Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge:

An Empirical Test of the Anti-Commons Hypothesis

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Phenomenon

Harvard Oncomouse

Leder & Stewart, Harvard 1984 develop the “Oncomouse”

- First mouse with genes inserted to predispose mouse to cancer
- A significant advance along two dimensions:
  - Advancing *basic research* into the role of genes in cancer
  - An input into *applied research* focused on cancer therapies

Oncomouse is a “dual” discovery & serves as foundation for

- On-going scientific discovery AND
- Translation, innovation & economic growth

Harvard is granted US patent in 1988 & signs an *exclusive* license with DuPont

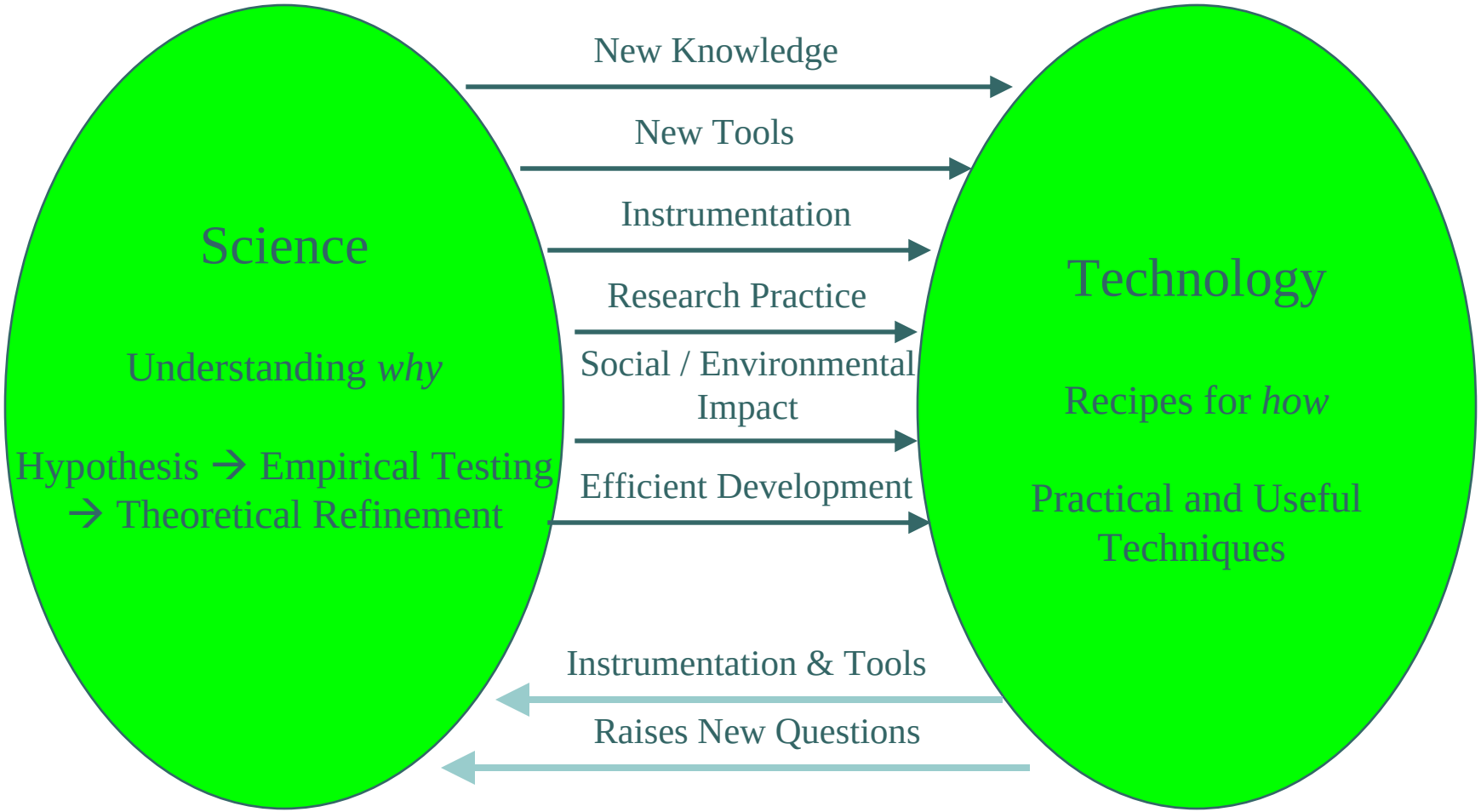
- Distribution through Jackson Laboratory
- Distribution comes with controversial licensing restrictions on use (e.g., reach-through rights and article review)

Agenda

- **Dual Knowledge**
  - A single discovery contributes to both scientific & commercial research
- **The Anti-Commons Hypothesis**
  - Expansion of IPR over scientific knowledge traditionally in public domain hinders progress & limits cumulative innovation
- **Patent-Paper Pairs**
  - Patent-paper pairs are a specific instantiation of the expansion of IPR over public knowledge – they arise when a “piece” of scientific knowledge is dual-purpose (in Pasteur’s Quadrant) and thus can be disclosed through patents AND publications.

When a discovery has both scientific and commercial potential, how do IP rights impact the rate and direction of scientific discovery & the ability of researchers to cumulatively build on one another's discoveries?

Science Versus Technology (Brooks, 1993)

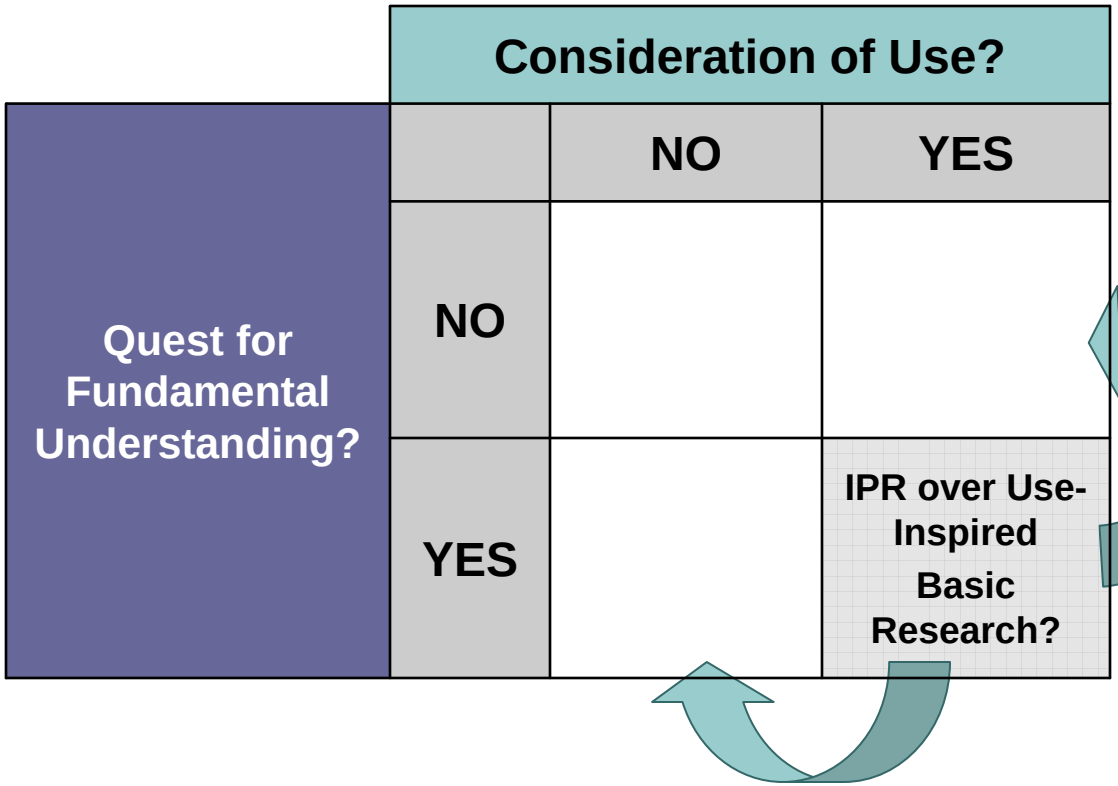


Dual Knowledge: Pasteur's Quadrant

		Consideration of Use?	
		NO	**YES**
Quest for Fundamental Understanding?	**NO**		**Pure Applied Research (Edison)**
	YES	**Pure Basic Research (Bohr)**	**Use-Inspired Basic Research (Pasteur)**

The traditional framework fails when knowledge has **both** basic and applied value. Indeed, there is some evidence that a large amount of research is located in *Pasteur's Quadrant*, with implications for discovery, development and commercialization.

The Anti-Commons Debate: What is the impact of IP over knowledge which has traditionally been maintained in the public domain?



IPR can stifle downstream commercial exploitation as the result of a patent thicket and associated hold-up and transaction costs (Heller and Eisenberg, 1997; Shapiro, 2002)

IPR stifles further scientific progress through transaction costs and hold-up (Heller and Eiseberg, 1997), rent-seeking (David, 2002), shifting research agendas (Thursby & Thursby 2003). Indeed, IP can limit the process of cumulative scientific discovery (Aghion et al)

The Anti-Commons Effect in Practice: Death and Taxes

- **Foreclosure**
  - Rights owner might limit the ability of rival research teams and/or entrant teams to compete in a particular scientific area
  - Duke Versus Madey Decision Restricts “Experimental Use” Exemption
- **Royalty Stacking**
  - Reach-through rights can result in multiple “taxes” on follow-on commercial research, particularly if there are multiple stages prior to commercialization (Aghion, et al 2005)
  - OncoMouse license required even academic users to commit to royalties for any commercial applications that resulted from the research
- **Patent Thickets**
  - When rights are dispersed, research teams (particularly entrant teams) face significant transaction costs in pursuing follow-on research
  - Multiple patents over identical gene sequences with unclear overlap in claims and degree of rights enforcement

Whether or not IP raises the price of research or distorts research choice, the anti-commons effect suggests that IP will slow the “diffusion” of scientific knowledge in Pasteur’s Quadrant

→ Can we evaluate the empirical salience of the impact of formal IP on the diffusion of scientific knowledge?

The Experiment

Exploit characteristics of patent-paper pairs

- **Collect a sample of research articles that are *at risk* for patenting**
  - All Research Articles From A Single Journal with a “dual” focus
- **Patent-paper pairs vs. non pairs**
  - Since not all articles are associated with pairs, we are able to contrast a treament (“patented”) and control (“non-patented”) group
- **Patent Grant Delay**
  - Scientific publication is rapid (~ 3-6 months), patent grant delay is substantial (>2 yrs)
  - Prior to March, 2001, applications are secret until granted
  - Rights are uncertain until approval
  - No legal mechanism to enforce rights pre-grant & no damages for use (particularly in research) during pre-grant period
- **Identification**
  - Measure the citation rate by follow-on articles to each sample article
  - Assumption: For some follow-on researchers, patent grant is “news”
    - Also can rely exclusively on variation in patent grant delay itself

Experiment

The impact of IP on the diffusion path of scientific knowledge

Using the annual rate of forward citation to a publication as a measure of its diffusion and impact, and estimated using a negative binomial citation function (conditional fixed effects)

- Cross-Sectional Approach: How do the citation rates to different types of knowledge differ?

$$CITES_{i,t} = f(\varepsilon_{i,t}; \beta_t + \delta_{t-pubyear} + X_i'\beta + \lambda\, PATENTED_i)$$

- Differences-in-Differences : How does the grant of IP shift the diffusion pattern?

$$CITES_{i,t} = f(\varepsilon_{i,t}; \gamma_i + \beta_t + \delta_{t-pubyear} + \psi POST-GRANT_{i,t})$$

In other words, how does the citation rate to a scientific paper change after a patent (associated w/ paper) is granted - accounting for fixed differences across articles & relative to the trend in citation rates for articles w/ similar characteristics?

When (and for whom) should patent grant matter?

Data

- Raw sample population is composed of *all* research articles published in *Nature Biotechnology 1997-1999*
  - Founded in 1986 & “renamed” Nature Biotech in 1996
  - Leading outlet for “dual type” life sciences research
  - Editorial mission to contribute knowledge of interest to academia and industry, basic and applied problems
- Of 340 initial papers, 169 are associated with a specific patent, involving matching on name/institution and a content evaluation
  - Most research published in *Nature Biotechnology* has a degree of *patentability* (external validation with patent attorney)
- For each article and paired patent, we then collected detailed patent and paper characteristics

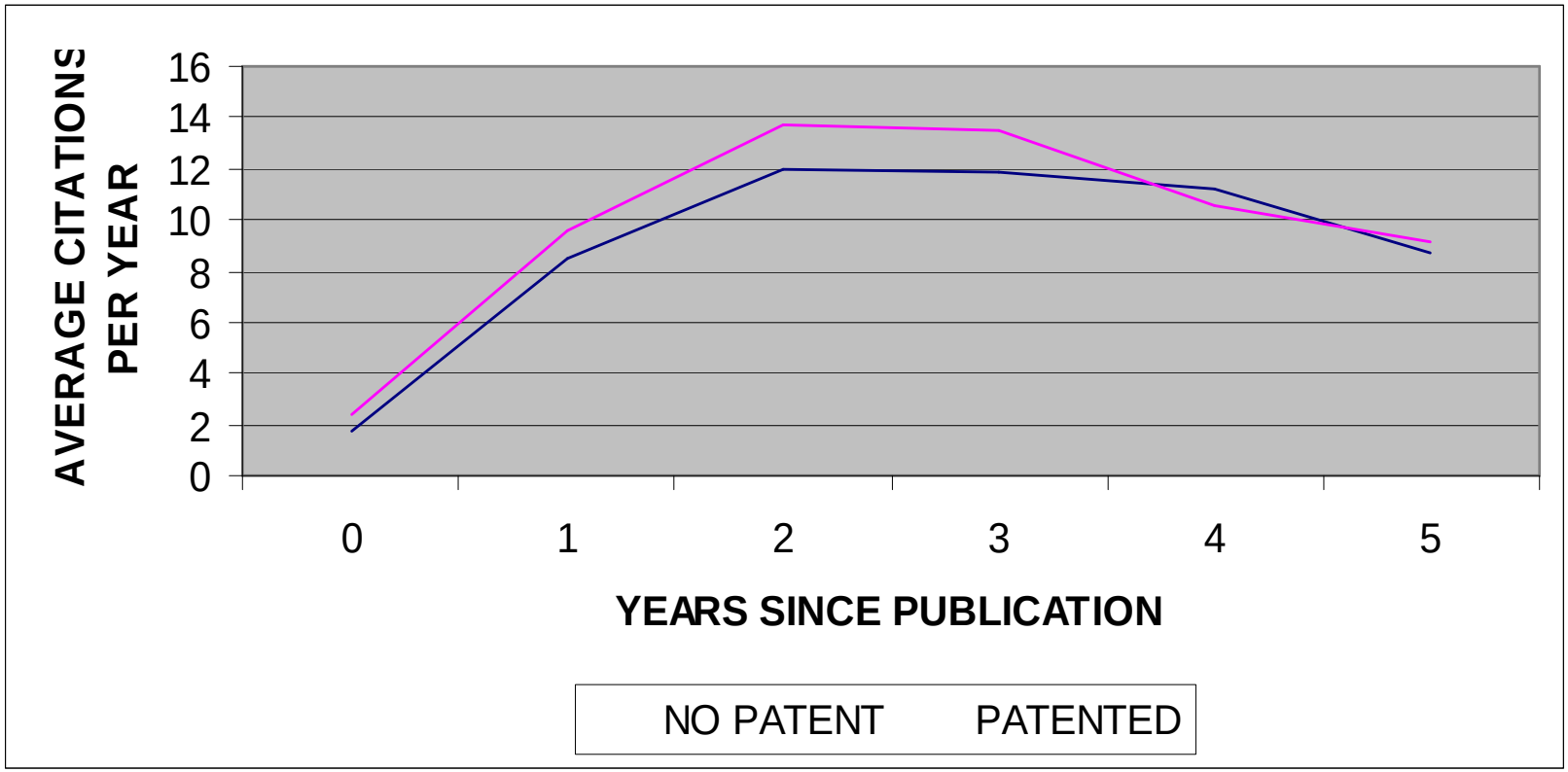
Key Variables & Definitions

VARIABLE	DEFINITION	MEAN	SD
Forward Citations$_{jt}$	# of Forward Citation for Article j in year t	9.34	12.29
Publication Year$_{j}$	Year in which j was published	1998	0.83
Age$_{jt}$	Year – Publication Year.	2.05	1.52
Patented$_{j}$	Dummy if Article is associated w/ a Patent	0.50	0.50
Grant Year$_{j}$	Year in which patent was granted	2000	1.52
Patent, Post-Grant$_{jt}$	Dummy if Patented = 1 & Year > Grant Year	0.24	0.43
# Authors$_{j}$	Count of the Number of Authors.	5.89	3.20
Public Author$_{j}$	Dummy = 1 if *at least* one institutional affiliation is university or government.	0.90	0.30
Private Author$_{j}$	Dummy = 1 if *at least* one affiliation is pharmaceutical or biotech firm	0.32	0.47
US Author$_{j}$	Dummy if *at least* one affiliation is U.S.	0.59	0.49

Patented Articles have a modestly higher citation rate, tend to be US based, & are more likely to include a private sector author

	NO PATENT	PATENTED
# Publications	171	169
FORWARD CITATIONS	8.86	10.16
# AUTHORS	5.76	6.03
US AUTHOR	0.53	0.65
PUBLIC SECTOR AUTHOR	0.93	0.86
PRIVATE SECTOR AUTHOR	0.25	0.38

Patented publications have an higher rate of initial citation (peaking two years after publication) but *converge* to the non-patented level in years 4 and 5

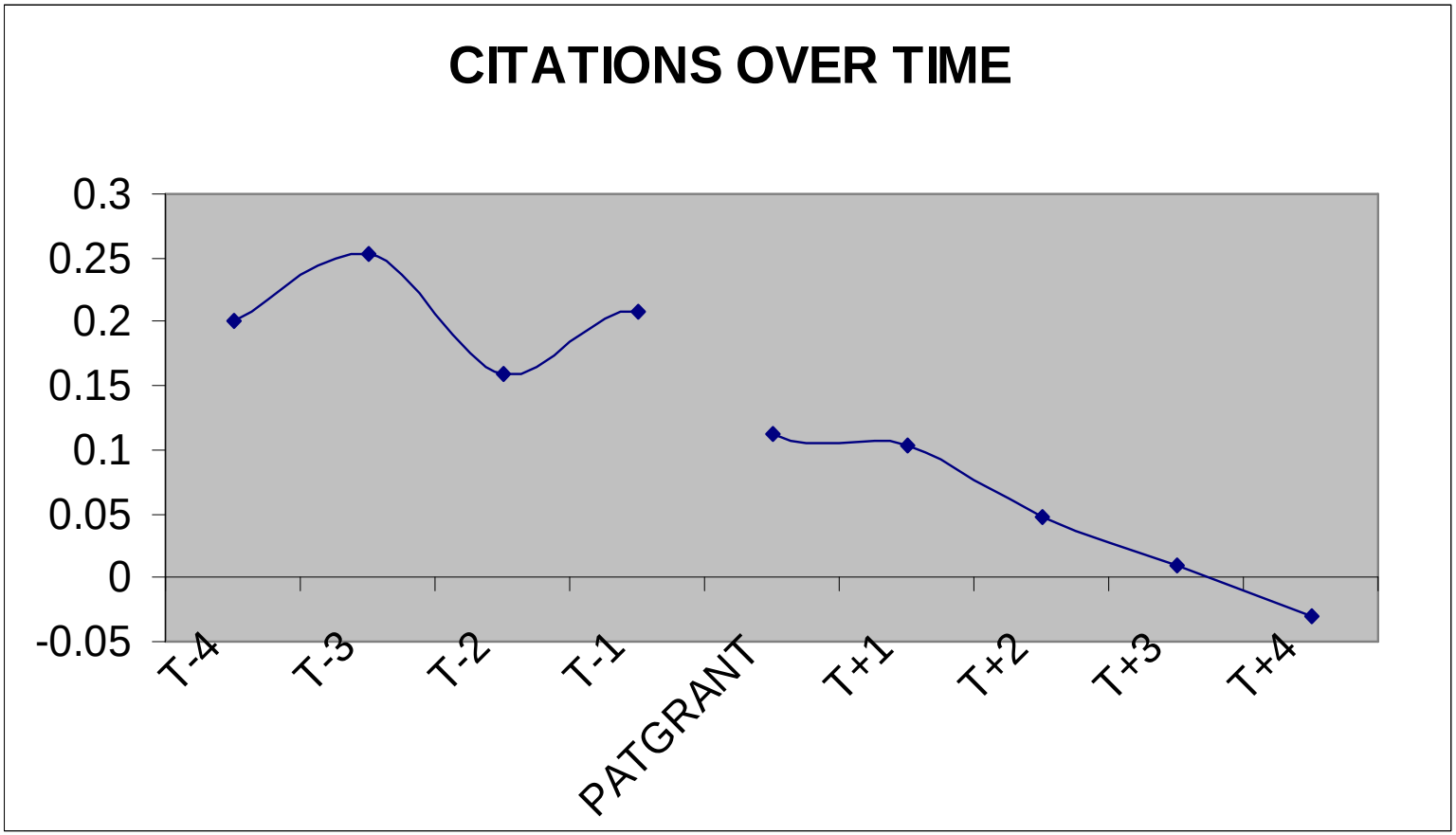


The Impact of Patent Grant:
Controlling for article fixed effects, age effects, and cohort effects, the citation rate declines by 10% -20% after a patent is granted

Negative Binomial Specifications	Dep Var = FORWARD CITATIONS (Coeffs reported as incident rate ratios)	
PATENTED	**1.195 (0.068)**	
PATENTED, POST-GRANT	**0.817 (0.099)**	**0.893 (0.056)**
AUTHOR AND INSTITUTION CONTROLS	*Y*	
Article FE		Y
Age FE	Y	Y
Citation-Year FE	Y	Y
Log-likelihood	-5270.42	-4021.44

Timing

While there is no significant downward trend prior to patent grant, the decline in citations increases significantly with the time elapsed from the grant date



When Does Patent Grant Matter?

- Articles Published by Public Sector Authors
- Articles Associated with Longer Patent Lags
- Composition of Matter Patents
- *We are also able to identify the effect from differences in the patent grant lag – in other words, conditioning the sample only on public sector authored articles that ultimately receive formal IPR*
- *But, the current paper does not specify the "mechanism"...which we are tackling in follow-on work...*

Results Summary

Interpretation

- Implies that about 1 in 9 cumulative research papers projects stopped (or never started) due to IP
- Decline in forward citations suggests NOT that there is less research overall, but that scientists choose alternative (next best?) projects
- Also impact of potential IP on initial entry undetermined (by this test)…

BUT who is impacted and through what mechanisms?

Conclusions

- A Negative Finding: Patenting does not seem, as of yet, to have somehow fatally undermined the academic system
  - Evidence for an anti-commons effect - patent grant has a *significant* effect on forward citations - 10%-20% decline - ***first citation-based evidence that patents are linked with a tax on the rate of scientific progress***
  - Modest relative to claims that IP has a “devastating” impact
- Within Pasteur’s Quadrant, the increased use of formal IPR seem to be significantly shaping the structure, conduct and performance of both university and industry researchers
  - Reductions in the overall use of knowledge by follow-on scientists
  - Patenting impacts the citation of public sector authored research by other public sector authors
  - More co-authorships, fewer independent citations, lower quality?
- Not simply a legal document within a seamless web of cooperation, nor a bludgeon to stop scientific progress in its tracks, patents seem to be changing the “rules of the game” for scientific exchange, cooperation, and credit

Policy Thoughts

- Rather than facing a fundamental tradeoff between basic versus applied research, much “scientific” research has dual application
  - A single research investment has applications over both future public and private sector research activities
- The classical justification for public funding of research investments is premised on about the social value of research. In contrast, the dual purpose knowledge framework suggests a separate rationale for public funding; that the social impact of a given piece of knowledge will be enhanced when it is funded by public investment and disclosed in accordance with public norms and governance expectations.
- Ultimately, the ability to design and implement policies research in Pasteur’s Quadrant depends on having an effective system for measuring (a) the amount and type of research being conducted in this sphere, and (b) the scientific and technological outputs of that research.
  - The life sciences acccounts for a higher share of research, and more of that research is counted as *applied.* To the extent that this research is in Pasteur’s Quadrant, should we infer that the Federal commitment to basic fundamental research has somehow been compromised?