68,240.27,810 436/548,811,63,64,813,808 530/350,387 935/110,103

Constructing the Database

- US Patents (1975-2002) for five countries (US, Jap., Ger., Fr, UK) give a lot of information on inventors characteristics.
- Prolific= 15 patents and more
- Merged with the NBER patent data base.
- No code for inventors => we perform inventor name matching ("the John Smith problem").
- Huge task, done manually with some automatic procedures (exception: Soundex coding method for UK).
- Effectiveness of matching algorithms (Raffo and Lhuillery, 2007) is an open question :
- Pioneer work by Trajtenberg (May 2004, Oct. 2004), Sing (2004), and Kim *et al*. (2005)
- Entering into the black box of matching :
  - Our method is similar to Sing (2004): We consider that two records identify the same inventor when the family names and the first names are the same and when the middle name, when it exists, is identical in both records.
  - When we have no information concerning the middle name we first look at the address of the inventor and second at the name of the assignee

From records to prolific inventors patenting by country

	GB	FR	USA	GER	JP	Total 5 countries
Number of inventors	61730	66127	985652	139671	265708	1518888
Total amount of patents : A	76532	76919	1459911	221081	490143	2324586
Total amount of prolific inventors: B	813	1157	25123	5270	19418	53407
Total amount of prolific inventors patents: D	15515	26631	492268	88467	326497	950985

Indexes of prolificness and descriptive statistics by country

	GB	FR	USA	GER	JP	Total 5 countries
Index1 total amount of prolific inventors / total amount of inventors (%)	1,32	1,75	2,55	3,77	7,31	3,52
Index 2 PI patenting/ total patenting (%)	20,27	34,62	33,72	40,02	66,61	40,91
Inventor average number of patents	2,34	2,38	2,80	3,49	4,94	3,20

Countries ranking : Indexes of "Prolificness" and R&D indicators

ranking	Index 1 total amount of prolific inventors / total amount of inventors	Index 2 prolific inventors patents/total amount of patents	Percentage of the national R&D expenditures funded by E.(1992 and 2002)	Private RD expenditures/ GNP (2006) OECE/Eurostat/OST
1	Japan	Japan	Japan	Japan (2.62)
2	Germany	Germany	Germany	USA (1.84)
3	USA	France	USA	Germany (1.77)
4	France	USA	France	France (1.34)
5	U-K	U-K	U-K	U-K (1.10)

Prolific inventor patenting by country and technological field

	GB	FR	USA	GER	JP
Chemicals	**29,35**	**32,51**	**26,03**	**38,00**	19,41
Computers and Communications	9,25	7,95	**13,62**	3,60	**19,18**
Drugs and Medical	**24,94**	19,63	13,48	10,65	4,72
Electrical and Electronic	11,76	12,01	**18,13**	11,71	**22,90**
Mechanical	14,45	16,09	14,66	**22,56**	**23,63**

Prolific inventor patenting by country and type of assignee

	GB	FR	USA	GER	JP
US Enterprise	24,09	6,31	87,78	5,37	0,87
Non-US Enterprise	70,66	86,28	1,43	89,25	97,23
Individual	0,05	0,41	0,64	0,98	0,28

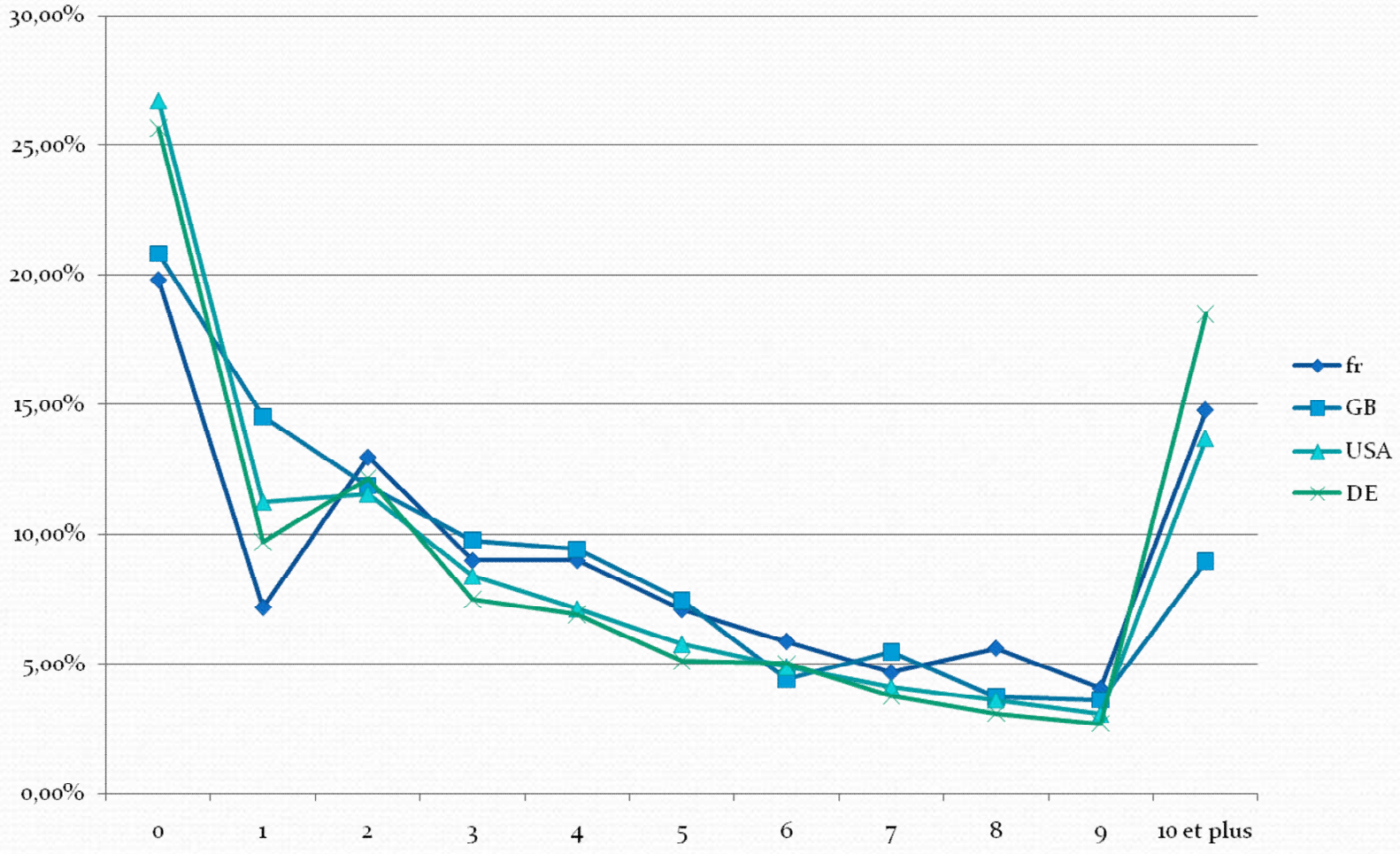
Macro technological specialization and prolifcness

- **High correlation (adj R square = 0.52, with dummy for countries et techn. Fields) between the Revealed Technological Advantages Index and the proportion of prolific inventor at technological class level (37)**
- **In line with this new evidence, Pilkington et al. (2009) have recently shown that key inventors are primarily located within a limited number of key firms having a real technological leadership.**
- **Possible "virtuous circle" of positive feedbacks or self-reinforcing processes linking national technological specialisation (countries), technological leadership (firms) and highly productive human capital (prolific individual inventors).**

Prolific inventor's mobility (number of moves between firms) by country

Number of moves	0	1	2	3	4	5	6	7	8	9	10 et plus	Total
Fr	19,79	7,17	12,96	8,99	8,99	7,09	5,88	4,67	5,62	4,06	14,78	100,00
GB	20,81	14,53	11,86	9,77	9,42	7,44	4,42	5,47	3,72	3,60	8,95	100,00
USA	26,68	11,22	11,53	8,38	7,11	5,76	4,88	4,10	3,60	3,04	13,70	100,00
All	25,64	9,71	12,14	7,48	6,91	5,11	5,01	3,77	3,08	2,68	18,47	100,00

Prolific inventor's mobility by country

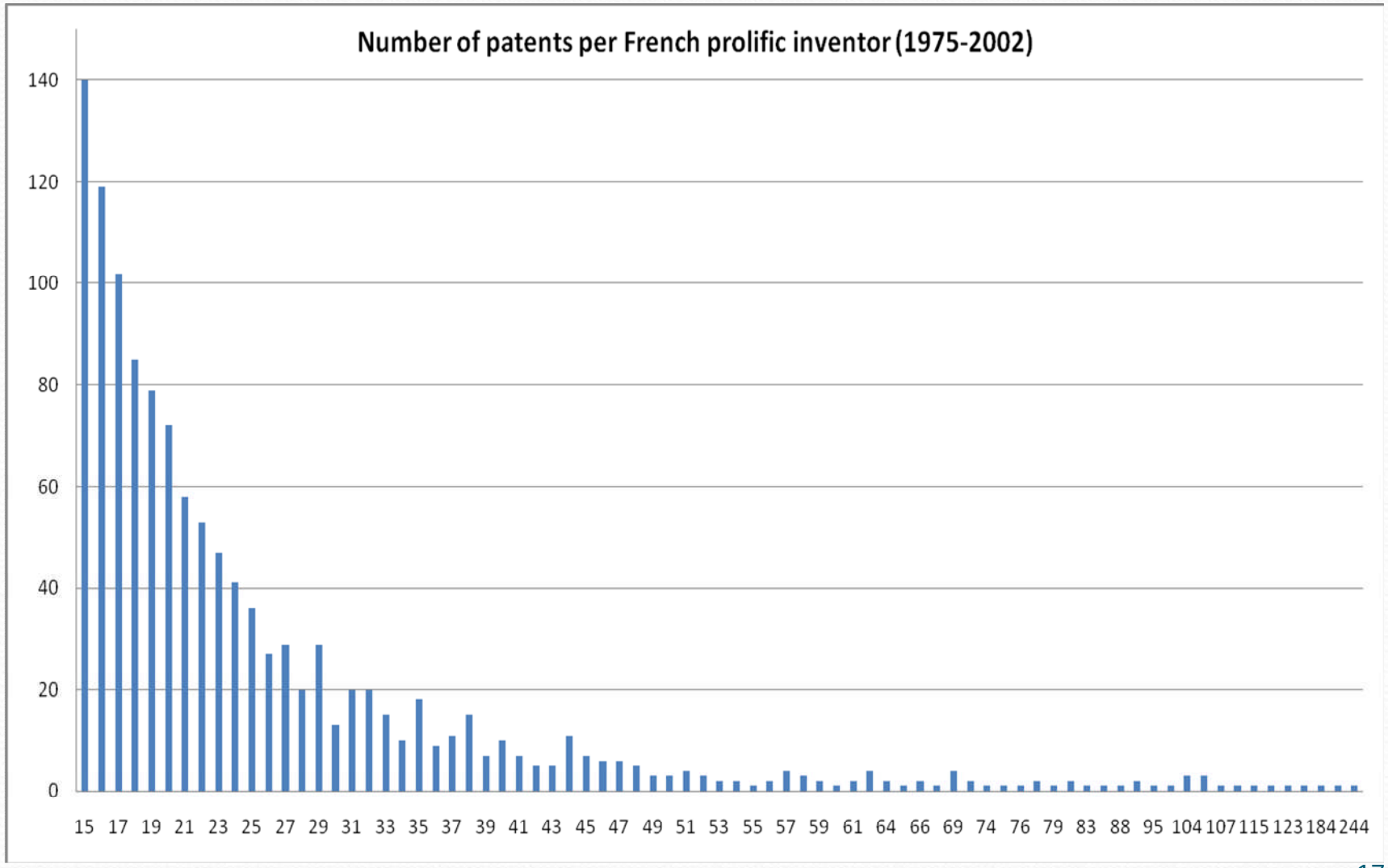


Comments

Difficult to assess the interfirm mobility

- **Trajtenberg (2004) : 66 % of inventors are non movers**
- **Prolific inventor data set : according to the countries, from 20 to 26 % are non movers**
- **Average number of moves : UK 4.3, FR 4.9, Ger. 5.7 ; USA 4.5**
- **International mobility is very high for UK**

Prolific Inventors Patents Distribution (France)



Explaining inventor productivity (number of patents) country: France

nbpat	Coef.	Std. Err.	z
mov_ass	.0162868	.0022902	7.11
mov_inter	.0132403	.0242156	0.55
variete	.0478337	.0122155	3.92
pat_duration	.0164744	.0030788	5.35
timeconc	-1.428615	.1716169	-8.32
cat1	.1154219	.0479926	2.40
cat2	.0505945	.0629762	0.80
cat3	.2151276	.0487985	4.41
cat4	-.0480333	.0567236	-0.85
cat5	.045541	.0542906	0.84
assdom1	.1817115	.1972645	0.92
assdom2	-.36062	.2081836	-1.73
assdom3	.0686796	.0544527	1.26
assdom5	-.093279	.0987379	-0.94
a74	-.3507972	.0917203	-3.82
a7579	-.5293371	.0908022	-5.83
a8084	-.4063051	.0885934	-4.59
a8589	-.3918631	.0852121	-4.60
a9094	-.2425276	.0852843	-2.84
_cons	3.322313	.1286691	25.82

Productivity of PI : Comments

- **Prolific inventors differ greatly as regards their level of "prolificness" (inventive productivity) likely persistence (Allison et Stewart, 1974)**
- **Histogram displays heterogeneity and skewness with a *long tail***
- **Distributions appear similar across countries**
- **What factors explain PI productivity : we estimate a negative binomial model for each country and across countries:**

  Variables with *positive impact* : mobility, technological variety, and patent duration. two exceptions : patent duration is positive but not significant for Great-Britain, the same for international mobility for France.

  Variable with *negative impact* : Time concentration

We aim to answer the question posed by Hoisl and Tratjenberg : What is the causal link between mobility and productivity at the inventor level?

Conclusion

- **Main finding : Prolificness is linked to national technological strengths**
- **A likely transmission medium is through key large nationally- based firms (Patel et Pavitt, 1995) that assert real technological leadership (Pilkington *et al*., 2009)**
- **Productivity of PI explained by mobility, technological variety, patent duration, time concentration (negative impact), but bias of endogneity**
- **Research in progress : investigating the links among prolificness, mobility, and invention values**