

## Database on individual Swedish patents

### Sample selection and survey

This detailed database on individual Swedish patents is based on a survey undertaken during the years 2003 and 2004.<sup>1</sup> The aim of the database is to focus on the commercialization process of patents owned by individual inventors and small firms.

A pilot survey was undertaken in 2002. Then, it turned out that if commercialization occurred, this process started within five years after the application date for most patents. Therefore, Swedish patents granted in 1998 were chosen as the preliminary population for the current database.<sup>2</sup> In 1998, 2760 patents were granted in Sweden. 776 of these were granted to foreign firms, 902 to large Swedish firms with more than 1000 employees, and 1082 to Swedish individuals and firms with less than 1000 employees. Information for each patent about inventors, applying firms and their addresses was bought from the Swedish Patent and Registration Office (PRV). Thereafter, a questionnaire was sent out to the inventors of the patents.<sup>3</sup> In the pilot survey, many large Swedish firms refused to provide information on individual patents. Furthermore, it is impossible to persuade foreign firms to fill in questionnaires about patents. These firms are almost always large multinational firms. Therefore, the final population consists of 1082 patents granted to Swedish individuals and firms with less than 1000 employees. This sample selection should not be a problem when analyzing the data, as long as the conclusions are drawn just for small firms and individuals.

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<sup>1</sup> All inventions do not result in patents. However, since an invention that does not result in a patent is not registered anywhere, there are two problems in empirically analyzing the invention rather than the patent. First, it is impossible to find these new ideas, products and developments among all firms and individuals. On the other hand, all patents are registered. Second, even if the “inventions” are found, it is difficult to judge whether they are sufficient improvements to qualify as inventions. Only the national and international patent offices make such judgements. Therefore, the choice of the patent rather than the invention is the only practical alternative for an empirical study of the commercialization process.

<sup>2</sup> Granted rather than filed patents are used. Filed patents may also be commercialized, but many of these are never granted and do not qualify as real inventions. The decision to only include granted patents increases the homogeneity of the sample. There is also a trap when using granted patents. If the sample criteria had been all granted patents that are *filed in the same year* (e.g. in 1996), there would have been a sample selection problem, since it can take several years before patents are granted. Patents filed in 1996 and not yet granted at the end point of observation (2003) would then have been systematically omitted from the sample. By using all patents that are *granted in the same year*, the sample will include both patents for which it took a short and a long time until they were granted.

<sup>3</sup> Each patent always has at least one inventor and often also an applying firm. The inventors or the applying firm can be the owner of the patent, but the inventors can also indirectly be owners of the patent, via the applying firm. Sometimes the inventors are only employed in the applying firm, which owns the patent. If the patent had more than one inventor, the questionnaire was sent to one inventor only.

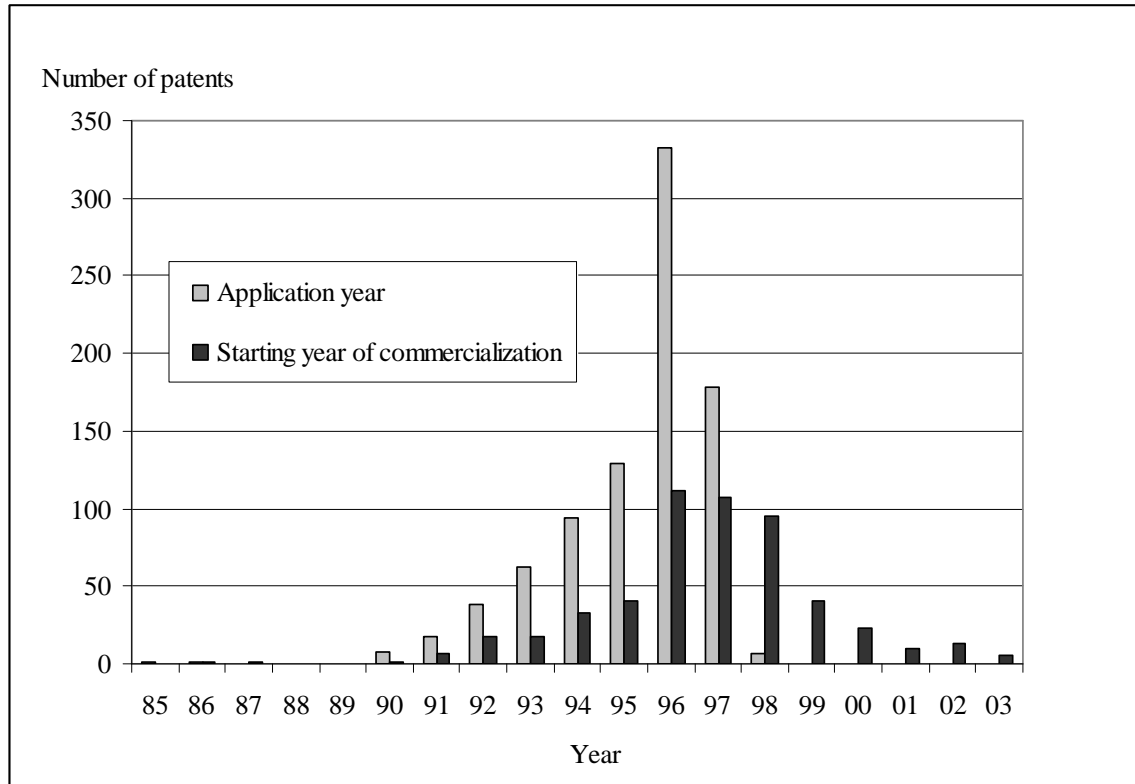
As many as 867 of the inventors filled in and returned the questionnaire, i.e. the response rate was 80 percent (867 out of 1082). This response rate is satisfactorily high, taking into account that such a database has seldom been collected before and that inventors or applying firms usually consider information about inventions and patents to be secret. In the questionnaire, we asked the inventors about the work place where the invention was created and the financing of the invention during the R&D phase, whether the invention had been commercialized, which kind of commercialization mode was chosen (licensing, selling, commercialization in an existing or in a new firm), how the commercialization was financed, the inventors' incomes and profits from the patent, and if there were any problems with the commercialization – alternatively why the patent was never commercialized.

After the collection, the questionnaire was complemented with two kinds of data: 1) from *espacenet's* homepage ([www.espacenet.com](http://www.espacenet.com)), we collected information about renewal of the patents (e.g. if and when the patents had expired), whether the Swedish patents had any sister-patents in the U.S. or Europe, as well as how many forward citations the patents (and their sister-patents) had received within and between industries; 2) for the patents that had been commercialized through a licensing or an acquisition contract, we contacted the inventors once more. We then asked detailed questions about the contracts, for example whether fixed and/or variable payment fees were included in the contracts. All variables in the database from the questionnaire and other sources are shown in the end of this PDF-file.

### **Commercialization**

The application year of the 867 patents is shown as light-gray bars in Figure 1. 85 percent of the patents were applied for between 1994 and 1997. In 2003, commercialization had been started for 526 of these patents (61 percent). The starting year of the commercialization is represented by dark bars, which almost follow a normal distribution. Although the last year of observation is 2003, it is not likely that many of the 341 non-commercialized patents will be commercialized after 2003.

**Figure 1. Application year and starting year of commercialization**



The 867 patents and the commercialization rate are described across firm groups in Table 1. As many as 408 patents (47 percent) were granted to individual inventors, and 116, 201, 142 patents were respectively granted to medium-sized firms (101-1000 employees), small firms (11-100 employees) and micro companies (2-10 employees).<sup>4</sup> The commercialization rate for the whole sample is 61 percent. This rate should be compared to the few available studies that have measured commercialization of patents: 47 percent for American patents found by Morgan *et al.* (2001) and 55 percent in the studies surveyed by Griliches (1990).<sup>5</sup> The higher commercialization rate in this database is explained by the fact that only patents owned by small firms and individual inventors are included – large (multinational) firms have many more defensive patents. Griliches (1990) confirms this view and reports that the commercialization rate is as high as 71

<sup>4</sup> The group of individual inventors includes private persons, self-employed inventors as well as two-three inventors, who are organized in trading companies or private firms without employees.

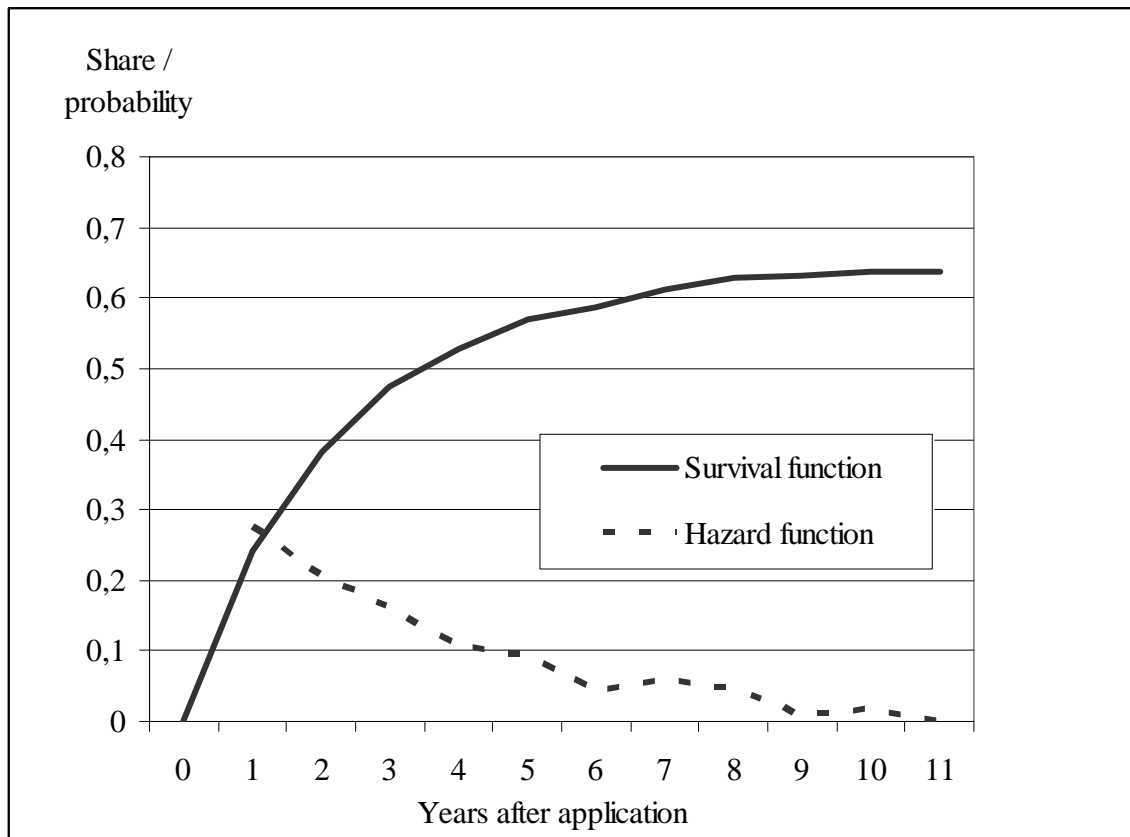
<sup>5</sup> These other studies have a similar definition of commercialization as here, i.e. that the patent has been used commercially. In Morgan *et al.* (2001), commercialization means a commercialized product or process or a licensing contract, and in Griliches, it means that the patent is used commercially. In neither of these studies does the commercialization need to be profitable for the owner.

**Table 1. Commercialization of patents across firm sizes and inventors' ownership**

| Kind of firm where invention was created | Number of patents |            |            | Percent Commercialized | Percent Inventor ownership |
|--|-------------------|------------|------------|------------------------|----------------------------|
|  | Commercialization |            | Total      |                        |                            |
|  | Yes               | No         |            |                        |                            |
| Medium-sized firms (101-1000 employees)  | 77                | 39         | 116        | 66 %                   | 4 %                        |
| Small firms (11-100 employees)           | 137               | 64         | 201        | 68 %                   | 48 %                       |
| Micro companies (2-10 employees)         | 105               | 37         | 142        | 74 %                   | 86 %                       |
| Inventors (1-4 inventors)                | 207               | 201        | 408        | 51 %                   | 97 %                       |
| <b>Total</b>                             | <b>526</b>        | <b>341</b> | <b>867</b> | <b>61 %</b>            | <b>72 %</b>                |

percent for small firms and inventors. In Table 1, the commercialization rate of the firm groups is between 66 percent and 74 percent, whereas the rate of the individuals is not higher than 51 percent. A contingency-table test suggests there to be a significant difference in the commercialization rate between firms and individuals. The chi-square value is 30.55 (with 3 d.f.), significant at the one-percent level.

**Figure 2. Survival and Hazard functions of commercialization of patents**



Note: The survival function is depicted as the inverse of the survival function by pedagogical reasons.

In the last column of Table 1, inventors' ownership of the patents is shown. The larger is the firm, the higher is the share of the patents that is partly or wholly owned by the inventors. In fact, when the inventors are owners of the patent, the firm has never more than 200 employees.

In reality, the commercialization decision is not a usual dichotomous variable, but rather an event. In Figure 2, the survival and hazard functions of the commercialization decision for the patents in the sample are estimated by the Life-table method (actuarial method). The patent application year is set to 0. The inverse of the survival function increases steeply at the beginning, but it levels away after 4-5 years. The hazard function (conditional probability) is highest during the first three years after the application.

### Renewal

Owners must pay an annual renewal fee to the national patent office to keep their patents in force. If the renewal fee is not paid in one single year, the patent expires. The renewal rates of the 867 patents by firm size are described in Table 2. The renewal rate is increasing in the firm size, rising from 44 percent for individuals to 76 percent for medium-sized firms. A contingent table test indicates a statistically significant difference between firm size categories. The chi-square value is 46.7 (with 3 d.f.), significant at the one percent level.

Table 3 compares commercialized patents and renewed patents. As expected, renewed patents (71 percent) are commercialized to a higher degree than expired ones (48 percent). The chi-square test statistic reported at the bottom of Table 3 shows that we

**Table 2. Renewal of patents across firm sizes, number of patents and percent.**

| Kind of firm where invention was created | Still alive in 2007 |            | Total number of patents | Percent renewed in 2007 |
|--|---------------------|------------|-------------------------|-------------------------|
|  | Yes                 | No         |                         |                         |
| Medium-sized firms (101-1000 employees)  | 88                  | 28         | 116                     | 76 %                    |
| Small firms (11-100 employees)           | 127                 | 74         | 201                     | 63 %                    |
| Micro companies (2-10 employees)         | 86                  | 56         | 142                     | 61 %                    |
| Individuals (1-4 inventors)              | 181                 | 227        | 408                     | 44 %                    |
| <b>Total</b>                             | <b>482</b>          | <b>385</b> | <b>867</b>              | <b>56 %</b>             |

can clearly reject independence of commercialization and renewal. However, 35 percent of the patents have been commercialized, but have already expired. This is either due to the products having a short lifecycle or the commercialization having failed. 42 percent of the non-commercialized patents are still alive. Many of these patents might be defensive patents, with the purpose of defending other patents, but then the owner should have more similar granted patents. Among the commercialized patents in our dataset, 46 percent of the owners have at least one more similar patent. Among the non-commercialized patents, this percentage is only 33 percent. If the patent had not been commercialized, the inventor was also asked: why the patent had not been commercialized. Among the 341 non-commercialized patents, only 15 inventors listed shadow-patenting as one of the reasons for why the patent had not been commercialized.<sup>6</sup> This indicates that keeping patents for strategic reasons, as is frequently done by large multinational firms (Cohen *et al.*, 2000), is uncommon among individuals and small firms.

**Table 3. Commercialized patents and patents still alive 2004, number of patents and percent.**

| Patents still alive 2004 | Commercialized patents latest in 2003 |      |       | Percent Commercialized |
|--------------------------|---------------------------------------|------|-------|------------------------|
|                          | Yes                                   | No   | Total |                        |
| Yes                      | 340                                   | 142  | 482   | 71 %                   |
| No                       | 186                                   | 199  | 385   | 48 %                   |
| Total                    | 526                                   | 341  | 867   | 61 %                   |
| Percent still alive      | 65 %                                  | 42 % | 56 %  |                        |

Note: Chi-square-value is 44.32, significant at the 1 percent level for 1 d.f.

<sup>6</sup> The most frequent reasons here were: 1) problems with financing (115 patents); 2) problems with marketing (75 patents); 3) problems in finding a manufacturing firm/licensor (74 patents); and 4) the product is not yet ready for commercialization (62 patents). Note that inventors may have mentioned more than one reason for why the patent was not commercialized.

## Financing

In Table 4, the commercialization rate is related to external financing in the R&D phase. Patents with external financing in the R&D phase have a significantly lower commercialization rate than those without. When dividing the external financing into different sources, the commercialization rate is significantly lower only for patents supported by government funds.

**Table 4. External financing during the R&D phase and commercialization**

| Any external financing  |                   |     |       |         |
|---|-------------------|-----|-------|---------|
| External financing during the R&D-phase                             | Commercialization |     | Total | Percent |
|   | Yes               | No  |       |         |
| No  | 421               | 239 | 660   | 63.8 %  |
| Yes   | 105               | 102 | 207   | 50.7 %  |
| Total   | 526               | 341 | 867   | 60.7 %  |
| Chi-square-test = 11.27 ***   |                   |     |       |         |
| Government external financing                                       |                   |     |       |         |
|   | Commercialization |     | Total | Percent |
|   | Yes               | No  |       |         |
| No  | 457               | 268 | 725   | 63.0 %  |
| Yes   | 69                | 73  | 142   | 48.6 %  |
| Total   | 526               | 341 | 867   | 60.7 %  |
| Chi-square = 10.38 ***  |                   |     |       |         |
| Private venture capital   |                   |     |       |         |
|   | Commercialization |     | Total | Percent |
|   | Yes               | No  |       |         |
| No  | 498               | 321 | 819   | 60.8 %  |
| Yes   | 28                | 20  | 48    | 58.3 %  |
| Total   | 526               | 341 | 867   | 60.7 %  |
| Chi-square = 0.12   |                   |     |       |         |
| Other external financing (e.g., universities, research foundations) |                   |     |       |         |
| Other external financing  | Commercialization |     | Total | Percent |
|   | Yes               | No  |       |         |
| No  | 509               | 322 | 831   | 61.3 %  |
| Yes   | 17                | 19  | 36    | 47.2 %  |
| Total   | 526               | 341 | 867   | 60.7 %  |
| Chi-square = 2.85 *   |                   |     |       |         |

*Note:* 207 patents have external financing, but 19 patents have financing from more than one source.

The distribution of external financing among firm groups is described in Table 5. It is obvious that external financing – irrespective of source – is more common among individuals and micro companies. The risk should be higher in patent projects owned by individuals as compared to projects owned by companies. It would then be expected that the government finances projects with higher risk than the average patent project. This might be an explanation for the lower commercialization rate among government-financed projects. However, in the group of 408 patents owned by individuals, the

commercialization rate is 45 percent for government-financed projects and 54 percent for projects with no government financing.

**Table 5. External financing across firm groups**

| Firm groups        | No. of patents with external financing during the R&D-phase |                   |                 | Total number of patents |
|--------------------|---|-------------------|-----------------|-------------------------|
|                    | Government financing  | Private financing | Other financing |                         |
| Medium-sized firms | 3   | 1                 | 4               | 116                     |
| Small firms        | 3   | 7                 | 6               | 201                     |
| Micro companies    | 25  | 3                 | 0               | 142                     |
| Inventors          | 111   | 37                | 26              | 408                     |
| Total              | 142   | 48                | 36              | 867                     |

### References

Cohen, W.M., Nelson, R.R., Walsh, J.P., 2000, 'Protecting their intellectual assets: appropriability conditions and why U.S. manufacturing firms patent (or not)', NBER Working Paper No. 7552, NBER, Cambridge, MA.

Griliches, Z., 1990, 'Patent statistics as economic indicators: a survey', *Journal of Economic Literature*, 28, 1661-1707.

Morgan, R.P., Kruytbosch, C., Kannankutty, N., 2001, 'Patenting and invention activity of U.S. scientists and engineers in the academic sector: comparisons with industry', *Journal of Technology Transfer*, 26, 173-183.



### Available variables in the database

| Variable description  | Type of variable | Answer alternatives  |
|---|------------------|--|
| <b>From the questionnaire</b>   |                  |  |
| Patent identification No.   | Continuous       | Various  |
| Name of inventors   | Characters       | Various  |
| Name of applying firm   | Characters       | Various  |
| Addresses of inventors and applying firm  | Characters       | Various  |
| Number of inventors   | Continuous       | 1-4  |
| Region dummies (based on addresses)   | Dummies          | 0 or 1   |
| Inventors' ownership share of the patent (invention) at the application date (direct or indirect) | Percent          | 0-100  |
| Number of employees at the application date   | Continuous       | 1-1000   |
| Sex of inventors  | Dummies          | 0 or 1   |
| Ethnicity of inventors  | Dummies          | 0 or 1   |
| Work place where invention was created  | Category         | <ul style="list-style-type: none"> <li>• University</li> <li>• Firm located at university</li> <li>• Independent firm</li> <li>• At inventors' home</li> </ul>   |
| Financing before patent application and the share of each financing alternative                   | Category         | <ul style="list-style-type: none"> <li>• Inventors' own capital</li> <li>• Applying firm</li> <li>• Other firm</li> <li>• Private venture capital/business angel</li> <li>• Government capital</li> <li>• Private research foundations</li> <li>• Government research foundations</li> <li>• University</li> </ul> |
|   | Percent          | 0-100  |
| Does the owner have similar (competing) patents?  | Dummy            | 0 or 1   |
| Are complementary patents needed for commercialization?   | Dummy            | 0 or 1   |
| Commercialization of the patent   | Dummy            | 0 or 1   |
| Starting year of the commercialization  | Continuous       | 1987-2003  |
| Mode of commercialization   | Category         | <ul style="list-style-type: none"> <li>• Acquisition</li> <li>• Licensing</li> <li>• Applying firm, where inventors are employed</li> <li>• Applying firm where inventors are owners</li> <li>• New firm where inventors are owners</li> </ul>   |
| Financing during the commercialization and the share of each financing alternative                | Category         | <ul style="list-style-type: none"> <li>• Inventors' own capital</li> <li>• Applying firm</li> <li>• Other firm</li> <li>• Private venture capital/business angel</li> <li>• Government capital</li> <li>• Stock market</li> </ul>  |
|   | Percent          | 0-100  |

|  |            |   |
|--|------------|---|
| Inventors were active during commercialization   | Dummy      | 0 or 1  |
| Inventors were at least partly owner during the commercialization                        | Dummy      | 0 or 1  |
| Inventors' incomes during the commercialization  | Dummies    | <ul style="list-style-type: none"> <li>• Salary</li> <li>• Profit</li> <li>• Royalties</li> <li>• Acquisition fees</li> </ul> |
| Expected profitability of the patent for the owner (in 2003 – at the end of observation) | Category   | <ul style="list-style-type: none"> <li>• Profit</li> <li>• Break-even</li> <li>• Loss</li> <li>• Uncertain</li> </ul>         |
| The new product replaced a previous product in the firm                                  | Dummy      | 0 or 1  |
| Production in other countries than Sweden  | Category   | Various   |
| Number of employment years generated in Sweden   | Continuous | Various   |
| Problems during the commercialization  | Category   | Various responses, 1-2 reasons for each <i>commercialized</i> patent  |
| Reasons why patent was not commercialized  | Category   | Various responses, 1-3 reasons for each <i>non-commercialized</i> patent  |

|  |       |        |
|--|-------|--------|
| <b>Complementary variables for licensed and acquired patents in the database</b> |       |        |
| Variable payment fees  | Dummy | 0 or 1 |
| Fixed payment fees   | Dummy | 0 or 1 |

|   |            |           |
|---|------------|-----------|
| <b>From espacenet</b>   |            |           |
| Patent is alive   | Dummy      | 0 or 1    |
| Expiration date   | Continuous | 1994-2007 |
| ISIC sectors  | Category   | Various   |
| Sector dummies (based on ISIC)  | Dummies    | 0 or 1    |
| 4 citation variables:<br>Number of forward citations from 1) EPO-patents, 2) PCT-patents, 3) U.S. patents and 4) other patents (self-citations excluded). All these are divided on citations within and between industries. | Continuous | 0-40      |
| Sister (equivalent) patents in the rest of the world  | Category   | Code      |

|  |            |            |
|--|------------|------------|
| <b>From PRV (Swedish National Patent Office)</b> |            |            |
| Patent renewal fees every year                   | Continuous | 0-5000 SEK |