University-Industry Research Partnerships in the U.S.

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Outline for the presentation

1. Introduction
2. Univ.-ind. research partnering in the U.S.
3. Why? – motivation of the two partners
4. Hall, Link, and Scott study of ATP partnerships with university members
5. Research questions and findings
6. Conclusion and open questions

Selected references

- Papers available on my website:
  - "University-Industry Research Partnerships and Intellectual Property," presented at the NSF-CISTP Workshop, Washington, DC, October2001.
  - "Universities as Research Partners," with Albert N. Link and John T. Scott, NBER Working Paper No. 7643 (March 2000), forthcoming *Review of Economics and Statistics*
  - "Barriers Inhibiting Industry from Partnering with Universities: Evidence from the Advanced Technology Program," with Albert N. Link and John T. Scott, *Journal of Technology Transfer* 26: 87-98 (2000).
- Work by others in the *Journal of Technology Transfer* (2000, 2001):
  - R. Nelson, M. Thursby, J. Thursby, A. Link, J. Scott, M. Feldman, I. Feller, L. Zucker, M. Darby, J. Adams, W. Powell, S. Maital, P. Stephan, R. Morgan, N. Rosenberg, D. Blumenthal, etc.

University-industry research partnering in the United States

- Long history – more than 100 years old, both in agriculture and manufacturing
  - See Mowery and Rosenberg, *Technology and the Pursuit of Economic Growth*.
- Increase in past 10-20 years restores strong links from the first half of the twentieth century
- Current partnerships have a wide variety of organizational forms
- Still a relatively small fraction of university research funding in the U.S. (~6 to 7 percent)

Variety of partnership types

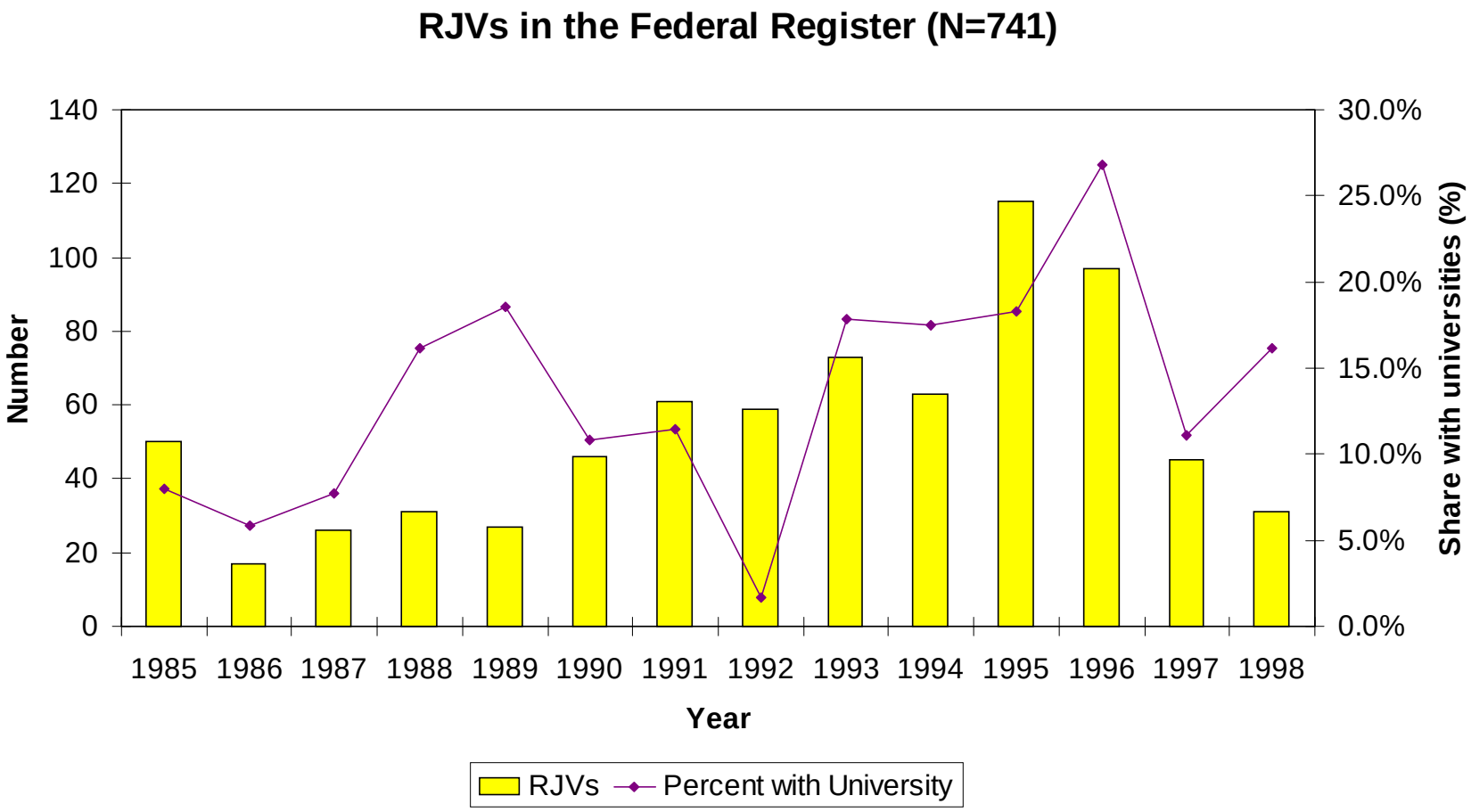
- Industry support of particular university researchers via grants and consulting
- Large laboratories funded by industry consortia involving 10s to 100s of firms, such as the Stanford Center for Integrated Systems
- Quasi-permanent FFRDCs and UIRCs, partially funded by federal government
- Onetime projects that involve a university as a partner
  - Ordinary research joint venture (RJV) with specific goal
  - Government cost-shared RJV, such as those funded by ATP

$\Rightarrow$ comprehensive survey data that includes all types of funding does not exist – studies usually based on one particular type

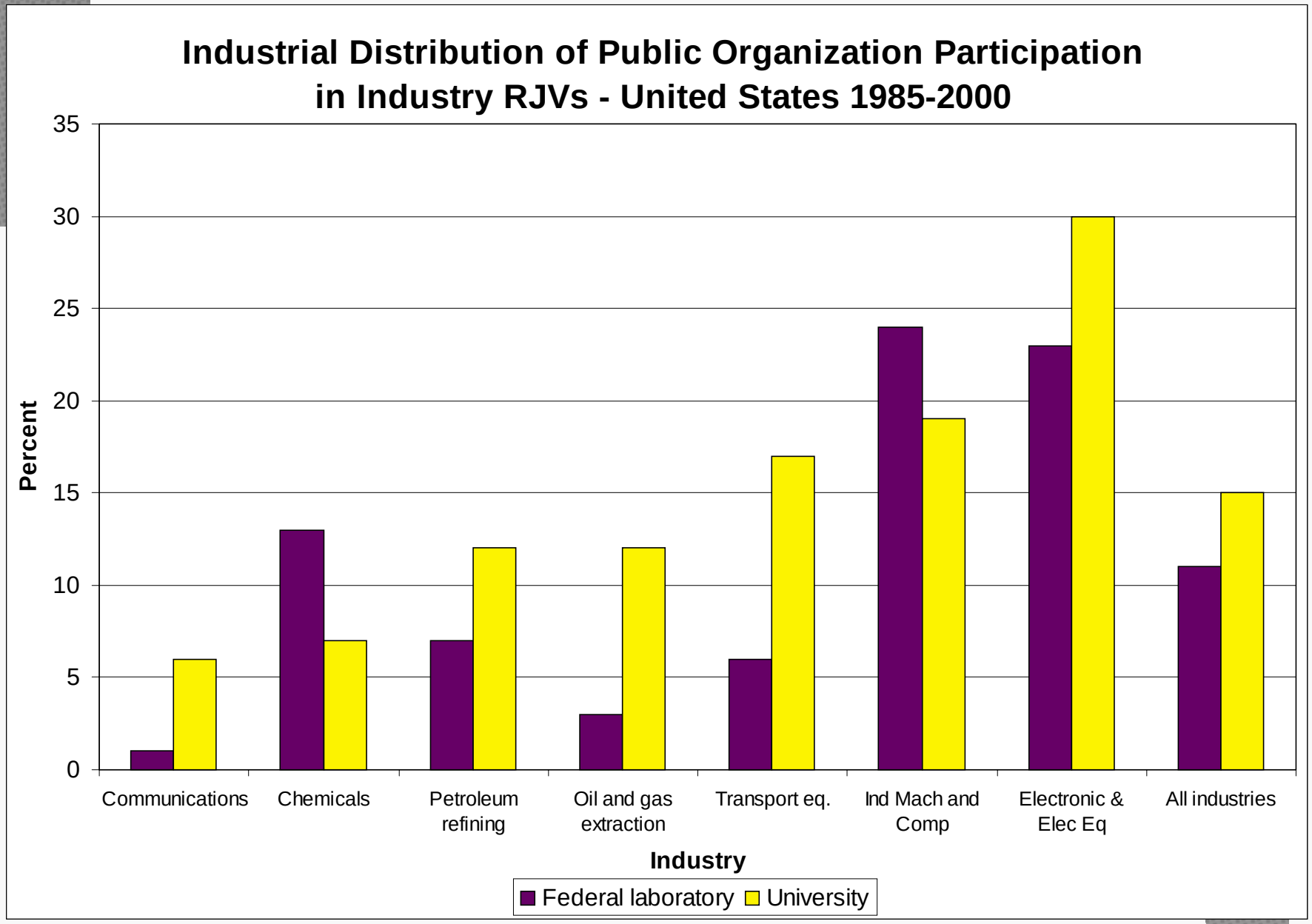
Trends in university R&D funding in the United States

	Source of Funds		
Year	Government	University & Non-profit	Industry
1960	84.9%	11.3%	3.9%
1970	84.7%	13.3%	2.0%
1980	82.5%	14.7%	2.8%
1990	74.9%	19.8%	5.3%
2000	71.0%	22.9%	6.1%

U.S. Research Joint Ventures



Based on Data from the *Federal Register* and the CORE Database (Link 2000)


Industrial Distribution of Public Organization Participation in Industry RJVs - United States 1985-2000
35
30
25
20
15
10
5
0
Percent
Communications
Chemicals
Petroleum refining
Oil and gas extraction
Transport eq.
Ind Mach and Comp
Electronic & Elec Eq
All industries
Industry
Federal laboratory
University

Benefits to Industry (Lee 2000)

- Access to new and complementary research
  - also found to be important by Cohen et al survey (1997)
- Development of new products
- Maintaining a relationship with the university
- Obtaining new patents
- Solving technical problems
- Less important
  - Improving products, recruiting students

(based on a survey of ~400 R&D managers)

Benefits to Faculty (Lee 2000)

- Funds for research assistance, lab equipment, and one's own research agenda.
- Insights into own research; field test theory and empirical research.
- Less important
  - Practical knowledge useful for teaching
  - Student internships and job placement
  - Patentable inventions and business opportunities
- Variation across research field

(based on a survey of ~400 university researchers)

Evaluating the benefits

- Henderson and Cockburn (1996) – in pharmaceuticl industry, access to university research enhances sales, R&D productivity, and patenting
- Zucker, Darby, and Armstrong (2001) – collaborating (publishing) with "star" university scientists important for firm performance in biotechnology
- Adams, Chiang, and Starkey (2001) – Ind-Univ Cooperative Research Centers, especially those funded by NSF, promote tech transfer and increase patenting rates at industrial laboratories.
- Rosenberg and Nelson (1994) – university research enhances and stimulates R&D in industry, rather than substituting for it.
- Pavitt (1998) – augments capacity of business to solve complex problems.

Why has partnering increased?

Industry motivation:

- Universities become more important as technical change is closer to “science.”
- Declines in direct industry spending on basic research following the wave of corporate restructuring in the 1980s
- Special basic research tax credit introduced in 1981 and strengthened in 1986
  - Currently a tax credit equal to 20% of payments to a “qualified” research organization (university or non-profit) is available to taxpaying firms

Why has partnering increased?

University motivation – changes in government levels of support

- Real growth in federal R&D funding:
  - 16% between 1953 and 1968
  - 1% between 1969 and 1983
  - 5% between 1984 and 2000, but with substantial declines in non-biomedical areas
- As federal funding declined, universities used more of their own funds and more funds from industry
- University administrators increasingly pressure faculty to engage in applied commercial research.

Motivation for our study

- Increased reliance of industry on partnerships with universities for the performance of R&D – important to understand what works and what doesn't
- Want to evaluate performance aspects of the US Advanced Technology Program (cost-sharing for pre-commercial R&D with industry).
- Concern that such partnerships may be difficult to consummate or may not perform as well as we would like – what are the reasons for this?

Selected projects

- Ultra-High Density Magnetic Recording Heads
- Engineering Design with Injection-Molded Thermoplastics
- Enhanced Molecular Dynamics Simulation Technology for Biotechnology Applications
- Computer-Integrated Revision Total Hip Replacement Surgery
- Film Technologies to Replace Paint on Aircraft
- Low-Cost Advanced Composite Process for Light Transit Vehicle Manufacturing
- Low Cost Manufacturing and Design/Sensor Technologies for Seismic Upgrade of Bridge Columns
- Automated Care Plans and Practice Guidelines
- Development of Rapid DNA Medical Diagnostics
- Integrated Microfabricated DNA Analysis Device for Diagnosis of Complex Genetic Disorders
- Diagnostic Laser Desorption Mass Spectrometry Detection of Multiplex Electrophore Tagged DNA
- Automated DNA Amplification and Fragment Size Analysis

Hall, Link, Scott sample of ATP projects

Total # projects 1991-97 **Terminated very early**	**352** **-1**	**Type of Selection**
Terminated early	351 -20	Non-random
Require still active and active for 1 year or more	331 -139	Mostly random
Not sampled	192 -138	Stratified (random)
Sampled Non-respondents	54 -7	Non-random
Results based on	47	

Early termination

- More likely if the project did not include a university participant
- Less likely if govt share of funding was high
- More likely if lead partner was a midsized for-profit firm (rather than very small or very large)

Distribution of ATP projects by type of university involvement

Type of University Involvement	Number of Projects	Share of Projects	Sample Projects	Number Responding
Joint Venture	118		36	29
No university involvement (jv)	47	13.4%	9	8
Universities involved as subcontractors (jvs)	42	11.9%	9	8
Universities involved as research partners (jvu)	16	4.5%	9	8
Universities involved as both partner and sub. (jvus)	13	3.7%	9	5
Single applicant	234		18	18
No university involvement (s)	106	30.1%	9	9
Universities involved as a subcontractor (ss)	128	36.4%	9	9
Total	352		54	47

8.2% had university partner; 56.5% had some university involvement

Research questions

1. Are there systematic differences in the research performance within ATP-funded projects that have university partners and those that do not?
2. Are there identifiable barriers that inhibit universities from partnering with industry?
3. Are there identifiable barriers that inhibit industry from partnering with universities?

Differences in research performance within projects with and without university partners?

Research Performance = f(budget, size, technology, university participation, controls)

*where **Research Performance** is defined as*

1. Difficulties acquiring and assimilating basic knowledge - *Projects reporting greater likelihood of experiencing difficulties have university involvement.*
2. Unexpected research problems - *Truly unexpected.*
3. Productive use of research time and financial resources - *Technology specific – personnel problems in frontier technology; equipment problems fewer in info technology; more unproductive time/cost in electronics.*
4. New applications of technology - *Nothing can predict this.*
5. Sooner-than-expected commercialization of the technology - *Projects less likely to commercialize sooner than expected have university involvement.*

Summary of research performance findings

Universities are included (e.g., invited by industry) in those research projects that involve what we have called “new” science.

- This type of project encounters more difficulty in assimilating knowledge.
- Such research will not commercialize sooner than expected.
- Nor is it likely to terminate early.

Identifiable barriers that inhibit universities from partnering with industry?

Based on interviews (n=9, so caution is urged):

1. Most significant barrier that inhibits research partnerships with industry—as a joint venture member or as a subcontractor—related to intellectual property concerns, specifically patenting rights.
   - Universities want to be able to patent whatever research results from their partnering relationship, but found industry extremely difficult to deal with on this issue; publication rights were, for the most part, an non-issue from the perspective of the university.
2. Small companies tended to subcontract with universities rather than include them as a research partner. Universities reported a higher false start rate with small companies primarily because they seemed less familiar with the university bureaucracy. (less tolerant of?)

Identifiable barriers that inhibit industry from partnering with universities?

Firms answer “YES” and intellectual property reasons are frequently cited. Representative remarks (n=47) are:

- “IP is often a stumbling block for collaborations because many universities want to publish results prior to IP protection, and sometimes will not grant exclusivity of results.”
- “Universities have an over-inflated view of their intellectual property value, and university licensing officers have an over-inflated view of the value they bring to the project.”

Caveats and future research

One small survey-based sample, and the investigation was undertaken in an exploratory manner.

Some areas for future work:

1. What types of intellectual property protection mechanisms do RJVs use, and do they differ when universities are involved?
   - See Hertzfeld, Link, and Vonortas, *Research Policy*, forthcoming
2. What impact does the increasing involvement of universities as research partners have on the educational process?