In or Out?

Faculty Research and Consulting

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Supported by the E.M. Kauffman Foundation & National Science Foundation
Motivation: An Empirical Anomaly

• 28% of a sample of 1767 US patents with faculty from 11 major US universities as inventors are solely assigned to for-profit firms
  – Employment contracts specify university IP ownership
  – Bayh-Dole Act allows university ownership of federally funded IP
  – US universities typically insist on ownership of firm sponsored research

• Consulting as an explanation?
  – Interviews with TTO, industry, and university personnel
  – Thursby et al. (2007) analysis of 5711 patents of faculty in 87 universities
    • 26% assigned solely to for profit firms
    • Firm assigned patents less basic than university assigned
    • Inventor share of license revenue increases likelihood of univ assignment
Motivation --continued

• Consulting a known but understudied phenomenon
  – Cohen et al. (1998) survey of R&D managers
     • 31% gave consulting as very important; 17% patents; 9% licenses
  – Mansfield (1995) shows two way flow
  – Beath et al. (2003) examines as a way to relax university budget constraints

• Understanding assignment requires understanding
  – Decisions of faculty on activity inside and outside the university
  – Decisions of government and industry on research funding

• Theoretical model plus empirical analysis of patent assignment
Theoretical Model

- Faculty can research own project in the university with gov and firm funding and receive $c$ for time spent outside on the firm’s project
  - Patents from university project assigned to university
  - Patents from consulting assigned to firm
- Two stage game
  - Stage 1: Gov and firm choose $G$ and $F$
  - Stage 2: Firm chooses $c$ and Researcher chooses $t$
- Allow for
  - Projects of different difficulty ($x_1, x_0$)
  - Differing faculty quality ($q$)
  - Benefit to firm project from faculty’s university research ($\beta$)
  - Difference in effectiveness of $G$ and $F$ for university research ($1, \alpha$)
  - University and firm infrastructure ($K_1, K_0$)
Probability of success: \( p(\tau, e; q, x) \)

- \( \tau = \) time devoted to project, \( e = \) effective funding, \( q = \) researcher quality
  \( \tau, e, q \) inputs with +, diminishing marginal products, complements
- \( x = \) scientific merit (difficulty)
  negative marginal effect, cross-partial derivatives w.r.t. others are negative

University research project: \( e_1 = K_1 + G + aF \)

- \( K_1 = \) research support provided by university
- \( G = \) federal funding
- \( F = \) industrial (firm) funding
- \( a = \) fraction of industrial funding equivalent to university funding

Firm consulting project: \( e_0 = K_0 + \beta G + F + ct \)

- \( K_0 = \) research support provided by firm in its lab
- \( \beta = \) fraction of \( G \) that spills over to firm project
- \( c = \) unit consulting fee
- \( t = \) time spent consulting by researcher
**Payoffs**

**University researcher:**

\[ EU(G,F,t,c) = p(T-t,e_I,q,x_I)U(R_s,S+\gamma L+ct) + [1-p(T-t,e_I,q,x_I)]U(R_p,S+ct) \]

\[ R_i = \text{reputation (}i = \text{succeed, fail)}\), S = \text{salary, } L = \text{license income, } \gamma = \text{share of } L \]

**Government:**

\[ EU_g(G,F,t,c) = p(T-t,e_I,q,x_I)U_g(R_{gs}) + [1-p(T-t,e_I,q,x_I)]U_g(R_{gf}) - V(G) \]

\[ R_{gi} = \text{agency’s reputation } i=s,f \), V = \text{opportunity cost of funding} \]

**Firm:**

\[ E\Pi(G,F,t,c) = p(T-t,e_I,q,x_I)(\pi_I -L) - F + p(t,e_O,q,x_O)\pi - ct \]

\[ \pi_I = \text{profit from successful university invention} \]
\[ \pi = \text{profit from successful consulting project} \]
Second Stage Comparative Statics
Testable Hypotheses

(i) ↑ spillover from university research, firm support in its lab, or difficulty of firm project → ↓ c*

(ii) ↑ quality → ↑ c*

(iii) ↑ attractiveness of firm funding, research funding from the university, license revenue, or license share → ↑ c* & ↓ t*

(iv) No spillover from university research, then ↑ G → ↓ t*
• Firm assigned patents result largely from consulting.
• Obviously, not a complete measure of consulting.

Due to data availability we consider 1993 science & engineering faculty 1990’s patents at

Purdue
MIT
Stanford
Wisconsin
Georgia Tech
Cornell
Pennsylvania
Texas A&M
### Sample Characteristics

1767 Patent/Inventor Pairs

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Firm</td>
<td>28.2%</td>
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<tr>
<td>University</td>
<td>67.2%</td>
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<tr>
<td>Unassigned</td>
<td>1.9%</td>
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<tr>
<td>US Gov't</td>
<td>0.9%</td>
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<tr>
<td>Not-For-Profit &amp; Firm</td>
<td>1.6%</td>
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<tr>
<td>US Gov't &amp; Not-For-Profit</td>
<td>0.2%</td>
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Econometric Model

Dependent Variable = 1 if assigned to university
                 = 0 if assigned to firm

Independent Variables
   Total publications
   Total citations to these publications
   Federal research funds
   Industry research funds
   Other research funds
   Gender
   Age
   Fixed effects
      University
      Year
      Technology category
• What about faculty who do not patent?
• What about patent characteristics?
Means for Important Variables

Publications 7
Citations 271
Federal funding 796000
Industry funding 157000
Other funding 77000
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<tr>
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<th>Odds Ratio</th>
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<td>Citations</td>
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