Technology Commercialization in Universities -Experiences from China

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Outline

☐ I. Background
☐ II. Overview
☐ III. Universities in China’s innovation system
☐ IV. The first wave of reform
☐ V. The second wave of reform
☐ VI. The case of Tsinghua University
☐ VII. Lessons and future issues
I. Background--Major transformations in 30 years

- Economic system:
  - Central planning => market-based;
  - Sustained high growth (see graph)

- Industrial structure:
  - Agriculture + Manufacturing => high-tech and service industries

- Society:
  - Rural => Urban (urban population: 1982: 20.6% => 2005: 43%)
  - Closed => Open (overseas travel 1998=8.43 million => 2004=28.85 million)

- Governance
  - Personal charisma and authority => broad participation and rule of law

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II. An Overview of Technology Commercialization in Chinese Universities--30 years of experiments

- Reforms and experiments in the innovation system and the university system
  - Reform of the national innovation system
    - Application orientation and enterprise-centered
  - Reform and higher education system
    - Expansion and financial constraints
- Technology commercialization experience: A full cycle of changes with wide range of institutional experiments
  - From traditional to entrepreneurial in the 1980-1990s
  - From the “radical entrepreneurial” to the “moderate entrepreneurial” in the 2000s
    - Licensing, spin-offs, technology alliances and etc.;
    - University-run enterprises
- Learning from the process and developing visions for the future.

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III. Universities in China’s national innovation system

- 1949-early 1980s--Establishment of a centralized system based on the Russian model: Separation of functions and mission orientation;
  - human resources=>universities & technical colleges;
  - basic research=>Chinese Academy of Sciences (CAS);
  - applied research=>ministerial/provincial Research Institutes
  - development=>in house services in enterprises.

- Assessments
  - Great achievements in selected missions (e.g. in defense);
  - Weak linkage to economic development.
IV. The first wave of reform: from traditional to radical entrepreneurial

☐ The innovation system reform in 1980s
   ■ Opening up in the coastal areas and FDI, and the growth of township enterprises=> Market demand for S&T;
   ■ Success in agricultural reform led to reforms in other areas;=> impetus for reform;

☐ The reform strategy
   ■ Creating Incentive regime for R&D organizations to serve for the economic development.
The outcome: Changing pattern of R&D spending

<table>
<thead>
<tr>
<th>Organization</th>
<th>1986 (%)</th>
<th>1997 (%)</th>
<th>2001 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>business</td>
<td>35.3</td>
<td>42.9</td>
<td>60.4</td>
</tr>
<tr>
<td>Research Institutes</td>
<td>60.7</td>
<td>42.9</td>
<td>27.7</td>
</tr>
<tr>
<td>Universities</td>
<td>4.0</td>
<td>12.1</td>
<td>9.8</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>2.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

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The outcome: Characteristics of R&D Work in Chinese R&D Organizations (2001, %)

<table>
<thead>
<tr>
<th>R&amp;D work Organization</th>
<th>Basic research</th>
<th>Applied Research</th>
<th>Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business</td>
<td>0.25</td>
<td>6.6</td>
<td>93.1</td>
</tr>
<tr>
<td>Research Institutes</td>
<td>11.6</td>
<td>27.7</td>
<td>60.6</td>
</tr>
<tr>
<td>Universities</td>
<td>18.6</td>
<td>55.3</td>
<td>26.2</td>
</tr>
</tbody>
</table>
Impacts of the reforms on universities

- Focus shifted from teaching to research
  - Funding opportunities through competitions
- Developed close ties with the industry because:
  - Opportunities due to weak industrial R&D capabilities;
  - Financial need due to funding shortage;
- Ways of engagement with industry:
Technology commercialization—the regular model:
- Technology service (through contracts with Ind.)
  - Close to 80% of R&D spending by universities are non-basic;
- University patenting
  - Close to 1/3 of domestic patents were granted to universities
- University-based science parks:
  - about 40 parks nationwide;

Technology commercialization—the URE model
- Difficulties to transfer technology to the industry;
- Low entry barrier to Jump into the “sea”;
- Policy encouragement
University-run enterprises: a special case

- University-run enterprises:
  - Companies totally owned by universities;
  - Shareholding companies in which universities have shares;
  - Companies started with university money but now have fuzzy ownership.
  - There were 5451 of UREs in 2000 in China.
Growth of university-run enterprises

- Early 1980s-1990==initial development: university-run factory, technology service companies, and JV (1989=470 million yuan);
- 1991-2000==rapid growth: expansion and getting on the stock markets (see tables below)
- 2001-current==Reflection and adjustment: doubts about university-affiliated enterprises and new policy initiatives
Growth of university-run enterprises (1997-2000, billion Y.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales</th>
<th>Profit</th>
<th>Income to University</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>29.55</td>
<td>2.72</td>
<td>1.58</td>
</tr>
<tr>
<td>1998</td>
<td>31.56(6.8)</td>
<td>2.59(-5.6)</td>
<td>1.50(-5.1)</td>
</tr>
<tr>
<td>1999</td>
<td>37.90(20.1)</td>
<td>3.05(18.0)</td>
<td>1.59(6.0)</td>
</tr>
<tr>
<td>2000</td>
<td>48.46(27.9)</td>
<td>4.56(49.5)</td>
<td></td>
</tr>
</tbody>
</table>
## Characteristics of university-run enterprises

<table>
<thead>
<tr>
<th>Enterprise Characteristics</th>
<th># of enterprise</th>
<th>Total Income</th>
<th>Total Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business Orientation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>1995</td>
<td>28.61</td>
<td>2.66</td>
</tr>
<tr>
<td>Trade</td>
<td>849</td>
<td>4.35</td>
<td>0.24</td>
</tr>
<tr>
<td>Others</td>
<td>2607</td>
<td>15.50</td>
<td>1.66</td>
</tr>
<tr>
<td><strong>Ownership Structure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>university</td>
<td>4793</td>
<td>32.18</td>
<td>2.51</td>
</tr>
<tr>
<td>JV with D. partners</td>
<td>556</td>
<td>14.37</td>
<td>1.81</td>
</tr>
<tr>
<td>JV with F. partners</td>
<td>102</td>
<td>1.90</td>
<td>0.24</td>
</tr>
<tr>
<td><strong>Level of Management Control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>4217</td>
<td>45.53</td>
<td>4.38</td>
</tr>
<tr>
<td>School, Department</td>
<td>1234</td>
<td>2.93</td>
<td>0.18</td>
</tr>
</tbody>
</table>
V. The second wave: radical to moderate?

- Reforms in higher education system:
  - Dramatic increase in university enrollment (see graph);
    - Gross enrollment rate
      - 1990=3.7%; 2001=10%; 2005=21%
    - Total enrollment
      - 1998=3.41 million; 2004=13.34 million
Number of University Entrants by Level & Type

- Graduate Education (Unit: Person)
- Undergraduate Education (Unit: in 10 thousand Person)
Consolidation of universities:

- Merging specialized universities and institutes (637) => comprehensive universities (270);

- Delegations of administrative authorities:
  - Universities administrated by different central ministries: 367=>120 (73 national universities by Ministry of Education);
  - The authority of issuing permit to start advanced professional college/associate college is decentralized to provincial government.

- Market-based reform on university infrastructure development and service provision.
Reforms in China’s national innovation system

- China’s S&T reform-2nd phase (since mid 90s)
  - CAS knowledge innovation program
    - Strategic planning process for CAS and for each institute in CAS;
    - Consolidation of research institutes (from a total of over 120 to about 80);
    - Establishment of innovation centers (lean and mean, with high pay and high pressure) within research institutes;
    - .............
Reforming Public Research Institutes - pushing them into the market

- 242 ministerial research institutes were transformed into business entities in 1999 government reform;
- 134 ministerial research institutes followed the path;
- Over 600 provincial research institutes also followed.

Strengthening universities’ R&D capability

- World class university (985)” project
  - Focused support for 2 (Tsinghua and Beida) +9 universities;
- 2<sup>nd</sup> phase of 211 program
  - Focused support for selected centers of excellence in about 100 universities.
Industrial R&D

- Supporting the establishment of R&D centers in major SOEs
  - Close to 300 centers were certified by the central government;
  - Over 2000 centers were certified by provincial governments;
- Supporting small business innovation
  - SME innovation fund;
- Helping MNCs to establish R&D centers in China
  - Over 100 MNC R&D centers were established in Beijing, Shanghai, Guangzhou, Chengdu, etc.
The outcome: Changing pattern of R&D spending

<table>
<thead>
<tr>
<th>Organization</th>
<th>1986 (%)</th>
<th>1997 (%)</th>
<th>2001 (%)</th>
<th>2006 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>business</td>
<td>35.3</td>
<td>42.9</td>
<td>60.4</td>
<td>71.1</td>
</tr>
<tr>
<td>Research Institutes</td>
<td>60.7</td>
<td>42.9</td>
<td>27.7</td>
<td>18.9</td>
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<td>4.0</td>
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<td>9.2</td>
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<td>0</td>
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Resource: Data are collected from “Chinese Technology Statistics Data” by MOST, 2007
## The outcome: Characteristics of R&D Work in Chinese R&D Organizations (2006, %)

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<th>Applied Research</th>
<th>Development</th>
</tr>
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<tr>
<td>Business</td>
<td>0.6</td>
<td>7.6</td>
<td>91.7</td>
</tr>
<tr>
<td>Research Institutes</td>
<td>12.0</td>
<td>34.6</td>
<td>53.5</td>
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<td>25.8</td>
<td>49.6</td>
<td>24.6</td>
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The Outcome: R&D fund and Productivity

<table>
<thead>
<tr>
<th></th>
<th>R&amp;D Total (Billion yuan)</th>
<th>R&amp;D from government (Billion yuan)</th>
<th>Publication</th>
<th>Patent Application</th>
<th>Patent Granted</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>27.7 (9%)</td>
<td>15.2</td>
<td>243,485 (60%)</td>
<td>17,312 (21%)</td>
<td>6,189 (34%)</td>
</tr>
<tr>
<td>Industry</td>
<td>213.4 (71%)</td>
<td>9.7</td>
<td>13,269 (3%)</td>
<td>56,455 (69%)</td>
<td>9,433 (51%)</td>
</tr>
<tr>
<td>Public Research Research Institute[1]</td>
<td>56.7 (19%)</td>
<td>48.1</td>
<td>42,354 (11%)</td>
<td>6,845 (8.5%)</td>
<td>2,553 (14%)</td>
</tr>
<tr>
<td>Others</td>
<td>2.5 (1%)</td>
<td>1.3</td>
<td>14,467 (4%)</td>
<td>873 (1.5%)</td>
<td>216 (1%)</td>
</tr>
<tr>
<td>Total</td>
<td>300.3 (100%)</td>
<td>74.3</td>
<td>404,858[2]</td>
<td>81,485 (100%)</td>
<td>18,400 (100%)</td>
</tr>
</tbody>
</table>

Resource: Data are collected from “Chinese Technology Statistics Data” by MOST, 2007
The impact of reforms on universities

- A gradual shift towards the traditional model of teaching and basic research
  - Intense debates about the university-run enterprises and the rising cases of mis-management of UREs
  - New policies to change from UREs to UOEs
  - Social concerns about teaching quality after expansion;
  - Increased funding to research universities
  - International benchmarking on publications (SCI etc) changes the internal quality criteria;
VI. The case of Tsinghua University

- A leading national university founded in 1911;
  - Student population = 35369 (14285 + 14090 + 6994);
  - 14 schools and 56 departments;

- Leadership in education:
  - A 2007 study on national leadership roles played by Chinese university graduates:
    - Tsinghua led by having educated the most (249)

- Leadership in research:
  - #1 in research budget, awards, and etc.
The institutional arrangement for technology commercialization in Tsinghua University

- R&D Management Department (RDMD);
- University-industry Cooperation Committee (UICC);
- International technology transfer center (ITTC);
- Tsinghua Science Park Co (TusPark);
- Tsinghua Holding Co.
RDMD

- Founded in 1983. In addition to regular responsibility for sponsored research, the following was included:
  - To coordinate collaborations between Tsinghua University and regional governments;
  - To facilitate collaborations between Tsinghua and business partners;

- Technology transfer model:
  - Technology transfer contract
  - Research collaboration foundation
  - Regional research and development institute
    - Shenzhen, zhejiang, and hebei.
  - Joint research labs.
UICC

- Founded in 1995 with 180 domestic and multinational industry members by 2006

- Goals:
  - Encourage research collaboration
  - Technology Transfer

- Collaboration model:
  - Member seminars and meetings
  - Joint research institutes
  - Investment on technology development
ITTC

- A professional technology transfer center;
- Certificated by MOE and MOST in 2001
- Operate through a commercial entity: Coway International Tech Trans Co., Ltd. (2002);
- Commercializing not only Tsinghua’s technology, also helping to facilitate the commercialization of technologies from other countries.
TusPark

- The mission of Tsinghua University Science park (TusPark):
  - to facilitate technology commercialization, foster creative talents, and providing services to high-tech R&D.

- History of TusPark:
  - In 1993, Tsinghua University’s proposal to start a science park in the heart of Zhongguancun area was approved by Beijing and construction began in 1994;
  - In 1998, the first phase of construction of 120,000 M2 was completed;
  - By 2000, the second phase of construction started. Registered firms in the Park reached 200;
  - By 2005, all the construction work of 690,000 M2 was finished and fully occupied.
Management:
- managed by Tsinghua Science Park Co., Ltd., which is a joint venture between Tsinghua Holding and other high-tech companies;
- 3 major areas for over 100 different companies:
  - Main Area: mixed service companies and high-tech MNCs;
  - Innovation Park: high-tech incubators for start-ups;
  - Returned Students Pioneer park: for students returned from overseas;
- 10 division parks around China;
- It was the only level A university science park recognized in China by the Ministry of Science and Technology and Ministry of Education.
Tsinghua Holdings: URE⇒UOE

- 2001, State Council policy:
  - “Suggestions on standardizing university-owned enterprise management trial using Peking University and Tsinghua University as trial cases”

- 2003, Tsinghua Holdings. Co. Ltd. was established to manage the assets of Tsinghua University. The following steps were taken:
  - The total assets owned by Tsinghua University as of Dec. 31st, 2001 was valued as 2.71 billion Yuan;
  - Liquidation of all the operating assets of the university and transferred them all into the holding company;
  - University administrators gradually withdraw from their management positions in Tsinghua Holding Co Ltd;
  - For the 42 companies owned by Tsinghua University, they were either merged into Tsinghua Holding Co. Ltd, or being dismissed.
VII. Lessons and future issues

- The roles of universities are defined not only by its internal logic but also by the external environments;
- There is a delicate balance between the academic and entrepreneurial model; the two are not mutually exclusive;
- Future issues:
  - What is the intrinsic comparative advantages of universities over other forms of organizations?
  - What should be the roles of universities in NIS in a developing country like China? Do they play different roles compared with their peers in developed countries?
  - What are proven practice/policies in supporting technology commercialization in universities?
Thank you!