IMPACT OF ACADEMIC ENTREPRENEURSHIP ON SCIENTIFIC ACTIVITIES: AN EXAMPLE OF POLICY RESEARCH FROM SOCIOLOGY OF SCIENCE

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SHARING OF SCIENTIFIC RESOURCES IN ACADEMIA

- **Common practice**
  - Frequent sharing: e.g., 4-5 requests per year in biomedicine (Walsh, et al., 2007)
  - High compliance: 80%-90% of requests (Campbell, et al., 2002; Walsh, et al., 2007)
    * Scientific resources: research data and materials

- **Underpinned by a strong norm for sharing**
  - Sharing is important for progress of science: replication, efficiency, standardization, cumulative discovery
  - Consistent with the norm of communism (Barber, 1952; Merton, 1973)

- **Policies for sharing (Eisenberg, 2006; Schofield et al., 2009)**
  - UPSIDE (National Academies): share with all, free and without conditions
  - NIH sharing policies

- **Mechanism to suppress non-sharing & enforce norm**
  - Sanctions (Coleman, 1990; Hechter, 1987): obstruction for employment, bad rumors, no support in the future, etc.
  - Regulations by funding agencies, academic journals: obligation of sharing for grantees and authors
Still, norms are contextual, not completely followed

- Science is integrated in a socio-political system (Blume 1974)
- Norms depend on social, economic, and political system of society (Blume 1974, Frickel 2005)
- Norms are influenced by scientific fields, historical periods, organizational contexts (Hackett 1990)

Existence of counter-norms (Mitroff 1974)

- Scientists are under the tension between norms and counter-norms

Systemic anti-normative forces against sharing

- Competition, cost of sharing, commercialism, etc. (Cohen and Walsh, 2008; Merton, 1973; Stephan, 1996)

Thus, practice/norm for sharing is affected by social context
Growing concern about adverse effects of academic entrepreneurship (AE)

- Emphasis on commercialization, link with industry, etc. (e.g., Slaughter & Leslie 1997; Etzkowitz 1998)
- Global phenomenon: policy changes in US, Japan, Europe, etc.
- Undermines the norm of communism (scientific commons) and deters scientific advancement (e.g., Dasgupta & David 1994; Nelson 2004)

Empirical evidence
- Commercial activity, industry collaboration, and patenting
  - Discourage sharing of research data and materials (e.g., Blumenthal et al., 1997; Blumenthal et al. 2006; Walsh et al., 2007; Campbell, 2000; Murray & Stern 2007; Vogeli, 2006)
- Increasing denial of requests for material transfers (Walsh 2007; Campbell 2002)
COMPLIANCE AND DENIAL IN US

- Frequency of requests
  - US Agriculture: 3 times/year (Lei 2009)
  - US Biomedical: 3.5 times/year (Walsh 2007)
  - US Life science: 3 times/year (Campbell 2002)

- Denial
    - Increase from 10% (1997-1999: Campbell 2002)
MOTIVATION OF THE STUDY

- Strong evidence on the conflict between AE and sharing specifically in the US
  - How about the case in other countries like in Japan?
- Still remains theoretical questions about the impact of AE context on sharing
  - What has happened to the majority of scientists who are not participating in AE?
  - AE might have not only deterred sharing, but also changed the forms of sharing?
RESEARCH SETTING & DATA: JAPANESE UNIVERSITIES

- Policy reform toward AE regime
  + Attempt to copy US system in response to the economic stagnation in the 1990s (Nagaoka 2009)
  + Change in legal framework
    - Technology Transfer Law (1998)
    - Relaxation of National Public Service Law (2000)
    - Patent system reform (2002-)
    - Incorporation of national universities (2004)
  + Result was greater policy emphasis and actual rates of AE (Walsh, et al., 2008)

- Japanese scientist sample
  + Relatively recent rise in AE
    - Still heterogeneity in the stance toward AE
  + Focus on the impact of field-level AE
    - Measured by AE activities averaged in each scientific field
Survey data of Japanese scientists
- 698 professors (full & associate) in Japanese universities
- 42% response rate (out of 1,674 scientists)
- Life science & Material science (16 fields)
- Research active (National grantees within 5 years)
- Feb-Apr 2009

Focus on a specific form of sharing
- Material transfer
  - e.g., reagents, cell lines, chemical compounds, model animals
### Research field

<table>
<thead>
<tr>
<th>Field</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical</td>
<td>14%</td>
</tr>
<tr>
<td>Basic Bio</td>
<td>20%</td>
</tr>
<tr>
<td>Basic Med</td>
<td>18%</td>
</tr>
<tr>
<td>Material</td>
<td>17%</td>
</tr>
<tr>
<td>Pharm a</td>
<td>10%</td>
</tr>
<tr>
<td>Med E ng</td>
<td>3%</td>
</tr>
</tbody>
</table>

**Private university** 9%

**PRO** 16%

**The year when the 1st degree was given** 1988

**#Labs previously experienced** 2.81

**#Years in the current lab** 13.0

**#PhD in the lab** 5.74

**#Publication/year** 5.77

**#Patent/year** 0.62
## DESCRIPTION: MATERIAL TRANSFER

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>%Received at least one request (in 2 years)</td>
<td>61%</td>
</tr>
<tr>
<td># Requests (received) / year</td>
<td>2.6</td>
</tr>
<tr>
<td>% Denial for the latest request</td>
<td>8.7%</td>
</tr>
<tr>
<td>% Co-authorship offered</td>
<td>50%</td>
</tr>
</tbody>
</table>
CONSEQUENCE OF BEING DENIED

0% 10% 20% 30% 40% 50%

Change approach
Prepare/purchase by oneself
Abandon the topic
Delay for >1 month
Unable to retest prior studies
DE-MOTIVATING FACTOR
ENTREPRENEURIAL ACTIVITY (1)

Distribution of commercial income

- Univ, 33%
- Lab, 43%
- Self, 29%
- Others, 13%

At least one type of commercial activity: 34%

- Development of new product: 6%
- Establishment of start-up: 2%
- Feasibility study: 3%
- Licensing: 7%
- Commercial negotiation: 29%
DE-MOTIVATING FACTOR
ENTREPRENEURIAL ACTIVITY (2)

At least one patent: 41%
At least one industry partner: 37%
Non-zero industry funding: 49%
<table>
<thead>
<tr>
<th>Activity</th>
<th>Yes group</th>
<th>No group</th>
<th>T-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involved in commercial activities</td>
<td>192</td>
<td>291</td>
<td>n.s.</td>
</tr>
<tr>
<td>Early stage (negotiation &amp; feasibility study)</td>
<td>109</td>
<td>291</td>
<td>n.s.</td>
</tr>
<tr>
<td>Late stage (start-up &amp; new technology on market)</td>
<td>46</td>
<td>291</td>
<td>n.s.</td>
</tr>
<tr>
<td>Licensing income</td>
<td>37</td>
<td>291</td>
<td>n.s.</td>
</tr>
<tr>
<td>Collaborated with industry</td>
<td>186</td>
<td>316</td>
<td>n.s.</td>
</tr>
<tr>
<td>Received industry fund</td>
<td>237</td>
<td>254</td>
<td>n.s.</td>
</tr>
<tr>
<td>Applied patents</td>
<td>224</td>
<td>271</td>
<td>n.s.</td>
</tr>
<tr>
<td>Requested material is patented</td>
<td>68</td>
<td>309</td>
<td>n.s.</td>
</tr>
<tr>
<td>Requested material is related to commercial activities</td>
<td>26</td>
<td>476</td>
<td>†</td>
</tr>
</tbody>
</table>

† p<0.10; * p<0.05; ** p<0.01
a. Comparison with non-commercially active scientists
DE-MOTIVATING FACTOR
COMPETITION (1)

How many research groups could compete with your research group?

For the latest request you received, how likely did you think you will compete with the consumer?

- **Very unlikely**
- **Unlikely**
- **Not sure**
- ** Likely**
- **Very likely**

<table>
<thead>
<tr>
<th>Competitors</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>14%</td>
</tr>
<tr>
<td>1-2</td>
<td>19%</td>
</tr>
<tr>
<td>3-5</td>
<td>41%</td>
</tr>
<tr>
<td>6-10</td>
<td>12%</td>
</tr>
<tr>
<td>&gt;11</td>
<td>14%</td>
</tr>
</tbody>
</table>
### De-Motivating Factor: Competition (2)

<table>
<thead>
<tr>
<th></th>
<th>Yes group</th>
<th>No group</th>
<th>T-test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>47</td>
<td>453</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>%Denial</strong></td>
<td>15%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>Likely to compete with the consumer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 6 competitor</td>
<td>135</td>
<td>362</td>
<td>n.s.</td>
</tr>
<tr>
<td></td>
<td>11%</td>
<td>8%</td>
<td></td>
</tr>
</tbody>
</table>
What kind of benefits did you expect provided that you gave your material?

- Coauthorship
- Data feedback
- Acknowledgment
- Research funds
- Monetary income
- Other benefits
- Nothing

For the latest request you received, how likely did you expect that the relationship with the consumer will benefit you?

- Very likely
- Likely
- Not sure
- Unlikely
- Very unlikely
### MOTIVATION FACTOR EXCHANGE (2)

<table>
<thead>
<tr>
<th></th>
<th>Yes group</th>
<th></th>
<th>No group</th>
<th></th>
<th>T-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%Denial</td>
<td>N</td>
<td>%Denial</td>
<td></td>
</tr>
<tr>
<td>Material transfer leads to a certain form of return a</td>
<td>386</td>
<td>6%</td>
<td>115</td>
<td>17%</td>
<td>***</td>
</tr>
<tr>
<td>Coauthorship</td>
<td>238</td>
<td>5%</td>
<td>115</td>
<td>17%</td>
<td>***</td>
</tr>
<tr>
<td>Data feedback</td>
<td>155</td>
<td>6%</td>
<td>115</td>
<td>17%</td>
<td>**</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>122</td>
<td>7%</td>
<td>115</td>
<td>17%</td>
<td>*</td>
</tr>
<tr>
<td>Research funds</td>
<td>40</td>
<td>8%</td>
<td>115</td>
<td>17%</td>
<td>n.s.</td>
</tr>
<tr>
<td>Monetary income</td>
<td>18</td>
<td>11%</td>
<td>115</td>
<td>17%</td>
<td>n.s.</td>
</tr>
<tr>
<td>Relationship with the consumer is useful in the future</td>
<td>197</td>
<td>5%</td>
<td>303</td>
<td>12%</td>
<td>**</td>
</tr>
</tbody>
</table>

† p<0.10; * p<0.05; ** p<0.01

a. Comparison between requests with return in each form and requests without return.
MOTIVATION FACTOR
PREVIOUS RELATIONSHIP

<table>
<thead>
<tr>
<th>% Denial</th>
<th>% Respondent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>NOT known before the request</td>
</tr>
<tr>
<td>10%</td>
<td>Known of name</td>
</tr>
<tr>
<td>20%</td>
<td>Directly known w/o collaboration</td>
</tr>
<tr>
<td>15%</td>
<td>Collaborated before</td>
</tr>
</tbody>
</table>

*ANOVA: p<.01
Do you have a research tool which is widely provided without charge through publicly accessible channel?

**PUBLICLY SHARED MATERIAL**

<table>
<thead>
<tr>
<th>Media of Publication</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conference</td>
<td>78</td>
</tr>
<tr>
<td>Own website</td>
<td>34</td>
</tr>
<tr>
<td>Registered in repository</td>
<td>32</td>
</tr>
<tr>
<td>Journal ads</td>
<td>9</td>
</tr>
<tr>
<td>Others</td>
<td>13</td>
</tr>
</tbody>
</table>
THEORETICAL EXPLORATION: INTRODUCING
SOCIAL EXCHANGE THEORY

Generalized exchange (GE)

- Unilateral transaction
- Giver not reciprocated by recipient, but possibly by a third person
- e.g., sharing in traditional academia (free and without conditions)

*Generalized vs. direct exchange (Befu, 1977; Blau, 1964; Ekeh, 1974; Sahlins, 1972)*
MECHANISMS TO SUSTAIN GE

Collective mechanism
- Norm of reciprocity
  (Gouldner 1960; Ekeh, 1974; Uehara, 1995)
- Sanctions to sustain collective actions
  (Yamagishi 1986; Yamagishi 1988)

Individual benefit
- Actors in exchange system are just benefit seekers (e.g., Emerson, 1987)

To encourage ALL actors to share

To motivate ONESELF to share
DETERIORATION OF GE-SHARING

(-) Actors following collective mechanisms

AE-active scientists (unwilling to share)

(-) Shared resources

To encourage ALL actors to share

Collective mechanism

Individual benefit

To motivate ONESELF to share

H1: As AE prevails, GE-sharing is more likely to be denied.
SHIFT IN SHARING FORMS: PREVAILING AE ENDS UP IN A DECREASE OF SHARING?

Generalized exchange (GE)

- Unilateral transaction
- Giver possibly reciprocated by a third person
- High risk of non-reciprocity (Takahashi, 2000; Yamagishi & Cook, 1993)

Innately, but more true in AE context

Direct exchange (DE)

- Direct contribution by 2 actors
- Based on promise or expectation of reciprocity from recipient
- Reduced risk of non-reciprocity (Molm, 1994; Molm et al., 2007)
Secure reciprocity at the time of giving
- When requested for sharing, suppliers (who give) demand compensation from consumers (who receive) (a form of DE (*negotiated exchange*); Emerson 1981)
- e.g., sharing based on coauthorship, etc.

Restrict the network of generalized exchange
- In a small network, members can strictly monitor each other
  Reduced to a 2-member unilateral reciprocity
  (another form of DE (*reciprocal exchange*); Emerson 1981)
- e.g., sharing based on expectation of future support, etc.

Greater preference on direct exchange (DE) sharing
H2: As AE prevails, %DE increases while %GE decreases
H3: As AE prevails, (P[denial for GE] - P[denial for DE]) increases
MEASURES

- **Individual-level AE-activity**
  - Commercial activity
  - Industry collaboration
  - Industry funding (Yes=1/No=0 for each)

- **Denial for the latest request**
  - Denied=1, Fulfilled=0

- **Latest request received**

- **Field-level AE prevalence**
  - %AE-active scientists at 16 field level

- **Forms of sharing**
  - Expect coauthorship (Yes=1)
  - Expect future support (Yes=1)
DESCRIPTION: FIELD-LEVEL AE PREVALENCE
% SCIENTISTS INVOLVED IN COMMERCIAL ACTIVITIES

Medical Engineering
Molecular Science
Material Chemistry
Agricultural Chemistry
Internal Clinical Medicine
Compound Chemistry
Pharmaceutical Science
Nano Chemistry
Material Science
Veterinary Science
Surgical Clinical Medicine
Fundamental Medicine
Biological Science
Neuroscience
Basic Biology
Agricultural Science

0% 20% 40% 60% 80% 100%
CONCLUSION : IMPACT OF PREVAILING AE

- Broader impact of entrepreneurship
  - Not only AE-active scientists but any scientists in AE prevailing fields tend to withhold
    - Weakening norm for sharing in specific academic fields
- Shift in sharing forms
  - From generalized exchange toward direct exchange
    - To secure reciprocity
- Decrease in total sharing
  - Limitation of direct exchange
    - Suppliers may not be satisfied with the offered return
    - Consumers may not want to give authorship, etc.
    - Suppliers may demand unreasonably costly reciprocity
**DISCUSSION**

**Implication:**
Shift to hybrid norms of industry and open science (e.g. Murray, 2010; Owen-Smith, 2003)
- Need to encourage generalize exchange (GE) sharing
  - Secure the benefits for suppliers by community (e.g., Rome agenda for mouse lines)
    - Guideline of acknowledgment, etc.
    - System to increase the exposure of suppliers
    - (Central repository of research tools, etc.)

**Limitation**
- Specificity of sample, research context
  - Japanese culture, material transfer
- Endogeneity
  - Field-level AE may be caused by DE-oriented culture
- Self-report measures
- Social exchange: not completely controlled test