

International cooperation for Swedish inventors – an exploratory study

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Abstract

In this paper we report from a research project exploring the reasons behind why Swedish domestically invented patents end up being owned a foreign company. Based on survey data, we find that the majority of inventors behind these foreign-owned patents are professional inventors who have a relatively high amount of patent experience. They are also highly educated with about one third of the respondents having doctoral training. They are primarily motivated to invent because it is meriting and good for their career and as it gives them higher influence in the milieu where they are working. Only about 11% of the inventors had any influence on the decision to collaborate with a foreign firm. In most of the cases the inventors were either employed by a private firm who controlled the patent, or the invention behind the patent was ordered by the foreign firm already from the beginning. In the case where inventors had any influence on the decision, the most common reasons for seeking international collaboration was that the foreign firm provided better opportunities to commercialize the patent compared to Swedish firms and that the foreign firm could offer more money for financing development costs compared to Swedish firms.

Key words: domestic inventions, foreign ownership, international cooperation, inventors

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1. Introduction and aim of study

Technological progress is today well recognised as a major driver of long term economic growth. This recognition has among other things led technological advanced economies to implement national policies to support the generation and commercial exploitation of domestic inventions. As a result, many European countries spend large sums of government money on research in the public sector, especially in science and technology fields. In addition, many countries have publicly sponsored financial support for private R&D efforts. These include programmes for boosting the innovative performance of small firms, support for R&D partnerships between large and small firms, and special tax concessions which allow private companies to deduct qualifying expenditure incurred on R&D activities. These efforts are all expected to have a positive effect on national competitiveness and the overall innovation performance of the country.

An important indicator of the innovation performance of countries is their total number of patent applications¹. Patenting activities is in this respect following the general trend towards globalization of the economy (OECD, 2006). This means that patents, as well as the inventors behind the patents and the ownership of these patents, are increasingly crossing international borders (Guellec and van Pottelsberghe, 2001). However, this general trend also suggest that public efforts to support domestic innovation through direct funding or through tax concessions may risk having a more uncertain impact as the resulting inventions may end up being controlled and commercially exploited by firms in foreign countries. In the case where the increasing internationalization affects all countries to a similar extent this may be no problem. But, in the case of an uneven balance between countries, which have been indicated in recent reports (Guellec and van Pottelsberghe, 2001; OECD, 2006), this may be a sign that the area deserves further scholarly attention to better understand the causes and effects of this potential unbalance.

One issue that we find relevant to examine is to what extent the decision to collaborate with a foreign firm as the applicant for the patent is a deliberate choice, which means that domestic investors actively pursues the opportunity to collaborate with a foreign applicant for their

¹ A patent is a set of exclusive rights to an invention for a fixed period of time in exchange for a disclosure of the invention. This means that the owner of the patent has the right to prevent or exclude others from making, using, selling, offering to sell or importing the invention. For a discussion of the strength and weaknesses of using patents as indicator of innovative output, see Griliches (1990).

patent. There is often an implicit assumption that the lion share of domestic inventions that end up in foreign hands is due to cross-border ownership of companies and where inventors is corporate employees and thus has no influence on patent decisions. However, international studies of patent inventors (e.g., Sirilli, 1987) have suggested that the share of independent inventors with no formal affiliations is larger than what is often expected. Comarov (2002), for example, estimated that the number of patents awarded to independent inventors in the USPTO increased by 30% between 1990 and 2000. Also, in recent years we have in Europe seen an increasing amount of patents originating from the public research sector (Geuna and Nesta, 2006). In both of these scenarios, patent inventors have larger degrees of freedom in choosing what to do with and where to place the patent. Therefore, against this background we are interested in finding out the proportion of domestic patent inventors that actively pursues the opportunity to find a foreign firm as the applicant.

In the case where the decision to collaborate with a foreign firm as the applicant for the patent is a deliberate choice, a relevant question is also to examine the motives behind this choice. For example, is it issues related to taxation, lack of competence or other problems in the innovation system that made inventors turn to foreign firms? Or, do personal considerations such as career motives and informal network linkages play an important role in this process? Surprisingly, this is an issue that so far have received very little attention despite its relevance for both theory building and policy making in the area of international cooperation in patenting.

In this paper we are focusing on the Swedish context. To examine the reasons for why Swedish domestically invented patents end up being owned a foreign company we ask the following research questions:

- How common is it that Swedish domestically invented patents have a foreign firm as applicant?
- Who are the inventors behind these patents?
- What are the main reasons for their collaboration with a foreign (non-Swedish) firm as applicant for the patent?

By addressing these questions we believe our paper will contribute to the accumulation of knowledge about why international knowledge transfer takes place and why this is a rising phenomena.

The rest of the paper is structured as follows. In the next section we present a literature review which serves as our point of departure for the following empirical study. Thereafter we describe the overall research design and the data collection process. We continue with a section where we present data for how common is it that patents with a Swedish inventor have a foreign firm as the applicant. Then we present an overview of the profiles for these patent inventors. This section is followed by an overview of the inventors' main reasons for collaborating with a foreign firm as applicant for the patent. Lastly, we conclude with a summary of the main findings.

2. Literature review

International cooperation in patenting is becoming increasingly common. Guellec and van Pottelsberghe (2001) in their study of patent data for example show that there is an increasing trend towards globalisation of technology in the OECD area. Moreover, they observe large cross-country differences where the degree of technological internationalisation is higher in small open economies such as Sweden. In a recent report from the OECD, it is furthermore pointed out that the pattern of technological internationalisation is increasing and that it continues to be uneven between countries (OECD, 2006). Among other things, this increasing trend towards globalisation of technology consequently opens up questions about the profiles and motives of domestic inventors who have a foreign applicant on their patent. By doing so, we can better understand why they collaborate with a foreign applicant and to what extent these inventors actually have an influence on this decision.

However, most academic studies on the issue of international cooperation in patenting have largely focused on the perspective of companies who are exploiting and commercializing patents (i.e., Hagedoorn & Schakenraad, 1990; Suarez-Villa & Walrod, 2003; Edler, 2004), while the perspective of the inventors behind the patents has been left largely unexplored. Neglecting this issue has led to that there is very little contemporary knowledge in the scholarly community about the reasons for why inventors located in one country end up cooperating with foreign companies and to what extent these inventors have any influence on

this decision. By doing so, we can better understand why domestic inventors collaborate with a foreign applicant and to what extent they actually have an influence on this decision.

The role of inventors in the patent process has generally been overlooked in literature and research on innovation. A review of published articles reporting results from empirical studies of inventors identified only a handful articles dealing with the topic. An overview of the articles can be found in table 1 below.

Table 1: Overview of articles dealing with the role of inventors in the patent process

Authors	Topic and context	Method
Schmookler (1957)	A study of independent inventors in the US.	Mail survey to a selected number of 122 inventors that applied for a US patent in 1953. 87 usable questionnaires was received (71 % response rate).
MacDonald (1986)	A study of the characteristics and work of Australian independent inventors	Mail survey to independent inventors who had applied for patent protection in 1978. Responses from 601 respondents were analyzed.
Sirilli (1987)	A study of Italian inventors and their inventions.	Mail survey to 7014 Italian inventors who applied for a patent in 1981. 555 usable questionnaires was received (7.9% response rate).
Amesse et al (1991)	A study of the nature of the inventive process among individual inventors in Canada.	Mail survey to 887 inventors to whom Canada had issued patents in 1978 and 1983. 374 usable questionnaires was received (42.2 % response rate).
Dagenais, Séguin-Dulude & Desranleau (1991)	A study of individual Canadian inventor behavior.	Mail survey to Canadian inventors. No information about initial sample. 265 cases are analyzed.
Kassicieh, Radosevich & Umbarger (1996)	A comparative study of the entrepreneurial environment and the incidence of entrepreneurial spin offs in three large US national laboratories	Mail survey to 213 inventor-employees (49.4%) and 24 entrepreneurs (55.8%) who have previously been inventors at the national laboratories.
Livesay, Lux & Brown (1996)	A study of different types of US inventors and their motivations to invent.	Data collected from small business and independent inventors who participated in the Energy Related Inventions Program (ERIP). Qualitative case studies were conducted on 101 participants. The economic impact of the program was assessed at five points in time by mail and/or telephone surveys. The progress of 442 ERIP technologies was tracked.

Authors	Topic and context	Method
Markman, Balkin & Baron (2002)	A study of patent inventors and the incidence of new venture formation in the US.	Mail survey to random selection of 586 patent inventors. Sample was obtained from USPTO. 217 questionnaires was received (37% response rate).
Tijseen (2002)	A study of science dependence of technologies in the Netherlands.	Nation-wide mail survey amongst inventors working in the corporate sector and the public research sector. Study is based on a stratified sample of 171 inventors from all Dutch-invented patents on technological inventions filed through international patent offices (EPO, PCT, USPTO) in 1998 and 1999. A total of 93 usable questionnaires was received (55 % response rate).
Meyer (2004)	A study of independent inventors and the public efforts supporting them in protecting and capitalizing on their inventors in Finland.	Multi-case study methodology. 33 cases were selected out a databank of 682 inventors and 967 patent records. Interviews were semi-structured aided by an interview guideline.
Ibrahim & Fallah (2005)	A study of the various sources and forms of knowledge that have influence on the innovation process in the US.	Mail survey to a random sample of 250 inventors in the telecommunications industry who had filed for patents in the past three years. 122 usable questionnaires was received (48.8% response rate).
Giuri et al (2005)	A study of European patent inventors.	Large scale survey to 27531 inventors of European patents granted by EPO between 1993 and 1997, located in France, Germany, Italy, the Netherlands, Spain and the United Kingdom. 9017 responses were returned (32.8% response rate).
Weick & Eakin (2005)	A study of the role of independent inventors in the innovation process in the US.	Electronic survey to independent inventors using “snowball” technique. Two major US inventor organizations mailed their members and encouraged independent inventors to answer the survey. Data from 352 usable questionnaires was received.
Weick & James (2006)	A study of part time and full time US inventors	Mail survey to independent inventors. Interviews were also conducted with successful inventors.

Schmookler (1957) in his classical study of independent inventors in the US challenged the prevailing assumptions of the diminishing role of these inventors. The background of his study was that the inventive activity had gone from being overwhelmingly dominated by independent individuals in the beginning of the 20th century towards more and more taking part in business enterprise. In his study he showed that about 40 % of inventions were not made by technologists or employed inventors, and a respectable part came from non-college

graduates. He concluded that the process of transfer of the inventive function from independent to employed corporate inventors was slowing down.

Macdonald (1986) in a study of Australian independent inventors examined their characteristics and whether their work is different from that of formal research units. He report that most inventors were middle-aged, middle-class males with a fairly high level of education. He moreover report that individual inventors work in different areas from corporate research units. Their work is moreover regarded as less professional compared to formal research. However, even if research units have little contact with independent inventors and generally do not consider their work as valuable, they show an interest in their patents and occasionally license from them.

Sirilli (1987) investigated Italian inventors and their inventions. He found that the vast majority of inventors were males. Their average age was 46.5 years and as high as 40% of them were independent inventors not working for a company. The level of formal educational training was fairly high with more than 75% had a diploma or university degree. Moreover, only one third of respondents claimed invention to be their main activity. For the others it represented either one of several activities, or a sporadic or minor activity. About 80% of the inventions relate to products and the rest to processes. The major sectors to which the patent application was related were (in descending order): mechanical engineering, chemicals, electrical-electronic and vehicles.

Amesse et al (1991) studied the characteristics of individual inventors and the fate of their inventions. They report that individual inventors were highly experienced both in terms of technical and commercial knowledge, with educational and income level above average. Educational training was mostly in engineering or applied science and in 46.3% of the cases they were self-employed. The invention process varied widely in its length and cost. Half of inventions were made within a short time and at low cost. About 25% of the inventions require a good deal of time and substantial expenditures. They also reported that about 43% of all inventions were commercialized.

In a study of individual Canadian inventor behavior Dagenais, Séguin-Dulude and Desranleau (1991) found that almost half of all individual inventors did nothing with their invention. Individuals who were self-employed had much higher probability of commercializing their

invention. Inventions with more schooling moreover tended to be less innovative, and if it was more innovative the probability of obtaining financial success were much lower. Prior patent experience was moreover positive for the likelihood of commercializing the patent, succeeding financially and making patent agreements or licensing. Non-native Canadians have a much higher financial success rate and were more likely to be involved in successful transactions. Probabilities of financial success are lower for inventions of processes than products. Inventors using patent agents are more likely to commercialize their invention.

Kassicieh, Radosevich and Umbarger (1996) examined laboratory inventors in three large US national laboratories by measuring their personal characteristics, attitudes, and perceptions of situational variables commonly associated with entrepreneurship. They report that inventor-employees are reluctant to leave their laboratory and start up entrepreneurial spin offs based on their research. Attributes of inventors who have started up spin-offs moreover differ significantly from non-entrepreneurial inventors on the bases of personal characteristics, perceptions of the supportive situation, and attitudes towards entrepreneurship. They conclude that the level of actual support at national laboratories seems to be a key factor in explaining the low incidence of entrepreneurship rather than inventors' own perception of their situation or their attitudes towards entrepreneurship.

Livesay, Lux and Brown (1996) present a study of different types of US inventors and their motivations to invent. They identify five categories of inventors based on their view of success and their corresponding attitudes toward technology, reaching the market and creating a business. Their likely commercial success is in diminishing order as follows: i) entrepreneurs with technology, ii) industry-specific inventors, iii) professional inventors, iv) grantsmen and v) inveterate inventors. In addition, they categorize thirteen different motives underlying the choice to develop technology, which form the basis for a motivational taxonomy.

Markman, Balkin and Baron (2002) report a study of patent inventors and the incidence of new venture formation in the US. Using concepts and theories from cognitive psychology they find that self-efficacy and regretful thinking distinguish inventors who start up their own firms (technological entrepreneurs) from non-entrepreneurial inventors. Technological entrepreneurs have higher self-efficacy (belief in one's own capability). Also, technological entrepreneurs have stronger regrets about business opportunities, while technological non-

entrepreneurs have stronger regrets about career and education decisions. However, there was no difference in quantity of regrets.

Tijseen (2002) examine inventors' perspectives of the role of scientific and engineering research in the development process leading to patented inventions. He report several more or less equally influential factors influence knowledge creation and transfer processes leading to successful technical innovations. These include inventors' own capabilities and previous R&D achievements, external information sources, and the general R&D environment. He also finds that citations in patents refereeing to basic research literature were invalid indicators of a technology's science dependence. Moreover, about 20% of private sector innovations were based on public sector research.

Meyer (2004) reported from a study where he examined the experiences of independent inventors in Finland trying to protect, patent and utilize their inventions, with a focus on the extent to which the inventors received public support. He shows that independent inventors are a heterogeneous group of inventors encompassing a variety of types. Different types of inventors and their patents concur with different levels of access to and use of support measures. Access to innovation support does not necessarily coincide with commercialization success. Inventor categories with some success in utilizing patented inventions coincided with little support and advice from public organizations.

Ibrahim and Fallah (2005) in their study of US inventors examine the individual knowledge creation process and explore sources of knowledge that them in coming up with their inventions. They report that the company environment and interaction with co-workers in terms of their tacit knowledge and non-codified explicit knowledge. The influence of collective and individual tacit knowledge was rated higher than the influence of explicit knowledge. Inventors who commercialized their inventions generally rate the influence of knowledge from their organizations as higher than those who did not.

Giuri et al (2005) in their large scale study of inventors in France, Germany, Italy, the Netherlands, Spain and the United Kingdom examine their characteristics, the sources of their patents, the importance of formal and informal collaborations, the motivations to invent, and the actual use and economic value of the patents. They report that 75% of the surveyed inventors have a university degree, while 25% have a PhD degree. Personal and social

rewards (like personal satisfaction, prestige, reputation and contribution to the performance of the organization) were more important motives for patenting compared to monetary rewards and career advances. Most patents are the outcome of team activity - only 1/3 of the patents were developed by individual inventors and the vast majority of co-inventors belong to the same organization. Customers were the most important source of knowledge for the patents, followed by other patents and scientific literature. University and research laboratories were ranked as the least important sources. Geographical proximity does not influence probability of collaboration if researchers belong to different organizations. About one third of the patents were not used for specific economic or commercial activities. Half of these were dormant and the rest were blocking patents. The distribution of patent values was moreover skewed and only a few patents yielded any large returns.

Weick and Eakin (2005) examined the role of independent inventors in the innovation process in the US. They report that the inventions of these independent inventors tended towards hardware/tool, household products, industrial/commercial products, novelty items and toys/games/hobbies. About 39% of the respondents generated sales from their inventions and about 20 % profited from them. Inventors who started up a firm to exploit a patent were more likely to achieve higher sales compared to only licensing. However, inventors with a firm who licensed the invention were more likely to achieve higher sales, compared to only commercializing through their own firm or only through licensing.

Weick and James (2006) examined differences between part time and full time inventors. They report that part time and full time inventors are similar in terms of age, gender, educational level and the types of invention they pursue. Sales levels are significantly related to the combination of a full time commitment to inventing and a willingness to invest in patent protection. The transition from part time to full time inventing was driven by unexpected events, a desire to change careers, or preference for working in a more creative atmosphere.

In sum, the identified studies reviewed above have all great merit in contribution to our understanding of the role of inventors in the patent process. However, although giving some reference points for comparisons most of them deal with inventors operating in their national contexts. Hence, much is still unknown about the issue of international collaboration in patenting and the reasons for why domestically invented patents end up being owned a

foreign company from the perspective of inventors. It thus seems fair to argue that there is a need for more research that addresses these questions.

3. Data collection

To meet our addressed research questions we collected our data in two major steps. First, we investigated patent data in the European Patent Office (EPO) database. At this stage we identified Swedish domestically invented patents² with foreign ownership over the period 1978 to 2005. We also identified its mirror image, i.e., the number of foreign inventions with Swedish ownership. We counted patent applications rather than granted studies as we were interested in the reasons for why Swedish patent inventors' patents seek collaboration with foreign companies. Whether or not they become granted was hence a minor issue for us.

We identified the names and addresses of 553 Swedish inventors who in 2003³ were reported as inventors where there was a foreign firm reported as applicant. The EPO database provides full names and addresses of inventors and applicants, which made it possible to track both inventors and applicants. This information about names and addresses of the inventors was cross-checked against the official Swedish population register (SPAR) where all people living in Sweden are registered. By using SPAR we were able to check the address was correct, if he or she has moved to a new address, and whether the person was still living in Sweden - thus giving us the opportunity to update the addresses. This effort consequently led to that we could identify the names and addresses of 528 inventors.

The second major step in our data collection was the construction of a questionnaire survey sent to the 528 inventors who were identified in the previous step. The questions were derived from a careful review of previous theoretical and empirical work surveying patent inventors. Before sending out the questionnaire it was pilot tested both on a group of practioners (inventors and people working with patents) and scholars working in the field of innovation studies. Based on this feedback, the questions were honed and clarified for the final research instrument.

² Swedish inventions are in this study treated as inventions made by inventors who in the patent database report a Swedish postal address.

³ Due to a time lag in the update of the EPO-database this is the last year from where we have reliable data.

The questionnaire was sent out in February 2007, and was addressed to the inventors. After the first send-out we received 37 returned envelopes due to problems of finding the inventor (unknown address). This reduced the total number to 491 inventors. Following the initial mail survey and one postal follow up, 229 usable responses were returned. This corresponds to an effective response rate of approximately 46.6%, which compares favorably to previously published studies of patent inventors reported in international journals (e.g., Sirilli, 1987; Weick and Eakin, 2005).

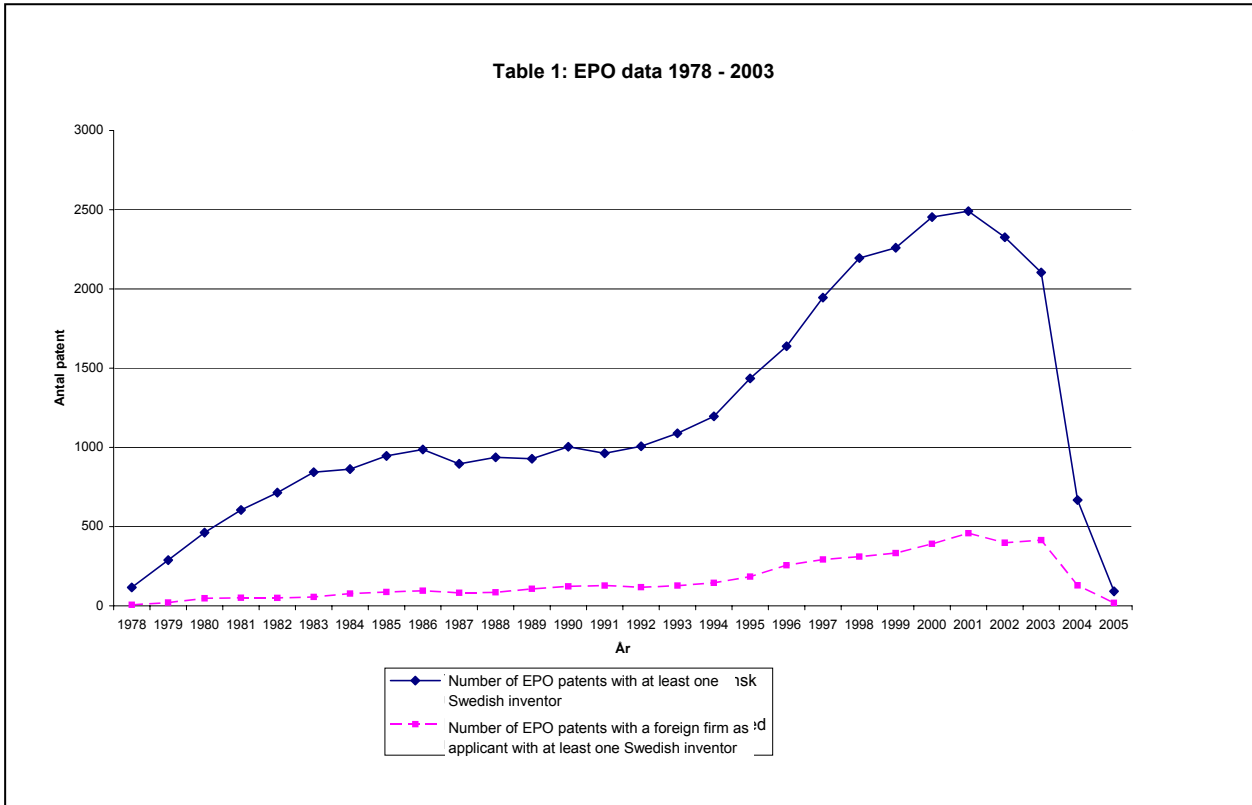
4. Results

In this section we present the results from our study with respect to the initial research questions that were addressed in the introduction.

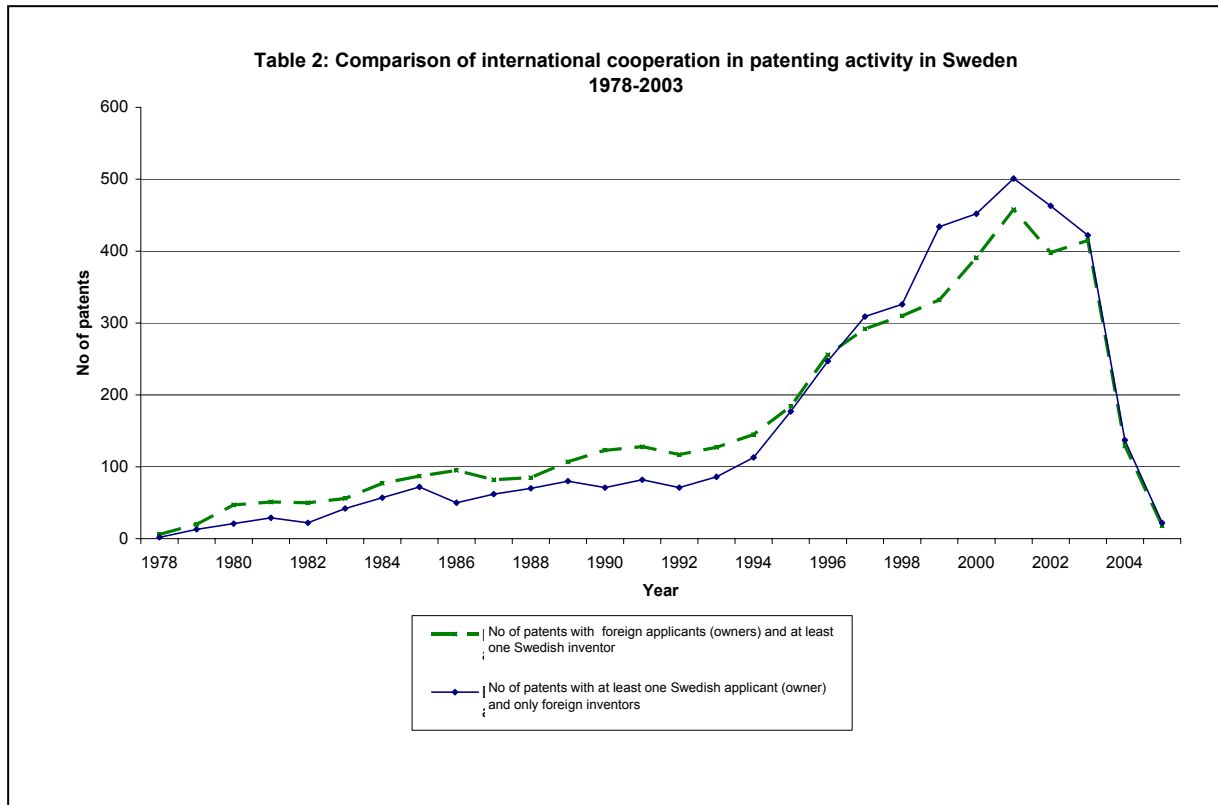
4.1 Patents domestically invented in Sweden with a foreign firm as applicant

Our first question was how common it is that patents that are domestically invented in Sweden have a foreign firm as applicant. In Table 1 we present data over the number of EPO-patents where Swedish inventors have been involved between 1978 and 2003. Here we can see that the number of EPO-patents with at least one Swedish inventor have increase steadily during the time period. Similarly, there is an increase in the number of EPO-patents where a foreign firm is listed as the applicant (owner) and where there is at least one Swedish inventor. In 2003 there were in total 2 104 patents with at least one Swedish inventor, and there were 413 patents⁴ where a foreign firm was listed as the applicant and where there was at least one Swedish inventor. A list of the sectors to which these 413 patents belong is presented in the appendix, following the classification of Breschi, Lissoni, and Malerba (2002).

⁴ In some cases there were more than one person listed as the inventor, hence giving slightly more inventors than patents.



In Table 2 below we present a comparison of international cooperation in patenting activity in Sweden between 1978 and 2003. Here we can see that there since 1997 on average have been more patents with at least one Swedish applicant (owner) and only foreign inventors compared to patents with foreign applicants and with at least one Swedish inventor. In 2003 there were in total 422 patents where there were at least one Swedish applicant and with only foreign inventors, and there were 413 patents with at least one Swedish applicant and only foreign inventors. In sum, in Sweden there seems to be about an equal balance between foreign ownership of domestic inventions and domestic ownership of inventions made abroad.



4.2 The inventors behind the patents

Our second research question addressed the issue of who the inventors behind these patents are. This data is based on responses from the 229 inventors who responded to the survey⁵. Table 3 below provides information about their age and patent experience. The data show that most of the respondents are middle aged. Despite different samples and time periods, this corroborates findings in previous studies of inventors which have reported that the typical inventor is in the range between 40-55 years old (MacDonald, 1986; Sirilli, 1987; Amesse, 1991). Many of the inventors are moreover quite experienced inventors with several EPO-patents in their portfolio. Many of them also have also multiple experiences from applying for EPO-patents with foreign firm as applicants.

⁵ We have information about age, geographic location and gender for the total population. This will be used to test for possible non-response biases in the sample.

Table 3: Age and patent experience

	Mean	Min	Max	Std.dev.
Age of respondent	47.8	25	82	10.5
Total number of EPO-patents	5.61	1	75	8.89
Total number of EPO-patents with foreign firm as applicant	3.91	0	40	5.09

Table 4 provides data about the educational level of the respondents. The table shows that the surveyed inventors have a fairly high level of education, with about 85% having experience of university studies and about 1/3 of them having doctoral training. The patent inventors are clearly better educated than the average adult Swedish citizen. The percentage of inventors with university degrees in this study is also fairly high compared to previous studies of patent inventors. Weick and Eikin (2005) in their study of independent patent inventors in the US for example report that about 56% of their respondents having experience of university studies and only 1% having PhDs. Other studies presenting data about the proportion of inventors with university degrees have reported 24.9% (Sirilli, 1987) and 46% (Amesse et al 1991).

Table 4: Educational level

	%
Compulsory school education (7 or 9 years)	0
Gymnasium/senior high school	15.6
University studies, less than 3 years	11.1
University studies, more than 3 years	39.6
Doctoral training	33.8

Moreover, we collected data about the inventors' motivation to invent. Here, inventors were asked to rate to what extent four different reasons were motivating them to be involved in patenting along a five point Likert-like scales (1=low extent, 5=high extent). As can be seen in table 5 below, most inventors state that they are motivated to invent because it is meriting and good for the career and that it gives higher influence in the milieu where they are working. This result is fairly similar to the results reported in Giuri et al. (2005). Possibilities for extra income besides ordinary salary were rated somewhat lower, and the possibility for an increase in their research budget was the least likely motive and rated considerably lower than the other alternatives. This is interesting as it suggest that monetary reasons are seen as fairly low motivators to invent.

Table 5: Motivation to invent

	Mean	Min	Max	Std.dev.
It is meriting and good for the career	3.09	1	5	1.25
It gives possibilities for extra income besides ordinary salary	2.46	1	5	1.35
It gives possibilities for an increase in research budget	1.91	1	5	1.18
It gives influence in the milieu where the inventor is working	3.09	1	5	1.35

With respect to the research questions motivating this study it is of interest to see where the patent inventors were employed when the EPO patent was applied for, as their affiliation has an impact on their ability to influence what to do with the patent⁶. In table 5 below, we can see that the major part of all patent inventors (90.1%) was affiliated with a private firm. Of these was about 6 % reported to collaborate with a university for the specific EPO patent in question, while 84.6% were operating alone. Only about 8.3% were affiliated with a university. The miscellaneous category “other” included inventors who were unemployed or had retired people and thus having no formal affiliation. Please note that the total percentage can be above 100% due to the possibility of cross-affiliations (for example inventors being employed both by a university and a private firm).

Table 6: Employment when EPO patent was applied for

	Percentage
University	8.26%
Private firm	90.1%
Civil service department/public authority	0%
Other	4.1%

4.3 Main reasons for collaboration with a foreign firm

Our third research question addressed the issue of the main reasons for collaboration with a foreign firm as the applicant for the patent. In table 7 below, we can see that about 52% of the respondents were employed inventors where the ownership of the invention belongs to the

⁶ For example, in Sweden academics who are employed by public universities have the full right to their inventions due to the so called ‘teacher’s exemption’.

employer. In these cases the inventor has no influence over decisions related to the patent. In fact, one inventor stated that the only patent he has no influence over is his own, because this was when he had to leave the room. About 37% of the respondents reported that the R&D activities that lead to the patent already from the beginning were ordered by the foreign firm. The remaining respondents (just above 11%) were inventors who had an influence on the decision on collaborating with a foreign firm.

Table 7: Influence on decision to collaborate with foreign firm

	Percentage
Employed inventor, with ownership of the invention belonging to the employer	51.8%
Inventor where the R&D activities that lead to the patent were already from the beginning ordered by a foreign firm	36.7%
Inventor having an influence on the decision (i.e., part of full ownership of the patent)	11.4%

The reasons for collaboration with a foreign firm for the group of inventors who had an influence on this decision are presented in Table 8 below. Here, inventors were asked to rate to what extent different reasons influenced their decision to collaborate with a foreign firm along a five point Likert-like scales (1=low extent, 5=high extent). As can be seen in the table, the most common reasons were that the foreign firm provided better opportunities to commercialize the patent compared to Swedish firms, and that the foreign firm could offer more money for financing development costs compared to Swedish firms. The least common reasons were previous employment in the foreign firm, and to increase the chances for future career opportunities.

Table 8: Reasons for collaboration with foreign firm

	Mean	Min	Max	Std.dev.
Lack of general competence for the technology which the patent is based on in Sweden	2.59	1	5	1.40
There were special competence in the foreign firm that is very hard or impossible to find in Sweden	2.63	1	5	1.46
The foreign firm provide better opportunities to commercialize the patent compared to Swedish firms	3.55	1	5	1.32
By collaborating with a foreign firm there was opportunities to make more money out of the patent	3.05	1	5	1.75
The foreign firm offered more money for the patent compared to Swedish firms	3.11	1	5	1.81

The foreign firm could offer more money for financing development costs compared to Swedish firms	3.48	1	5	1.54
Experience of earlier cooperation with the foreign firm in one or several research projects	2.35	1	5	1.70
Previous employment in the foreign firm	1.11	1	5	0.46
Informal contacts (friends, former colleagues etc.) in the foreign firm	2.66	1	5	1.64
The foreign firm had a better position on the market compared to similar Swedish firms in the area	3.18	1	5	1.65
Increasing the chances for future career opportunities	1.73	1	5	1.19
Increasing the chances for future research collaborations	2.56	1	5	1.61

5. Summary and conclusion

In this paper we have reported descriptive data from an exploratory study examining the reasons behind why Swedish domestically invented patents end up being owned a foreign company. In sum, the study show that international cooperation in patenting is a fast rising phenomenon but also that Sweden has about an equal number of domestic ownership of inventions that has been made abroad as there is foreign ownership of domestic inventions. We have also found that the Swedish inventors behind the foreign-owned patents are relatively experienced, both in terms of a high educational level and a high number of EPO-patents. We also find that a relatively low proportion of these inventors – only about 11% - have any influence on the decision to collaborate with a foreign firm. In most cases this is a decision by the firm where the inventor is employed, and in some other cases it is a result of that the R&D activities which results in the invention on which the patent is based is ordered by the foreign firm. However, in the case where inventors had any influence on the decision, the most common reasons for seeking international collaboration was that the foreign firm provided better opportunities to commercialize the patent compared to Swedish firms, and that the foreign firm could offer more money for financing development costs compared to Swedish firms. Hopefully, future studies will use the exploratory insights presented in this paper in their attempt to further increase our knowledge of international cooperation in patenting.

References

- Amesse, F., Desranleau, C., Etemad, H. Fortier, Y. & Seguin-Dulude, L. (1991) The individual inventor and the role of entrepreneurship: A survey of the Canadian evidence, *Research Policy*, 20: 13-27.
- Breschi, S., Lissoni, F. and Malerba, F. (2002) The empirical assessment of firms' technological 'coherence': data and methodology, in Cantwell, J., Gambardella A. and Granstrand, O. (eds.), *The Economics and Management of Technological Diversification*. London: Routledge.
- Dagenais, D.L., Seguin-Dulude, L. & Desranleau, C. (1991) Analysis of individual Canadian inventor behavior, *Technovation*, 11(6): 357-372.
- Edler, J. (2004) International research strategies of multinational corporations: A German perspective, *Technological Forecasting and Social Change*, 71(6): 599-621.
- Geuna, A. & Nesta L.J.J. (2006) University patenting and its effects on academic research: The emerging European evidence, *Research Policy*, 35(6): 790-807.
- Giuri, P., Mariani, M. et al. (2005) *Everything you always wanted to know about inventors (but never asked): Evidence from the PatVal-EU survey*, LEM Working Paper Series, 2005/20.
- Griliches, Z. (1990) Patent statistics as economic indicators: A survey, *Journal of Economic Literature*, 28(4): 1661-1707.
- Guellec, D. and van Pottelsberghe de la Potterie, B. (2001) The internationalisation of technology analysed with patent data, *Research Policy*, 30: 1253-1266.
- Hagedoorn, J. & Schakenraad, J. (1990), Inter-Firm Partnerships and Co-operative Strategies in Core Technologies in Freeman, C. & Soete, L. (Eds.), *New Explorations in the Economics of Technical Change*, Pinter Publishers: London.
- Ibrahim, S. & Fallah M.H. (2005) Where do inventors get their ideas? *Technology Management: A Unifying Discipline for Melting the Boundaries*, 31 July-4 Aug.: 359-367.
- Kassicieh, S.K., Radosevich, R. & Umbarger, J. (1996) A comparative study of entrepreneurship incidence among inventors in national laboratories, *Entrepreneurship: Theory & Practice*, 20: 33-49.
- Livesay, H.C., Lux, D.S. & Brown, M.A. (1996) Human factors and the innovation process, *Technovation*, 16(4): 173-186.
- Macdonald, S. (1986) The distinctive research of the individual inventor, *Research Policy*, 15(4): 199-210.

Markman, G.D., Balkin, D.B. & Baron, R.A. (2002) Inventors and new venture formation: the effects of general self-efficacy and regretful thinking, *Entrepreneurship: Theory & Practice*, 27: 149-165.

Meyer, M. (2005) Independent inventors and public support measures: insights from 33 case studies in Finland, *World Patent Information*, 27: 113-123.

OECD (2006) *Compendium of patent statistics*. The report is downloadable at:
<http://www.oecd.org/dataoecd/5/19/37569377.pdf>

Schmookler, J. (1957) Inventors past and present, *The Review of Economics and Statistics*, 39(3): 321-333.

Suarez-Villa, L. & Walrod, W. (2003) The collaborative economy of biotechnology: alliances, outsourcing and R&D, *International Journal of Biotechnology*, 5(3-4): 402-438.

Sirilli, G. (1987) Patents and inventors: an empirical study, *Research Policy*, 16(2-4): 157-174.

Tijssen, R.J.W. (2002) Science dependence of technologies: evidence from inventions and their inventors, *Research Policy*, 31: 509-526.

Weick, C.W. & Eakin, C.F. (2005) Independent inventors and innovation: An empirical study, *Entrepreneurship and Innovation*, 6(1): 5-15.

Weick, C.W. & Martin, J.D. (2006) Full-time and part-time independent inventors: Rising with the creative class, *International Journal of Entrepreneurship and Innovation*, 7(1): 5-12.

Appendix: List of sectors to which the identified patents belong, following the classification of Breschi, Lissoni, and Malerba (2002)

Technology class	No of patents
Undefined	2
Electrical engineering	17
Audiovisual technology	9
Telecommunication	19
Information technology.	19
Semiconductors	2
Optics	5
Control technology.	18
Medical technology	33
Organic chem.	25
Polymers	7
Pharmaceutics	27
Biotechnology	21
Materials	10
Food chem.	5
Basic materials chem..	2
Chemical engineering	19
Surface technology	8
Materials processing	33
Thermal processes	3
Environmental technology	8
Machine tools	12
Engines	16
Mechanical elements	9
Handling	25
Food processing	1
Transport	39
Nuclear engineering	0
Space technology	1
Consumer goods	11
Civil engineering	7
Total no of patents:	413