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The Scientific Output of a Database on Commercialized Patents

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The Scientific Output of a Database on Commercialized Patents

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Keywords: Patents, commercialization, innovation, small firms, inventors, acquisition, licensing, new start-up firms, forward citations, renewal, patent equivalents, financing, entry strategy, venture capital

JEL: G24, G34, L10, L20, M13, O30, O31, O32, O34, O38

Abstract

The purpose of this study is to present a unique database on commercialized patents and to illustrate how it can be used to analyze the commercialization process of patents. The dataset is based on a survey of Swedish patents owned by inventors and small firms with a remarkably high response rate of 80 percent. It contains some key variables on commercialization not found anywhere else, including whether, when and how (acquisition, licensing, existing or new firm) patents were commercialized as well as whether this commercialization was profitable or not. Thus, this patent database measures technological innovation. The dataset is complemented with indicators of patent quality (patent renewal, forward citations, and patent family) from archive sources. Basic statistics for the key variables are described. Finally, the scientific output in terms of published articles in peer-reviewed journals shows how this database can be used to analyze the commercialization process of patents. The dataset has, for instance, been used to 1) evaluate government loan programs for inventors; 2) analyze the different roles of the inventor and the Schumpeterian entrepreneur during commercialization; 3) estimate the transfer of tacit knowledge when patents are sold or licensed; and 4) analyze the entry strategy among inventors in oligopolistic markets.

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1. Introduction

Governments have several policy instruments to spur innovation and growth. One such instrument is to offer patent rights through legislation, giving the inventor exclusive rights to use the invention for a limited time and space. Patents can increase welfare in three main ways (Lévêque and Ménière 2004):

- Inventors obtain incentives to invent and commercialize new and improved products, which benefits consumers and increases welfare.
- Knowledge is standardized, published, and disseminated.
- Contracts (licenses/acquisitions) between inventors and producers are facilitated so that the most efficient agent commercializes the new knowledge.

Patent data have long been used to measure R&D output and innovative activities. However, almost no patent databases contain information on the commercialization process and whether innovations based on patents were introduced in the market. Instead, most studies have used different quality-adjusted indicators of patent value, such as patent renewal patterns, forward and backward citations and patent family size (equivalents) (see, e.g., Schankerman and Pakes 1986, Griliches 1990, Harhoff *et al.* 1999).

Therefore, in 2002, I undertook a survey on Swedish patents granted in the medicine and hygiene sectors in 1994. The result of the survey was satisfactory, with a response rate of 63 percent (Svensson 2002). The commercialization rate was higher for small firms and individuals (55 percent) than for medium-sized and large firms (25 percent). However, two important lessons were learned from this pilot survey. First, many large firms had a policy of not participating in external surveys. Second, inventors had difficulties estimating the value of their patents in monetary terms, even seven years after the patents were granted.

A larger survey was conducted in the years 2003–2004. This time, all Swedish patents granted in 1998 and owned by Swedish small and medium-sized firms (max 1,000 employees) and individual inventors were included in the sample. In total, 867 out of 1,082 inventors completed the questionnaire, resulting in a remarkably high response rate of 80 percent. The detailed information on the commercialization process of the patents makes this dataset unique. Such variables include *if, when and how patents were commercialized* as well as whether this commercialization was profitable for the owners. Thus, this database measures technological innovation. The commercialization mode can be licensing or selling the patent, commercializing the patent in the original firm where the inventors are owners or employed,

or commercializing the patent in a new start-up firm. Other key variables in the database are whether inventors had an active role during the commercialization process and how the R&D and commercialization phases were financed. The database has been complemented with patent-value indicators from archive sources (Espacenet 2019), such as forward citations, patent renewal, patent family size (patent equivalents) and technology sectors (IPC classes).

The purpose of this study is to describe the variables and statistics of the database and illustrate how the dataset can be used to analyze the commercialization process by summarizing its scientific output.

Some of the published scientific output in the database is given as follows. Analysis of the commercialization mode shows the importance of Schumpeter's entrepreneurship when inventions were introduced as innovations in the market. When inventors sold or licensed the patent to a specialized entrepreneur, the probability of successful commercialization increased compared to the cases where the inventor commercialized the patent himself, indicating that invention and innovation require different skills (Braunerhjelm and Svensson 2010). The financing variables could be used to evaluate the performance of government loan programs allocated to Swedish inventors (Svensson 2007, 2008, 2013). Patents with government soft loan programs in the R&D phase underperformed with respect to commercialization, renewal, and profitability. Since patents with more normal government financing conditions performed at an average level, it is likely that the design of the soft loans rather than bad government selection of projects explains the underperformance of soft loans. In another study, we analyze the entry strategy among inventors in oligopolistic markets. Then, the presence of private venture capital (VC) firms could be used as an indicator of lower transaction costs when selling/licensing patents (Norbäck *et al.* 2017). It turned out that inventor activity was a practical variable when analyzing the transfer of tacit knowledge from inventors to external entrepreneurs as patents were sold or licensed (Maurseth and Svensson 2020).

The study is organized as follows. The collection and variables in the database are presented in section 2. In section 3, basic descriptive statistics on key variables and quality-adjusted indicators are shown. The scientific output using the database and extended abstracts of the articles are addressed in section 4. The final section summarizes the paper, and the original questionnaire is described in the Appendix.

2. The patent database with variables

2.1 Sample, collection, and response rate

To analyze the commercialization of patents, it is necessary to have a detailed database of individual patents.¹ In a previous pilot questionnaire, most patents were commercialized within five years after they had been granted. Therefore, patents granted in 1998 were chosen for the current survey and database, when collected in 2003–04.² In 1998, 2,760 patents were granted in Sweden. A total of 776 of these patents were granted to foreign firms, 902 to large Swedish firms with more than 1,000 employees, and 1,082 to Swedish individuals and firms with less than 1,000 employees. In the pilot survey, large Swedish firms generally refused to provide information on individual patents (Svensson 2002). Furthermore, it is impossible to persuade foreign firms to fill in questionnaires about Swedish patents, and these firms are almost always large multinational enterprises (MNEs). Therefore, the population consists of 1,082 patents granted to Swedish individuals and firms with fewer than 1,000 employees. This sample selection is not a problem if the conclusions reached when analyzing the data are drawn only for individuals and small firms.

Information on each patent's inventors, applying firm and their addresses was obtained from the Swedish Patent and Registration Office (PRV). Thereafter, a questionnaire was constructed sent out to the inventors of the patents by snail mail in March 2003 (see Appendix).³ We promised the inventors full confidentiality since information about patents and their commercialization is considered secret and/or sensitive. We sent out a reminder to inventors who had not returned the questionnaire after three weeks. Those who did not reply after the reminder were contacted by telephone. Sometimes, we had to persuade the inventors to fill in the questionnaire. When calling inventors who worked alone and asked them why they had not filled in and returned the questionnaire, many of them answered that they did not

¹ Not all inventions result in patents. However, since an invention that does not result in a patent is not registered anywhere, there are two problems with 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 national and international patent offices make such judgments. Therefore, the choice to use the patent rather than the invention is the only practical alternative for an empirical study on the commercialization process.

² 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.

³ Each patent always has at least one inventor and often also an applying firm. The inventor or the applying firm can be the owner of the patent, but the inventor can also indirectly own the patent via the applying firm. Sometimes, the inventors are only employed by the applying firm, which owns the patent. If the patent had more than one inventor, the questionnaire was sent to the first inventor only. If he/she did not respond, we tried to contact the second, etc.

intend to participate in the investigation because they had failed to make their inventions profitable. By calling these inventors, we succeeded in including such failed patents in the sample and to avoid a biased sample. The survey collection was completed in April 2004. The total effort to collect, code and adjust the database as well as collect and update complementary variables is estimated to be two man-years.

As many as 867 of the 1,082 inventors filled in and returned the questionnaire, i.e., the response rate was 80 percent. The survey fall-off was not systematic.⁴ This response rate is remarkably high, considering that inventors or applying firms usually regard information about inventions and patents to be sensitive. In 2009, the database was updated with respect to two questions: commercialization performance in profit terms and new questions about the contract terms when a patent was licensed or sold.

Turning to the filing routes, only eight of 867 patents were first filed abroad, and all these filings were in the US. No patent was filed first with the EPO or WIPO and thereafter in Sweden. This pattern markedly contrasts with the filing routes undertaken by Swedish MNEs. Various explanations may account for this result; for example, the owners in our database are individuals and small firms, and the data cover patent filings in the 1990s, when it was still common to file patents in the home country first.

2.2 Key variables

In the survey, commercialization occurs when a product or process innovation based on a patent has been introduced in the market—by the inventor, by the inventing firm or by an external firm that has licensed or acquired the patent. This definition is like that used in previous patent survey studies (Griliches 1990, Morgan *et al.* 2001) and like the definition of innovation used in the CIS surveys (Gault 2013), i.e., that the invention has been used commercially. The approach in our survey means that only technological product and process innovations are measured and excludes innovations linked to changes in the organizational structure or to new marketing methods, as defined in the OSLO manual (OECD 1997, 2005).

The key commercialization variables in the database include the following:

- Whether the patent has been commercialized (yes/no).

⁴ The fall-off occurred because 10 percent of the inventors had old addresses; 5 percent had correctly postal addresses, but we could not get in touch with them; and 5 percent refused to reply. The only information we have about the non-respondents is the IPC class of the patent and the region of the inventors. For these variables, there was no systematic difference between the respondents and non-respondents.

- The year the patent was commercialized.
- A category variable representing the commercialization mode: sold or licensed to a domestic or foreign firm, commercialized in the original firm where the inventors were owners or employed, commercialized in a new firm or if the inventors sold consulting services based on the patent.
- The year and commercialization mode if the patent was commercialized a second time using another mode.
- The profitability of the commercialization for the original owners: profit, break-even or loss (ordered variable in three steps).
- If the inventors were active during the commercialization (yes/no) (only available for commercialized patents).
- Percentage of the R&D and commercialization phases financed by 1) government authorities, 2) private VC firms/business angels, or 3) other sources (percent).

All the listed variables above have an almost 100 percent response rate, except for financing during the commercialization phase.

2.3 Other variables

From the PRV, we received information about the patent publication number, the number of inventors and the sex and postal address of the inventors.

In addition to the variables listed in the previous section, we asked the inventors about the workplace (university, firm, government authority, at home) where the invention was created, how many employees the firm had when filing the patent, the inventors' ownership (directly or indirectly) of the patent as a percentage, and if there were any problems with the commercialization or, alternatively, why the patent was never commercialized (see the Appendix). Further questions included whether the inventors had previously been granted similar patents, whether the patents were based on biotechnology and whether commercialization would require complementary patents. For university patents and patents created in firms near universities, we asked whether the university could assist with financing, legal or marketing advice. For commercialized patents, we asked what kind of incomes the original owners had received (salary, profit, incomes from selling the patent, royalty fees, consultancy incomes, etc.) and how many employment years had been generated in Sweden through the commercialization of the patent.

2.4 Complementary variables from archive sources

The complete IPC classes of the patents were collected from Espacenet (2019). Up to four different IPC classes are registered in the database on the 4-digit level. However, it is not possible to determine the main IPC class, as the classes are listed in alphabetical order for each patent in Espacenet (2019). Based on the IPC classes, patents are divided into 30 technology groups according to Breschi *et al.* (2004). Since a specific patent may have several IPC classes, it may also belong to several technology classes. If one creates additive dummies from the technology classes, they will not be mutually exclusive.

Patent renewal data were collected and updated several times from Espacenet, most recently in October 2019, when all patents were at least 20 years old and had expired. The patent renewal variable measures the number of years the patent was renewed.

Patent family size (patent equivalents) was also collected from Espacenet. Patent equivalents are documented in the most important 35 foreign countries. It is also documented whether the patent is an EPO patent or a PCT application.

Forward citations are collected from Espacenet (2019). These are measured within five years of the patent application date, excluding self-citations.⁵ Two main measures of forward citations are included: the number of forward citations the patent or its equivalents have received from 1) all other patents and 2) EPO patents and PCT applications. The second definition is due to the problem that many U.S. patents have an inflationary tendency to cite other patents. The forward citations are also divided on whether the citing and cited patent had at least one similar IPC class on the 4-digit level. If this is the case, it is registered as “a within technology citation”; if not, it is registered as “a between technology citation”.

Based on postal addresses, the patents could be divided into six different regions in Sweden according to NUTEK (1998): large-city regions, university regions, regions with important primary city centers, regions with secondary city centers, small regions with private employment, and small regions with government employment. If additive dummies are created from this region category, they will be mutually exclusive.

⁵ Variants are also measured within seven and ten years after the application date.

3. Descriptive statistics

3.1 Commercialization

Among the 867 patents, 624 were owned by the inventors, and for 243 patents, the inventors were employed by the owning firm and did not own the patent. Employment increases with firm size. Up to four inventors per patent are registered in the dataset. The 867 patents have 1,165 inventors, of which only 29 (2.5 percent) are women.

The commercialization rate of the patents is described across firm groups in Table 1. As many as 408 patents (47 percent) were granted to individual inventors, and 116, 201, and 142 patents were granted to medium-sized firms (101–1000 employees), small firms (11–100 employees) and micro companies (2–10 employees), respectively.⁶ The commercialization rate for the whole sample is 61 percent.⁷ The commercialization rate for firm groups is between 66 and 74 percent, but for individuals, it is no higher than 51 percent.⁸ For the timing of the commercialization decision, see Figure 3 below.

Table 1. Commercialization of patents across firm sizes, number of patents and percent.

| Firm size where the invention was created | Commercialization | | Total | Percent commercialized |
|---|-------------------|-----|-------|------------------------|
| | Yes | No | | |
| Medium-sized firms (101–1000 employees) | 77 | 39 | 116 | 66 % |
| Small firms (11–100 employees) | 137 | 64 | 201 | 68 % |
| Micro-companies (2–10 employees) | 105 | 37 | 142 | 74 % |
| Inventors (1–4 inventors) | 207 | 201 | 408 | 51 % |
| Total | 526 | 341 | 867 | 61 % |

When the database was collected (2003–04), the inventors were asked to estimate whether the commercialized invention would yield profit, break even, or result in a loss. If they did not know, their reply was registered as a missing value (uncertain outcome). This variable was

⁶ The group of individual inventors includes private persons, self-employed inventors and groups of two to three inventors who are organized in trading companies or private firms without employees.

⁷ This rate should be compared to rates in the few available studies that have measured the commercialization of patents. These figures include 47 percent commercialization for American patents found by Morgan *et al.* (2001) and 55 percent in the studies surveyed by Griliches (1990). The higher commercialization rate in the present study 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 percent for small firms and inventors. These other studies use a definition of commercialization like the one used here, i.e., that the patent has been used commercially.

⁸ A contingency-table test suggests a significant difference in the commercialization rate between firms and individuals. The chi-square value is 30.55 (with 3 d.f.), which is significant at the one-percent level.

updated for uncertain outcomes in 2009.⁹ In Table 2, discrete values of the outcomes in profit terms are described across firm groups.¹⁰ As described in the table, the outcomes are quite different across firm groups, where the group of individual inventors has the least favorable outcomes.

Table 2. Performance of commercialization across firm groups, number of patents.

| Firm size | Performance | | | | Total |
|--------------------|-------------|------------|------|---------------|-------|
| | Profit | Break-even | Loss | Missing value | |
| Medium-sized firms | 55 | 18 | 3 | 1 | 77 |
| Small firms | 97 | 24 | 15 | 1 | 137 |
| Micro-companies | 60 | 17 | 27 | 1 | 105 |
| Inventors | 69 | 47 | 87 | 4 | 207 |
| Total | 281 | 106 | 132 | 7 | 526 |

Table 3. Commercialization mode firm groups, number of patents.

| Commercialization mode (phase 1) | Firm size | | | | Total |
|----------------------------------|--------------|-------|-------|----------------------|-------|
| | Medium-sized | Small | Micro | Individual inventors | |
| Sold | 0 | 2 | 4 | 13 | 19 |
| Licensed | 0 | 2 | 7 | 37 | 46 |
| Existing firm, employed | 73 | 67 | 16 | 2 | 158 |
| Existing firm, owner | 4 | 66 | 77 | 85 | 232 |
| New firm | 0 | 0 | 1 | 70 | 71 |
| Total | 77 | 137 | 105 | 207 | 526 |
| Commercialization mode (phase 2) | | | | | |
| Sold | 4 | 8 | 5 | 20 | 37 |
| Licensed | 0 | 0 | 6 | 3 | 9 |
| New firm, owner | 1 | 1 | 2 | 0 | 4 |
| Total | 5 | 9 | 13 | 23 | 50 |

The commercialization mode is described in Table 3. Most patents were commercialized in the original firm in which the invention was created and in which the inventors were either employed or owners. Approximately 12 percent (65 patents) were either sold or licensed. Most of these patents were created in micro companies or by individual inventors.

⁹ For most the patents, commercialization had reached such a stage that there was no uncertainty at all about performance. However, there was still an uncertain outcome for 64 out of 526 commercialized patents. Therefore, the information on the profitability of commercialization was updated through phone calls to inventors who had previously announced an uncertain outcome in 2009, resulting in only seven unsettled outcomes.

¹⁰ It would have been desirable to measure the outcomes in monetary terms. However, such information was impossible to collect. It is very complicated to estimate the profit flows of individual patents because most firms have many products in their statement of account and many individual inventors do not have any statement of account at all (see the pilot survey in Svensson 2002).

Approximately 13 percent (71 patents) were commercialized in a new firm. For analysis of performance vis-à-vis the commercialization mode, see Braunerhjelm and Svensson (2010).

As seen in the lower part of Table 3, the commercialization mode could change. As many as 50 patents changed the commercialization mode, of which most were sold or licensed. An interesting observation (not shown in the table) is that most of these (38 out of 50) were first commercialized through entry and thereafter sold or licensed. In Norbäck *et al.* (2017), it is argued that asymmetric information about the quality of the invention gives inventors incentives to first enter the market to verify the invention's high quality and thereafter sell/license the patent. Therefore, owners can receive a higher acquisition or licensing price through bidding competition when the true quality is revealed.

Table 4. Inventor activity across firm sizes, number of patents and percent.

| Firm size | Inventor activity | | Total | Percent active |
|--------------------|-------------------|----|-------|----------------|
| | Yes | No | | |
| Medium-sized firms | 51 | 26 | 77 | 66 % |
| Small firms | 125 | 12 | 137 | 91 % |
| Micro-companies | 97 | 8 | 105 | 92 % |
| Inventors | 185 | 22 | 207 | 89 % |
| Total | 458 | 68 | 526 | 87 % |

Inventor activity during commercialization is defined only for commercialized patents. As shown in Table 4, 87 percent of the inventors had an active role during commercialization. Inventor activity is the lowest in medium-sized firms. The difference is statistically significant compared to the other groups.¹¹ For more statistics and estimations on inventor activity, see Maurseth and Svensson (2020).

3.2 Financing variables

The distribution of external financing during the R&D phase among firm groups is described in Table 5. It is obvious that external financing – irrespective of the source – is more common among individuals and micro companies. A total of 660 out of 867 patents did not have any external financing at all. Government soft loans were given to 92 patents and government VC financing was given to 50. Only 48 patents received private VC.

¹¹ A contingency table test suggests a significant difference in activity between firms of different sizes. The chi-square value is 35.45 (with 3 d.f.), significant at the one percent level.

Table 5. External financing during the R&D-phase across firm sizes, number of patents.

| Firm size | External financing | | | | Total with external financing * | No external financing |
|--------------------|--------------------|---------------------|-----------------------|-----------------|---------------------------------|-----------------------|
| | Private VC-funds | Government VC-funds | Government soft loans | Other financing | | |
| Medium-sized firms | 1 | 3 | 0 | 4 | 8 | 108 |
| Small firms | 7 | 0 | 3 | 6 | 11 | 190 |
| Micro-companies | 3 | 9 | 16 | 0 | 28 | 114 |
| Inventors | 37 | 38 | 73 | 26 | 160 | 248 |
| Total | 48 | 50 | 92 | 36 | 207 * | 660 |

* The total (207) is lower than the sum of the sub-groups (226), since some patents had external financing from different sources.

The patents with soft government loans had a commercialization rate of 48 percent compared to 62 percent for patents without such financing.¹² Similar rates for patents with government VC are 50 and 61 percent. In both cases, the differences are significant at the one percent level. On the other hand, patents with private VC (58 percent) had almost as high a commercialization rate as those without such financing (61 percent). An additional analysis of government financing can be found in section 4, where it turned out that patents with government soft loans underperformed with respect to commercialization, profitability, and renewal (Svensson 2007, 2008, 2013). An important conclusion from these studies is that it is the bad design of the loans (moral hazard) rather than bad selection of promising projects (adverse selection) that explains underperformance.

Table 6. External financing during the commercialization-phase across firm sizes, number of patents.

| Firm size | External financing | | | | Total with external financing * | No external financing |
|--------------------|--------------------|---------------------|-----------------------|--------------|---------------------------------|-----------------------|
| | Private VC-funds | Government VC-funds | Government soft loans | Stock market | | |
| Medium-sized firms | 1 | 0 | 0 | 0 | 1 | 76 |
| Small firms | 2 | 0 | 1 | 5 | 7 | 126 |
| Micro-companies | 10 | 2 | 6 | 2 | 17 | 84 |
| Inventors | 31 | 12 | 21 | 2 | 58 | 136 |
| Total | 44 | 14 | 28 | 9 | 83 * | 422 |

* The total (83) is lower than the sum of the sub-groups (95), since some patents had external financing from different sources.

¹² The risk should be higher in patent projects owned by individuals 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 explain the lower commercialization rate among government-financed projects. However, in the group of 408 patents owned by individuals, the commercialization rate is 44 percent for government soft loan projects and 52 percent for projects without financing, which is a significant difference.

Similar statistics on external financing during the commercialization phase are shown in Table 6. Among the 505 commercialized patents (21 missing values), 44 received private VC, 14 received government VC, 28 received soft government financing, and 9 were listed on the stock market.

3.3 Quality-adjusted indicators of patent value

In the literature, four main indicators of patent quality have been used to determine the value of the patents: forward citations, patent equivalents (family size), patent renewals and oppositions (van Zeebroeck 2011). Patent renewals, patent equivalents and forward citations have been collected from Espacenet (2020). Whereas patent renewal and equivalents represent private value, forward citations are usually considered to measure technology transfer and social value. Oppositions are only available in Espacenet for Swedish patents that have a patent equivalent at EPO and are therefore not included in the database.

Patent renewal

As seen in Figure 1, there is, as expected, a strong positive relationship between commercialization and renewal decisions. Approximately 86 percent of those patents renewed for 20 years had been commercialized. A similar relationship between the renewal and outcome of commercialization reveals a positive relationship. In Svensson (2015), patent renewal is estimated to be a better indicator of both technological innovation and successful innovation than patent equivalents and forward citations.

Figure 1. Relationship between patent renewal and commercialization, number of patents.

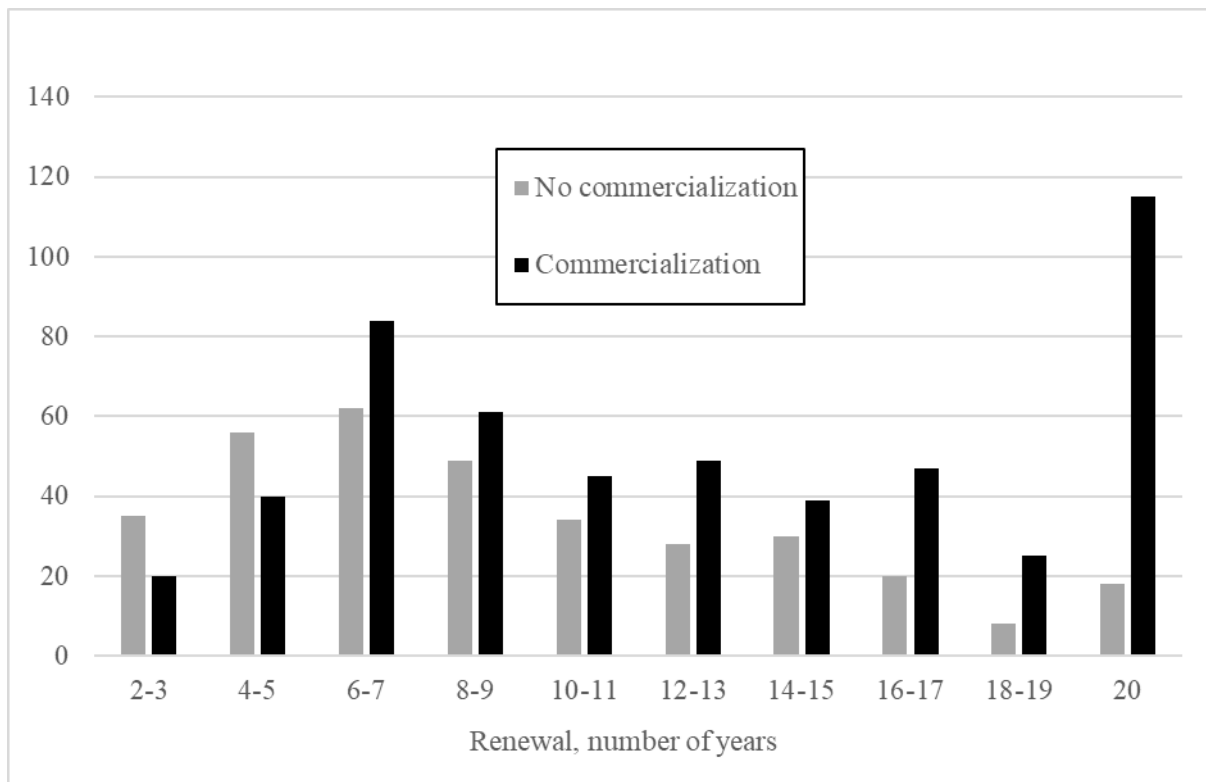
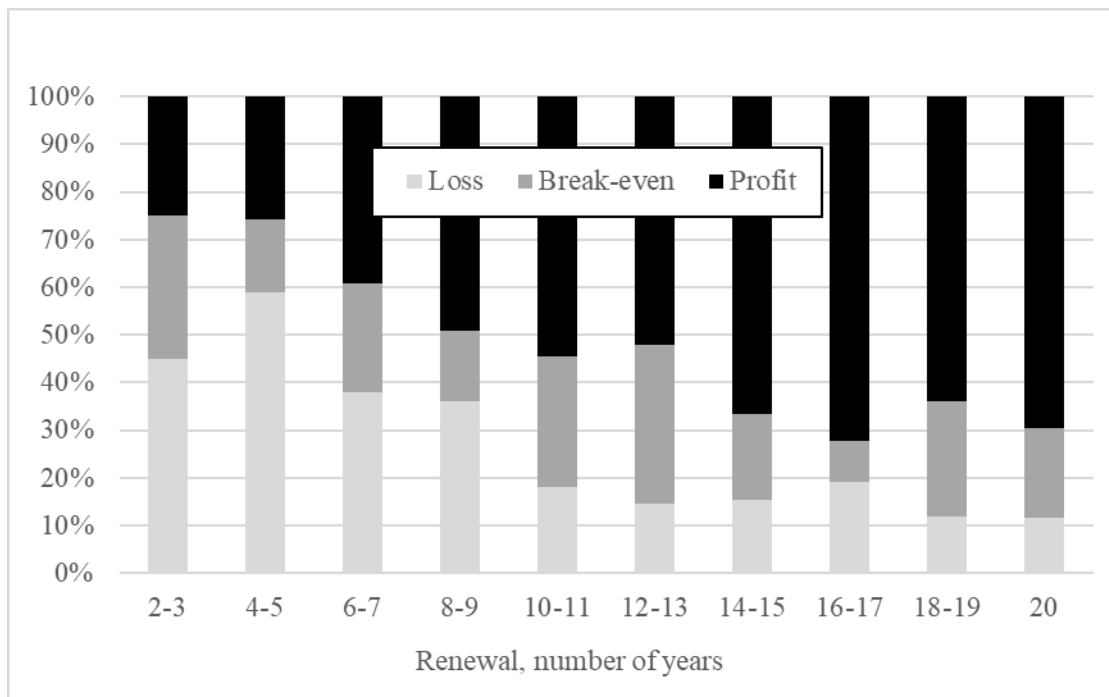


Figure 2. Relationship between patent renewal and commercialization performance, percent.



Patent equivalents

The 867 patents in the database together have 1,733 patent equivalents abroad, i.e., approximately two equivalents per patent on average. The frequency distribution of patent equivalents is shown in Table 7. Only 335 (39 percent) of the 867 patents have any equivalents. Given that a Swedish patent has equivalents, the average number of equivalents per patent is 5.2. The maximum number of equivalents for a given patent is 24. In total, there are patent equivalents in 35 different countries in the dataset. There were 224 equivalents in the U.S. and 141 in Japan, as well as 217 EPO patents. EPO patents must be validated in individual member countries. The EPO patents resulted in 1,104 individual patents in the EPO member countries, i.e., 5.1 individual patents per EPO patent on average.¹³

Table 7. Distribution of the number of patent equivalents in the database.

| | Number of patent equivalents | | | | | | | | | | | | | | | Total |
|----------------------------------|------------------------------|----|----|----|----|----|----|----|----|----|----|-------|-------|-------|-----|-------|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11-15 | 16-20 | 21-24 | | |
| Number of observations (patents) | 532 | 81 | 43 | 36 | 27 | 27 | 23 | 20 | 14 | 13 | 8 | 31 | 10 | 2 | 867 | |

Table 8 shows partial relationships between the number of patent equivalents and firm size, the commercialization decision, and forward citations. Firms have considerably more patent equivalents than individual inventors.¹⁴ Valuable inventions should be more frequently patented abroad than less valuable inventions since patenting is costly. Therefore, international patenting should correlate with variables such as commercialization, forward citations, and patent renewal, all of which are related to the private or social value of patents. Commercialized patents have more frequent patent equivalents than non-commercialized patents. The commercialization decision should reflect a higher private value. Forty-eight percent of the commercialized patents have equivalents, compared to 23 percent of the non-commercialized patents. The chi-square tests categorically reject independence between commercialization and equivalents.

¹³ Only 30 equivalents were filed directly at the national patent offices in the EPO area without an EPO patent application being filed first. The EPO patents in our database are filed most frequently in Germany, the UK, and France – the large EPO countries. Thus, patent equivalents are not distributed randomly across countries.

¹⁴ For example, 57 percent of the medium-sized firms had at least one equivalent, compared to 28 percent of the individual inventors. The differences in patent equivalents across firm groups are significant, according to a chi-square test. However, there is no uniform relationship between firm size and equivalents. Micro companies have more equivalents per patent than small firms.

Table 8. Patent equivalents across firm groups and commercialization, number of patents and percent.

| Categories | Patent equivalents abroad | | No. of patents per category | Average No. of equivalents | Chi-square test |
|--|---------------------------|--------------|-----------------------------|----------------------------|-----------------|
| | Yes | No | | | |
| Medium-sized firms | 66 (57%) | 50 (43%) | 116 | 2.54 | 40.6 *** |
| Small firms | 87 (43%) | 114 (57%) | 201 | 2.10 | |
| Micro companies | 66 (46%) | 76 (54%) | 142 | 2.44 | |
| Individual inventors | 116 (28%) | 292 (72%) | 408 | 1.64 | |
| Commercialization | Yes | 252 (48%) | 274 (52%) | 526 | 48.5 *** |
| | No | 83 (24%) | 258 (76%) | 341 | |
| Forward citations (from any source) | Yes | 243 (76%) | 75 (24%) | 318 | 302.3 *** |
| | No | 92 (17%) | 457 (83%) | 549 | |
| Total number of patents | 335 (39%) | 532 (61%) | 867 | 2.00 | |

Note: ***, ** and * indicate significance at the 1%-, 5%- and 10%-level, respectively.

The positive relationship is even stronger between patent equivalents and forward citations. Patents with citations had, on average, 4.1 equivalents, compared to 0.8 for patents without citations. Seventy-six percent of the cited patents had equivalents, compared to only 17 percent of non-cited patents.¹⁵ For more information about the patent equivalents in the database, see Maurseth and Svensson (2014).

Forward citations

As noted above, there is a strong positive relationship between forward citations and patent equivalents. The patents in the dataset and their equivalents have 1,046 forward citations in total. If only considering citations from EPO patents and PCT applications, this number is 378. Using the first definition of citations, as many as 549 patents in the dataset have no

¹⁵ Forward citations are used as a measure on the social value of patents. One explanation for this use is that patents that are cited by subsequent patents may be basic inventions that are useful for the subsequent development of new knowledge. However, there may also be other reasons why this correlation is so high. Citations are most often added by independent patent examiners in patent offices. When a Swedish patent has equivalents abroad, it may be much more visible to patent examiners, which will increase the probability that the patent is cited, even if the citations do not signal a higher private value for the cited patent.

citations at all (see Table 9). The more citations there are, the higher the probability that the patent is commercialized, but the correlation is not as strong as that between commercialization and patent renewal or equivalents, as shown in Table 10. For more information about the strength of the relationships, see Svensson (2012, 2015).

Table 9. Relationship between forward citations and commercialization, number of patents.

| Commercialization | Number of forward citations (all sources) | | | | | | | | | | | | All |
|-------------------|---|----|----|----|----|----|---|---|---|---|----|-----|-----|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | >10 | |
| Yes | 305 | 82 | 49 | 35 | 11 | 11 | 8 | 5 | 4 | 2 | 5 | 9 | 526 |
| No | 244 | 51 | 9 | 8 | 5 | 9 | 5 | 3 | 1 | 0 | 3 | 3 | 334 |

Table 10. Correlation matrix between commercialization and patent quality indicators, Spearman rank parameters.

| | | | | |
|--|--------------------------|--------------------|--------------------|--------------------|
| <i>Citations 1</i> (number, all) | 0.14 *** | | | |
| <i>Citations 2</i> (number, EPO + PCT) | 0.07 ** | 0.78 *** | | |
| <i>Equivalents</i> (number) | 0.24 *** | 0.61 *** | 0.41 *** | |
| <i>Renewal</i> (years) | 0.27 *** | 0.22 *** | 0.16 *** | 0.39 *** |
| | <i>Commercialization</i> | <i>Citations 1</i> | <i>Citations 2</i> | <i>Equivalents</i> |

Note: n = 867. ***, ** and * indicate significance at the 1%-, 5%- and 10%-level, respectively.

4. Scientific output from the database

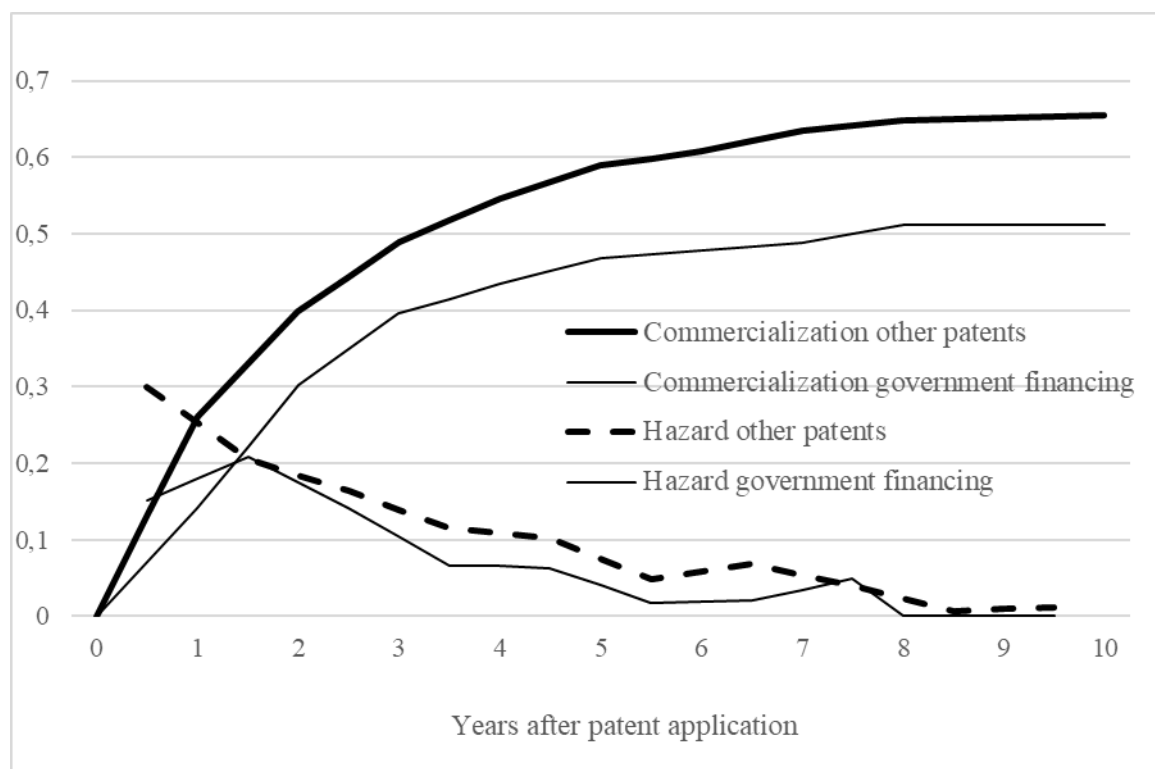
All studies presented in this section have applied the above described database. However, since the database has been updated a few times (profitability was updated in 2009 and renewal has been updated continuously), the studies have partly used different versions of the database.

4.1 Articles in peer-reviewed journals

Svensson, R., 2007, ‘Commercialization of Patents and External Financing during the R&D-Phase’, *Research Policy*, Vol. 36(7), pp. 1052–69.

In this study, survival models estimate how different factors influence the decision to commercialize patents. Such an analysis has seemingly never previously been undertaken. Since owners know more about their patents than potential external financiers do, problems related to information asymmetry are present. To overcome these problems when inventors and small technology-based firms need financing, Sweden has long relied on government support rather than private VC firms.

Figure 3. Share and hazard functions of commercialized patents.



The empirical results show that the larger the share of patent owners' costs covered by government financial support during the R&D phase is, the lower the probability that patents will be commercialized (see Figure 3). This lower degree of commercialization is likely to depend on (1) the soft terms of the government loans, where the patent owner can avoid paying back the loan if the patent is never commercialized, and/or (2) the government being unable to select promising projects. The first explanation is related to moral hazard, and the second explanation is related to adverse selection. The policy suggestion is for the government to change the design of the loans and to base them on firms rather than projects.

Patents with private external financing during the R&D phase are commercialized to the same extent as patents on average. On the other hand, university patents have a significantly lower conditional probability of commercialization in some of the estimations. Firm size had a strongly significant impact on the commercialization decision in the estimations. Patents created in firms (medium-sized and small firms as well as micro companies) are commercialized more quickly and with a higher probability than patents owned by individuals, thereby indicating how important complementary resources, such as financing, marketing and manufacturing, are for commercialization.

Svensson, R., 2008, 'Innovation Performance and Government Financing', *Journal of Small Business and Entrepreneurship*, Vol. 21(1), pp. 95–116.

External financing is important when inventors and small technology-based firms commercialize their inventions. However, inventors' private information about the quality of their products causes information asymmetries and moral hazard problems. To help compensate for potentially nonexistent capital markets, the Swedish government has intervened by offering loans with different terms to firms and inventors. This study analyzes the association between various forms of external financing and performance in profit terms when patents are commercialized. The estimations show that projects with soft government financing in the R&D phase have a significantly inferior performance compared to projects without such financing, whereas those receiving government financing on commercial terms have average performance. Distinguishing between governmental financing alternatives with different terms makes it possible to draw the conclusion that government failure depends primarily on bad financing terms rather than on bad project selection. A policy implication is therefore that public loans should be granted on more commercial terms in the R&D phase of projects.

Braunerhjelm, P. and Svensson, R., 2010, ‘The Inventor’s Role: Was Schumpeter Right?’, *Journal of Evolutionary Economics*, Vol. 20(3), pp. 413–44.

According to Schumpeter, the creative process of economic development can be divided into the stages of invention, innovation (commercialization) and imitation. Each stage is associated with specific skills. This paper examines whether Schumpeter’s assertion was correct, i.e., whether the invention and innovation stages should be undertaken by different agents. In addition, we examine whether there is a rationale for the Schumpeterian entrepreneur to include the inventor in the commercialization process. Combining the abilities of the entrepreneur and the inventor may serve to facilitate customer adaptation, strengthen knowledge transfers, and reduce uncertainty, thereby expanding market opportunities. The empirical analysis shows that profitability increases by 22 percentage points when inventions are commercialized by an external entrepreneur instead of by inventors. However, active involvement of the inventor is shown to have a significantly positive impact on profitability, irrespective of commercialization mode.

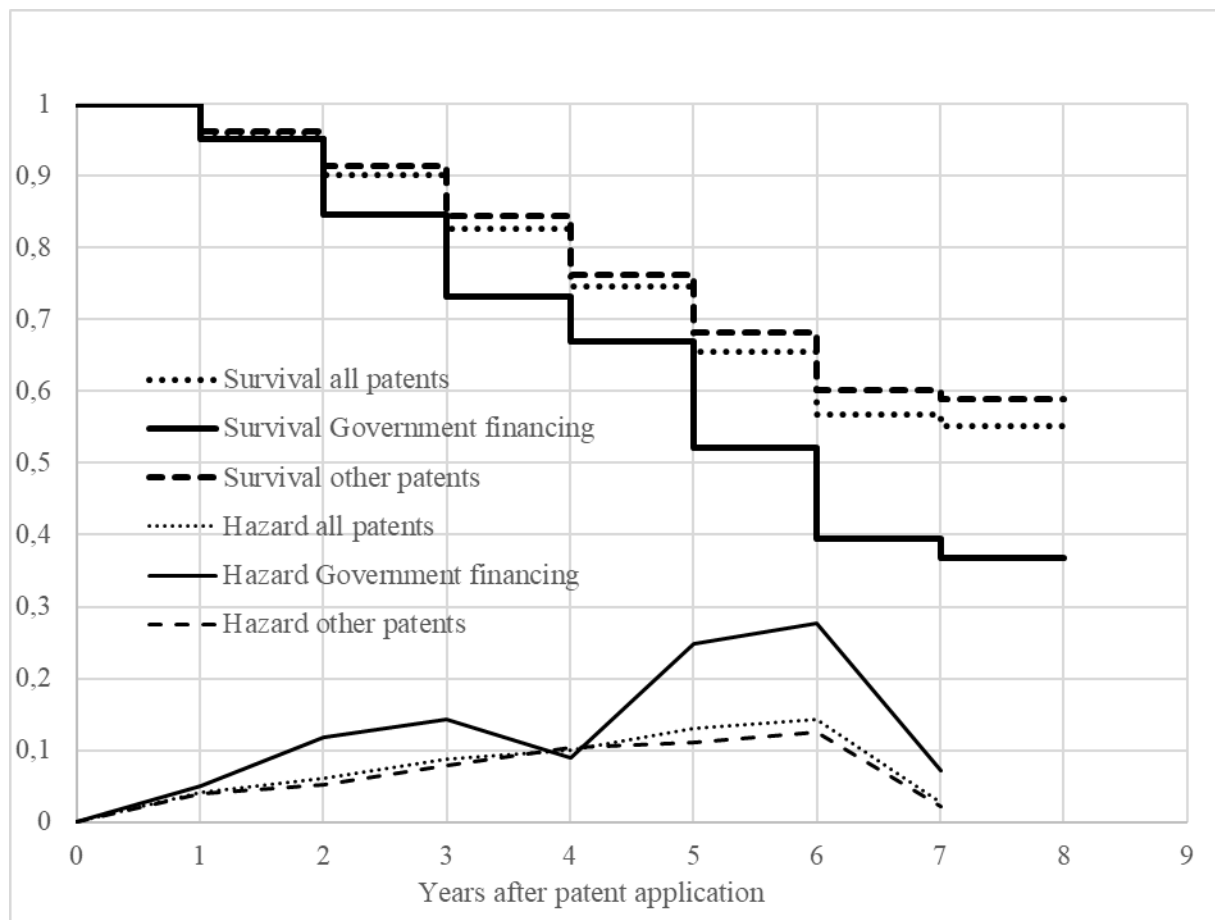
Svensson, R., 2012, ‘Commercialization, Renewal and Quality of Patents’, *Economics of Innovation and New Technology*, Vol. 21(1–2), pp. 175–201.

One of the major reasons why inventors are awarded patents by governments is that patents encourage R&D investments and the commercialization of inventions. If the patent holder commercializes an invention, he or she has stronger incentives to retain the patent. The purpose here is to empirically analyze the relationship between commercialization and the renewal of patents. Using a detailed database of Swedish patents, a survival model is utilized to estimate how commercialization is related to the patent renewal decision. Basic results show not only that commercialization and defensive strategies increase the probability that a patent will be renewed but also that quality influences commercialization and renewal decisions. When controlling for the endogenous commercialization decision, there is still a strong positive relationship between commercialization and the renewal of patents. Thus, given the quality of the patent, if the owner decides to commercialize the patent on the margin, it leads to a longer survival of the patent. Regarding commercialization modes, there is some evidence that licensed patents and patents commercialized in original and new firms – but not acquired patents – survive longer than noncommercialized patents.

Svensson, R., 2013, 'Publicly-Funded R&D-Programs and Survival of Patents', *Applied Economics*, Vol. 54(10–12), pp. 1343–58.

A survival model is applied to a detailed dataset of Swedish patents to estimate how different financing factors affect the likelihood of patent renewal. Since owners know more about patents than potential external financiers, there is an information asymmetry problem. To overcome this, Sweden has long relied on government support rather than private VC. In the empirical analysis, two kinds of government loans are unbundled. The empirical results show that patents that have received soft government loans in the R&D phase have a higher probability of expiring than patents without such financing (see Figure 4). However, patents that have received more market-oriented government financing during the commercialization phase are renewed for as long as other commercialized patents. This finding suggests that the nature of the contract terms – not the bad choice of projects – explains the low renewal of some patents with government financing.

Figure 4. Survival and hazard functions for patents with different financing,



Maurseth, P.B. and Svensson, R., 2014, ‘Micro Evidence on International Patenting’, *Economics of Innovation and New Technology*, Vol. 23(4), pp. 398–422.

Globalization, high growth rates in high-tech industries, growing emerging markets and the harmonization of patent institutions across countries have stimulated patenting in foreign markets. A simple model of international patenting is used, where the decision to patent in a foreign country depends on the country’s characteristics (market size, growth, and patent costs) and the quality of the patented invention. With access to a detailed database on individual patents owned by small Swedish firms and inventors, we can estimate some of these relationships and test their validity.

The empirical results support the predictions of the theoretical model. First, more valuable patents – measured in terms of either patent renewal, commercialization, or forward citations (both within and between technologies) – have more patent equivalents. Second, the country-specific variables have estimates in line with expectations. Market size, economic growth and distance have coefficients with the expected signs, and these coefficients are not insignificant. Additionally, indicators of technological rivalry in foreign markets, generally in terms of R&D intensity or relative specialization in the relevant patent classes (NRCA), stimulate international patenting. Finally, IPR policies are consequential on multiple levels. High patenting costs in the host country reduce patenting. The index for patent institutional quality significantly influences international patenting, and Swedish patent owners patent more frequently in EPO member countries than in other countries. However, our results are applicable only to patents owned by individuals and small firms since the database was restricted to such owners.

The results are in line with – but go considerably beyond – those of Harhoff *et al.* (2009). They estimate a gravity relationship for patenting among European countries (and for other non-European patent applications in Europe) and find similar results for the aggregate number of patent equivalents between these countries. Equivalents depend positively on market size and negatively on distance and costs. However, Harhoff *et al.* (2009) estimate aggregated numbers of international patents and thus are unable to incorporate patent-specific characteristics in the same way we do. They conclude their study by acknowledging that an “improvement would be to confirm these results at the patent level”.

Maurseth, P.B. and Svensson, R., 2020, ‘The Importance of Tacit Knowledge: Dynamic Inventor Activity in the Commercialization Phase’, *Research Policy*, Vol. 49(7).

Inventors generally know more about their inventions than what they disclose in patent applications. Because they possess this tacit knowledge, inventors may need to play an active role when patents are commercialized. We build on Arora (1995) and model firm-inventor cooperation in the commercialization of a given invention. Tacit knowledge warrants inventor activity. However, imperfect IPRs may reduce inventors’ incentives to engage in the commercialization process. We analyze when first-best inventor activity is achieved in a two-stage contract.

In the empirical analysis, we distinguish between situations in which the inventors themselves are responsible for the commercialization (owners) and when somebody else commercializes the patent. The latter situation occurs when patents are sold or licensed or when patents are commercialized in the existing firm and the inventors are only employed by the owning firm (nonowners). To the best of our knowledge, the importance of tacit knowledge in the commercialization process of inventions and patents has not been analyzed in previous empirical studies, except for university patents only. The empirical estimations show that inventor activity is positively related to the successful commercialization of patents. This positive relationship is even stronger when the patent is licensed or sold to an external firm. Inventor activity also has a strong positive correlation with profitability when the patent is commercialized in the existing firm and the inventor is only employed by the firm. Although a patent can be commercialized in several phases, inventor activity in the first commercialization phase matters most for successful commercialization. This finding was also predicted by the theoretical model. Our interpretation of the results is that the tacit knowledge of inventors and the cooperation between inventors and external firms are crucial for profitability when someone other than the inventor is responsible for commercialization.

4.2 Book chapters

Svensson, R., 2010, 'New Start-Up Firms among Swedish Patent Holders', pp. 11–32 in C. Holmquist and J. Wiklund (eds.), *Entrepreneurship and the Creation of Small Firms*, Cheltenham, UK, and Northampton, Ma, Edward Elgar.

I analyze how patents are commercialized and the implications for this choice for the performance of commercialization and the renewal of patents. Specific emphasis is placed on new start-up firms, which have been compared with other modes, i.e., patents that are sold, licensed, or commercialized in existing firms. Approximately 60 percent of the patents in the sample are commercialized. Most of the commercialized patents are commercialized in the same firm in which the invention was created, whereas 14 percent are commercialized in new start-up firms. The new firms are almost exclusively founded by individual inventors who did not previously have firms or employees. Inventors who have more similar patents and women are more likely to commercialize their patents in new firms.

The mode of commercialization is statistically related to the performance of commercialization in terms of profit. The performance is significantly higher if somebody other than the inventor is responsible for the commercialization. This is not surprising, given that the invention and innovation stages require quite different skills. However, the performance is improved if the inventors are engaged by the entrepreneur during commercialization. Inventions need to be adapted to the market conditions before commercialization, and inventors often have crucial, tacit knowledge. The main conclusion is that inventors are important as knowledge transmitters but are not successful as firm creators.

Patents commercialized in new and existing firms, as well as acquired/licensed patents with both fixed and variable fees, are renewed for significantly longer than non-commercialized patents. Among these commercialization modes, there is no significant difference. However, acquired/licensed patents that lack either variable or fixed fees are not renewed for longer than non-commercialized patents. This situation depends on moral hazard problems with respect to inventor and/or firm effort.

The good performance, in terms of renewal, of new firms' patents contrasts with their poor performance in terms of profitability. A possible explanation is that individual inventors may be overoptimistic and renew their patents beyond the optimal level. This hypothesis is supported by previous research indicating that individuals who start new firms are overoptimistic (de Meza and Southey 1996; Fraser and Greene, 2006).

4.3 Works-in-progress and restructured papers

Svensson, R., 2015, ‘Measuring Innovation Using Patent Data’, IFN Working paper No. 1047.

I provide empirical evidence that quality-adjusted patents can identify technological innovation in small and medium-sized enterprises. Survey data on the commercialization of patents are related to patent quality indicators (patent renewal, patent family and forward citations) from archival sources. Among the patent quality indicators, both the length of patent renewal and the size of the patent family indicate that the patent has been commercialized. Patent renewal for at least six years is sufficient to predict an accurate probability of commercialization. Furthermore, patent renewal is the only indicator revealing whether commercialization is successful or not. Forward citations have a weak relationship with both commercialization and successful innovation, which may reflect the fact that citations are outside the control of the patentees. Although the correlations of the patent value indicators with technological innovation are noisy, this study provides stronger empirical support for the true relative value of different indicators with respect to innovation.

Norbäck, P.J., Persson, L. and Svensson, R., 2017, ‘Verifying High Quality: Entry for Sale’, IFN Working paper No. 1186.

When and how do entrepreneurs sell their inventions? To address this issue, we develop an endogenous entry-sale asymmetric information oligopoly model. We show that low-quality inventions are sold directly or used for their own entry. Inventors who sell post-entry use entry to credibly reveal information on quality. Incumbents are then willing to pay high prices for high-quality inventions to preempt rivals from obtaining them.

Using Swedish data on patents granted to small firms and individuals, we find evidence that high-quality inventions are sold under preemptive bidding competition post entry. A significant share of the sales/licenses of patents takes place after the inventor has entered the product market. Product market entry is used as a verification mechanism for high-quality inventions. Selling inventions before entry is associated with asymmetric information problems, meaning that the price will be too low for entrepreneurs with high-quality inventions. These entrepreneurs will then use an entry-for-sale strategy to mitigate the information problems and sell their high-quality inventions under bidding competition post entry.

These results show that entrepreneurs with high-quality inventions have a strong incentive to enter the product market to credibly signal the market value of their inventions. Moreover, the price premium for high-quality inventions implies that entrepreneurs have a strong incentive to pursue risky projects that lead to high-quality inventions if successful.

Many countries in Europe and elsewhere grant fiscal advantages to entrepreneurs who market their inventions themselves rather than selling out to an incumbent firm. The results derived in this paper suggest that such policies can be sensible if combined with policies that improve the post-entry merger and acquisition market.

Maurseth, P.B., 2019, ‘The Impact of Patent Citations on Patent Survival’, stencil.

Patent citations are often used as an indicator of technology spillovers. Patent citations may therefore indicate that the cited patent has a high value. Important technological predecessors that have high values are cited more often than other patents. However, patent citations may signal the creative destruction of the cited patent. New innovations occur that render the cited patent obsolete. Patent citations may therefore have ambiguous effects on the renewal of patents. Maurseth analyzes both whether patents are cited during their lifetime and the timing of patent citations. The evidence indicates that cited patents both have longer lifespans and that hazard rates increase with the occurrence of citations.

Maurseth, P.B. and Svensson, R., 2019, ‘Payment Terms and Survival of Patents’, stencil.

How should payment be structured when external firms acquire or license patents from individual inventors or small firms? Variable fees, such as equity sharing or royalties, provide incentives for inventor effort during commercialization. Fixed fees provide incentives to the external firm to make investments in the commercialization process. Excluding either variable or fixed fees from the contract leads to a moral hazard problem. Alternatively, there is an adverse selection problem. By including both variable and fixed fees, the incentives of the inventor and the firm become more aligned. The performance of licensed and acquired patents with different payment structures has, however, seldom been analyzed empirically. Using a detailed database on Swedish patents, we utilize a survival model to estimate how the commercialization decision and the payment structure influence the patent renewal decision. We find that commercialization substantially increases the probability of renewal, but only for patents that are (i) commercialized by the original owner or (ii) licensed/acquired using both variable and fixed fees. If the contract relies uniquely on either fixed or variable fees, the

probability of renewal is as low as the renewal rates of non-commercialized patents. It is also shown that acquired/licensed patents with both variable and fixed fees survive longer than such patents with either variable or fixed fees. Acquired/licensed patents lacking variable fees underperform. The explanation is that inventors have fewer incentives to make efforts during commercialization.

Norbäck, P.J., Persson, L. and Svensson, R., 2009, ‘Creative Destruction and Productive Preemption’, IFN Working paper 2009 (also published as CEPR Discussion Paper No. DP8281 in 2011 and CESifo Working Paper Series No. 4075 in 2013).

We develop a theory of innovation for entry and sale into oligopoly and show that an invention of higher quality is more likely to be sold (or licensed) to an incumbent due to strategic product market effects on the sales price. Preemptive acquisitions by incumbents are shown to stimulate the process of creative destruction by increasing the entrepreneurial effort allocated to high-quality invention projects. Using data on patents granted to small firms and individuals, we find evidence that high-quality inventions are sold under bidding competition.

When the paper was published in a journal (Norbäck *et al.* 2016), the empirical part using the patent database was dropped. Instead, the empirical estimations were extended by considering asymmetric information in Norbäck *et al.* (2017), see above.

5. Summary

The purpose of this study was to present a unique database on commercialized patents and to show how it can be used to analyze the commercialization process of patents. The dataset is based on a survey of Swedish patents owned by inventors and small firms and has a remarkably high response rate of 80 percent. It contains some key variables on commercialization not found anywhere else:

- If, when and how (acquisition, licensing, existing or new firm) patents were commercialized.
- Whether the commercialization was profitable for the original owners.
- The activity of the inventor during commercialization.
- Financing during the R&D and commercialization phases.

Thus, this patent database measures technological innovation. The dataset is complemented by patent-quality indicators (patent renewal, forward citations, and patent family) from archive sources. Basic statistics for the key variables are described.

Finally, the scientific output in terms of published articles in peer-reviewed journals shows how this database can be used to analyze the commercialization process of patents. The financing variables could be used when evaluating the performance of government soft loan programs allocated to Swedish inventors (Svensson 2007, 2008, 2013). Patents with such loans underperformed with respect to commercialization, profitability, and renewal. However, patents that have received more market-oriented government financing during the R&D phase showed average performance. This finding suggests that the nature of the contract terms (moral hazard) – rather than bad choices of projects (adverse selection) – explains the low renewal of patents with soft government financing. Another study showed that inventor activity was a practical variable when analyzing the transfer of tacit knowledge from inventors to external entrepreneurs as patents were sold or licensed (Maurseth and Svensson 2020). As predicted by the model, the empirical estimations showed that inventor activity was crucial for the success of commercialization when patents were sold or licensed. If the patent was commercialized in a second phase, only the transfer of tacit knowledge in the first commercialization phase was important for a successful outcome.

Analysis of the commercialization mode showed the importance of Schumpeter's entrepreneurship when inventions were introduced as innovations in the market. When inventors sold or licensed the patent to a specialized entrepreneur, the probability of a

successful commercialization increased compared to the case of an inventor commercializing the patent him/herself, indicating that invention and innovation require different skills (Braunerhjelm and Svensson 2010). The entry strategy among inventors in oligopolistic markets is analyzed in Norbäck *et al.* (2017). Due to asymmetric information, it is difficult for inventors to obtain a high price if patents are sold directly. However, an entry strategy to verify the invention's high quality causes a preemptive bidding auction post-entry. The higher acquisition price gives incentives for entrepreneurs to create high-quality inventions. However, many countries in Europe and elsewhere grant fiscal advantages to entrepreneurs who market their inventions themselves rather than selling them to an incumbent firm. Our results suggest that such policies can be sensible if combined with policies that improve the post-entry merger and acquisition market.

The link between patent equivalents, commercialization and host country characteristics is analyzed in Maurseth and Svensson (2014). In addition to a strong relationship between family size and commercialization and forward citations, host country characteristics such as market size, economic growth and distance had a positive influence on patenting in individual countries. Additionally, indicators of technological rivalry in foreign markets stimulate international patenting. The survival of patents and commercialization is analyzed in Svensson (2012). Regarding commercialization modes, there is some evidence that licensed patents and patents commercialized in original and new firms – but not acquired patents – survive longer than non-commercialized patents.

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Commercialization of Swedish Patents

Confidential

| | | | |
|--|-----------|----------------------------------|---------------|
| 1. Basic information about the patent. | | Identity No. (PRV) | |
| Name of the patent | | | |
| Year of application | | Year when the patent was granted | 1998 |
| Inventor(s) | | | |
| Applying firm | | | |
| The inventors' share of ownership in the firm when the patent was filed. | | | |
| | | % | |
| The inventors' and the applying firm's ownership of the patent when it was filed. | | | |
| Percent | Inventors | % | Applying firm |
| | | | % |
| The number of employees in the applying firm when the patent was filed. | | | |

| | |
|--|--|
| 2. Type of workplace where the invention was created. Mark with one cross. | |
| University (name)..... | |
| Private firm (in connection with university.....) | |
| Private firm (not in connection with university) | |
| Government firm or authority | |
| Other workplace (e.g., at home) (mention which)..... | |

| | | | |
|--|---|--|---|
| 3. Financing of the invention until the application was filed. Percent. | | | |
| Government research foundation | % | University | % |
| Private research foundation | % | Inventors' own capital | % |
| Applying firm | % | Private venture capital/business angle | % |
| Other private firm | % | Government venture capital | % |
| Other financing (state which)..... | | | % |

| | | | |
|--|-----|--|----|
| 4. Have the inventors or the applying firm previously been granted patents in nearby areas. Where a "nearby area" includes patents that could be competitors to the patent. | | | |
| | Yes | | No |

| | | | | |
|--|-----|--|----|--|
| 5. Is the invention based on biotechnology ? Biotechnology means if it uses, produces, or analyzes biological systems on the micro, cellular or molecular level. | Yes | | No | |
|--|-----|--|----|--|

| | | | |
|---|-----|-------------|----|
| 6. If the invention was created at a university or at a firm close to a university: Do you estimate that the university would be able to assist with support when the patent is commercialized? | | | |
| | Yes | Yes, partly | No |
| Venture capital | | | |
| Legal advices | | | |
| Management or marketing advices | | | |

| | | | | | |
|---|--|----|--|-------------|--|
| 7. If the patent will be commercialized: Are complementary patents required to create a product? Mark with one cross. | | | | | |
| Yes | | No | | Do not know | |

| | | |
|---|-----|----|
| 8. Has the commercialization of the patent started? Mark with one cross. Definition. Here, the term “commercialization” means that measures have been taken to generate incomes from the patent or an innovation has been introduced in the market. | Yes | No |
| | | |

If you answered “**Yes**” in question 8, then questions 9-17 should be answered; if you answered “**No**”, continue to question 18.

| | | | |
|---|----------------|---|------|
| 9a. Which year did the commercialization start? Enter the year . Note: The commercialization may have started before the patent was granted. | | | |
| 9b. Which mode of commercialization was used? Mark with one cross and state the name of the buyer if the patent was sold. | Buyer | X | |
| The patent was sold to another existing Swedish firm | | | |
| The patent was sold to another existing foreign firm | | | |
| The patent was commercialized in a new firm (founded for this patent) where the inventors are owners | | | |
| The patent was commercialized in an existing firm where the inventors are owners | | | |
| The patent was commercialized in an existing firm where the inventors are employed | | | |
| The patent was licensed to another Swedish firm | | | |
| The patent was licensed to another foreign firm | | | |
| The inventors sold consulting services based on the patent | | | |
| 9c. Has the situation in question 5b changed since the start? If Yes, mark with one cross and state the year and buyer , if any. | Buyer (if any) | X | Year |
| The new/existing firm was sold to a Swedish firm | | | |
| The new/existing firm was sold to a foreign firm | | | |
| The patent was licensed to another Swedish firm | | | |
| The patent was licensed to another foreign firm | | | |
| Other alternative (mention which)..... | | | |

| | | | |
|---|---|-------------------------------------|---|
| 10. If the commercialization was started in a new or existing firm where the inventors are owners , how was the commercialization financed ? Percent. | | | |
| Existing firm's capital | % | Private VC (state source) | % |
| Inventors' own capital | % | Government VC (state source) | % |
| Inventors borrowed capital | % | Other financing (state which) | % |

| | | | |
|--|--|-------------------------------|--|
| 11. The role of the inventors during the commercialization. Mark with one cross. | | | |
| Active role and owner | | Owner but not active role | |
| Active role but not owner | | Neither active role nor owner | |

| | | | |
|---|--|----------------------------------|--|
| 12. State the incomes/profits that the patent has generated up to now for the inventors and/or for the firm that is owned by the inventors . | | | |
| Income when the patent or firm was sold | | Salary from employment | |
| Income or profits from an existing or new firm | | Incomes from consulting services | |
| Royalties | | No income | |
| Other income (mention which)..... | | | |

| | | | |
|---|--------------------------|---------------------------|--------------------------|
| 13. Has the commercialization been profitable for the original owners? Mark with one cross. | | | |
| Very profitable | <input type="checkbox"/> | Profitable | <input type="checkbox"/> |
| Break-even (in principle +/- 0) | <input type="checkbox"/> | Loss (failed) | <input type="checkbox"/> |
| No profit yet, but good prospects | <input type="checkbox"/> | Difficult to estimate now | <input type="checkbox"/> |
| Other alternative | <input type="checkbox"/> | | |

| | |
|--|-------|
| 14. How many employment years has the patent generated in Sweden since the commercialization started? (If 5 persons were employed in 4 years, then 20 years.) | years |
|--|-------|

| | | | | |
|--|-----|--------------------------|----|--------------------------|
| 15. Did the new/improved product based on the patent replace a previous product from the firm or the inventor? | Yes | <input type="checkbox"/> | No | <input type="checkbox"/> |
|--|-----|--------------------------|----|--------------------------|

| | | | | |
|--|-----|--------------------------|----|--------------------------|
| 16a. Has the invention been manufactured in countries other than Sweden? | Yes | <input type="checkbox"/> | No | <input type="checkbox"/> |
| 16b. If “ Yes ”, mention these countries. | | | | |

| | | | |
|---|--------------------------|---|--------------------------|
| 17a. State one or two difficulties during the commercialization. Mark with one or two crosses | | | |
| Financing | <input type="checkbox"/> | Finding a firm that could manufacture the product | <input type="checkbox"/> |
| Legal advices | <input type="checkbox"/> | The product was not good enough | <input type="checkbox"/> |
| Marketing | <input type="checkbox"/> | Other alternative | <input type="checkbox"/> |
| Information about the market | <input type="checkbox"/> | | |
| 17b. Describe problems encountered during the commercialization | | | |
| | | | |

If the patent has **not** been commercialized yet, answer question 20.

| | | | |
|--|--------------------------|--|--------------------------|
| 18a. If the patent has not been commercialized yet: Why not? Mark with one or several crosses , or mention your own alternatives . | | | |
| Financing problems | <input type="checkbox"/> | Difficult to find a manufacturing firm | <input type="checkbox"/> |
| Legal advice is lacking | <input type="checkbox"/> | The invention was not good enough | <input type="checkbox"/> |
| Marketing advice is lacking | <input type="checkbox"/> | Other better products in the firm were prioritized | <input type="checkbox"/> |
| Too small or uncertain market | <input type="checkbox"/> | Competitors had better inventions/products | <input type="checkbox"/> |
| “Shadow patent”, which protects other close patents | <input type="checkbox"/> | The patent is used in negotiations to obtain access to competitors’ technologies | <input type="checkbox"/> |
| Product not ready for commercialization yet | <input type="checkbox"/> | Other alternative | <input type="checkbox"/> |
| Difficult to find information about the market | <input type="checkbox"/> | | |
| 18b. Describe other opinions about the difficulties in commercialization of patents in Sweden: | | | |
| | | | |