

# Lessons Learned From Research on the Effectiveness of University Technology Transfer



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## Journal of Technology Transfer

**-The only journal devoted to the managerial and policy implications of technology transfer (recently included in the SSCI) –especially its entrepreneurial dimension**

## Technology Transfer Society –

**A non-profit organization devoted to the interdisciplinary scholarly analysis of technology transfer from universities and federal laboratories to firms**

**National Meetings-2004-RPI**

**National Meetings-2005-Kaufmann Foundation**

**National Meetings-2006-Georgia Tech (Atlanta)**

**National Meetings-2007-UC-Riverside**

**National Meetings-2008-University at Albany**

**National Meetings-2009-UNC-Greensboro**



## **Summary of Findings Included in This Presentation:**

**1) Handbook of University Technology Transfer,  
University of Chicago Press (under contract-Link and Siegel)**



**2) Innovation, Entrepreneurship, and Technological Change, Oxford University Press (Link & Siegel (2007))**



**3) Technological Entrepreneurship: Institutions and Agents Involved in University Technology Transfer,  
Edward Elgar Publishing-(Siegel (2006))**

**“Technology Transfer Offices and Commercialization of University Intellectual Property: Performance and Policy Implications,” Oxford Review of Economic Policy, 23(4), 640-660, Winter 2007 (with R. Veugelers and M. Wright)**

**“The Rise of Entrepreneurial Activity at Universities: Organizational and Societal Implications,” Industrial and Corporate Change, 16(4), 489-504, August 2007 (with M. Wright and A. Lockett) –and 7 other special issues**

# University Technology Transfer and New Industry Creation

<b><u>Period</u></b>	<b><u>Technology Developed</u></b>	<b><u>(Primary) University</u></b>	<b><u>Industry Created</u></b>
<b>1940s</b>	<b>Electronic Calculator</b>	<b>University of Pennsylvania</b>	<b>Computers</b>
<b>1960s</b>	<b>Fiber Optics</b>	<b>MIT</b>	<b>Telecommunications</b>
<b>1970s</b>	<b>rDNA</b>	<b>Stanford, UCSF</b>	<b>Biotechnology</b>
<b>1980s</b>	<b>Supercomputing</b>	<b>Illinois</b>	<b>Internet</b>
<b>1990s</b>	<b>Sequencing of DNA/ Human Genome Project</b>	<b>Cal Tech, Johns Hopkins</b>	<b>Pharmacogenomics</b>
<b>2000s</b>	<b>Nanotechnology</b>	<b>U-Albany</b>	<b>??????</b>

## **Background Information on University Technology Transfer**

**□ U.S.-1960's, 1970's Decline in Competitiveness**

**(“Japanese Challenge”, Productivity Slowdown)**

**⇒ Dramatic Changes in U.S. National Innovation Policy**

**□ Expansion of Programs to Support Public-Private Partnerships (e.g., Advanced Technology Program-ATP, NSF-ERC, IUCRC)**

**□ Relaxation of Antitrust Enforcement to Promote Collaborative Research (e.g., NCRA)**

**□ Policies Promoting More Rapid Diffusion of Federally-Funded Technologies From Universities and Federal Labs to Firms (e.g., Bayh-Dole, Stevenson-Wydler, SBIR )**

## Legacy of the Bayh-Dole Act

□ **Bayh-Dole Act of 1980: Universities Own the Rights to Technologies That Arise from Federal Research Grants**

⇒ **Purpose: Accelerate the Rate of Technological Diffusion, Promote Economic Development**

⇒ **Almost All Universities Have Established a Technology Transfer or Licensing Office**

⇒ **Rapid Growth in Commercialization of University Technologies:**

	U.S. Universities	
	<u>1980</u>	<u>2007</u>
University Patents	300	3622
Licensing Agreements	276	5109
Startups	35	555

# **Research on Institutions and Agents Involved in University Technology Transfer**

## **Agents and Institutions**

- University Scientists**
- Industry Scientists (Interacting/w University Scientists)**
- Academic Entrepreneurs**
- Non-Academic Entrepreneurs**
- Industry-University Cooperative Research Centers**
- University Technology Transfer Offices**
- Science Parks**
- Incubators**
- Firms That Interact With Universities**
- Venture Capital Firms**

# **Research on Institutions and Agents Involved in University Technology Transfer**

## **Indicators of Output/Performance**

- Invention Disclosures**
- Patents**
- Number of Licensing Agreements**
- Licensing Revenue**
- Research Productivity of Industry Scientists/Firms**
- Research Productivity of University Scientists**
- “Productivity” of Universities in Technology Transfer**
- Start-Up Formation**
- Survival**
- Employment Growth**
- Changes in Stock Prices**

**NBER/Alfred P. Sloan Foundation Project on  
Industrial Technology and Productivity**

**Theme: Economists Need to Supplement Statistical  
Analysis of Productivity and Technology  
With “Pin-Factory” Visits:**

**Inside the “Black Box”:**

**Organizational Structure/Design -Milgrom & Roberts (1992)**

**HRM- “Personnel Economics”)-Lazear (1995)**

**Organizational Strategy-Jensen (1998)**

**Technology Transfer Offices-Siegel, Waldman, & Link (1999)**

## **Goals of My Original NBER/Sloan Study**

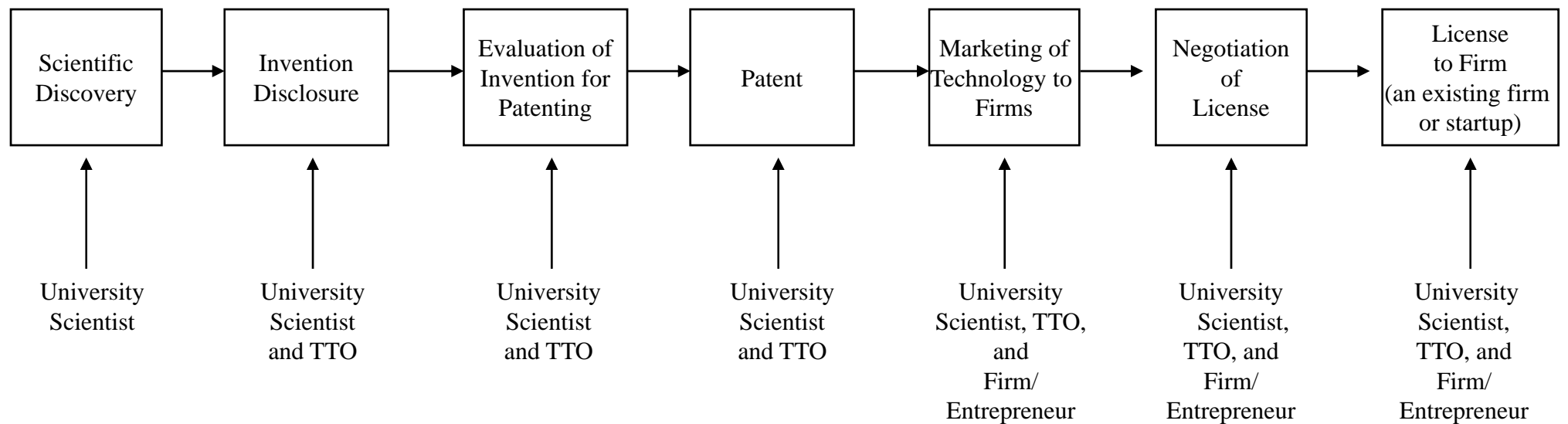
- Specify a UTT “Production Function”**
- “Explain” Relative Productivity in UTT**  
**(Assess the Relative Importance of Organizational Factors in Explaining Variation in UTT Performance)**

## **Tactics of the NBER/Sloan Study**

- Quantitative Methods-Constructed Estimates of the Relative Productivity of 113 U.S. Universities with Regard to Licensing**
- Qualitative Methods-Inductive Analysis to Explore Organizational Issues, Based on Structured Interviews of Academic and Industry Scientists, University Administrators, and Firms/Entrepreneurs**

# FIGURE 1

## How A Technology is Transferred from a University to a Firm or Entrepreneur (According to Theory)



**Key Stylized Facts From My Initial Inductive, Qualitative Research (Relevant to the Measurement and Analysis of the Effectiveness of Technology Transfer)-  
(Siegel et al., 2003a, 2003b, 2004)**

- ❑ Patents Are Not that Important for Certain Technologies/Industries**
- ❑ Many Scientists do not Disclose Inventions**
- ❑ Faculty Involvement/Engagement is Critical**
- ❑ Universities Often Hire Outside Lawyers to Negotiate with Firms**
- ❑ Multiple “Outputs” (e.g., licensing, startups, sponsored research )**

# UTT Production Function

**LICENSE & STARTUP=f (RESEARCH, STAFF, LEGAL )**

where **LICENSE** = licensing agreements or revenue

**STARTUP** = start-up activity (counts)

**RESEARCH** = research expenditure

**STAFF** = TTO staff

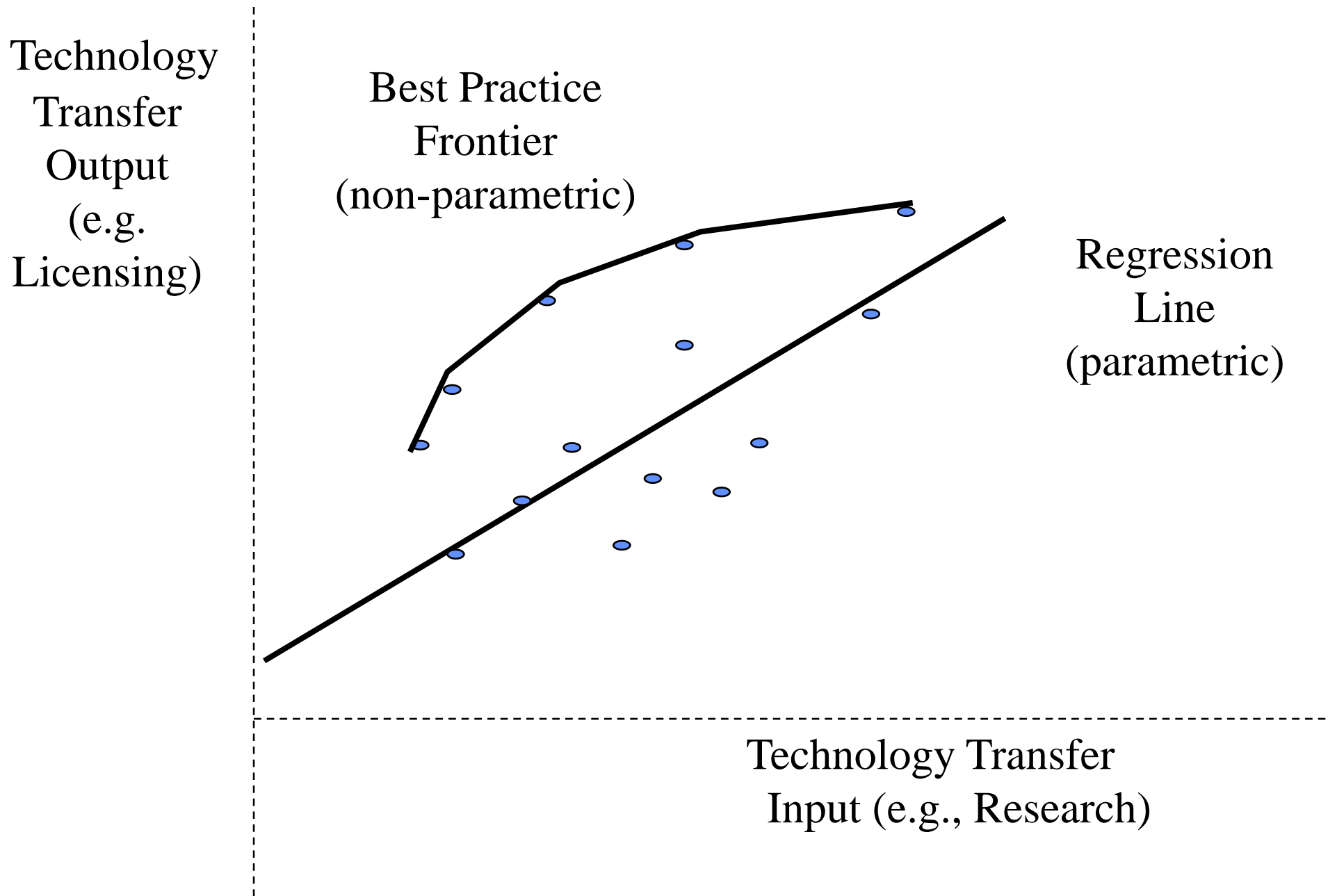
**LEGAL** = (external) legal expenditures

**We also need to account for environmental, institutional, and organizational factors that are not typically included in a production function.**

**Choices: Parametric or Nonparametric estimation?**

**Single vs. Multiple Outputs?**

# Frontier Production Function (Single Technology Transfer Output and Input)



## **Key Quantitative Results**

- Production Function Models Provide a Good Fit (Single or Multiple Outputs)**
- Staff in the TTO Add Significant Value to the Commercialization Process**
- No Strong Consensus on Returns to Scale**
- Private Universities and Those With Medical Schools Appear to Be Somewhat More Productive**
- Limited Evidence Suggests That Property-based Institutions (Incubators and Science Parks) Appear to Enhance University Technology Transfer**

## **Key Quantitative Results (cont.)**

- ❑ Incentives Matter (e.g., Royalty Distribution Formula), But So Do Organizational Practices, Other Institutional Policies, and “Cultural” Factors**
- ❑ Universities Increasingly Emphasizing the Entrepreneurial Dimension of Technology Transfer**
- ❑ Social Networks of Star Scientists Important for New Firm Creation**
- ❑ University Involvement Enhance the Probability of Startup Success (Siegel and Wessner (2009)-based on analysis of SBIR/STTR Program)**

# **Key Stylized Facts From Qualitative Research**

## **Major Impediments to University Technology Transfer:**

- ❑ Informational and Cultural Barriers Between Universities and Firms (Especially for Small Firms)**
- ❑ Insufficient Rewards for Faculty Involvement in Technology Transfer at Some Institutions, Especially w.r.t. Entrepreneurial Activity**
- ❑ TTO Staffing and Compensation Practices (High Rate of Turnover, Insufficient Business/ Marketing Experience, Possible Need for Incentive Compensation)**
- ❑ Education/Training is Needed for Faculty Members, Post-Docs, and Graduate Students in the Specifics of the Entrepreneurial Process, the Role of Entrepreneurs, and How to Interact with the Business/Entrepreneurial Community**

## **Key Stylized Facts From Qualitative Research (cont.)**

- ❑ A Failure to Address These Barriers Will Induce More Faculty Members and Firms to Circumvent the TTO and Engage in “Informal” UTT (Link, Siegel, Bozeman (2007)-ICC; Markman, Gianiodis, and Phan (2008)-IEEE-TEM)**
- ❑ University Technology Transfer Should be Considered From a Strategic Perspective**

# **Strategic Implications of University Technology**

## **Transfer-Formulation Issues (for Universities)**

- ❑ Setting Institutional Goals/Priorities**
- ❑ Resources Devoted to University Technology Transfer**
- ❑ Choices Regarding Technological Emphasis**
- ❑ Strategic Choices Regarding Modes of University Technology Transfer:**
  - ❑ Licensing**
  - ❑ Startups**
  - ❑ Sponsored Research**
  - ❑ Other University Technology Transfer Mechanisms**  
**That are Focused More Directly on Stimulating**  
**Economic Development (e.g., Incubators and Science**  
**Parks)**

# **Strategic Implications of University Technology Transfer**

## **-Implementation Issues (for Universities)**

- ❑ Improving Information Flows**
- ❑ Organizational Design/Structure**
- ❑ HRM Practices-Staffing/Compensation of TTO Personnel**
- ❑ Reward Systems for Faculty Involvement in University Technology Transfer (perhaps including P&T- e.g., 6/-06-Texas A&M)**
- ❑ Implementation Issues Regarding Modes of University Technology Transfer**
  - ❑ Different Ways of Structuring Licensing Agreements**
  - ❑ Academic vs. Surrogate Entrepreneurs**
  - ❑ Different Ways to Manage University-Based Incubators and Science Parks**

# **Limited Evidence on the Effectiveness of University-Based Technology Incubators**

- ❑ University Technology Incubators Enhance The Performance of Tenant Firms (e.g., Hackett (2004), Rothaermel and Thursby (2005) )**
- ❑ Technology Incubators (In General) Are More Successful If Located on a University Campus (Amezcuca (2008))**

## **Limited Evidence on the Effectiveness of University-Based Technology Incubators (cont.)**

- ❑ Technology Incubators Appear to Work Best When There is a Complementary Innovation System-Siegel and Phan (2006)**
  - ❑ VCs Involved in Designing and Operating the Incubator**
  - ❑ Complementary Education System**
  - ❑ Work With Real Estate Developers**
  - ❑ Local Executives and Entrepreneurs as Mentors**
  - ❑ Angel Networks**
- ❑ Concern with Evaluation Studies-Selection/Endogeneity Problem**

## **Stronger (Foreign) Evidence on the Impact of Science Parks**

- ❑ Numerous “Matched Pairs” Studies in Many Nations (Including Sweden-Ferguson and Olofsson-2004; Loftsen and Lindelof-2003, 2004 and the U.K.)**
- ❑ Firms Located on University Science Parks Have Higher Research Productivity Than Comparable Firms (Siegel, Westhead, and Wright (2003)-Addresses Selection and Endogeneity Problems)**
- ❑ Science Parks Enable Universities to Generate More Publications and Patents, More Easily Place Graduates, and Hire Preeminent Scholars (Link and Scott (2003))**
- ❑ Science Park Firms With a Link to the University Have a Higher Survival Rate Than Science Park Firms Without Such a Link (Westhead and Storey (1995))**

# **Universities Focusing on Start-up Formation Should Develop a Technological Entrepreneurship Curriculum, Applied to UTT Stakeholders (Siegel-Phan (2006))**

- ❑ Entrepreneurship Courses Across the University (Theory and Practice )**
- ❑ Evaluation/Policy Research**
  - ❑ Link-Siegel NSF Grant to Evaluate U.S. Science Parks**
- ❑ Practitioner Research (Draw More Practitioners into the Classroom)-Entrepreneurs in Residence Programs**
- ❑ Academic Conferences**
  - ❑ Technology Transfer Society Conference**
- ❑ Research Workshops**
- ❑ Master's and Ph.D. Programs in Entrepreneurship**

# **Aspects of a Technological Entrepreneurship Curriculum -Institutional Level**

- Incubator/Accelerator**
- Technology/Science Park**
- Technology Transfer Office/Policies Receptive to Entrepreneurship**
- Idea Labs**
- Venture Forum**
- Angel Network (e.g., Tech Valley Angel Network, Proposed U-Albany School of Business Alumni Commercialization Fund)**
- Senior Administrative Position in Entrepreneurship (e.g., Vice Provost-Entrepreneurship-RPI, Wake Forest)**
- Incentives for Faculty Members to Be Engaged in Entrepreneurial Activity (and Perhaps For Successful Ones to Serve As Mentors)**