The Influence of Patent Rights on Academic Entrepreneurship

Andrew A. Toole
Economic Research Service, USDA

Coauthors:
Dirk Czarnitzki, KU Leuven & ZEW Mannheim
Thorsten Doherr, ZEW Mannheim
Katrin Hussinger, U Luxembourg
Paula Schliessler, ZEW Mannheim

Economics of Entrepreneurship Conference
National Academy of Sciences
June 29, 2015

Background

- Policy makers in the U.S. and abroad generally believe that university research findings and inventions contribute to innovation and economic growth.
- This has led to new legal structures intended to stimulate academic entrepreneurship (broadly defined).
  - U.S. Bayh-Dole Act of 1980 granted ownership rights to patentable inventions discovered using Federal funds (from the government) to universities, not individual inventors. This policy is considered a success by many.
  - For other countries, university ownership has evolved into "model" of how to spur university invention and technology transfer.
    - Germany, Denmark, Japan, China, and others implemented similar policies.

What's the issue?

- In the economics and policy literatures: Little systematic evidence supporting a university-ownership (UO) model over other alternatives.

- One prominent alternative is inventor-ownership.
  - Inventor-ownership: University researchers retain the patent rights to their discoveries and choose the commercialization path.

- Main Question:
  - How do the university-ownership and inventor-ownership models compare in terms stimulating academic entrepreneurship by university scientists?

Contributions of this research

- We have a fortuitous empirical context – a "natural" experiment based on a law change in Germany from inventor-ownership to university-ownership.
  - The German Federal law change was exogenous to individual scientists
  - The institutional structure of the German research system creates a natural “treatment” group and “control” group for evaluating the effect of patent rights

- Use scientist-level data and difference-in-difference methods to evaluate changes in academic entrepreneurship due to the shift to a UO model.

“Knowledge Creates Markets”

- In Feb 2002, the German Federal government launched “knowledge creates markets”
  - a new comprehensive program to promote technology commercialization from German universities
- It addressed a number of areas such as:
  - Ownership of university-based inventions
  - Creation of Patent Valorization Agencies (PVAs) to support invention evaluation, licensee search, and faculty startups
  - Similar subsidies to university TTOs

Aspects related to invention ownership

- Until early 2002, university researchers owned the rights to their inventions, called “professor privilege” (PP)
  - This only applied to university professors. Other academic researchers in public research organizations (like Max Planck) were not affected. These institutions already followed a Bayh-Dole type ownership model
- In 2002, the German Federal Government abolished professor privilege
- From 2002 onwards university researchers had to disclose their inventions to the university.
  - If the university decides not to claim the invention, the IP right is transferred back to the researcher.
  - The university pays all expenses related to patent process and will search for potential licensees.
  - If the invention is licensed by the university, the researcher (inventor) will receive a 30% royalty on gross revenues.

Existing Literature (theory)

- Hellmann (2007): A search model to examine the ex post rationale for patenting scientific inventions:
  - Results depend on the relative search efficiency of the TTO versus the researcher. If researcher is more efficient, UO is suboptimal and produces less commercialization (fewer matches).
- Kenney and Patton (2009): Provide a conceptual comparison of university invention ownership models:
  - Argue that UO model is plagued by ineffective incentives, information asymmetries, and contradictory motivations.
  - Conclude: PP model is more effective for promoting commercialization than the UO model.

Existing Literature (theory)

- Damsgaard & Thursby (2013): Used expected utility and revenue models to examine the mode and success of commercialization across IP ownership systems:
  - They emphasize that the UO model creates an agency problem as inventor effort is critical for commercialization
  - If established firms have some commercialization advantage, UO system less conducive for faculty startups than PP (TTO prefers established firms).
  - If TTO has a search advantage, UO has fewer faculty startups relative to PP (more licensing to established firms).

Existing Literature (empirical)

- Schmoch (2007): Empirical investigation of German law change:
  - The number and share of university-owned patent applications increased; private and firm-owned decreased
  - Change in mix: Active patenting faculty inventors discouraged, non-patenting inventors encouraged
- Von Proff et al (2012):
  - After the law change, the number of university-invented patents increases. First time-patenting professors contributed more to this total than those with prior patenting experience

Existing Literature (emprical)

- Lissoni et al. (2009), Lissoni (2013), and more…
  - Danish case: (1) patenting activity has moved from professors to universities; (2) bulk are inventions owned by business companies (both before and after)
  - Special issue: I&I on academic patenting in Europe
- Kenney and Patton (2011): Res. Policy Special Issue 2011
  - Compare the number and type of spin-offs across 6 universities, one with PP (Waterloo in Canada)
  - Observed that university with PP model generated more spin-offs

Existing Literature (emprical)

- Czarnitzki et al. (2015)
  - Used this “natural” experiment to examine how the change from PP to UO influenced the volume of patents (nothing about faculty startups or patent ownership).
  - Showed differential impact on patent volume across “high” and “low” cost faculty inventors
  - Due to the pre-policy mix, the shift to UO decreased the overall volume of patented inventions by university professors

Hypothesis 1: Direct Effect

- Direct effect of the shift from PP to UO on faculty startups is ambiguous.
  - The new German PVAs and subsidies to TTOs suggest lower costs to faculty for startups == increase startups
  - Kenney and Patton suggest fewer faculty startups for reasons of TTO inefficiency
  - Within Damsgaard & Thursby model, fewer faculty startups if TTO has search cost advantage and/or established firms have commercialization advantage (TTO wants established firm)

Hypothesis 2: Indirect Effect

- Indirect effect of the shift from PP to UO on faculty startups acts through patents.
  - From prior work, faculty patents are postively associated with faculty startups.
- But, Czarnitzki et al. show the shift to UO reduced faculty patents and Schmoch and others suggest changes in patent ownership due shift to UO.
  - Indirect effect depends on available patents.

Data Collection

- Study population: All academic inventors in Germany (university and public research organizations like Max Planck) who have at least one patent at the German or European Patent Office between 1978 and 2008.
- Treatment group: University researchers
  - Identification of professors by "Prof. Dr." title in inventor field of patents
- Control Group: Non-university public research institutions
  - E.g. Max-Planck Society, Helmholtz Society, Fraunhofer Society, Leibniz Society and other PROs
  - Identified all patents with PRO applicants
  - Obtained lists of inventors.
- Matched Thomson Reuters Web of Science publication data
- Variables obtained: yearly patent and publication count, career age as measured as time elapsed since first publication/patent, previous patenting experience, previous patenting with industry

Link to faculty startups

- Sample of (all) academic inventors linked to "Mannheim Foundation Panel"
- Data on all firm foundations in Germany since 1990.
- Includes complete records on founder names and other individual as well as corporate/institutional stakeholders
- Match panel of inventor names to names of firm founders by text-field search engine
- Note: not all inventors could be matched because of name homonyms.
  - Smaller sample than in Czarnitzki et al. 2015

Final sample

- Panel database of researchers over time
- Excludes people that switch between (or are employed at both) treatment and control group (1,800 researchers)
- Panel: 1996-2008
  - 3,265 professors (treatment group)
  - 6,558 PRO researchers (control group)

What is academic entrepreneurship?

- Grimaldi et al. (2011) define academic entrepreneurship as efforts to commercialize innovations developed by academic scientists.
  - Includes: startups, patenting, licensing, university-industry partnerships
- We observe two forms of academic entrepreneurship:
  - New firms with the academic scientist as a founder (not only through TTO)
  - Academic patenting = patents with the academic scientist as one of the inventors

Key Explanatory Variables

- ***New policy*** dummy variable splitting time into 1996-2001 (prior to policy change) and 2002-2008 (post policy change) period
- ***Professor*** dummy variable indicating treatment group versus control group
  - Interaction between ***Professor*** dummy and ***New policy*** shows the treatment effect of the policy change on the treated researchers (the professors)
- ***Patents by ownership type***: categorize patents as owned by firms, academic institutions, or personal
  - Interaction between ***Professor*** dummy and ***New policy*** and ***Patent type*** shows the treatment effect of the policy change on the treated researchers‘ patent ownership types

Descriptive statistics

	University researchers							
	prior to law change (N = 9,180)				after law change (N = 8,237)			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
New Firms	0.04	0.23	0	5	0.04	0.23	0	4
Patents	0.58	1.41	0	24	0.34	1.03	0	28
Firm Patents	0.45	1.34	0	24	0.23	0.96	0	28
Employer Patents	0.02	0.19	0	4	0.10	0.39	0	6
Personal Patents	0.14	0.51	0	10	0.04	0.24	0	5
3yr avg. publications	2.38	4.87	0	67.33	3.22	6.22	0	73.33
Career age	7.74	6.09	0	32	11.78	7.31	0	35
ln(DE-invented tech.)	7.38	0.58	5.53	8.72	7.73	0.50	6.02	8.96
	PRO researchers							
	prior to law change (N = 15,507)				after law change (N = 19,846)			
Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
New Firms	0.01	0.14	0	4	0.01	0.12	0	4
Patents	0.56	1.27	0	29	0.40	1.07	0	26
Firm Patents	0.21	0.98	0	29	0.16	0.90	0	26
Employer Patents	0.39	0.91	0	16	0.28	0.71	0	17
Personal Patents	0.02	0.21	0	9	0.01	0.09	0	4
3yr avg. publications	0.87	2.11	0	44	1.12	2.46	0	63.67
Career age	5.17	4.85	0	33	7.45	6.01	0	35
ln(DE-invented tech.)	7.40	0.60	5.53	8.72	7.74	0.53	6.02	8.96

Regression Methods

- Fixed effects count data models:
  - Firm Foundation = f(patents, law change, X)
  - Patents = f(law change, X, Z)

  - $E[FF_{it}|X] = \exp[\,\beta_1(Prof_i \cdot NewPolicy_t \cdot PAT_{ijt}) + \beta_2 PAT_{ijt} + \beta_3(Prof_i \cdot NewPolicy_t) + \delta_i + \gamma_t]$

  - $E[PAT_{ijt}|X] = \exp[\beta_1(Prof_i \cdot NewPolicy_t) + \beta_2 z_{it} + \delta_i + \gamma_t]$

Faculty Startups: Fixed Effects Poisson

	Coef.	SE	Coef.	SE	Coef.	SE
PROF*POL.CHG	0,015	0,175	0,022	0,176	-0,006	0,177
Patents:						
ALL	0,114***	0,03				
FIRM			0,055	0,039	0,054	0,039
EMPLOYER			0,090*	0,048	0,052	0,055
PERS			0,281***	0,085	0,285***	0,091
*EMPLOYER*POL CHG*PROF*					0,245**	0,105
*PERS*POL CHG*PROF*					0,069	0,201
Career age	0,261***	0,078	0,260***	0,078	0,256***	0,078
Career age^2	-0,218*	0,112	-0,222**	0,111	-0,216*	0,11
Publications	0,016	0,013	0,017	0,013	0,016	0,013
Observations	6035		6035		6035	

Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Patents by Ownership Type

- 6,498 individuals (1,947 profs; 4,551 PRO researcher)
- In total, these people are involved in 830 firm foundations between 1990 and 2008

Patents	Before 2002		After 2002	
Firm	0.46	78%	0.23	68%
Personal	0.14	12%	0.04	12%
Publ. Science Emp.	0.02	3%	0.10	29%
Total	0.59	100%	0.34	100%

Note: numbers do not add up to total because of co-applications

Patent Ownership: Fixed Effects Poisson

	all patents		firm patents		personal patents		employer patents	
	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error
PROF*POL.CHG	-0,208**	0,081	-0,685***	0,11	-0,291	0,201	1,586***	0,138
Career age	-0,127***	0,023	-0,023	0,034	-0,334***	0,066	-0,222***	0,026
Career age^2	0,137***	0,044	-0,243***	0,059	0,469***	0,099	0,648***	0,058
Publications	0,042***	0,009	0,028**	0,014	0,020*	0,012	0,070***	0,011
Tech. Opp.	0,370***	0,136	0,623***	0,183	0,648**	0,32	0,084	0,15
Observations	52777		24319		9607		39406	

Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Econometric remark

- Researcher may patent because he/she intends to start a business!
  - Eqs. can only be estimated separately if we assume that error terms are not correlated
  - How to test? IV approach. Need candidates for Z
  - At the moment: technological opportunities
  - Take all DE-invented patents per year per 35-Fraunhofer tech field category in t-2
  - Wooldridge test for Poisson models (like Rivers and Vuong 1988)
  - Result: Instrument is strong, but no endogeneity is found.

Conclusions

- The shift from PP to UO reduced academic entrepreneurship in Germany!
  - Faculty startups did not increase due to policy shift (direct effect is insignificant).
  - Patents associated with startups increased, but only slightly.
  - Patents associated with university-industry academic entrepreneurship decreased strongly.
- Results are consistent with Kenney and Patton perspective.

Thank you

Academic vs. All DE-invented patents