Measuring and estimating patent value

WIPO-OECD
Workshop on Statistics in the Patent Field
Sept. 18/19, 2003

Dietmar Harhoff
Ludwig-Maximilians-Universität München
Institute for Innovation Research, Technology Management, and Entrepreneurship (INNO-tec)
Overview

- Why do we care?
- Basic value concepts
- Skewed distributions
- Valuation of individual patents
- Valuation of patent portfolios
- A calibration method
- Conclusions
Why do we care?

- IP is becoming more important in firms’ activities.
- Accounting rules are changing from very conservative postures to a market-value orientation. IP valuation is likely to become a common accounting task.
- In national statistics, intangibles represent difficult measurement problems, too. More precise measures are needed in many fields of economic analysis, e.g. growth accounting and productivity analysis.

- Changes in the use of patents make (simple) patent counts an increasingly unattractive measure of innovation output.
- Improved valuation methods for IP can lower cost of capital.
- Ex ante valuation (estimation) is considerably more difficult than ex post valuation (measurement).
Basic value concepts (1/2)

- private vs. social value
- value of patent protection vs. value of the invention under patent protection
- value of keeping a patent in force (renewal value) vs. value of owning the patent as an asset (asset value)
Basic value concepts (2/2)

Suppose the owner of patents #1 and #2 considers selling #1 to another party.

In some cases, the invention patented in #2 can no longer be practiced by the owner, unless he obtains a license.

Letting patent #1 lapse into the public domain (no renewal) allows the owner to practice the invention without a license.

\[ \text{asset value} > \text{renewal value} \]
Skewed distributions (1/3)
Results from a survey of patent owners

<table>
<thead>
<tr>
<th>Valuation of Patent</th>
<th>Cases</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; DM 100,000</td>
<td>203</td>
<td>27.0 %</td>
</tr>
<tr>
<td>DM 100,000 – 399,999</td>
<td>200</td>
<td>26.6 %</td>
</tr>
<tr>
<td>DM 400,000 – 999,999</td>
<td>154</td>
<td>20.5 %</td>
</tr>
<tr>
<td>DM 1 - 5 million</td>
<td>129</td>
<td>17.2 %</td>
</tr>
<tr>
<td>DM 5 - 10 million</td>
<td>28</td>
<td>3.7 %</td>
</tr>
<tr>
<td>DM 10 - 20 million</td>
<td>16</td>
<td>2.1 %</td>
</tr>
<tr>
<td>DM 20 - 40 million</td>
<td>15</td>
<td>2.0 %</td>
</tr>
<tr>
<td>DM 40 - 80 million</td>
<td>5</td>
<td>0.7 %</td>
</tr>
<tr>
<td>&gt; DM 80 million</td>
<td>2</td>
<td>0.3 %</td>
</tr>
<tr>
<td>Total</td>
<td>752</td>
<td>100.0 %</td>
</tr>
</tbody>
</table>

Quelle: Harhoff, Scherer, Vopel (2003a) – Research Policy
Skewed distributions (2/3)

Figure 3
Plot of All Renewed German Patent Values on Pareto Coordinates

Quelle: Harhoff, Scherer, Vopel (2003b)
Skewed distributions (3/3)

The heterogeneity of patent value is not an unusual result – it applies in general to patent portfolios, but also to the portfolios of venture capital investors.

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Patents resp. Portfolio Firms</th>
<th>Value Share of Top 10% Patents/Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>German Patents (1977)</td>
<td>772</td>
<td>88%</td>
</tr>
<tr>
<td>USPTO Patents 1977</td>
<td>222</td>
<td>83%</td>
</tr>
<tr>
<td>University Patents USA</td>
<td>411</td>
<td>92%</td>
</tr>
<tr>
<td>Portfolio Venture Economics</td>
<td>383</td>
<td>62%</td>
</tr>
<tr>
<td>Portfolio Horseley-Keogh</td>
<td>670</td>
<td>59%</td>
</tr>
</tbody>
</table>

Source: Scherer, Harhoff, Kukies (2000) – *Journal of Evolutionary Economics*
Valuation of individual patents

At the level of individual patents, a number of basic approaches have been developed (Hagelin, *AIPLA, Summer 2002*):

- Ranking methods
- Disaggregation methods
- Monte Carlo methods
- Option methods
- Competitive advantage valuation

For most applications at the portfolio level (nation, region, industry), these approaches are not feasible.
Valuation of patent portfolios

- **Approach 1:**
  average patent value is common and not (too) heterogeneous across firms.
  \[ \text{pv}_i = \text{av} \ast n_i \]

- **Approach 2:**
  average patent value is heterogeneous across, but not too heterogeneous within firms.
  \[ \text{pv}_i = \text{av}_i \ast n_i = f(x_i) \ast n_i \]

- **Approach 3:**
  patent value is heterogeneous across and within firms. We need to computed weighted patent counts.
  \[ \text{pv}_i = \sum \text{v}_{ik} = \sum g(y_{ik}) \]

  i denotes firms, k denotes individual patents.
A calibration method

Reference portfolio

Value Indication generated by the Patent System
- citations
  - "backwards"
  - "forwards"
- opposition/appeals
- litigation
- patent breadth
- application path
- family size
- utility models

Top-down

Bottom-up

Calibration of Value Indicators using Results of the Detailed Assessment

R&D Experts
Legal Experts
Marketing Experts

Detailed Evaluation of Patents in the Reference Portfolio

Empirically Tested Patent Valuation Model
A calibration method

Regression Model

\[
\ln V = X\beta + \varepsilon = \beta_0 + \beta_1 \ln SCOPE + \beta_2 \ln(1+CIT_DPA) + \\
\beta_3 \ln(1+CIT_EPO) + \beta_4 \ln(FAMSIZE) + \beta_5 \ln(1+REFPAT) + \\
\beta_6 \ln(1+REFNPAT) + \beta_7 OPPOSITION + \beta_8 ANNULMENT + \varepsilon
\]

Data Structure

- 772 patents with known value
- 9,349 patents not renewed to year 18 (\(V<\alpha\))
- 659 patents renewed to year 18, but without value information (\(V>\alpha\))
A calibration method

- SCOPE - number of separate 4-digit IPC classes
- CIT_DPA - citations received in subsequent DPA patents
- CIT_EPO - citations received in subsequent EPO patents
- FAMILY SIZE - number of jurisdictions in which patent protection was granted for the invention
- REFPAT - references to prior patents
- REFNPAT - references to the non-patent literature
- OPPOSITION - patent survived opposition
- ANNULMENT - patent survived anulment suit
A calibration method

<table>
<thead>
<tr>
<th>Unabhängige Variable</th>
<th>Alle Patente</th>
<th>Patente in Chemie und Pharmazeutik</th>
<th>Patente in Elektrotechnik</th>
<th>Patente in Mechnik</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(SCOPE)</td>
<td>-0.150 (0.084)</td>
<td>-0.383 (0.497)</td>
<td>0.050 (0.109)</td>
<td>-0.237 (0.260)</td>
</tr>
<tr>
<td>ln(1+CIT_DPA)</td>
<td>0.505 (0.135)</td>
<td>0.523 (0.502)</td>
<td>0.556 (0.230)</td>
<td>0.461 (0.190)</td>
</tr>
<tr>
<td>ln(1+CIT_EPO)</td>
<td>0.893 (0.132)</td>
<td>1.670 (0.398)</td>
<td>0.583 (0.217)</td>
<td>0.793 (0.202)</td>
</tr>
<tr>
<td>ln(FAMSIZE)</td>
<td>0.811 (0.077)</td>
<td>1.178 (0.244)</td>
<td>0.577 (0.129)</td>
<td>0.780 (0.115)</td>
</tr>
<tr>
<td>ln(1+REFPAT)</td>
<td>0.751 (0.092)</td>
<td>0.749 (0.307)</td>
<td>0.466 (0.164)</td>
<td>0.804 (0.130)</td>
</tr>
<tr>
<td>ln(1+REFNPAT)</td>
<td>0.448 (0.158)</td>
<td>1.131 (0.447)</td>
<td>0.459 (0.257)</td>
<td>0.319 (0.268)</td>
</tr>
<tr>
<td>OPPOSITION</td>
<td>2.415 (0.284)</td>
<td>2.113 (0.946)</td>
<td>2.508 (0.502)</td>
<td>2.263 (0.394)</td>
</tr>
<tr>
<td>ANNULEMENT</td>
<td>3.753 (0.782)</td>
<td>0.188 (3.410)</td>
<td>4.436 (1.810)</td>
<td>3.296 (0.998)</td>
</tr>
<tr>
<td>α/1000</td>
<td>45.144 (2.913)</td>
<td>41.644 (7.721)</td>
<td>43.332 (5.118)</td>
<td>46.647 (4.482)</td>
</tr>
<tr>
<td>σ</td>
<td>4.174 (0.159)</td>
<td>4.974 (0.466)</td>
<td>3.656 (0.266)</td>
<td>4.114 (0.238)</td>
</tr>
<tr>
<td>Pseudo-R-Squared</td>
<td>0.139</td>
<td>0.172</td>
<td>0.133</td>
<td>0.118</td>
</tr>
</tbody>
</table>

A calibration method

- identification of important patents and rough calculations of portfolio values feasible
- decent precision for portfolios > 100 patents

Problems

- option value
- timing of indicator information
- time-varying coefficients
- unit of analysis (independence)
Conclusions

- The definition of patent value depends on your perspective (social/private) and on the appropriate counterfactual (asset vs. renewal value).
- Patent values display considerable heterogeneity and range from 0 to several billion €.
- The distribution of patent value is highly skew and can be approximated with a log-normal distribution.
- The distributions is skew even within firms.
- Patent value can be approximated using citation, opposition, family size and other measures. Citations are only one part of the picture!
References (1/3)


References (2/3)


References (3/3)

