



Analysis of Patenting by DOD SBIR Firms

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Overview



- Innovation/knowledge production link to economic growth
- Assignment of private patent rights on publicly funded R&D
- Analysis of DOD SBIR patenting

Economic Theory: Future Growth through Innovation Requires Policy Intervention



Cumulative Knowledge Creation Leads to Economic Growth

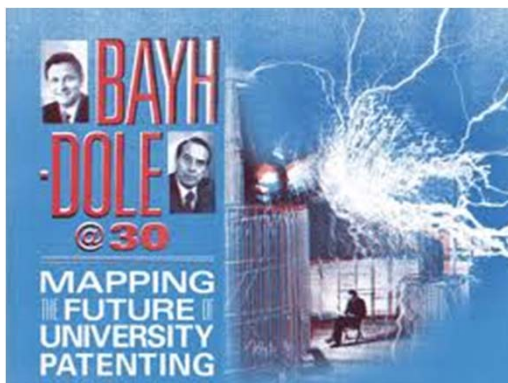
- Endogenous growth theory Romer (1990)
 - Investment in knowledge creation, human capital and innovation lead to growth
 - Spillover effects of a knowledge centered economy lead to economic development
 - Sustained growth required policy interventions: R&D subsidies, education and increased incentive to innovate.

Market Failures in innovation

- Nelson (1959) and Arrow (1962)
 - New innovations can be rapidly copied once disclosed
 - This causes underinvestment in innovation
 - Could result in lower future growth
 - Therefore governments should correct market failure with: protection, patronage or prizes

Innovation Policy Mechanisms

- Prizes
- Protection
- Patronage

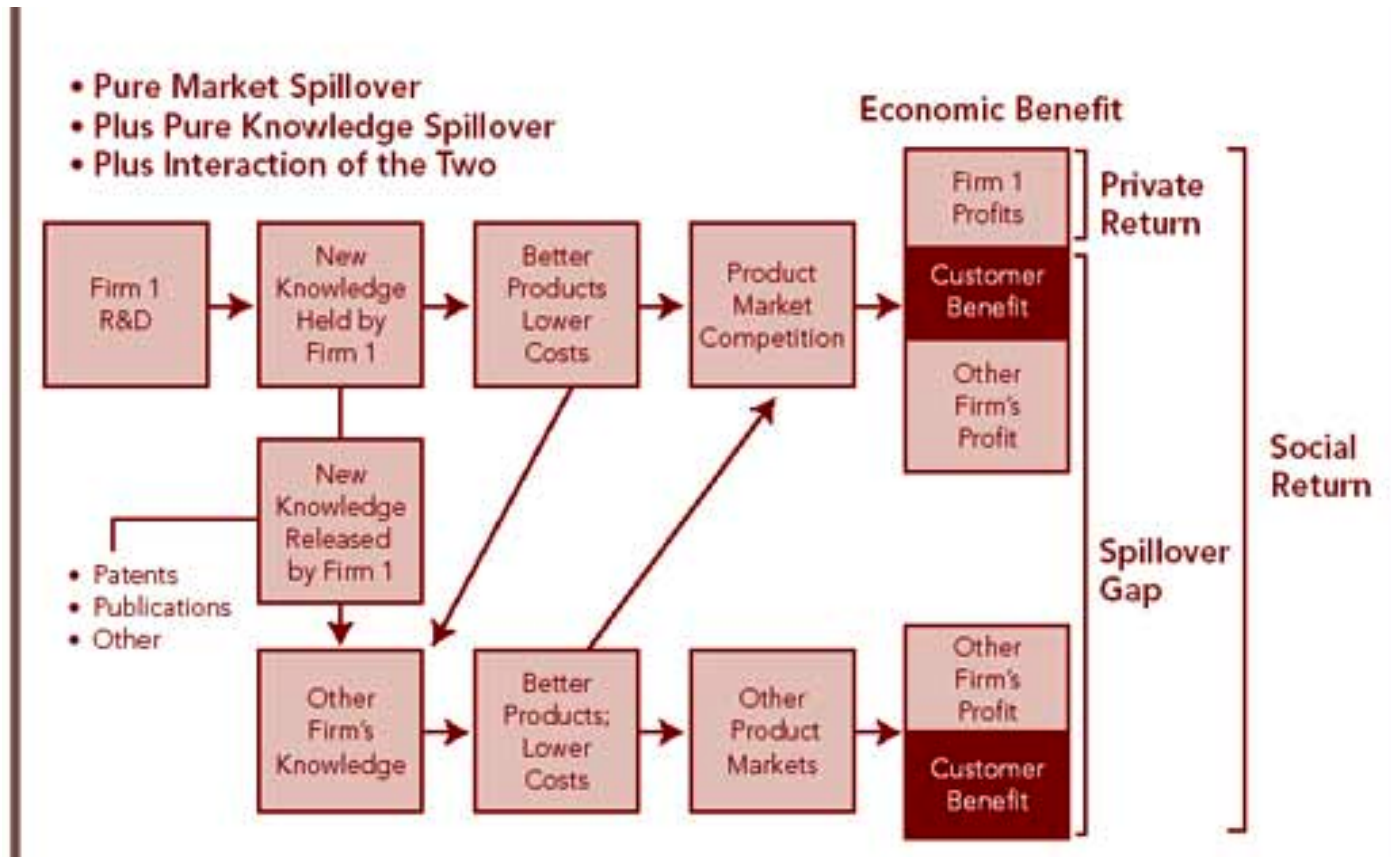


How to Measure?



- Innovative output
 - Papers, invention declarations, patents
- Economic output
 - Sales growth
 - GNP growth
- Spillovers

Knowledge Production Function



Source: Griliches, Z. "Patent Statistics as Economic Indicators: A Survey," *Journal of Economic Literature*, 1990 pp.1661-1707

Granting Private Patent Rights to Publicly Funded Research is Controversial and Largely Un-examined



Multiple Rewards Problem

Protection or Patronage or Prizes

Versus

Protection and Patronage and Prizes

Paucity of Analysis

“Yet, for every public intervention that spurs entrepreneurial activity, there are many failed efforts that waste untold billions in taxpayer dollars.” Lerner 2008

An advantage of the accountability safeguards embedded in Bayh-Dole is that they should produce a wealth of data. But these data are currently shrouded in secrecy, so their robustness cannot be assessed, and policy lessons cannot be drawn from them.. (Rai, Sampat 2012)

Milestones in Patent Rights Assignment for Federally Funded Research



Year	Legislation	Description
1945	National Patent Planning Commission	Allow agencies to set unique patenting policies
1947	US DOJ Investigation of Government Policies and Practices	Urged adoption of uniform policy granting government title to most inventions
1950	Executive order 10096	Established central Government Patent Board to assign patent ownership
1961	Executive order 10963	Allowed agencies to set separate patent policies and occasionally grant non exclusive licenses
1980	Bayh-Dole Act	Gave non-profits and small businesses the right to patent innovations
1980	Stevenson Wilder Act	Made technology transfer a key mission of federally funded laboratories
1982	SBIR Act	Allowed firms to retain intellectual property rights to SBIR funded innovation

Federal Acquisition Regulations and Intellectual Property



- FAR 52.227-12-c-1 Patent Rights—Retention by the Contractor The Contractor shall disclose each subject invention to the Contracting Officer within 2 months after the inventor discloses it in writing to Contractor personnel responsible for patent matters or within 6 months after the Contractor becomes aware that a subject invention has been made, whichever is earlier.

Working with Patents

Messy:

Boeing, Beoing, The Boeing Corporation....

Controversial:

An intermediate innovation output

Validated:

An accepted measure of innovation by OECD, NSF, ATP

What I created: a Data set of ~30,000 defense interest patents from 1983-2002

- (54) **BODY ARMOR**
- (75) Inventor: **David P. Colvin**, Cary, NC (US)
- (73) Assignee: **Pyramid Technologies International, Inc.**, Cary, NC (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
- (21) Appl. No.: **09/558,496**
- (22) Filed: **Apr. 26, 2000**
- (51) Int. Cl.⁷ **F41H 5/04**
- (52) U.S. Cl. **89/36.02; 89/36.05; 2/2.5**
- (58) Field of Search **89/36.05, 36.02; 2/2.5**

- (56) **References Cited**
- U.S. PATENT DOCUMENTS
- | | | | | |
|-------------|---|---------|--------------|----------|
| 4,905,320 A | * | 3/1990 | Squyers, Jr. | 2/2.5 |
| 4,965,138 A | * | 10/1990 | Gonzalez | 89/36.08 |
| 5,317,950 A | * | 6/1994 | Binon et al. | 89/36.02 |
| 5,349,893 A | * | 9/1994 | Dunn | 89/36.05 |
| 5,435,226 A | * | 7/1995 | McQuilkin | 89/36.02 |
| 5,654,518 A | * | 8/1997 | Dobbs | 89/36.02 |
| 5,918,309 A | * | 7/1999 | Bachner, Jr. | 2/2.5 |

FOREIGN PATENT DOCUMENTS

DE 4125918 * 2/1992 89/36.02

* cited by examiner

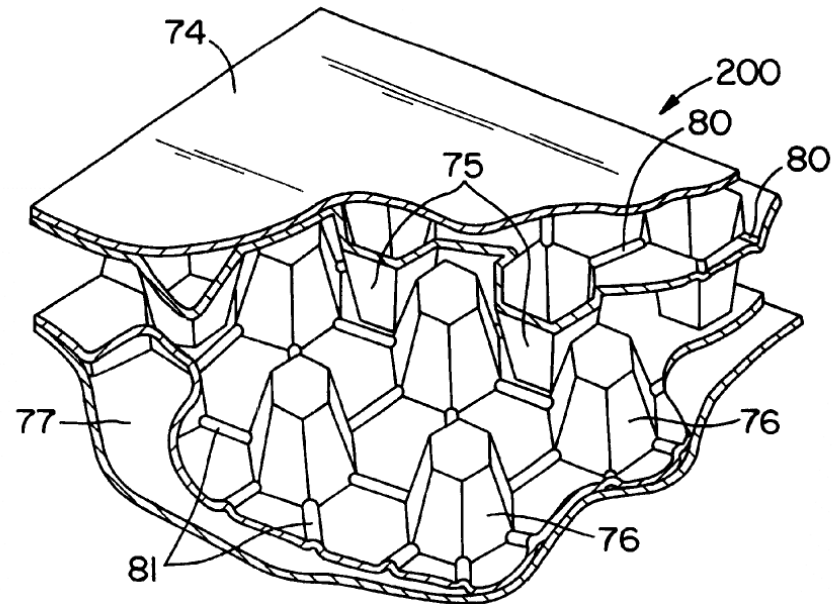
Primary Examiner—Stephen M. Johnson

(74) Attorney, Agent, or Firm—Robert G. Rosenthal

(57) **ABSTRACT**

A body armor system having improved impact energy absorbing characteristics includes a projectile penetrant inhibiting layer and an impact energy absorbing layer positioned in overlying relation to one side of the projectile penetrant inhibiting layer such that the impact energy absorbing layer is adapted to absorb the impact energy from an incoming projectile. The impact energy absorbing layer spreads at least a portion of the impact energy in the plane of the impact energy absorbing layer. An anti-spalling layer is positioned on the opposite side of the projectile impact inhibiting layer. In another aspect of the invention, the impact energy absorbing layer contains a foam to further enhance impact energy absorption. Additionally, a temperature stabilizing means such as a phase change material is placed within the impact energy absorbing layer and provides thermal regulation. The phase change material may be bulk, microencapsulated or macroencapsulated and may be placed directly within the impact energy absorbing layer or within the foam as desired.

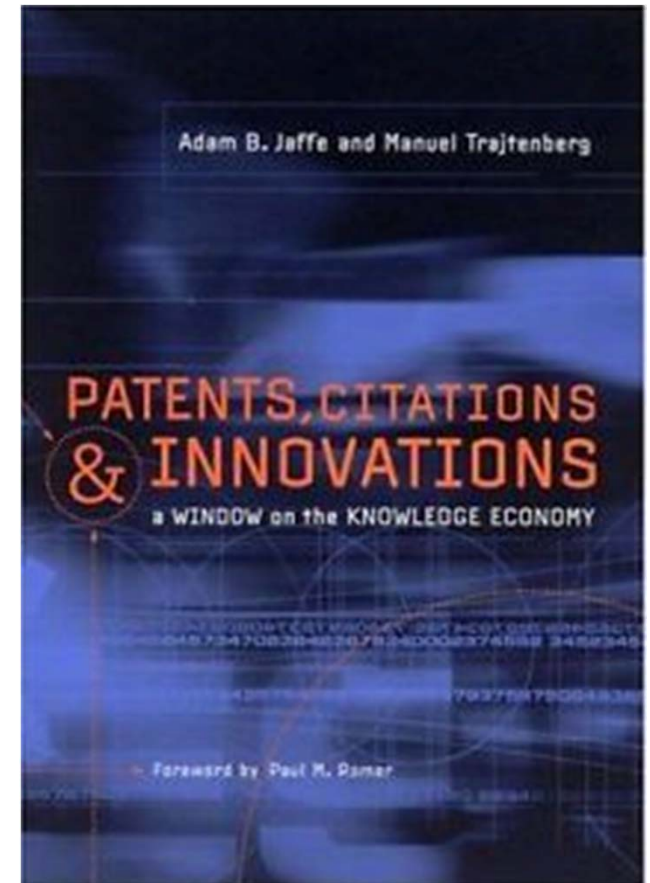
19 Claims, 4 Drawing Sheets



Prior Patent Methods



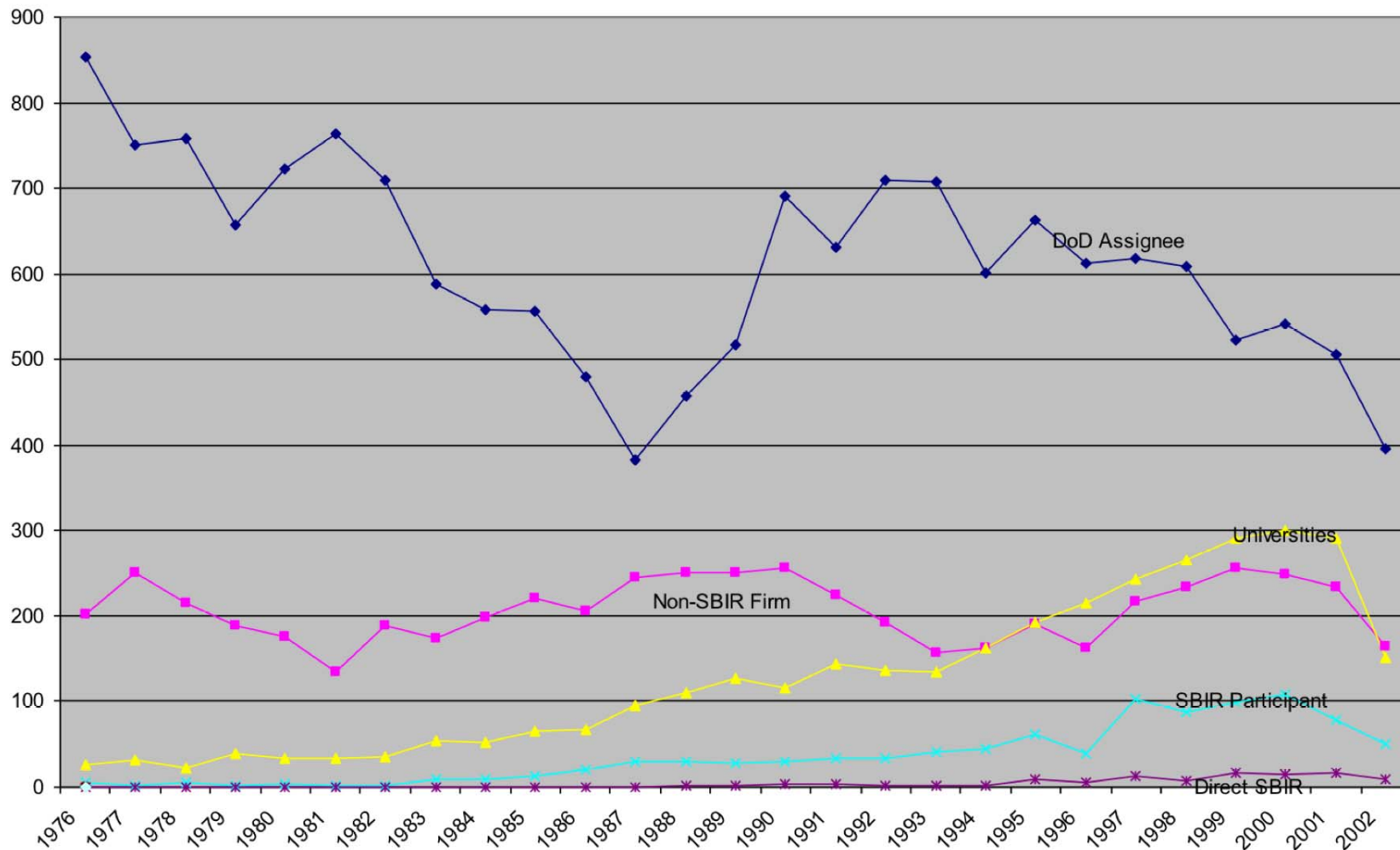
- The National Bureau of Economic Research Patent Methods:
 - Manually clean firm names
 - Use primary assignee
 - Date of application vs award date
 - Use discrete count methods: poisson, negative binomial, take care with zero observations
 - Control with industry type, technology category, organization type
 - Use one year lag of R&D budget



The Dataset: Cumulative DOD Patenting



Patents by application year by organization type

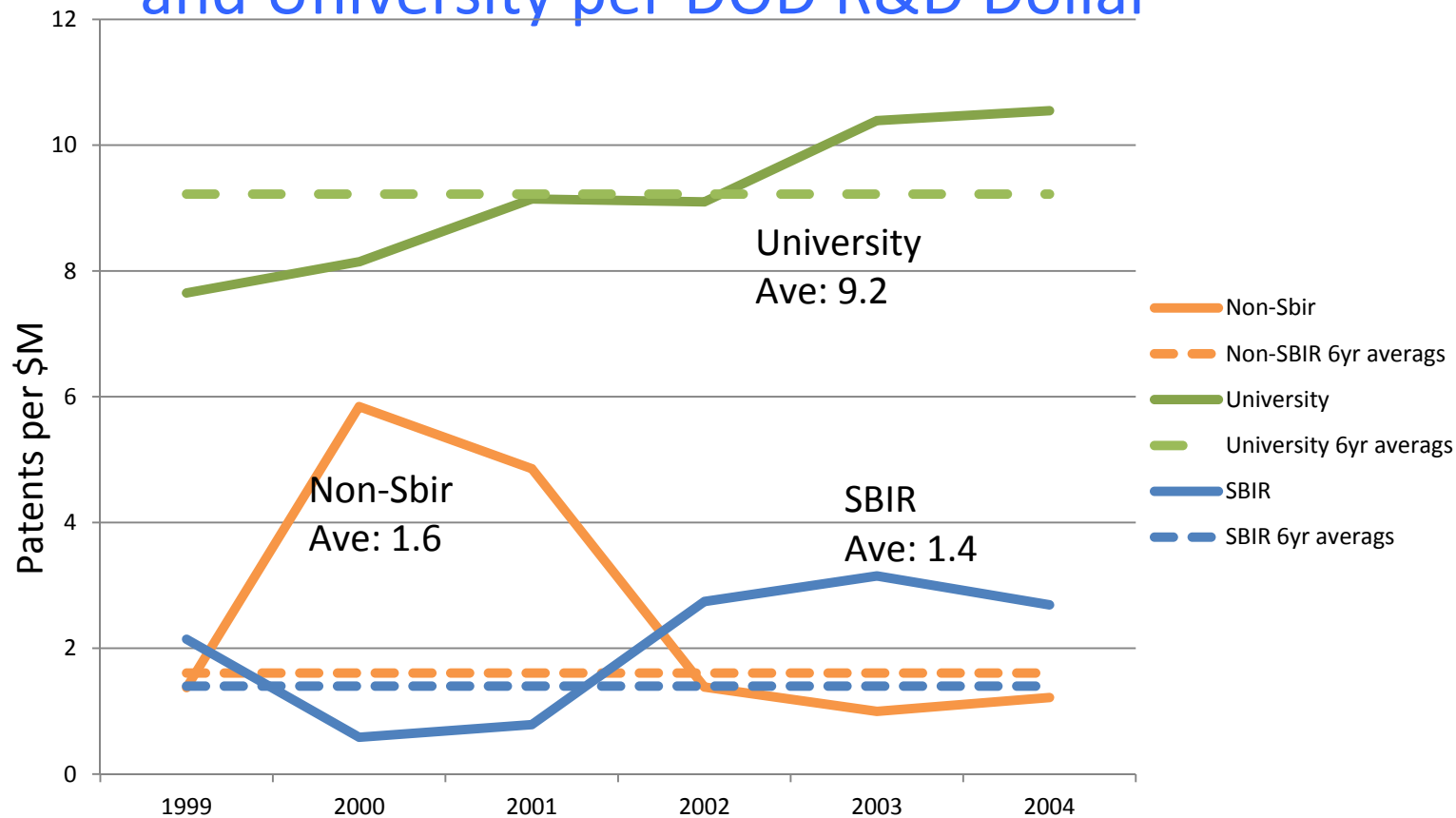


SBIR Patent Hypothesis Tests



- Hypothesis 1:
 - SBIR participants have a higher patent output per R&D dollar than other research performers.
- Hypothesis 2:
 - SBIR participants receive more citations per patent than other research performers
- Hypothesis 3:
 - SBIR participants produce more high citation patents per patent, or per R&D dollar than other research performers

Hypothesis Test 1 Results: SBIR Participants Produce fewer patents than non-SBIR business and University per DOD R&D Dollar



SBIR Participants Produced fewer Patents per R&D Dollar over the period of 1999-2004

-Patents count by year of application, per Hall, et al

Hypothesis Test 2 Results: SBIR Participants' Receive more do not receive more citations than other DOD Patents



Method: Negative Binomial regression comparing citation frequency per patent by DOD R&D Organization type controlling for R&D \$, technology type and year.

Data: DOD patents 1983-1999 in year 2003.

Results: Patents generated by SBIR firms do not receive significantly more citations that other patents generated by DOD funding. But all 'privately' assigned patents receive more citations that patents with rights retained by the DOD.

	Std.		
	Mean	Dev	Obs.
DOD Assignee Patents	5.3	6.7	11755
Non-SBIR Firm	8.5	8.9	3692
SBIR Firm Assignee Patents	9.8	10.5	555
University Assignee Patents	11.0	10.6	1772

Hypothesis test 3: SBIR Participant patents have a higher probability of receiving greater than 20 citations per patent



1983-1999 Patents 27,681
 Mean Citations 6.5
 Standard Deviation 5

Method: Ordinary least squared regression on Probability of receiving a patent with 20 or more citations 15-20 years from patent award

Data: DOD patents 1983-1999 in year 2003.

Results: Patents generated by SBIR firms have a slightly better (8.12% vs 8.09% for University) chance of receiving a high citation patent. Though statistically significant, this difference is of not practical significance.

Total Citations	Frequency	%	Cum. %
0	9,556	32.08	32.08
2	3,104	10.42	42.5
3	2,566	8.61	51.11
4	2,050	6.88	57.99
5	1,720	5.77	63.76
6	1,461	4.9	68.67
7	1,200	4.03	72.7
8	1,025	3.44	76.14
9	886	2.97	79.11
10	709	2.38	81.49
11	631	2.12	83.61
12	512	1.72	85.33
13	460	1.54	86.87
14	394	1.32	88.19
15	350	1.17	89.37
16	313	1.05	90.42
17	274	0.92	91.34
18	238	0.8	92.14
19	232	0.78	92.92

Summary of Results and Discussion



- SBIR funding generates fewer patents per R&D \$ than DOD funding to Universities, but about the same as other businesses
 - Non-profit vs for profit patenting strategies
 - Nature of University DOD R&D work
- SBIR patents do not receive more citations than Universities or other businesses, but do receive more citations than DOD assignee patents
 - When an invention is patented, privately owned patents seem to have greater spill-overs
- SBIR patents do not generate a significant increase in high citation patents vs Universities
 - High impact innovations hard to predict, but all private organizations seem to be on the same level.

Discussion



- Patronage and Patents and Prizes
 - Vs OR
- Willingness to analyze and research the private and social benefits
- “Sow a thousand seeds”
- Follow-one research: Effects on Competition and willingness to work with DOD

Conclusion



- Intellectual property a key part of innovation policy and competition
- The aggregate effects of changes in intellectual property rights have been little studied
- SBIR generated patent rate, citation rate, and high frequency citation rate not significantly different from other businesses.
- More analysis is needed.