The Impact of Technology Transfer Office on Knowledge Transfer
-Evidence from Natural Experiment in Japan-

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My Background: Kanetaka Maki

Present: Academic

Ph.D Candidate in Management
Innovation & Entrepreneurship
Economics of Innovation
Economics of Science
University-Industry Technology Transfer

Past: Practitioner

Keio University
Founding Chief Officer, Keio SIV Entrepreneur Laboratory

Professional Service:
- Academic Entrepreneurship Committee (hosted by METI)
- Committee member for university incubation
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Motivation

• End of 1990s: Japan was considered to be trailing the US in university-technology transfer.
• Japanese government introduced to new national innovation system in late 1990s, using the US system as a model.
• The center pillar of the transformation was the launch of Technology Transfer Office (TTO).

• After the transformation, is the new national innovation system in Japan working effectively?
The Role of TTO
Multiple Pathways of University-Industry Technology Transfer

- Licensing (TTO)
- Research (Publications)
- Joint Research
- Start-ups
- Consulting
- Education
- Co-authoring
Anecdotal Evidence Among Practitioners

• Advocates of TTOs (mostly by university and policymakers)
  – The establishment of TTO system in 1998 was the starting point of university-industry technology transfer in Japan.

• Critics of TTOs (mostly by industry)
  – TTO caused the university to become too aggressive in owning patents.
  – The transaction cost for negotiating joint contract increased.
  – As a result, university-industry technology transfer became more difficult.

We examine the data to see if we can discern a pattern.
Tech Transfer in Japan: Prior to Reform

1. Strong belief that academia must be independent from industry existed.
2. National university professors were not allowed to receive compensation from industry, or be involved in side business.
3. National universities were not allowed to own patents.
4. University facilities were open to public under supervision of professors.
## Innovation Policy in Japan

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
</table>
| 1998 | Formulation of the Act on the Promotion of Technology Transfer from Universities to Private Industry (the TTO Act)  
Amendment of the Law for Facilitating Governmental Research Exchange |
| 1999 | Creation of the Small Business Innovation Research Program (“Japanese SBIR”)  
Formulation of the Act on Special Measures for Industrial Revitalization (Japanese version of the Bayh–Dole Act)  
Establishment of the Japan Accreditation Board for Engineering Education (JABEE) |
| 2000 | Formulation of the Industrial Technology Enhancement Act |
| 2001 | “Hiranuma Plan” announced “Plan for 1,000 university-originated ventures in three years” |
| 2002 | Revision of the Ministry of Finance Property Administration Bureau Notification No. 1  
Revision of the TLO Law Notification |
| 2003 | Formulation of the Intellectual Property Basic Act |

Revised based on http://www.rieti.go.jp/jp/publications/nts/11e008.html
TTO Act

• Incentivized or Mandatory?
  – METI incentivized universities with subsidies to launch the TTO.
  – METI explicitly guided particular universities to launch the TTO.
  – Many universities believed that creating the TTO was a new source of income, necessary for economic sustainability.
<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>December, 1998</td>
<td>Univ Tokyo, Tohoku Univ, Kyoto Univ, Kyoto Inst Technol, Nihon Univ, Yamagata Univ, Nara Inst Sci &amp; Technol, Ritsumeikan Univ, Iwate Univ, Doshisha Univ, Hirosaki Univ, Akita Univ, Ryukoku Univ</td>
</tr>
<tr>
<td>April, 1999</td>
<td>Univ Tsukuba, Waseda Univ</td>
</tr>
<tr>
<td>August, 1999</td>
<td>Tokyo Inst Technol, Keio Univ</td>
</tr>
<tr>
<td>December, 1999</td>
<td>Hokkaido Univ, Yamaguchi Univ, Muroran Inst Technol</td>
</tr>
<tr>
<td>April, 2000</td>
<td>Nagoya Univ, Kyushu Univ, Kobe Univ, Nagoya Inst Technol, Toyohashi Univ Technol, Toyama Univ, Gifu Univ, Kwansei Gakuin Univ, Toyama Prefectural Univ</td>
</tr>
<tr>
<td>June, 2000</td>
<td>Tokyo Denki Univ</td>
</tr>
<tr>
<td>September, 2000</td>
<td>Yamanashi Univ</td>
</tr>
<tr>
<td>December, 2000</td>
<td>Tokyo Metropolitan Univ, Univ Electrocommun, Hosei Univ, Toyo Univ, Kogakuin Univ</td>
</tr>
<tr>
<td>April, 2001</td>
<td>Yokohama Natl Univ, Univ Tokushima, Ehime Univ, Yokohama City Univ, Meiji Univ</td>
</tr>
<tr>
<td>August, 2001</td>
<td>Osaka Univ, Univ Osaka Prefecture, Osaka City Univ, Kumamoto Univ, Kansai Univ, Kinki Univ</td>
</tr>
<tr>
<td>December, 2001</td>
<td>Tokyo Univ Agr &amp; Technol, Niigata Univ, Nagaoka Univ Technol</td>
</tr>
<tr>
<td>January, 2002</td>
<td>Univ Shizuoka, Shizuka Univ</td>
</tr>
<tr>
<td>April, 2002</td>
<td>Kyushu Inst Technol, Mie Univ, Fukuoka Univ</td>
</tr>
<tr>
<td>December, 2002</td>
<td>Kanazawa Univ</td>
</tr>
<tr>
<td>February, 2003</td>
<td>Kagoshima Univ</td>
</tr>
<tr>
<td>April, 2003</td>
<td>Shinshu Univ</td>
</tr>
<tr>
<td>May, 2003</td>
<td>Miyazaki Univ</td>
</tr>
<tr>
<td>September, 2003</td>
<td>Sci Univ Tokyo</td>
</tr>
<tr>
<td>October, 2003</td>
<td>Hiroshima Univ</td>
</tr>
<tr>
<td>December, 2003</td>
<td>Shimane Univ</td>
</tr>
<tr>
<td>April, 2004</td>
<td>Okayama Univ, Okayama Univ Sci, Konan Univ</td>
</tr>
</tbody>
</table>
Tech Transfer in Japan: Present

1. Government and universities promote tech. transfer (change in belief).
2. UIC now requires formal organizational procedure with contract.
3. TTO manages intellectual property.
Hypotheses

Based on anecdotal evidence and a theoretical model, we formulated two hypotheses.

- **Hypothesis 1:** The reform to new University-Industry Collaboration model is expected be associated with an increase in joint research between universities and firms, because the incentives for researchers to collaborate increased.

- **Hypothesis 2:** TTO activity could be negatively associated with the quantity of joint research between university and firm researchers, because the transaction costs increased.

We now test our hypotheses using data collected based on a unique dataset from a natural experiment in Japan.
Research Design

• Universities in Japan were “forced” to reform to the new system and to create a TTO by government policy, representing an exogenous shock from new policy implementation – natural experiment (Harrison and List, 2004).

• Using balanced panel dataset, we analyze the impact of policy change on joint research.

• Co-authorship of academic articles between universities and firms is used as the indicator of joint research (Zucker, Darby and Brewer, 1998)
  – Novel science discoveries are by nature tacit knowledge, and therefore not patentable.
  – New discoveries have characteristics of natural-excludability. They are transferable only through bench-science level collaboration.
  – Co-authoring per se is the process of transferring tacit knowledge.
Dataset

Nanobank
- Zucker and Darby (2007)
- Data in nanotechnology
- Articles, patents, and grants
- Title, journal, author, and organizations
- The dataset includes a unique identifier for the organization

TTO Characteristics
- Year of TTO establishment
- # of patent application by each TTO

Trend of Nanotech Research
- Database of Grants-in-Aid for Scientific Research <KAKENHI>
- # of PIs & total budget (per inst/year)

Balanced Panel Dataset
- Aggregating dataset above
- Time span: 1994-2004 (11 years)
- Top 100 universities by the volume of research
Trend of Nanotechnology

Total Number of Articles Published

Based on Nanobank. Universities and firms in Japan are identified by the address.
Empirical Model

\[ \log(\text{CoAuthoring}_{it}) = \beta_0 + \beta_1 \text{NewTT}_{it} + \beta_2 \text{TTO}_{it} + \beta_3 \text{RESEARCH}_{it} + \]
\[ \beta_4 \text{PI}_{i,t-2} + \beta_5 \log(BUDGET_{i,t-2}) + \delta_t + \alpha_i + U_{it} \]
Result

\[ \log(\text{CoAuthoring}_{it}) = \beta_0 + \beta_1 \text{NewTT}_{it} + \beta_2 \text{TTO}_{it} + \text{Control} + U_{it} \]

0.202

-0.0578

Figure: Effect of Reform

Figure: Effect of Activeness of TTO
Case Study: Univ. of Tokyo

Change Rate of Collaboration

NewTT x 20.2 % + TTO x (-5.78%)

For the University of Tokyo, in 2002, 4 patents were applied in the US. The marginal effect of NewUIC\textsubscript{it} and TTO\textsubscript{it} is -2.92%.
Result

• The data seems to confirm that
  – the reform to new UIC is associated with an increase of joint research between universities and firms (hypothesis 1 confirmed)
  – the activeness of TTO is negatively associated with the quantity of joint research between universities and firms (hypothesis 2 confirmed)

The amount of joint research in universities with active TTOs is actually decreasing.
Discussion

• Does this mean that TTO is an obstacle for UIC?
  – No. What we found in this analysis is that patent activities and co-authoring are the tradeoffs.
  – Multiple pathway of technology transfer is necessary. TTO is definitely the one, but must be appropriately managed.

• Does this apply to other research fields besides nanotechnology?
  – Probably yes. We controlled the trend of nanotechnology. Further investigation is necessary for validation.
Policy Implication

• Formal ties and Informal ties (cf. Walsh et al. 2008)
  – Transformation of national innovation system was the process of moving from informal ties to formal ties.
  – Existence of informal ties is still necessary after the transformation.

  allowing joint research without formal contract

• TTO as a Dual Agent (cf. Jensen et al. 2003, Ueyama 2013)
  – TTO is the dual agent of university administration and researchers.
  – Some TTO seems acting as the agent of university administration rather than agent of researchers.

  alignment of objectives between TTOs and researchers
Thank you.

More information is available in our paper.  
Additional Slides
## Summary Statistics

<table>
<thead>
<tr>
<th>Category</th>
<th>count</th>
<th>mean</th>
<th>sd</th>
<th>min</th>
<th>max</th>
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</thead>
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<td>Joint Research between Univ &amp; Firms</td>
<td>1100</td>
<td>4.36</td>
<td>9.23</td>
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<td>0.0</td>
<td>12</td>
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<td>1246</td>
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<td>7.10</td>
<td>0.0</td>
<td>84</td>
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<td>0.0</td>
<td>26776</td>
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<td>Research Conducted Internally</td>
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<td>0.0</td>
<td>265</td>
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<td>1.62</td>
<td>6.63</td>
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<tr>
<td>Joint Research by Junior Researcher</td>
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<td>14.04</td>
<td>29.04</td>
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<td>262</td>
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</tbody>
</table>

Summary statistics for the top 100 universities for years 1994-2004. Sample was attained from Nanobank, COMET and KAKENHI database.
Top 100 Universities with the Volume of Research

<table>
<thead>
<tr>
<th>University Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ Tokyo* , Tohoku Univ* , Osaka Univ* , Kyoto Univ* , Tokyo Inst Technol* , Nagoya Univ* , Hokkaido Univ* , Kyushu Univ* , Univ Tsukuba* , Hiroshima Univ* , Sci Univ Tokyo , Waseda Univ , Chiba Univ* , Univ Osaka Prefecture , Tokyo Metropolitan Univ , Keio Univ , Kobe Univ* , Nagoya Inst Technol* , Tokyo Univ Agr &amp; Technol* , Univ Electrocommun* , Osaka City Univ , Yokohama Natl Univ* , Toyohashi Univ Technol* , Sinshu Univ* , Kyushu Inst Technol* , Okayama Univ* , Kyoto Inst Technol* , Niigata Univ* , Univ Tokushima* , Yamaguchi Univ* , Gunma Univ* , Univ Shizuoka , Kanazawa Univ* , Saitama Univ* , Kumamoto Univ* , Mie Univ* , Nagaoka Univ Technol* , Meijo Univ , Nihon Univ , Shizuoka Univ* , Yamagata Univ* , Nara Inst Sci &amp; Technol* , Nagasaki Univ* , Toyama Univ* , Grad Univ Adv Studies* , Gifu Univ* , Kagoshima Univ* , Natl Def Med Coll , Ritsumeikan Univ , Fukui Univ* , Tokai Univ , Sophia Univ , Ibaraki Univ* , Ehime Univ* , Kwansei Gakuin Univ , Yamanashi Univ* , Kansai Univ , Saga Univ* , Kinki Univ , Ochanomizu Univ , Utsunomiya Univ* , Iwate Univ* , Nara Womens Univ* , Tottori Univ* , Univ Aizu , Doshisha Univ , Yokohama City Univ , Tokyo Med &amp; Dent Univ* , Shimane Univ* , Toho Univ , Muroran Inst Technol* , Hirosaki Univ* , Kanagawa Univ , Gakushuin Univ , Okayama Univ Sci , Aoyama Gakuin Univ , Musashi Inst Technol , Akita Univ* , Fukuoka Univ , Chuo Univ , Hosei Univ , Tokyo Denki Univ , Toyo Univ , Osaka Electrocommun Univ , Kitasato Univ , Meiji Univ , Tokyo Metropolitan Inst Neurosci , Kochi Univ* , Univ Ryukyu* , Konan Univ , Akita Prefectural Univ , Seikei Univ , Iwaki Meisei Univ , Tokyo Womens Med Univ , Kogakuin Univ , Teikyo Univ , Toyama Prefectural Univ , Toin Univ Yokohama , Miyazaki Univ* , Chubu Univ</td>
</tr>
</tbody>
</table>

* National Universities
Empirical Methodology

\[
\log(\text{CoAuthoring}_{it}) = \beta_0 + \beta_1 \text{NewUIC}_{it} + \beta_2 \text{TTO}_{it} + \beta_3 \text{RESEARCH}_{it} + \\
\beta_4 \text{PI}_{it-2} + \beta_5 \log(\text{BUDGET}_{it-2}^{\gamma}) + \delta_t + \alpha_i + U_{it}
\]

Unit: individual universities per year

- **CoAuthoring<sub>it</sub>**: the amount of joint research between univ. and firms, measured by # of co-authored papers (monotonic transformation, logarithm)
- **NewUIC<sub>it</sub>**: reform to new university-industry collaboration model, measured by launch of TTO (dummy variable)
- **TTO<sub>it</sub>**: activeness of TTO, measured by the # of patents granted in the US
- **RESEARCH<sub>it</sub>**: the volume of research, measured by # of published articles
- **PI<sub>it</sub>**: the number of researchers, measured by the # of principal investigators for granted projects (2 years lag)
- **BUDGET<sub>it</sub>**: the total budget for granted projects (monotonic transformation, logarithm, 2 years lag)
- **\(\delta_t\)**: time variable
- **\(\alpha_i\)**: unobservable individual characteristics (size, reputation etc.)

difference-in-difference estimation using OLS; robust standard errors
## The Impact of TTO on the Amount of Joint Research (OLS)

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New UIC Model</strong></td>
<td>0.893***</td>
<td>0.740***</td>
<td>0.183***</td>
<td>0.199***</td>
<td>0.202***</td>
</tr>
<tr>
<td></td>
<td>(0.0717)</td>
<td>(0.0682)</td>
<td>(0.0479)</td>
<td>(0.0551)</td>
<td>(0.0557)</td>
</tr>
<tr>
<td><strong>Activeness of TTO</strong></td>
<td>0.375***</td>
<td>-0.0915*</td>
<td>-0.0975*</td>
<td>-0.0578**</td>
<td></td>
</tr>
<tr>
<td>( x New UIC Model)</td>
<td>(0.0504)</td>
<td>(0.0496)</td>
<td>(0.0506)</td>
<td>(0.0251)</td>
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<tr>
<td><strong>Total # of Article</strong></td>
<td>0.00586***</td>
<td>0.00587***</td>
<td>0.00198***</td>
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<tr>
<td></td>
<td>(0.000589)</td>
<td>(0.000607)</td>
<td>(0.000389)</td>
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<tr>
<td><strong># of PI (2 yrs lag)</strong></td>
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<td>-0.0967***</td>
<td>-0.0358***</td>
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<td></td>
<td>(0.0160)</td>
<td>(0.0166)</td>
<td>(0.00979)</td>
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<tr>
<td><strong>Total Budget (log / 2 yrs lag)</strong></td>
<td>0.149***</td>
<td>0.151***</td>
<td>0.0263**</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.0105)</td>
<td>(0.0108)</td>
<td>(0.0106)</td>
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<tr>
<td><strong>Constant</strong></td>
<td>0.774***</td>
<td>0.738***</td>
<td>0.446***</td>
<td>0.454***</td>
<td>0.601***</td>
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<tr>
<td></td>
<td>(0.0304)</td>
<td>(0.0293)</td>
<td>(0.0243)</td>
<td>(0.0640)</td>
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<td><strong>Observations</strong></td>
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<td>1,100</td>
<td>1,100</td>
<td>1,100</td>
</tr>
<tr>
<td><strong>R-squared</strong></td>
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<td>0.242</td>
<td>0.622</td>
<td>0.624</td>
<td>0.274</td>
</tr>
<tr>
<td><strong>Number of CODE</strong></td>
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<td></td>
<td>100</td>
</tr>
<tr>
<td><strong>Time Dummies</strong></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td><strong>Fixed Effect</strong></td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses  *** p<0.01, ** p<0.05, * p<0.1  
The dependent variable is the amount of co-authoring(logarithm), measured by co-authorship between universities and firms. Top 100 universities are included for 1994-2004. (1) Pooled OLS with the existence of TTO as an explanatory variable. (2) Pooled OLS with explanatory variable of PATENT_US added. (3) Pooled OLS with control variables added. (4) Pooled OLS with time dummies controlled. (5) Fixed effect OLS.
## Comparison Between Senior & Junior Researchers

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Senior Researchers (log)</th>
<th>(2) Junior Researchers (log)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reform to NewUIC</td>
<td>0.148***</td>
<td>0.244***</td>
</tr>
<tr>
<td></td>
<td>(0.0505)</td>
<td>(0.0914)</td>
</tr>
<tr>
<td>Activeness of TTO</td>
<td>0.00267</td>
<td>-0.0612</td>
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<td>(0.0228)</td>
<td>(0.0412)</td>
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<td>Total # of Article</td>
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<td>0.00248***</td>
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<td>(0.000353)</td>
<td>(0.000639)</td>
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<tr>
<td># of PI (2 yrs lag)</td>
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<td>-0.0568***</td>
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<tr>
<td></td>
<td>(0.00887)</td>
<td>(0.0161)</td>
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<tr>
<td>Total Budget (log / 2 yrs lag)</td>
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<td>0.0510***</td>
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<td>(0.00958)</td>
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<td>0.986***</td>
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<td>Observations</td>
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<td>1,100</td>
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<td>R-squared</td>
<td>0.258</td>
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</table>

Standard errors in parentheses  *** p<0.01, ** p<0.05, * p<0.1  
The top 100 universities are included for 1994-2004. Fixed effect and time dummies are controlled. (1) The dependent variable is co-authoring between universities and firms by senior researchers. (2) The dependent variable is co-authoring between universities and firms by junior researchers.
Production of Trust (Zucker, 1986)

• Conducting joint research requires trust between researchers at universities and firms.
  – process-based (trust tied to past or expected exchange)
  – characteristics-based (trust tied to person)
  – institutional-based (truest tied to formal societal structures)

• The traditional Japanese model for joint research was based on process-based trust (long-term relationships).
• The creation of TTO aims to create institutional trust (intermediary).

• Senior researchers may rely on process-based trust.
• Junior researchers lack experience and process-based trust, and may benefit from the TTO as intermediary to promote UIC.
Summary of My Presentation

• Technology Transfer Office (TTO) is recognized as one of the fundamental functions of national innovation system.

• Long running dispute exists between proponents and opponents of TTO.

• Our preliminary result from a natural experiment in Japan demonstrates that the creation of TTO may adversely impact joint publications between universities and firms, if not properly managed.
Critics of TTO in the US

• Strong belief on the part of industry (80%) that universities are exercising their intellectual property rights too aggressively. The attitude of TTO has led some firms to completely avoid working with TTOs. (Siegel et al., 2003)

• Multiple pathways for university transfer exist. Multiple pathways increase the volume of the entire technology transfer, and ultimately increase the impact of innovation. However, TTOs behave as revenue maximizers and do not have an incentive to increase the volume. (Litan et al., 2008)
TTO and Other Pathways

• Most faculty members estimate that patents account for less that 10% of whole university-industry technology transfer. (Agrawal and Henderson, 2002)

• Patenting is not a substitute for fundamental research, but more likely a complimentary activity. (Agrawal and Henderson, 2002)

• The key channels through which university research impacts industrial R&D are related to “open science”, including published papers and reports, public conferences and meetings, informal information exchange, and consulting. (Cohen et al., 2002)

• Licensing, cooperative ventures, or the hiring of recent graduate has small importance overall. (Cohen et al., 2002)

• Knowledge spillovers occur when joint research such as co-authoring the articles is conducted. (Zucker et al., 2000)
The Role of TTO

• The TTO aims to promote collaboration between university and industry, *potentially* playing several roles:
  – investigating potential research that can be commercialized
  – applying for patents on newly created innovations
  – licensing patents to industry
  – earning profits for the university and individual researchers.
The TTO Act

- The TTO Act created guidelines and processes for universities to set up TTO.
- According to the new law, launching a TTO involved the following steps:
  - University decides to create a TTO
  - University proposes a plan to the Ministry of Economy, Trading, and Industry (METI) for approval
  - METI grants permission based on the validity of the plan
  - Based on approval, the university launches the office.
- Incentivized or Mandatory?
  - METI incentivized universities with subsidies to launch the TTO.
  - METI explicitly guided particular universities to launch the TTO.
  - Many universities believed that creating the TTO was a new way of income, necessary for economic sustainability.
Appropriate Organizational Design

• Siegel et al. (2003): The TTO is protecting intellectual property too aggressively. Firms may avoid working with universities.

• Litan et al. (2007): The TTO may behave like a monopolistic intermediary, maximizing licensing revenue and lacking an incentive to promote publishable research.

• The negative association between the activity of TTO and the amount of joint research suggests that an appropriate organizational design of the TTO is necessary to increase the total volume of joint research.