Labour Mobility of Academic Inventors

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Structure of the presentation

- Technology transfer and academic mobility: A framework for the analysis.
- European University Patenting and Mobility.
- First results for labour mobility.
- Conclusions.

Labour mobility as technology transfer

- Across firms: e.g. Almeida and Kogut (1999).
- Between universities and firms:
  - Case based sociological literature;
  - Mobility of doc or post-docs (Mangematin, 2000; Zellner; 2003);
  - Star scientists (Zucker, Darby and colleagues);
  - Cooperation versus “real” mobility (Zucker et al. (2002)).

Academic Inventor Mobility 1

- We want to explain why some academic inventors move to a company or a PRO.
- We think there are two main driving forces:
  - Career related issues;
  - Transfer of tacit knowledge.

Academic Inventor Mobility 2

- How can we model this situation? Following search theory based model, the decision to move from academia depends on two probabilities:

$$Pr(M=1) = f(\cdot) \times g(\cdot)$$

$$f(\cdot) = f(s, p, e)$$

$$g(\cdot) = g(w, b, c)$$

Academic Inventor Mobility 3

- The factors affecting the two probabilities can be organised in 6 main building blocks
  - ***Inventor characteristics,***
  - ***Retention strategy,***
  - ***Potential demand/regional effect,***
  - ***Network,***
  - ***Expected value of the patent,***
  - ***Knowledge characteristics.***

Career related

Tacit Knowledge Transfer

Academic Inventor Mobility 4

- ***Inventor characteristics:***
  - Education, experience, number of previous patent applications and publications, etc.could be interpreted as signal of a high individual productivity (+/-);
  - We expect greater mobility from a non-tenured researcher, the higher the academic position the higher the opportunity costs of leaving (-);
  - If the skills by the inventor are university specific, a job change may require skill adjustments that can be considered as sunk costs (-);
  - Willingness to move and to transfer (based on previous experience) (+).

Academic Inventor Mobility 5

- ***Retention strategy:***
  - A salary increase as a reward for patenting, share of the revenues from the patent, etc., would increase b leading to a less mobility (-).
- ***Potential demand/regional effect:***
  - Highly industrialised areas are more likely to generate potential job offers for academics, lower moving costs. But high quality university are usually in large cites, higher costs to move to a different region (+/-).
- ***Network:***
  - More connected the inventor is to a densely populated network of public and private organisations the higher is the probability that she will move to another job (+).

Academic Inventor Mobility 6

- ***Expected Value of the patent:***
  - Hiring the inventor gives the firm access to the inventor's tacit knowledge. The higher the *value* of the invention the higher will be the salary that is offered, and therefore the higher will be the probability of moving (+).
- ***Knowledge characteristics:***
  - The more *cumulative* the knowledge of the inventor is, the more it is embodied into the inventor, making him more valuable and hence increasing the probability of mobility (+).
  - Higher *generality* could mean a large scope and more possibilities to innovate from a given knowledge, increasing the transfer value. But, high *generality* (more basic knowledge) can require more complementary research to be carried to extract something from it (+/-).

European University Patenting and Mobility

- Patval Database:
  - 9,000 EPO Inventors 1993-1997; 18% of EPO pats;
  - UK, NL, I, F, D and S.
- European university patents (433 or ~5%):
  - ownership,
  - mobility.
  - {technological classes},
  - {country of inventor},

Ownership

Country	Respondent Frequencies			
	PatVal Database		University Sample	
Participation only (University invented patents)	1,010	11.2%	356	82.2%
Participation & Owned Patents	7,846	87.0%	77	17.8%
Missing value	161	1.8%	0	0%
Total	9,017	100%	433	100%

Mobility

Type of organisation	Respondent Frequencies					
	PatVal Database			Analysed University Sample		
Large firm (more than 250 employees)	826	9.16%	43.61%	8	3.48%	18.18%
Medium firm (100-250 employees)	174	1.93%	9.19%	1	0.43%	2.27%
Small firm (less than 100 employees)	359	3.98%	18.95%	4	1.74%	9.09%
Self Employed (spin-outs)	335	3.72%	17.69%	9	3.91%	20.45%
Hospital, Foundation, or Private Res. Organization	13	0.14%	0.69%	1	0.43%	2.27%
Government Research Organization	33	0.37%	1.74%	5	2.17%	11.36%
University and education	90	1.00%	4.75%	15	6.52%	34.09%
Other Government	10	0.11%	0.53%	0	0.00%	0.00%
Other (Unknown)	54	0.60%	2.85%	1	0.43%	2.27%
Non-mobile	6,645	73.69%		186	80.87%	
Missing value	478	5.30%		0	0.00%	
Total	9,017	100%	100%	230	100%	100%

Econometric Results

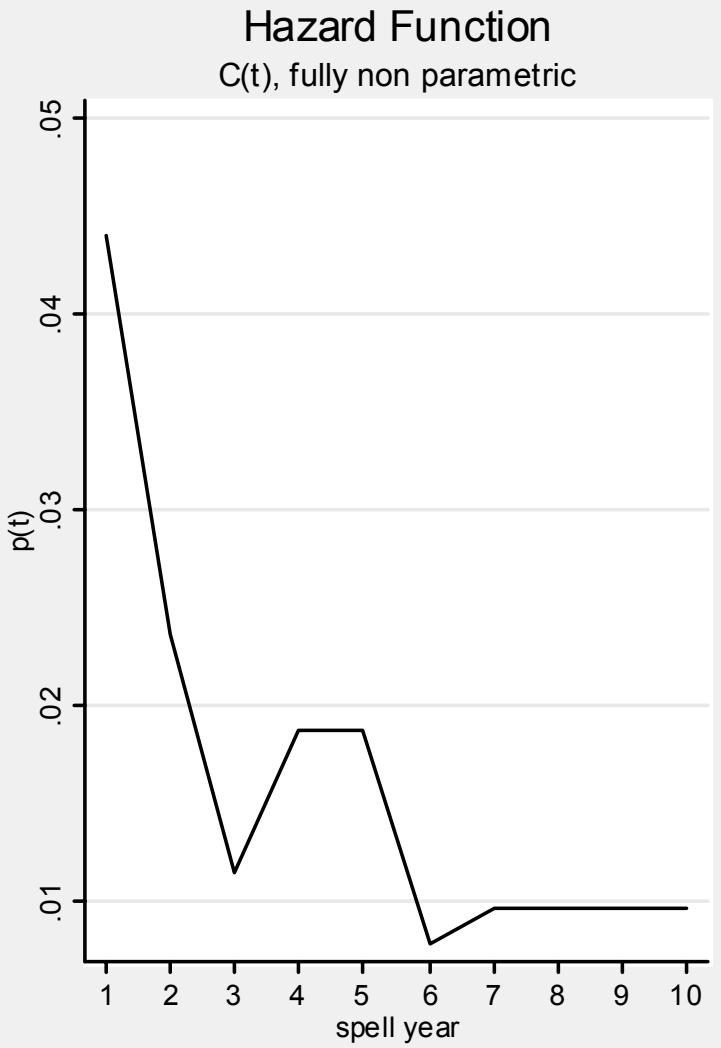
Modelling labour mobility 1

- Duration model for academic inventors' labour mobility:
  - we makes use of discrete-time hazard models to estimate the probability of moving for an academic inventor from the moment that she has filed for a patent application. We use a complementary log logistic –*cloglog*- function such as:

$$h(W)_{it} = 1 - \exp\left\{-\exp\left(W_i^{'}\beta + \theta(t)\right)\right\}$$

		1	2	3	4	5	6	7	8	9
Technology Fixed Effects	Instruments (0/1)	-0.411	-0.472	-0.1	-0.113	0.016	0.482	0.201	0.055	0.049
		[0.77]	[0.87]	[0.16]	[0.18]	[0.02]	[0.67]	[0.33]	[0.08]	[0.07]
	Chem/Pharm (0/1)	-0.169	-0.121	0.667	0.676	0.686	0.884	0.661	0.696	0.694
		[0.35]	[0.24]	[1.10]	[1.10]	[1.13]	[1.31]	[1.02]	[1.04]	[1.11]
	Proc Eng (0/1)	-0.135	-0.065	1.036	1.068	1.125	1.459	1.265	1.265	1.252
		[0.25]	[0.12]	[1.47]	[1.45]	[1.51]	[1.73]*	[1.69]*	[1.58]	[1.71]*
	Mech Eng (0/1)	-0.709	-0.704	-0.362	-0.389	-0.447	0.046	0.108	0.447	0.471
		[0.88]	[0.86]	[0.47]	[0.48]	[0.54]	[0.05]	[0.11]	[0.44]	[0.48]
Country Fixed Effects	Germany (0/1)		1.117	1.644	1.608	1.561	1.862	2.287	2.721	2.731
			[2.07]**	[2.30]**	[2.20]**	[2.14]**	[2.44]**	[2.63]***	[2.48]**	[3.19]***
	Netherlands (0/1)		0.887	1.457	1.401	1.395	2.007	2.5	2.873	2.895
			[1.51]	[2.26]**	[2.11]**	[2.13]**	[2.32]**	[2.31]**	[2.29]**	[3.08]***
	UK (0/1)		0.611	1.275	1.239	1.257	1.742	1.77	1.944	1.968
			[1.11]	[2.09]**	[1.97]**	[2.00]**	[2.12]**	[1.96]*	[1.86]*	[2.36]**
Iventor Background	Gender (0/1)			0.183	0.135	0.273	-0.033	-0.195	-0.464	-0.468
				[0.23]	[0.16]	[0.28]	[0.03]	[0.17]	[0.41]	[0.48]
	Education (yrs)			-0.095	-0.094	-0.086	-0.099	-0.101	-0.089	-0.091
				[2.15]**	[2.16]**	[1.84]*	[1.97]**	[1.88]*	[1.64]	[1.61]
	PhD graduated (0/1)			-0.331	-0.322	-0.367	-0.38	-0.509	-0.579	-0.594
				[0.64]	[0.63]	[0.73]	[0.64]	[0.90]	[1.01]	[0.97]
	Experience (yrs)			-0.184	-0.185	-0.182	-0.214	-0.236	-0.237	-0.238
				[4.23]***	[4.16]***	[3.97]***	[3.50]***	[3.07]***	[2.39]**	[3.30]***
	Tenure (yrs)			-0.114	-0.115	-0.112	-0.13	-0.141	-0.15	-0.151
				[3.75]***	[3.66]***	[3.70]***	[3.65]***	[3.84]***	[3.60]***	[4.43]***
	Mobility Before (0/1)			-0.665	-0.679	-0.643	-0.66	-0.632	-0.881	-0.891
				[1.34]	[1.34]	[1.30]	[1.26]	[1.33]	[1.58]	[1.72]*
	Publications (Stock)			0.02	0.018	0.015	0.01	0.016	0.001	0.001
				[0.71]	[0.63]	[0.49]	[0.28]	[0.46]	[0.03]	[0.02]
	Citations (Stock)			-0.003	-0.003	-0.003	-0.002	-0.003	-0.003	-0.003
				[1.14]	[1.08]	[0.99]	[0.96]	[1.13]	[0.97]	[1.19]
	Past Patents applications			-0.012	-0.013	-0.013	-0.018	-0.019	-0.035	-0.034
				[0.55]	[0.58]	[0.60]	[0.75]	[0.87]	[1.23]	[1.44]

Retention Strategy	Compensation (0/1)				-0.212 [0.33]	-0.215 [0.34]	-0.265 [0.40]	-0.241 [0.35]	-0.218 [0.33]	-0.229 [0.39]
Potential Demand	Ciy (0/1)					-0.291 [0.57]	-0.234 [0.45]	-0.424 [0.97]	-0.328 [0.65]	-0.335 [0.70]
Networks	Size of the Patent Team						-0.118 [0.58]	-0.095 [0.45]	-0.053 [0.27]	-0.052 [0.31]
	Co-ownership						-0.705 [0.75]	-0.72 [0.87]	-0.795 [0.79]	-0.838 [0.84]
	Collaboration (0/1)						1.109 [1.94]*	1.377 [2.09]**	1.526 [2.20]**	1.524 [2.36]**
Value of Patent	Expected Patent Value							0.204 [2.18]**	0.252 [2.71]***	0.251 [2.15]**
	Licensed (0/1)							0.848 [1.92]*	0.941 [1.74]*	0.933 [1.78]*
Knowledge Characteristics of the patent	Cumulativeness (0/1)								0.999 [1.77]*	1.008 [2.13]**
	Patent Breadth								-0.022 [0.08]	-0.029 [0.11]
	Incrementality								-0.036 [0.24]	-0.036 [0.32]
	Observations	1348	1348	1348	1348	1348	1348	1348	1348	1348
	Number of Inventor Id	198	198	198	198	198	198	198	198	198
	LL	-141.76	-139.17	-110.98	-110.9	-110.67	-108.19	-104.28	-101.9	-102.05
	Chi2	32.28	37.55	147.3	145.45	145.93	129.98	150.22	183.66	72.74
	ρ									5.06E-07
	Chi2-ρ=0									0.0000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.03
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1
2
3
4
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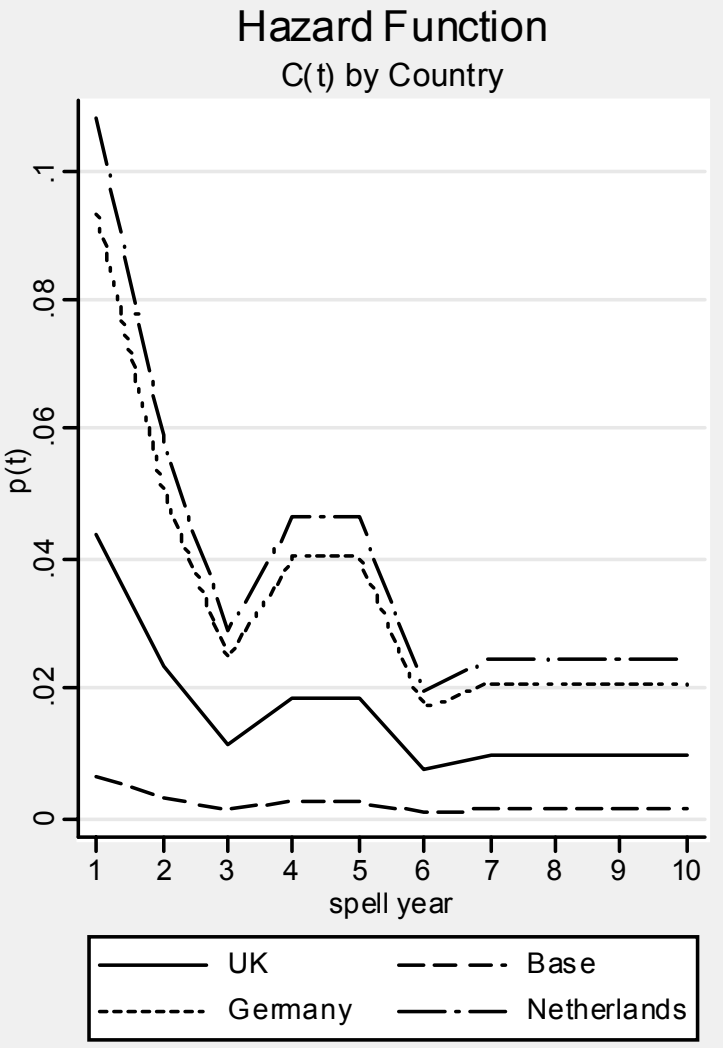
6
7
8
9
10
spell year


Hazard Function
C(t) by Country
p(t)
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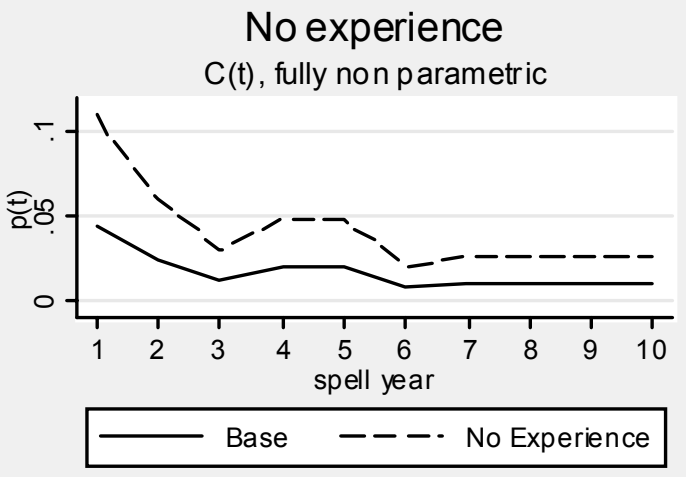
spell year
UK
Base
Germany
Netherlands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C(t), fully non parametric
p(t)
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.05
.1
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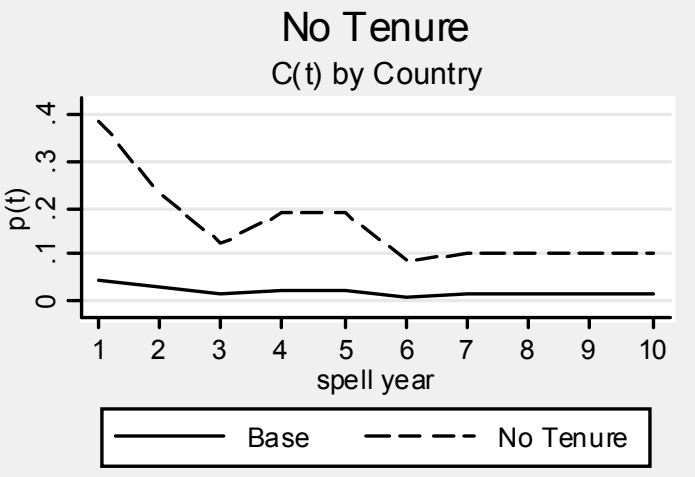
spell year
Base
No Experience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C(t) by Country
p(t)
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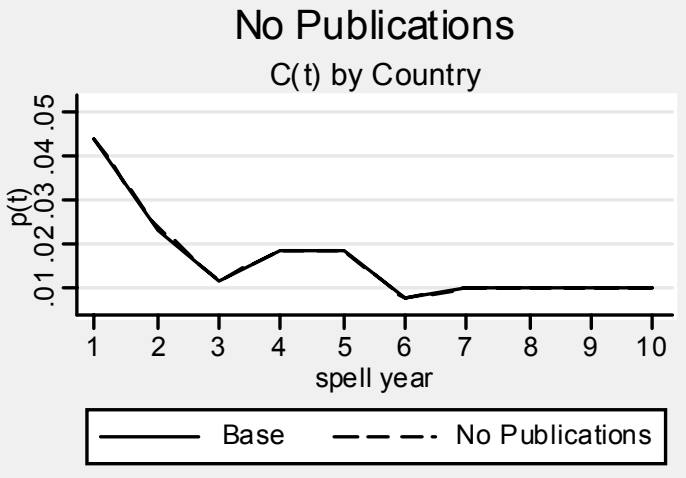
spell year
Base
No Tenure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p(t)
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.02
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spell year
Base
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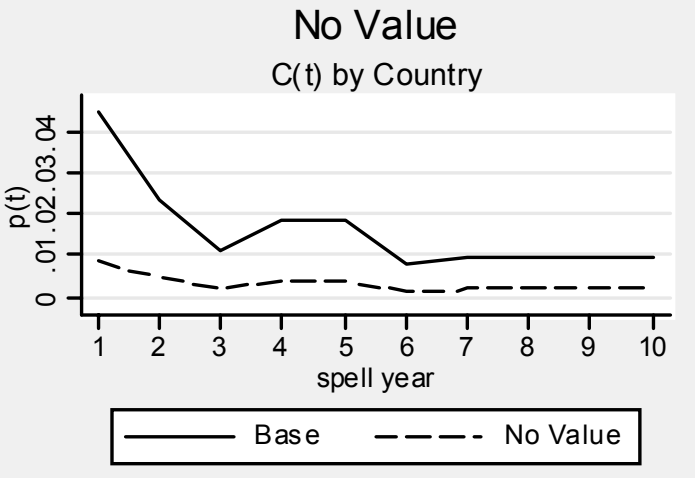
No Value
C(t) by Country
p(t)
0
.01
.02
.03
.04
1 2 3 4 5 6 7 8 9 10
spell year
Base
No Value

Duration model:

- Mobility occurs soon after the patent

  Tenure (-)
  Experience (-)
  Education (-)

  } Young academic inventors

  Productive inventors (- not sig)
  Network effect (+)

  More valuable the patent (+)
  Cumulative knowledge (+)

  } Transfer of Tacit knowledge

  Strong country effect; weak technology effect

Modelling labour mobility 2

- Competing risk duration model for inventor's occupational *choice.*

  J=

  - 0: do not move
  - 1: move to business
  - 2: move to PROs

$$h(W)_{ijt} = 1 - \exp\left\{-\exp\left(W_i^{'}\beta_j + \theta_j(t)\right)\right\}$$

		Pooled	Business	Pro
Technology Fixed Effects	Instruments (0/1)	0.104	-0.14	-0.089
		[0.17]	[0.16]	[0.09]
	Chem/Pharm (0/1)	0.688	0.048	0.757
		[1.17]	[0.06]	[0.84]
	Eng (0/1)	1.071	1.053	0.543
		[1.53]	[1.22]	[0.54]
Country Fixed Effects	Germany (0/1)	2.134	3.184	0.569
		[2.49]**	[1.61]	[0.58]
	Netherlands (0/1)	2.656	4.632	0.831
		[2.52]**	[1.94]*	[0.80]
	UK (0/1)	1.656	2.505	1.084
		[1.90]*	[1.23]	[1.47]
Inventor Background	Education (yrs)	-0.083	-0.2	-0.002
		[1.69]*	[1.44]	[0.04]
	PhD graduated (0/1)	-0.739	-1.233	0.399
		[1.43]	[1.36]	[0.39]
	Experience (yrs)	-0.228	-0.298	-0.167
		[2.75]***	[2.36]**	[1.50]
	Tenure (yrs)	-0.149	-0.212	-0.09
		[3.61]***	[2.38]**	[2.48]**
	Moved before (0/1)	-0.701	-0.477	-0.71
		[1.42]	[0.61]	[0.88]
	Publications (Stock)	0.006	0.023	-0.067
		[0.17]	[0.41]	[1.25]
	Citations (Stock)	-0.003	-0.006	0.002
		[0.99]	[1.32]	[0.67]

Retention Strategy	Compensation (0/1)	-0.017	-0.016	-0.176
		[0.03]	[0.01]	[0.24]
Potential Demand	City (0/1)	-0.239	0.006	-0.932
		[0.49]	[0.01]	[1.21]
Network	Size of Patent team	-0.057	-0.626	0.323
		[0.30]	[2.55]**	[1.35]
	Collaboration (0/1)	1.439	1.385	1.714
		[2.19]**	[0.99]	[2.50]**
Paten Value	Expected Patent value	0.263	0.305	0.191
		[2.77]***	[1.65]*	[1.46]
	Licensed (0/1)	0.826	1.332	0.408
		[1.66]*	[1.80]*	[0.36]
Knowledge Characteristics	Cumulativeness (0/1)	0.793	0.819	-0.025
		[1.66]*	[1.27]	[0.04]
	Patent breadth	-0.036	-0.535	0.053
		[0.15]	[1.72]*	[0.24]
	Incrementality	-0.126	-0.134	-0.058
		[1.00]	[1.10]	[0.28]
	Observations	1348	1348	1348
	LL	-103.69	-51.84	-59.96
	Chi2	145.73	203.76	206.1

Occupational choice

- Higher predictive power for the mobility to business;
- Mobility to companies
  Value of the patent (+)
  Cumulative knowledge (~+)
  Breadth knowledge (-)
  Size of the patent team (-)
  Country effect (+)
- Mobility to PROs
  Collaboration (+)
- Tenure and experience have a negative impact on both type of mobility, but less so for PROs

Conclusions

- Lower (smaller than expected) mobility compared to firms.
- Mobility to Business ≠ mobility to PROs
- Career effect versus tacit knowledge transfer (most of the patents are already owned by the firm).
- No technology effect, strong country effect (different incentive/regulation systems).