Dynamic effects of patent pools: Evidence from inter-generational competition in the optical disc industry

Tomoyuki Shimbo (Kanto Gakuin University),
Sadao Nagaoka (RIETI/Tokyo Keizai University)
and Naotoshi Tsukada (National Institute of Science and Technology Policy)
2017.12.8

This research is based on RIETI Discussion Paper Series, 15-E-132.
Background

• We have seen both an increasing need for combining technologies and an increasing fragmentation of patent ownership in recent years.

• They have enhanced the necessity for developing an efficient institutional mechanism for aggregating technologies.

• A patent pool is one candidate.
DVD patent pools

• The two pools (6C and 3C) cover almost all bundle of the essential patents globally
  => “Two” stop shopping for global operations

• A third party assesses essentiality of the patents

• The licensors commit to price.
  – No price increase for additional SEPs later disclosed

• The licensors commit to RAND (Reasonable and Non-Discriminatory) licensing based on published price list.

• Royalty is distributed based on the number of patents by licensors in 6C.
Prior research

• Theoretical research shows positive economic contributions of a well-designed pool on the diffusion of a standard.

• Empirical papers suggest some evidence of negative effects of the pools on R&D by licensors.

• Theoretical research also has begun to address a dynamic issue about generations.
  – Gallini (2014)
Inter-generational competition

• A modern pool guided by competition authorities focuses on the integration of complementary patents for a specific standard.

• Standards often evolve over time, and inter-generational competition is important.
  – CD, DVD, and BD/HDDVD in the optical disc industry

• Patent pools may affect not only R&D for the current generation standard, but also R&D for the next-generation standard.
• They focused the effects of the DVD pools (3C, 6C) on R&D by licensors and licensees.
  – Negative effects

• Aggregated all optical disc patents.
  – Ignored the inter-generational competition.

• Underestimated the effects of the pools.
  – They ignored the effect of the standard agreement before the pool formations.
  – The firms anticipate the pool formation at the time of the standard agreement.
Our research

• We identified the population of patents in optical disc technologies more correctly.
  – Cooperative Patent Classification (CPC)
  – Classification of essential patents by each pool

• Divided the patents into
  – CD
  – DVD: the Current Generation Standard (CGS)
  – BD/HDDVD: the Next-Generation Standards (NGS)
Number of patent families on CD, DVD, and BD/HDDVD
Our research

• Examine how the agreement and pool formations on the CGS affect R&D for the NGS.
  – DID framework

• Licensors (DVD): treated group
• Licensees (DVD): treated and control groups
• Nonparticipants: control group
  – Firms which are developing optical disc technologies, but are not licensors or licensees.

• Compare the performance of licensors with that of nonparticipants.
## Determinants of R&D for NGS

<table>
<thead>
<tr>
<th></th>
<th>After the standard agreement</th>
<th>After the pool formations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Licensors</strong></td>
<td>• R&amp;D opportunity for NGS (+)</td>
<td>• R&amp;D opportunity for NGS (+)</td>
</tr>
<tr>
<td></td>
<td>• Experience developing DVD technologies (+)</td>
<td>• Experience developing DVD technologies (+)</td>
</tr>
<tr>
<td></td>
<td>• Sunk cost and replacement effects (−)</td>
<td>• Sunk cost and replacement effects (−)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Collusive restraint of R&amp;D accompanying the patent pools (−)</td>
</tr>
<tr>
<td><strong>Licensees</strong></td>
<td>• R&amp;D opportunity for NGS (+)</td>
<td>• R&amp;D opportunity for NGS (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Experience exploiting DVD technologies (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sunk cost effect (−)</td>
</tr>
<tr>
<td><strong>nonparticipants</strong></td>
<td>• R&amp;D opportunity for NGS (+)</td>
<td>• R&amp;D opportunity for NGS (+)</td>
</tr>
</tbody>
</table>
R&D opportunity for NGS

• When innovation is cumulative and includes multiple generations, R&D for the NGS builds on the technologies for the CGS.
  – There exist 75 families on DVD / 239 essential families on BD (= 31%).

• If firms developing technologies on the NGS anticipate that the SEPs on the CGS are licensed under RAND conditions ex-post, they can expect that the hold-up problem can be avoided.

↓

• The agreement and pool formations on the CGS would have positive effects on R&D for the NGS
  – not only by licensors, but also by licensees and nonparticipants.
Experience (Licensors)

• When innovation is cumulative and includes multiple generations, the licensors have stronger R&D capability for the NGS
  – based on the experience of developing DVD technologies at the time of the agreement.

↓

• Both events on the CGS would have positive effects on R&D for the NGS by licensors.
Sunk cost and replacement effects (Licensors)

• Because the licensors made large sunk R&D investment in the CGS, they would have chosen a project for the NGS that would exploit the existing complementary assets.
  – Sunk cost effect

• The expected profit from the CGS would make the licensors reluctant to invest in the NGS.
  – Replacement effect

↓

• Both events on the CGS would have **negative effects** on R&D for the NGS by licensors.
Hypotheses

• (H1) Both the agreement and pool formations on the CGS will increase R&D for the NGS by licensors, relative to nonparticipants
  – if the effect of experience in the CGS dominates the sunk cost and replacement effects.
The standard wars

<table>
<thead>
<tr>
<th>Next-CD</th>
<th>SD (Toshiba, Panasonic)</th>
<th>6C (Toshiba, Panasonic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVD pools</td>
<td>6C (Toshiba, Panasonic)</td>
<td>3C (Sony, Philips)</td>
</tr>
<tr>
<td>Next-DVD</td>
<td>HDDVD (Toshiba)</td>
<td>BD (Sony, Philips, Panasonic)</td>
</tr>
<tr>
<td>BD pools</td>
<td>Premier BD (Toshiba)</td>
<td>One blue (Sony, Philips, Panasonic)</td>
</tr>
</tbody>
</table>

The DVD standard was announced based on **the SD format** in 1995.

- **Most of the 6C licensors** (Toshiba, Panasonic) were winners in the competition for the DVD standard.
- **They would have made more sunk R&D investment in the DVD standard than the 3C licensors** (Sony, Philips).
Hypotheses

• (H1) Both the agreement and pool formations on the CGS will increase R&D for the NGS by licensors, relative to nonparticipants
  – if the effect of experience in the CGS dominates the sunk cost and replacement effects.

↓

• (H2) These R&D promoting effects would be smaller for the 6C licensors with larger sunk R&D investment on the CGS, than the 3C licensors.
Data and dependent variable

- PATSTAT Database
  - US patents
- Panel dataset of 110 firms by application year from 1988 to 2010
  - 16 licensors, 14 licensees and 80 nonparticipants
- Dependent variables
  - the number of families
  - the number of families weighted by forward citations (to consider quality of inventions)
- DID framework
- OLS models, taking the log of these dependent variables
Independent variable

• **Standardization (1995-1997)**
  – A binary variable that takes a value of 1 for all observations between 1995 and 1997 before the pool formation

  – A binary variable of the first period after the pool formation

• **Pool (2001-2010)**
  – A binary variable of the second period after the pool formation

• **Licensor**
  – 6C, 3C

• **Licensee**

• **Control variables**
  – Firm fixed effects, firm technological diversity, firm age, application years
Number of families on NGS per firm of three types

Log

Standardization (DVD)

Pool formations (DVD)

- licensor
- licensee
- nonparticipant
<table>
<thead>
<tr>
<th></th>
<th>(2) In(Families)</th>
<th>(3)</th>
<th>(5) In(Citation-weighted families)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardization(1995-1997)×Licensor</td>
<td>0.068 (0.044)</td>
<td></td>
<td>0.556** (0.216)</td>
<td></td>
</tr>
<tr>
<td>Pool(1998-2000)×Licensor</td>
<td>0.306** (0.119)</td>
<td></td>
<td>1.145*** (0.356)</td>
<td></td>
</tr>
<tr>
<td>Pool(2001-2010)×Licensor</td>
<td>0.727*** (0.203)</td>
<td></td>
<td>1.585*** (0.384)</td>
<td></td>
</tr>
<tr>
<td>Standardization(1995-1997)×6C</td>
<td>0.051 (0.065)</td>
<td></td>
<td>0.608** (0.293)</td>
<td></td>
</tr>
<tr>
<td>Pool(1998-2000)×6C</td>
<td>0.082 (0.092)</td>
<td></td>
<td>0.730** (0.356)</td>
<td></td>
</tr>
<tr>
<td>Pool(2001-2010)×6C</td>
<td>0.381** (0.170)</td>
<td></td>
<td>1.102*** (0.345)</td>
<td></td>
</tr>
<tr>
<td>Standardization(1995-1997)×3C</td>
<td>0.052 (0.059)</td>
<td></td>
<td>0.087 (0.126)</td>
<td></td>
</tr>
<tr>
<td>Pool(1998-2000)×3C</td>
<td>0.716*** (0.255)</td>
<td></td>
<td>2.043*** (0.704)</td>
<td></td>
</tr>
<tr>
<td>Pool(2001-2010)×3C</td>
<td>1.220*** (0.339)</td>
<td></td>
<td>2.301*** (0.630)</td>
<td></td>
</tr>
<tr>
<td>Standardization(1995-1997)×Licensee</td>
<td>-0.013 (0.012)</td>
<td></td>
<td>-0.022 (0.017)</td>
<td>-0.050 (0.033)</td>
</tr>
<tr>
<td>Pool(1998-2000)×Licensee</td>
<td>0.002 (0.022)</td>
<td></td>
<td>0.031 (0.076)</td>
<td>0.023 (0.077)</td>
</tr>
<tr>
<td>Pool(2001-2010)×Licensee</td>
<td>0.037 (0.034)</td>
<td></td>
<td>0.051 (0.052)</td>
<td>0.034 (0.056)</td>
</tr>
</tbody>
</table>

- **Standardization × Licensor, Pool × Licensor**
  - Positive and significant
  - Support H1
- **Pool × 6C**
  - Smaller than 3C
  - Support H2
Conclusion

• Both the agreement and pool formations on the CGS encouraged the licensors to invest in R&D for the NGS.

• These R&D promoting effects were smaller for the 6C licensors with larger sunk R&D investment on the CGS, than the 3C licensors.
Implication

• The DVD pools seemingly didn’t constrain the R&D competition for the NGS among the licensors
  – contrary to the prior empirical work.

• The competition policy and RAND commitment would have contributed to it.
  – The scope of the pools was narrowly specified, and the clear commitment to RAND licensing for the CGS existed, which were essential for competitive R&D for the NGS.
Key references


### Determinants of R&D for CGS

<table>
<thead>
<tr>
<th></th>
<th>After the standard agreement</th>
<th>After the pool formations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Licensors</strong></td>
<td>• R&amp;D opportunity for CGS (+)</td>
<td>• R&amp;D opportunity for CGS (+)</td>
</tr>
<tr>
<td></td>
<td>• Experience developing DVD technologies and licensing income (+)</td>
<td>• Experience of developing DVD technologies, complementary assets and licensing income (+)</td>
</tr>
<tr>
<td></td>
<td>• Inefficiency of the patent pools (−)</td>
<td>• Inefficiency of the patent pools (−)</td>
</tr>
<tr>
<td><strong>Licensees</strong></td>
<td>• R&amp;D opportunity for CGS (+)</td>
<td>• R&amp;D opportunity for CGS (+)</td>
</tr>
<tr>
<td></td>
<td>• Experience of exploiting DVD technologies and complementary assets (+)</td>
<td>• Experience of exploiting DVD technologies and complementary assets (+)</td>
</tr>
<tr>
<td></td>
<td>• Inefficiency of the patent pools (−)</td>
<td>• Inefficiency of the patent pools (−)</td>
</tr>
<tr>
<td><strong>nonparticipants</strong></td>
<td>• R&amp;D opportunity for CGS (+)</td>
<td>• R&amp;D opportunity for CGS (+)</td>
</tr>
</tbody>
</table>
Hypotheses (CGS)

- \((H1)\) Both the events will increase R&D for the CGS by the licensors, relative to the nonparticipants
  – unless the pools are highly inefficient.

- \((H2)\) Both the events will increase R&D for the CGS by the licensees over time, relative to the nonparticipants
  – unless the pools are highly inefficient.
<table>
<thead>
<tr>
<th>(2) In(Families)</th>
<th>(4) In(Citation-weighted families)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.037*** (0.189)</td>
<td>1.500*** (0.240)</td>
</tr>
<tr>
<td>2.620*** (0.388)</td>
<td>2.760*** (0.506)</td>
</tr>
<tr>
<td>1.119*** (0.203)</td>
<td>-0.003 (0.029)</td>
</tr>
<tr>
<td>1.810*** (0.311)</td>
<td>-0.068 (0.100)</td>
</tr>
<tr>
<td>0.140 (0.103)</td>
<td>0.300*** (0.113)</td>
</tr>
<tr>
<td>0.363 (0.364)</td>
<td>0.525*** (0.198)</td>
</tr>
</tbody>
</table>

- **Standardization × Licensor**
  - Positive
  - Support H1

- **Pool × Licensor**
  - Positive
  - Support H1

- **Pool(2001-2010) × Licensee**
  - Positive
  - Support H2