# Understanding the Technology Market for Patents: New Insights from a Licensing Survey of Japanese Firms

Masayo Kani

Faculty of Economics, Tezukayama University

Kazuyuki Motohashi

Dept. of Technology Management for Innovation (TMI), School of Engineering, University of Tokyo, and RIETI

# Research Motivation

- Pro-patent policy reforms in Japan
- Open innovation era (growing external collaborations in R&D)
- But, re-orientation of patent market place services (Nine-sigma, yet2.com, etc.)

⇩
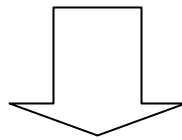
- Need deeper understanding on technology market for patents
- Particularly, what kind of factors are relevant to market imperfections (for policy implications)

# Substantial number of willing to license, but not license patents: why?

A: Technology market imperfections

Condition for well functioning market (Roth, 2008; Gans and Sterm 2010)

1.  Market safety
    *   Patent system (strength of IP in invention appropriation)
    *   Information asymmetry between licensor and licensee (science based invention, generality of technology…)

2.  Market thickness
    *   Patented technology: heterogeneity in nature, strategic patenting (balancing between patent and know-how)
    *   Same technology but difference in value by owner

3.  Lack of congestion
    *   Multiple sellers and buyers with series of bilateral non-disclosure agreement

# Other factors

(Licensors: supply side factors)

•"Revenue" or "Rent dissipation" effects: complementally assets, product market competition (Arora and Fosfuri, 2003; motohashi, 2008)

(Licensees: demand side factors)

•Absorptive capacity (Cohen and Levinthal, 1990)

•NIH syndrome

(Other factors)

•Industry characteristics (discrete or complex innovation) (Merges and Nelson, 1990)

•Cross licensing in semiductor (Grindley and Teece, 1997)

# Datasets

- Firm level datasets: Linked data with JPO's Survey of IP Activities, IIP-Patent database and U of Tokyo Licensing Survey (vs. patent level datasets in Gambardella et. al , 2007)

- Cross section data for 2006, about 1,000 firms

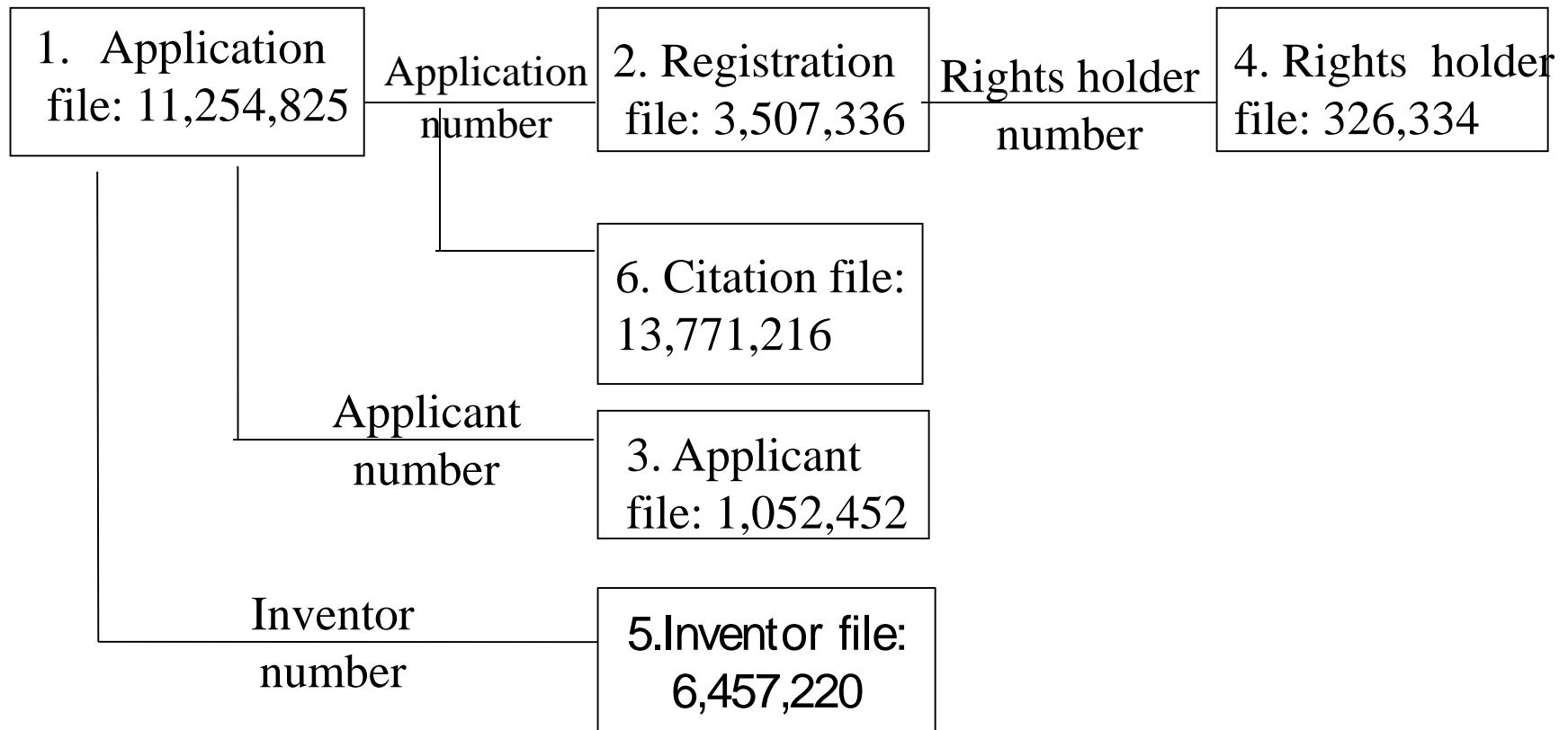# JPO's Survey on IP related activities (SIPA)

- Started in 2002 (for 2001 activities), data are available annually until 2010 (for 2009 data)
- 5,000-6,000 samples out of 16,000 mailing lists
- Survey items
  - IPR applications information
  - IPR stocks and its usage
  - Information on IPR section at firm
  - IP related infringement

# SIPA: Survey instrument

| Item | Patent rights | | Utility Model rights | Design rights | | Trademark rights | |
|---|---|---|---|---|---|---|---|
| | Number of domestic rights*19 | Number of foreign rights*19 | Number of domestic rights*19 | Number of domestic rights*19 | Number of foreign rights*19 | Number of domestic rights*19 | Number of foreign rights*19 |
| Number of rights owned *20 | | | | | | | |
| Number of rights used *21 | | | | | | | |
| Number of rights exploited by owner *22 | | | | | | | |
| Number of rights licensed to other companies *23 | | | | | | | |
| Percentage of rights licensed to other companies under a cross-license *24 | % | % | % | | | | |
| Percentage of rights licensed to other companies in consideration of royalties *25 | % | % | % | | | | |
| Percentage of rights licensed to other companies under a patent pool *26 | % | % | % | | | | |

# Patent Database in Japan

- IIP Patent Database (http://www.iip.or.jp/patentdb/index.html)
- Up to 2011 March publication data are available as a beta version
- NBER Patent Data like public database using JPO patent publication information

```
1. Application          Application    2. Registration      Rights holder    4. Rights  holder
   file: 11,254,825      number         file: 3,507,336      number           file: 326,334


                                        6. Citation file:
                                        13,771,216


                        Applicant       3. Applicant
                        number          file: 1,052,452


                        Inventor        5.Inventor file:
                        number          6,457,220
```

# Licensing Activity Survey: U of Tokyo

◆ Joint effort with OECD and EPO
◆ Samples: 5000 firms, out of 2006 patent applicant list from JPO (only company applicants, 2 or more patent applications)
◆ Survey period: 2007.10.20 -  11.20
◆ Response rate: 33.7%  (1640/4873)
◆ Survey items
• Patent propensity, appropriability importance
• Licensing activities
• Qualitative information on licensing failure

# Variables in regression models (1)

## Dependent variables:

| # of patents for which there is a willingness to license | | # of patents for which there is no willingness to license |
|---|---|---|
| Actually licensed | Not actually licensed | |

Total number of patents owned by a firm

LICENSE = The share of the number of actually licensed patents to the total number of patents owned

POTENTIAL = The share of the number of not actually licensed patents to the total number of patents owned

# Variables in regression models (2)

Technology market variable:

- Degree of patent right enforcement
  - PROETCTION: Order of "patent" as a tool for appropriating rents from invention (1-4): LAS
- Degree of information asymmetry
  - SCIENCE: average # of paper citation: IIP-PD
- Transaction cost : LAS
  - PARTNER: finding partner is difficultz(LAS)
  - NEGOTHIATE: drafting and negotiate contract is difficult (LAS)

# Variables in regression models (3)

## Supply side factors:

- Tech-Comp: HHI by patent holding in each IPC subgroup. (IIP-PD)
- Firm size: EMP (number of employees) (SIPA)
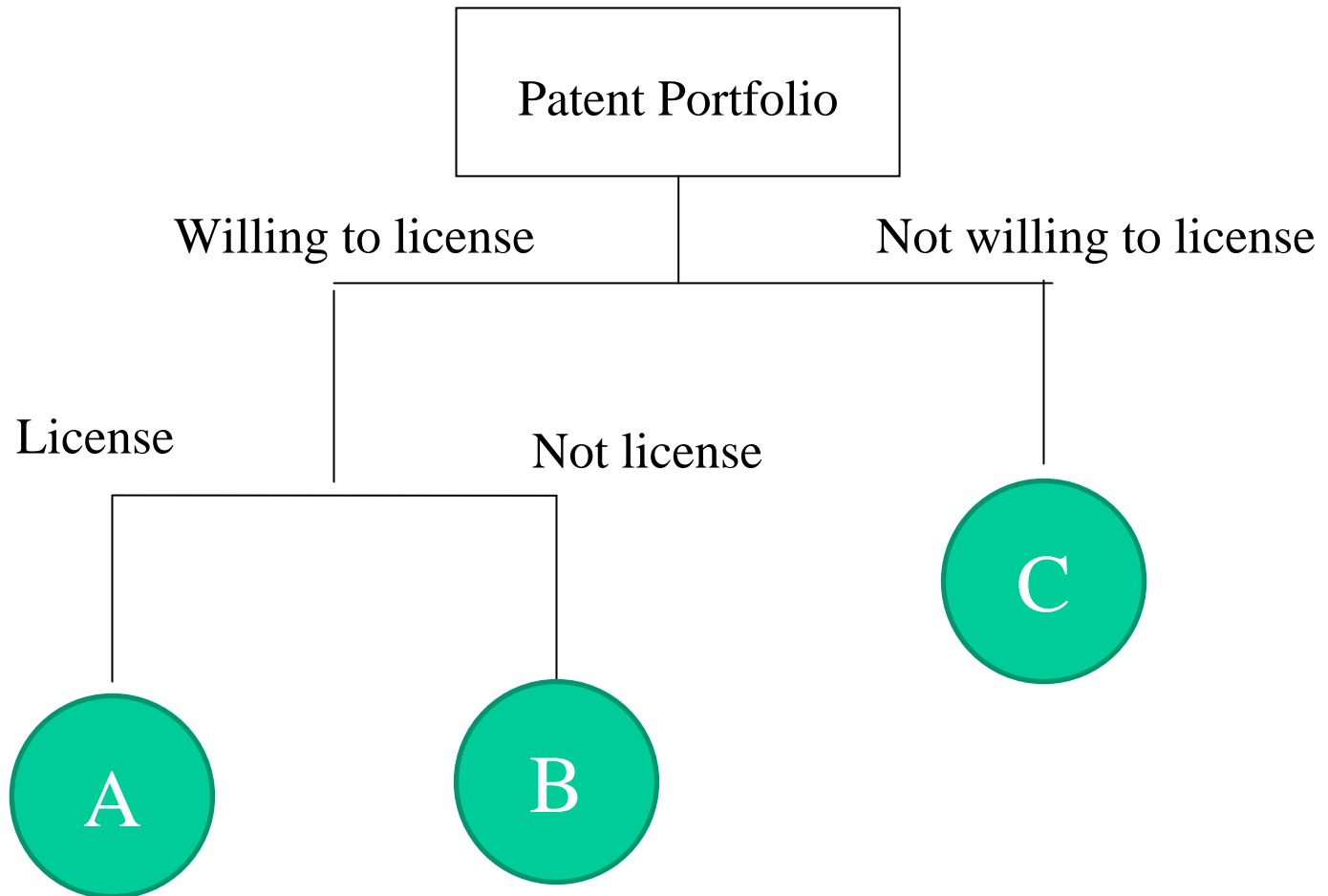- Specialized RD: dummy variable for high-tech start-ups (SIPA)

## Demand side factors;

- Number of forward citations: potentiality for licensing (IIP-PD)

## Other factors

- The share of license in (out) from (to) affiliated companies: AFFIL
- Industry dummies

# Analytical Framework

# Descriptive statitics

**Table 1**
Descriptive statistics.

| Variable | Data source | | A (296) | | B (260) | | C (80) | |
|---|---|---|---|---|---|---|---|---|
| | | | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| WILL | Dummy | SIPA&LAS | 1 | 0 | 1 | 0 | 0 | 0 |
| LICENSE | Value | SIPA | 0.121 | 0.197 | 0 | 0 | 0 | 0 |
| POTENTIAL | Score | LAS | 1.922 | 1.566 | 1.396 | 1.550 | 0 | 0 |
| PROTECT | Score | LAS | 3.459 | 0.731 | 3.327 | 0.822 | 3.250 | 0.974 |
| SCIENCE | Value | IIPDB | 0.239 | 0.657 | 0.120 | 0.424 | 0.052 | 0.171 |
| PARTNER | Score | LAS | 1.611 | 1.093 | 1.615 | 1.005 | 0 | 0 |
| NEGOTIATE | Score | LAS | 0.655 | 0.853 | 0.904 | 0.935 | 0 | 0 |
| TECH-COMP | Value | IIPDB | 0.938 | 0.042 | 0.940 | 0.036 | 0.934 | 0.049 |
| CITED | Value | IIPDB | 1.956 | 1.828 | 1.527 | 1.123 | 1.575 | 1.269 |
| EMP | Value | SIPA | 2217 | 4412 | 558 | 523 | 778 | 3408 |
| RD | Dummy | SIPA | 0.024 | 0.152 | 0.008 | 0.088 | 0.013 | 0.112 |
| AFFIL80-100 | Dummy | LAS | 0.355 | 0.479 | 0 | 0 | 0 | 0 |
| AFFIL60-80 | Dummy | LAS | 0.051 | 0.220 | 0 | 0 | 0 | 0 |
| AFFIL40-60 | Dummy | LAS | 0.051 | 0.220 | 0 | 0 | 0 | 0 |
| AFFIL20-40 | Dummy | LAS | 0.051 | 0.220 | 0 | 0 | 0 | 0 |
| AFFIL0-20 | Dummy | LAS | 0.493 | 0.501 | 0 | 0 | 0 | 0 |
| CROSS80-100 | Dummy | LAS | 0.078 | 0.268 | 0 | 0 | 0 | 0 |
| CROSS60-80 | Dummy | LAS | 0.020 | 0.141 | 0 | 0 | 0 | 0 |
| CROSS40-60 | Dummy | LAS | 0.051 | 0.220 | 0 | 0 | 0 | 0 |
| CROSS20-40 | Dummy | LAS | 0.051 | 0.220 | 0 | 0 | 0 | 0 |
| CROSS0-20 | Dummy | LAS | 0.801 | 0.400 | 0 | 0 | 0 | 0 |

*Note*: Values in parentheses are the number of firms in Groups A, B, and C.

# Estimation of licensing propensity

**Table 2**
Estimation of licensing propensity: the Tobit model and the double-hurdle model.

| Dependent var. | (1) | (2) | |
|---|---|---|---|
| | LICENSE | WILL | LICENSE |
| PROTECT | 0.036 (0.012)*** | 0.026 (0.014)* | 0.015 (0.007)** |
| SCIENCE | −0.008 (0.023) | 0.130 (0.032)*** | −0.001 (0.017) |
| PARTNER | −0.014 (0.01) | | 0.010 (0.01) |
| NEGOTIATE | −0.015 (0.012) | | 0.007 (0.009) |
| TECH-COMP | 0.654 (0.247)*** | 0.407 (0.274) | 0.271 (0.16)* |
| CITED | 0.004 (0.007) | 0.008 (0.007) | 0.006 (0.005) |
| log(EMP) | −0.031 (0.009)*** | 0.041 (0.014)*** | −0.019 (0.008)** |
| RD | −0.011 (0.105) | 0.056 (0.092) | −0.005 (0.084) |
| AFFIL80-100 | 1.354 (0.174)*** | | 0.130 (0.017)*** |
| AFFIL60-80 | 1.356 (0.17)*** | | 0.109 (0.026)*** |
| AFFIL40-60 | 1.347 (0.17)*** | | 0.143 (0.042)*** |
| AFFIL20-40 | 1.335 (0.165)*** | | 0.122 (0.02)*** |
| AFFIL0-20 | 1.367 (0.166)*** | | 0.159 (0.016)*** |
| CROSS80-100 | 0.098 (0.05)** | | 0.107 (0.055)* |
| CROSS60-80 | 0.238 (0.126)* | | 0.194 (0.129) |
| CROSS40-60 | 0.004 (0.04) | | 0.023 (0.04) |
| CROSS20-40 | 0.044 (0.055) | | 0.047 (0.05) |
| CHEMICALS | −0.110 (0.03)*** | −0.002 (0.032) | −0.045 (0.022)** |
| PHARMACEUTICALS | 0.053 (0.081) | 2.652 (0.05)*** | 0.048 (0.05) |
| ELECTRONICS | −0.029 (0.034) | −0.046 (0.031) | −0.019 (0.016) |
| MACHINERY | −0.083 (0.026)*** | 0.128 (0.032)*** | −0.038 (0.019)** |
| TRANSPORTATION | −0.075 (0.023)*** | −0.059 (0.039) | −0.040 (0.017)** |
| INSTRUMENTS | 0.172 (0.122) | 0.050 (0.078) | 0.037 (0.036) |
| Constant | −1.727 (0.324)*** | 4.895 (0.244)*** | −0.232 (0.127)* |
| Log likelihood | 98.982 | 283.502 | |
| Wald test | 229.95 | | |
| No. samples | 636 | 636 | |

*Note*: Values in parentheses are robust standard errors. Inference (1) is the result of the Tobit model, and inference (2) employs the double-hurdle model. Inference (2) consists of the first hurdle (WILL) and the second hurdle (LICENSE). CROSS0-20 is dropped for inferences because of multicollinearity.

\* Significance at the 10% level.
\*\* Significance at the 5% level.
\*\*\* Significance at the 1% level.

# Estimation of POTENTIAL

**Table 3**
Estimation of POTENTIAL: the ordered probit model and the double-hurdle model.

| Dependent var. | (1) POTENTIAL | (1-2) POTENTIAL | (2) WILL | (2) POTENTIAL |
|---|---|---|---|---|
| PROTECT | 0.052 (0.059) | 0.055 (0.063) | 0.049 (0.043) | 0.057 (0.081) |
| SCIENCE | 0.014 (0.092) | −0.008 (0.092) | 0.140 (0.047)*** | 0.047 (0.126) |
| PARTNER | 0.284 (0.047)*** | 0.158 (0.049)*** | | 0.479 (0.064)*** |
| NEGOTIATE | 0.008 (0.052) | −0.081 (0.053) | | 0.094 (0.072) |
| TECH-COMP | 0.521 (1.108) | 0.728 (1.146) | 0.187 (0.419) | 1.589 (1.51) |
| CITED | 0.014 (0.034) | 0.013 (0.036) | 0.021 (0.015) | 0.015 (0.038) |
| log(EMP) | 0.051 (0.036) | 0.044 (0.037) | 0.065 (0.015)*** | 0.060 (0.051) |
| RD | 0.511 (0.408) | 0.646 (0.425) | 0.348 (0.132)*** | 0.613 (0.522) |
| AFFIL80-100 | 0.129 (0.13) | −0.055 (0.131) | | 0.319 (0.175)* |
| AFFIL60-80 | 0.421 (0.161)*** | 0.311 (0.167)* | | 0.694 (0.282)** |
| AFFIL40-60 | 0.939 (0.225)***: | 0.677 (0.237)*** | | 1.680 (0.316)*** |
| AFFIL20-40 | 0.987 (0.264)*** | 0.794 (0.275)*** | | 1.562 (0.336)*** |
| AFFIL0-20 | 0.724 (0.127)*** | 0.528 (0.131)*** | | 1.191 (0.173)*** |
| CROSS80-100 | −0.176 (0.267) | −0.226 (0.262) | | −0.175 (0.367) |
| CROSS60-80 | −0.072 (0.559) | −0.125 (0.57) | | −0.042 (0.747) |
| CROSS40-60 | −0.086 (0.311) | −0.159 (0.333) | | −0.075 (0.392) |
| CROSS20-40 | 0.429 (0.292) | 0.411 (0.3) | | 0.417 (0.377) |
| CHEMICALS | −0.052 (0.138) | −0.117 (0.142) | 0.004 (0.038) | 0.026 (0.19) |
| PHARMACEUTICALS | 0.346 (0.281) | 0.280 (0.273) | 2.622 (0.06)*** | 0.556 (0.404) |
| ELECTRONICS | 0.290 (0.136)** | 0.377 (0.147)** | −0.134 (0.064)** | 0.361 (0.194)* |
| MACHINERY | 0.043 (0.149) | −0.020 (0.15) | 0.134 (0.032)*** | 0.116 (0.204) |
| TRANSPORTATION | 0.224 (0.195) | 0.290 (0.206) | −0.046 (0.067) | 0.297 (0.267) |
| INSTRUMENTS | −0.041 (0.232) | −0.080 (0.238) | 0.005 (0.065) | 0.041 (0.33) |
| CONSTANT | | | 4.766 (0.34)*** | −2.065 (1.46) |
| Log likelihood | −853.715 | −812.009 | | −1090.484 |
| Wald test | 141.66 | 79.75 | | |
| No. samples | 636 | 556 | | 636 |

*Note*: Values in parentheses are robust standard errors. The data for inference (1) is the result of the ordered probit model using the full sample, and inference (1-2) uses a subsample of firms that have a willingness to license out (WILL = 1). Inference (2) employs the double-hurdle model and consists of the first hurdle (WILL) and the second hurdle (POTENTIAL). CROSS0-20 is dropped for inferences because of multicollinearity.

* Significance at the 10% level.
** Significance at the 5% level.
*** Significance at the 1% level.

# Summary of findings

- Effectiveness of patent as a tool of appropriating rents from invention: robust effect on licensing -> Stronger patent rights leads to active licensing

- Degree of scientific nature (less information asymmetry): already takes into account ex-ante licensing willingness

- Difficulty in finding partners: relevant factors for willing but not licensing patents

- Size: positive effect for willingness, but negative for licensing

- Technology market works relatively well for pharma, but not for machinery, chemicals

# Current lines of research

- Open innovation project
  - Focusing on demand side story (difficulty in licensing in)
  - Comparison with US, OECD/TIP project
- IP strategy in emerging economies (China, India etc.)
- Patent database (linking with financial accounts etc.)
  - Japanese Science on Science and Technology program (database platform)