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Patents and Scientific Progress

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Outline

- Introduction: controversy over patents in science
- Science versus technology: the rationale for patents and the entrepreneurial university
- Background literature: a brief overview of “direct” and “indirect” effects of patents
- What is scientific progress? And why would patents shape the trajectory of scientific inquiry?
- Paper: patents and scientists’ choice of research projects
- Conclusions and future research

Introduction

- Much concern about patents in academe
  - BRCA gene, Oncomouse, etc
- The BRCA gene case
  - BRCA is a “caretaker” gene that produces a protein which repairs DNA. Identified at UC Berkeley 1990
  - Cloned and patented by other scientists in 1994, who formed a company called Myriad Genetics
  - Patent covers method to isolate & detect BRCA, not the gene itself
  - BRCA is an important tool for cancer researchers *and* has value as diagnostic screening mechanism
  - Patent invalidated in 2010, but appealed

Concerns About Patents

- Concerns about patents in academia
- They may have “direct” effects:
  - Crowd-out scientific publication
  - Lower the quality of publication
  - Promote *more* secrecy
- ... and “indirect” effects:
  - Slow down rate of innovation
  - Inhibit follow-on research by others
  - Discourage diversity of experimentation
  - Alter the direction of scientific progress
  - Affect scientists’ decision rights

Why is this Interesting?

- If concerns are true, aggregate productivity growth may be adversely affected
- Analysis helps us understand the relative costs & benefits of patenting in firms and academia
  - In academia: no under-investment problem, but patents aid formation of ‘markets for technology’
- Possible policy implications:
  - Should there be a research (experimental use) exemption from patent law?
  - How should we foster university-industry relations?
  - Are career choices affected by patents in science?

Science and Technology

- Historically, separation has been clear:
  - Scientists: produces basic research, share freely, no profit motive and no market per se
  - Technologists: creates new products/processes for companies often using "science"
- Simple taxonomy seems outdated:
  - Many biotech inventions are useful research tools ***and*** diagnostic tools with commercial application
  - Blurred boundary between science and technology
- Concerns about patents: due to blurred boundaries and different rationales for patents in science and industry

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Direct Productivity Effects

- Do patents crowd-out publication? Probably not:
  - *Azoulay et al. (2009)*: panel of 3,862 scientists with patents & publications. Model self-selection into patenting. No effect of patenting on publishing.
  - *Fabrizio and Di Minin (2008)*: inventor and non-inventor (control) groups from same institution and department. Compare samples (150 “pairs”). Find a +ve relationship between patents and publications
  - *Buenstorf (2009)*: Case study of 314 Max Planck scientists, 45% of whom have an invention. Patenting does not affect publication. But other commercialisation activities (e.g. spin off) do.

Patents and Quality

- Evidence here is more mixed:
  - Evidence that quality hasn’t been affected e.g. Azoulay et al. (2009) find a weak +ve relationship between patents and publication citations
  - BUT: some evidence that rate of citation decay has *increased* after publication. Murray and Stern (2007) construct patent-publication “pairs” which have distinct diffusion pathways (due to patent grant lag). Suggests evidence of an “anticommons”
  - AND: Fabrizio and Di Minin (2008) find no average change in citation intensity after 1st patent, but a reduction in intensity after subsequent patents

Other Effects

- *Secrecy*: there is some evidence that patents promote more secrecy than would otherwise be the case (see Blumenthal et al. 1997)
- *Publication delay*: some evidence that industry imposes conditions on timing of publication (see Czarnitzki, Grimpe and Toole 2010)
- *Diversity of experimentation*: Murray et al. (2009) examine an "openness shock" in the production of the Oncomouse – the "shock" was an NIH agreement to make the Oncomouse available to researchers (DuPont, had aggressively asserted their rights). The shock had a +ve effect on the creation of new research projects

Direction of Progress

- The effects of patents on the nature and direction of scientific progress is much harder to analyse. Why? There are a few reasons:
  - What do we mean by "direction"? Basic versus applied? Away or toward the patented areas?
  - Independent of patenting, there has been a trend towards Pasteur's Quadrant, where research is basic ***and*** has commercial application. This makes causality difficult to tease out.
  - Finally, what do we mean by "scientific progress" and how do we measure it?

What is Scientific Progress?

- "Progress" implies that the scientific knowledge base is improving over time. But:
  - It may take decades to confirm that knowledge is "correct". For example:
    - "In a tour de force of technology ... spanning half a century..., a team of experimenters ... reported ... that a set of orbiting gyroscopes had detected a slight ... twist in space-time. The finding confirms ... Albert Einstein's theory of gravity, general relativity." (NY Times, 4th May 2011)
  - And some new knowledge actually turns out to be wrong! (e.g. the geocentric universe, alchemy)
  - So, "progress" is complex and non-linear

What is Scientific Progress?

- How and why would patents shape scientific progress?
  - They might affect the choice of research project:
    - "Applied" research might be more attractive than "basic research" to academic entrepreneurs and private firms who fund research
    - Scientists might avoid research areas that are patent-intensive in order to have complete freedom in research
    - OR: scientists might be attracted to areas that are patent-intensive if it signals potential commercial value
    - AND: some scientists might patent as a defensive strategy aimed at preventing others from patenting
- These issues are difficult to disentangle

Theories of Progress

- Kuhn's *Structure of Scientific Revolutions* (1962)
  - Science undergoes periodic 'paradigm shifts'
  - Most research is 'normal science' (i.e. puzzle solving)
  - Anomalous results create the ground for revolution
- Feyerabend's *Against Method* (1975)
  - No single prescriptive method that scientists use since prescription only serves to inhibit scientists
  - Instead, progress follows an anarchic process: "anything goes"
- Also: Michael Polanyi, Imre Lakatos, Karl Popper

Some Recent Evidence

- "Do Patents Influence Academic Scientists' Choice of Research Projects?" (with Beth Webster)
- This paper focuses on the "indirect" effects (i.e. externalities) associated with patents in science
- Using survey data, we analyse whether patents affect *other scientists'* choice of research project:
  - Is it moderated by workplace culture?
  - Is it shaped by commercial orientation?
- NB: Australia has a common-law research exemption, but its scope is unclear

Are Patents a Problem?

Faculty	1=no effect	2	3	4	5	6	7= major effect	TOTAL (%)
Medicine	50.6	16.8	7.5	11.3	7.6	3.9	2.3	100
Science	57.5	13.3	6.2	8.9	7.2	4.1	2.9	100
Engineering	44.3	17.9	9.2	11.0	8.9	4.6	4.1	100
Architecture	77.7	5.3	4.3	7.5	3.2	1.1	1.1	100
ALL	**53.3**	**15.2**	**7.1**	**10.1**	**7.5**	**4.0**	**2.8**	**100**
					24.4			

Contribution

- Similar surveys of small samples of scientists in the U.S. (e.g. Cohen et al. 2005, 2007)
- Our survey has some unique features:
  - Large and comprehensive
  - Rich information on workplace culture and organizational mission
- However: we only observe the *degree to which patents influence choice* of research projects:
  - We do not observe the direction of any change
  - We do not observe "unlicensed use"
  - We do not observe defensive patenting

Survey

- In 2007 and 2009, we surveyed Australian scientists about their experience with patents
- Sample is large and systematic, covering science, medicine, agriculture & engineering
- Survey sent to 9,597 scientists from unis and public research institutes (Go8 unis, CSIRO,..)
- "Pooled" sample: 4,513 obs. (3,224 scientists)
- Response rate: ≈24%
- Info on: funding source, age, faculty, workplace culture and patenting activity

Workplace Culture

- Questions on the culture of the lab/department in which the scientist works:
  - "Scientists working in my field of research are secretive (=1) or open (=7)", (using a 7-point Likert scale)
  - "Publishing in a peer-reviewed journal (=1) is more important than patenting (=7)", (7-point Likert scale)
  - "We are (=1) (are not, =7) encouraged to present our findings at conferences", (7-point Likert scale)
  - "We are (=1) (are not, =7) encouraged to share information on our research with other scientists", (7-point Likert scale)

Organisational Mission

- Questions about the mission of the lab:
  - "We are under pressure (no pressure) from senior management to patent our significant inventions" (7-point Likert scale)
  - "We never (always) disclose our inventions before filing a patent application" (7-point Likert scale)
  - What % of funds come from private industry?
  - Do you work in a research-only environment?
  - How many patents do you have?
  - How many patent applications have you submitted in the last year?

Scientific Environments (1)

- We used this information to construct 3 clusters reflecting different scientific environments:
  - Open-&-Non-commercial: traditional teaching/ research environments (a la Merton)
  - Open-&-Commercial: hybrid organisations (a la Murray) that may patent but embrace openness ethos
  - Proprietorial-&-Commercial: new institutes who attempt to patent aggressively and don't share
- Clustering done on the individual scientist using Euclidean distance measures
- We explored several other ways to model this

Scientific Environments (2)

	Cluster 1 (n= 1,321)	Cluster 2 (n= 1,757)	Cluster 3 (n= 1,155)		
Type of employing unit	**Open-&-non-commercial %**	**Open-&-commercial %**	**Proprietorial-&-commercial %**	**Total %**	**Number**
University - department	34.5	43.2	22.4	100	3,247
University - institute or centre	33.3	41.7	25.0	100	156
Research institute	11.0	32.0	57.0	100	363
Hospital-based institute	23.6	37.3	39.2	100	467
Total	**31.2**	**41.5**	**27.3**	**100**	**4,233**

Patents & Research Choice

- Consider the following stylised example:
  - Scientist chooses a new research project/topic
  - Examines the literature to determine novelty
  - Applies for, and is awarded, a grant (fixed ex ante)
  - Becomes aware of another scientist's blocking patent which affects their project
- How do they proceed from here? They can:
  - Simply ignore the patent and proceed as is
  - Continue with project - negotiate with patent owner to obtain a license
  - Modify the project or work around the patent
  - Abandon the project

Patents & Research Choice (2)

- This decision depends on the following factors:
  - Beliefs about research exemptions
    - If the scientist holds this belief, they will simply "ignore patent". Evidence this is a dominant norm in science (Lemley 2008; Eisenberg 2011)
  - Expectation of detection if they infringe
    - If this is low, the scientist will also simply ignore the patent.
    - Remember that "detection" is costly.
  - Credibility of threat to sue if infringement is detected
    - This may depend on where the scientist works: many firms would be reluctant to sue a university
    - But scientists who commercialise might be fair game
    - And industry partners might need freedom to operate

Patents & Research Choice (3)

- Determinants of decision (cont.)
  - Experience with regard to requesting permission to use patented research tools
    - Scientists who have had previous requests denied might be less likely to attempt to negotiate a license
    - BUT: this also depends on the cost of replication. If this is low, no need to seek a license.
    - NB: we are ignoring MTAs here
  - Expectation of transaction costs associated with negotiating a license
    - If expectation is high, they might ignore the patent
    - However, they might receive a free license if they are not attempting to commercialise. Evidence suggests patent owners will offer a range of licenses (Williams 2010)

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Empirical Model (1)

- We constructed the following variables:
  - *Dep. Variable*: other researchers' patents have no (=1) / major (=7) effect on choice of research projects
  - *Legal Understand:* average of 3 statements regarding beliefs about research exemptions
  - *Experience:* # times permission sought to use another's patented technology (past year) minus # times permission was granted
  - *Transaction Costs:* mean of non-missing responses to 4 statements about difficulties getting data and patented research tools

Empirical Model (2)

$$ChRes_i = \beta_1 LegalUnderstand_i + \beta_2 Experience_i + \beta_3 TransactionCosts_i + \gamma_i X_i + \varepsilon_i$$

- *Transaction Costs* variable is endogenous:
  - Scientists can reduce transaction costs by avoiding patent-intensive areas. Thus, causality may run in reverse
- Thus, we use an IV model: we instrument *Transaction Costs* using the average survey response in the scientist's dept
- Should be correlated with individuals' response
- But individual's response shouldn't affect dept average (average # in dept = 15)

Empirical Model (3)

- In our preferred model, we pool responses across survey Waves and compare results across scientific environments
- We cluster standard errors to account for the fact that some scientists (n=1,100) responded to both Waves
- Note that a panel IV-RE model produced similar results. We don't present these results here.

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	IV nested regression		
Explanatory variables	**Open-&-non-commercial**	**Open-&-commercial**	**Proprietorial-&-commercial**
LegalUnderstand	0.153***	0.155***	0.239***
	(0.0424)	(0.0471)	(0.0756)
Experience	-0.565	-0.520	-0.0751
	(0.507)	(0.341)	(0.461)
TransactionCosts-IV	0.247***	0.331***	0.319**
	(0.0674)	(0.0857)	(0.135)
Ln(research team size)	0.0309	0.182***	0.270***
	(0.0541)	(0.0530)	(0.0805)
Age	-0.0610*	-0.138***	-0.141**
	(0.0349)	(0.0426)	(0.0630)
Constant	1.637***	1.764***	1.980**
	(0.566)	(0.529)	(0.791)
Observations		4,289	
Groups		3,224	
R-squared		0.673	

Robustness Check

- To check for endogeneity, we estimated the effects of lagged explanatory variables (Wave 1) on the dependent variable (Wave 2).
- 1,113 scientists responded to both survey waves
- Our pooled results indicate that:
  - *Lag-TransactionCosts*, *Lag-Legal Understand* and *Lag-Ln(research team size)* are +ve and significant
  - *Experience* is not significant and *Age* is significant at the 10 percent level
- This confirms our original findings

Conclusions

- There are similarities in the moderating factors across scientific environments:
  - Transaction costs and legal understanding matter
  - Previous experience doesn't seem to matter
- However, there are big differences in the size of effects across scientific environments:
  - Work culture matters (the constant is different)
  - There is an "age effect": older scientists are less inclined to change research project due to patents
  - Effect is largest in the Proprietorial & Commercial scientific environment

Caveats

- We don’t observe the following:
  - Quality of the other patent
  - Ownership of the other patent
  - Direction of the observed change (toward/away from patented subject matter)
- To the extent that “ignore patent” is strong, we may under-estimate the effects of patents
- Are the observed changes good for society? We don’t know – need more info on nature of progress
- However, our results do suggest that patents influence scientists’ choice of research project

Future Research

- The economics of scientific progress (the "science of science") is an interesting area for future research
  - What role do incentives play?
  - What are the determinants of academic entrepreneurship (as evidenced by patenting)? Does graduate training ("imprinting") shape this decision or are peer effects more important?
  - How are research ideas formed? Can industry contact stimulate basic research (Rosenberg 1998)? If so, causal relationships are quite complex

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