Universities and Local Systems of Innovation: A Strategic Approach

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Outline

- Is a strategy for economic development necessary for universities? Is it possible?
- Forms of engagement
- A preliminary strategy framework
- Conclusions
University roles in industrial innovation

a. Training skilled undergraduates and graduates
b. Increasing the stock of ÔcodifiedÕ useful knowledge
   i. Publications
   ii. Patents
   iii. Prototypes
c. Creating new scientific instrumentation and methodologies
d. Forming/accessing networks and stimulating social interaction
   i. Meetings and conferences
   ii. Industrial liason programs
   iii. Hosting standard-setting fora
   iv. Entrepreneurship centers
   v. Alumni networks
   vi. Faculty contacts
   vii. Personnel exchanges (internships, faculty exchanges, etc.)
e. Influencing the direction of search processes among users and suppliers of technology
f. Increasing the capacity for scientific and technological problem-solving
   i. Contract research
   ii. Cooperative research with industry
   iii. Technology licensing
   iv. Faculty consulting
   v. Providing access to specialized instrumentation and equipment
g. Creating new firms (licensing, incubation, financing, science parks, etc.)
Relative importance of university roles

- For many firms, the principal obstacle to innovation is not access to new technology but, rather, access to people with the necessary skills.
- Firms are increasingly relying on external sources of technology for their innovations, but are considerably more likely to view customers and suppliers as direct sources than universities.
- University patenting and licensing in the U.S. has rapidly increased, but remains a relatively minor pathway for the flow of knowledge to the private sector. Few faculty are involved in patenting.
- University licensing income is a very small fraction of income from sponsored research (3.4% for U.S. universities in 2001). Only a tiny fraction of university patents make money.
- New firm formation around university technology has increased, and tends to be geographically localized, but is a minor contributor to new business starts
  - ~500 firms based on academic discovery formed in FY 2001 in US; 84% of them in the same state
  - Total number of new employer firms formed in 2001: ~575,000; net increase in employer firms: ~90,000
Percentage of Companies with High Reliance on External Sources for Technology

Source: Unpublished IPC global survey of large technology-intensive companies (>$100M/yr in annual R&D expenses in 1999) (N=209)
Percentage of companies with high frequency of outside collaboration

<table>
<thead>
<tr>
<th>Collaborate with:</th>
<th>Japan</th>
<th>Europe</th>
<th>North America</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customers</td>
<td>52%</td>
<td>38%</td>
<td>44%</td>
</tr>
<tr>
<td>Suppliers</td>
<td>41%</td>
<td>45%</td>
<td>45%</td>
</tr>
<tr>
<td>Universities</td>
<td>34%</td>
<td>32%</td>
<td>34%</td>
</tr>
</tbody>
</table>

Source: Unpublished IPC global survey of large technology-intensive companies (>$100M/yr in annual R&D expenses in 1999) (N=209)
MIT faculty perceptions of relative importance of knowledge channels from university to industry (n=68)

Classical (linear) view of R&D and innovation is flawed

- "Fundamental"
- "Autonomous"
- "Curiosity-driven"
- "Pure science" (Universities/nat.labs)

- "Applied"
- "Practical"
- "Mission-driven" Product development (Firms)

‘FUNDAMENTAL’ vs. ‘APPLIED’ IS A FALSE DICHOTOMY
Both motivations may apply simultaneously

- Quest for fundamental discoveries?
  - Yes

- Is research motivated by practical goals?
  - Yes
Stokes’ matrix

<table>
<thead>
<tr>
<th>Quest for fundamental discoveries?</th>
<th>Practical goals?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Pure basic research (&quot;Bohr&quot;)</td>
<td>Pure development (&quot;Edison&quot;)</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>?? (e.g., insect taxonomies)</td>
<td>Use-inspired basic research (&quot;Pasteur&quot;)</td>
</tr>
</tbody>
</table>
In practice the distinctions are blurred

Any given innovation typically involves a network of organizations

Universities are active in all quadrants

Bohr

Pasteur

Edison
The take-up of technological knowledge

Four pathways of local/regional industrial development:

I. Indigenous creation of new industry

II. Importation/transplantation of new industry into the region

III. Diversification/transformation of existing industry into technologically-related new industry

IV. Upgrading of existing industry (product and process improvements, service enhancements, etc.)
## The Local Innovation Systems Project

[IPC (MIT) - CBR (Cambridge) - University of Tampere - HUT - Tokyo University]

<table>
<thead>
<tr>
<th>Country</th>
<th>Location</th>
<th>Industry</th>
<th>Type of transition</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>Rochester, NY</td>
<td>Photonics</td>
<td>Diversification</td>
</tr>
<tr>
<td>USA</td>
<td>Alfred-Corning, NY</td>
<td>Ceramics</td>
<td>Upgrading</td>
</tr>
<tr>
<td>USA</td>
<td>Allentown, PA</td>
<td>Optoelectronics</td>
<td>Diversification</td>
</tr>
<tr>
<td>USA</td>
<td>Akron, OH</td>
<td>Polymers</td>
<td>Diversification</td>
</tr>
<tr>
<td>USA</td>
<td>Newhaven, CT</td>
<td>Biotechnology</td>
<td>Creation</td>
</tr>
<tr>
<td>USA</td>
<td>Boston, MA</td>
<td>Wireless</td>
<td>Creation</td>
</tr>
<tr>
<td>USA</td>
<td>I-85 Corridor, NC/SC</td>
<td>Autos/machinery</td>
<td>Transplantation</td>
</tr>
<tr>
<td>USA</td>
<td>Youngstown, OH</td>
<td>Steel</td>
<td>Decline</td>
</tr>
<tr>
<td>USA</td>
<td>Charlotte, NC</td>
<td>Motor sports</td>
<td>Creation</td>
</tr>
<tr>
<td>Finland</td>
<td>Tampere</td>
<td>Industrial machinery</td>
<td>Upgrading</td>
</tr>
<tr>
<td>Finland</td>
<td>Turku</td>
<td>Biotechnology</td>
<td>Upgrading</td>
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<tr>
<td>Finland</td>
<td>Seinajoki</td>
<td>Industrial automation</td>
<td>Upgrading</td>
</tr>
<tr>
<td>Finland</td>
<td>Helsinki</td>
<td>Wireless</td>
<td>Creation</td>
</tr>
<tr>
<td>Finland</td>
<td>Oulu</td>
<td>Medical</td>
<td>Creation</td>
</tr>
<tr>
<td>Japan</td>
<td>Hamamatsu</td>
<td>Optoelectronics</td>
<td>Creation</td>
</tr>
<tr>
<td>Japan</td>
<td>Kyoto</td>
<td>Ceramics</td>
<td>Upgrading</td>
</tr>
<tr>
<td>Taiwan</td>
<td>Hinschu-Taipei</td>
<td>Electronics</td>
<td>Transplantation</td>
</tr>
<tr>
<td>Taiwan</td>
<td>Hsinchu-Taipei</td>
<td>Software</td>
<td>Creation</td>
</tr>
<tr>
<td>Ireland</td>
<td></td>
<td>Software</td>
<td>Creation</td>
</tr>
</tbody>
</table>
Some early observations . . . . .

**Type I:** Indigenous creation of new industry

**Type II:** Transplantation of new industry

**Type III:** Diversification of old industry into related new

**Type IV:** Upgrading of mature industry

- Success conditions (and failure modes) for each of these pathways are different.
- Patterns of innovation (technological knowledge provision and take-up) are different
- Roles of universities, financial institutions, government, and others are different
Indigenous creation of new (science-based) industry

Local R&D Intensity and Knowledge Flows

New fundamental knowledge?
- NO
- YES

Practical use?
- NO
- YES

Type I

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Summary: Alternative pathways of local industrial development

I. New industry creation
II. Transplantation
III. Diversification old→new
IV. Mature industry upgrading

R&D Intensity

Strategic Knowledge Flows

Bohr ↔ Pasteur
Pasteur ↔ Edison

FLOWS OF KNOWLEDGE FROM OUTSIDE THE REGION ARE CRUCIAL IN ALL CASES!
| Comparing the innovation conditions for Type I and Type IV local industrial development pathways |
|-------------------------------------------------------------------------------------------------
| **Creating New Industries** | **Industry Transplantation** | **Diversification (Old to New)** | **Upgrading Existing Industries** |
| **Financing** | Angel/venture capital (private and public); active asset management | | Internal financing, supplier financing, govt. financing for demonstrations |
| **Technology transfer** | Proactive, strategic technology transfer from universities & govt. labs; startup-oriented | | Long-term relationships between universities and established firms |
| **Education and training** | Ph.D.-level scientists and engineers; entrepreneurial business education | | MS-level engineers; faculty-student knowledge of industry practices and business problems. Internships, rotations. |
| **Innovation culture** | Science-driven; entrepreneurial | | Customer-driven; TQM; continuous improvement; ‘best practice’ |
| **Local anchors** | Research universities, Government labs | | Lead firms, Lead customers/users |
| **Leadership in the public space** | Creating an identity (‘evangelism’); standard-setting | | Anticipate/participate in regulatory processes; global scanning for best practice; ‘foresight’ exercises |
University roles in alternative local economic development pathways

I. Creating new industries
   - Forefront science and engineering research
   - Aggressive technology licensing policies
   - Promote/assist entrepreneurial businesses (incubation services, etc.)
   - Cultivate ties between academic researchers and local entrepreneurs
   - Creating an industry identity
     - Participate in standard-setting
     - Evangelists
     - Convene conferences, workshops, entrepreneurs’ forums, etc.

II. Importation/transplantation of industries
   - Education/manpower development
   - Responsive curricula
   - Technical assistance for sub-contractors, suppliers

III. Diversification of existing industries into technologically-related new ones
   - Bridging between disconnected actors
   - Filling ‘structural holes’
   - Creating an industry identity

IV. Upgrading existing industries
   - Problem-solving for industry through contract research, faculty consulting, etc.
   - Education/manpower development
   - Global best practice scanning
   - Convening foresight exercises
   - Convening user-supplier forums
Conclusions

- The university’s role in local economic development should be to **enhance the take-up of technology** by local industry (and other local organizations.)
  - This is more than just pushing technology out the door, ‘technology dissemination’, etc.
  - It also means helping to increase the absorptive capacity of local firms
- University’s economic development strategy needs to be aligned with the particular development/innovation pathways of the industries in the region.
- A one-size-fits-all economic development strategy will not be effective.