Ownership Of Patents in Spin-Off Firms

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Patent ownership by university spin-off firms proves profitable, study shows

In recent years there has been increased interest in the role of patents in industrial renewal as well as increased interest in small- and middle-sized entreprises as employers and developers of new business ideas. This has lead to a number of studies of the role and value of patents in the technology transfer process, for instance by the Roland Berger Forschungs-Institut fur Markt- und Systemforschung GmbH by the Royal Swedish Academy of Engineering Sciences, IVA, the Swedish Patent Office together with the Institute for Management of Innovation and Technology (IMIT). In the latter, some studies were found concerning the direct relationship between patent activity and commercial success. For example, Sanders, Rossman and Harris indicated that the average patent contributed $127,000 (1950s dollars, one 1955 dollar being about five 1990 dollars) to corporate profit before tax (for profitable patents $577,000 per patent and for not-profitable patents, $88,000). Scherer found that the average patent contributed something between $15,000 and $147,000 (early 1960s dollars) to corporate profit after taxes, depending on how the calculations are done.

When the number of patents owned by large (Fortune 500) companies (average sales per company about $350 million 1955 dollars) was regressed on corresponding sales he found that there were typically about 74 patents per billion 1955 dollars of corporate sales. This corresponds to one or two patents per thousand employees. Scherer also found that the correlation between number of patents and profitability in corporations is at most 0.268, a not unexpected result since patent ownership is only one of a large number of factors influencing a corporation's performance. Schankerman and Pakes found patent "values" between $6,900 and $19,000 (1980s dollars), depending on country for European patents in the 1950s, 1960s and 1970s. Whether this means that European patents are less valuable than U.S. patents is not clear. The difference in patent values can be due to differences in the measurement methods used.

◄ Distribution ►

An important point in connection with the above data is that the distribution of patent ownership with respect to firm size is strongly biased toward large firms and even more importantly that the distribution of patent profitability is extremely biased or skewed, as pointed out by Scherer. Other authors have pointed out similar characteristics of patent distributions, publication distributions, income distributions and the like.

An enterprise can achieve market dominance by other means than patent protection, of course. In fact, patent protection normally plays a relatively small role in most cases, as underlined by Mansfield. Undoubtedly, many of the spin-offs investigated here make more use of other advantages than of patent ownership in their operations. This was not investigated, however.

Ownership of a patent protecting a firm's products is not necessary, strictly speaking. An enterprise can buy the right to patent protection based on a patent owned by someone outside the enterprise. This kind of arrangement was not investigated here: how to find out about all patent licenses without going to each and every enterprise individually? Further, the idea of this study is to use only publicly available statistical information to test the hypothesis that patent ownership is a good business practice in small high-tech firms.

Against this background one might expect or hope that spin-off firms that own patents fare somewhat better economically than those that do not own patents. However, one should not expect this effect to be strong. Many other factors also determine a firm's economic well-being. Neither can such tendency be expected to have high statistical significance or useful predictive value, for the very same reasons and in accordance with the results of Scherer.

Out of the above several specific questions can be crystallized:

1. Are patents in general good investments for university spin-off firms?
2. Should university spin-off firms be encouraged to apply for more patents? If so, which spin-off firms should apply for what sort of patents?
3. What can be done to make patent protection more attractive to university spin-off firms (as well as other small, technology-based firms)?

VALUE ADDED AND TOTAL SALES IN SPIN-OFF COMPANIES

This investigation is based on information concerning companies that have been founded by a person or persons employed by a Swedish university at the time they founded the company or immediately prior to founding the com-

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pany. The majority of such companies are run in the form of corporations, which in Sweden must provide the Swedish Patent Office with copies of their annual financial reports. These financial reports are then public information and can be queried at will by anyone. For this study a CD ("Sveriges Aktiebolag" from Fritzes in Stockholm) containing the last four years' annual financial reports of all Swedish corporations was obtained.

Only university spin-offs manufacturing a physical product are included in the study since in the main it is physical products that are protectable by patents. Further, only those corporations that had been in existence for at least three years and employed at least three persons (full-time equivalent) at the time of the study are included. Of the 44 corporations studied, 24 had been spun-off from Chalmers University of Technology, eight from the University of Linkoping, five from the University of Uppsala, three from the University of Lund, three from the University of Stockholm and the Royal Institute of Technology, and one from the University of Lulea.

For each of the 44 spin-off corporations the data on the CD was transferred to a computer spreadsheet (Microsoft Excel) for analysis. Next, the latest available economic data (usually for the financial year 1990-1991) for the 44 spin-offs was transferred to a second spreadsheet in a format suitable for analysis. The goal was to find a useful measure of the financial or economic success of each spin-off.

The measure chosen includes the value added for the spin-off normalized by the number of employees as a measure of the present economic well-being of the spin-off multiplied by the number of employees in the spin-off normalized by the number of years the spin-off has been in existence as a measure of its growth rate. The product of these two ratios simplifies to the value added in the latest report year divided by the age of the spin-off. This seems to be as good an approximation to a fair (single number) estimate of the economic success of the spin-off as is reasonably possible to develop.

Another oft-used measure of corporation size is total sales. This is a fair measure if the structure of all the corporations' balance sheets is comparable. In the case of manufacturing industries the value added is normally 35% of total sales, while for trading companies for example it can be far smaller. In the present case only manufacturing firms are involved, so the use of total sales normalized by the number of years the spin-off has been in existence is also used to measure economic success.

◄ Accuracy ►

It is not reasonable to expect these measures of economic success (especially the value added) of a spin-off to be at all accurate for newly started spin-offs (less than three years old) or for very small spin-offs (less than three full time equivalent employees). Neither is it reasonable to assume that a newly started spin-off (less than three years old) has had time to exploit the advantages of the patents it owns. It might therefore be more correct to set the limit at five employees and five years' track record. However, had this been done, the number of university spin-offs included in the study would have been reduced drastically.

Table 1 shows economic characteristics of the spin-offs included in this study as well as corresponding data for 16 large Swedish manufacturing companies. The average value added per employee and the average salary expenses per employee as well as their difference are roughly the same for the 44 manufacturing spin-offs and the industrial companies. The implication is that the 44 manufacturing spin-offs as a group are relatively "normal" as industrial companies go, at least in respect to their economic structures.

PATENT OWNERSHIP

The patent situation for each of the 44 spin-off firms was investigated making use of the computerized database at the Swedish Patent Office (a service provided by them). For each spin-off firm all the patents that had been applied for with that firm as the applicant (not the inventor!) were listed and their history and status summarized (computerized data printout). From this data it was possible to evaluate how many patents a given spin-off firm owned (patent applications not leading to patents and abandoned patents were not included in this study), when they were applied for and how long they had been in effect when the database was queried (April 1994 and March 1995). This should be a nearly complete list of the patents owned by the spin-offs.

ECONOMIC AVERAGES IN STUDY

	24 spin-offs from Chalmers	20 other spin-offs	all 44 spin-offs	16 large industrial companies
Economic Measures *(Thousand Swedish crowns)*				
Sales/employee	879 ± 422	1045 ± 462	954 ± 443	960
Value added/employee	266 ± 194	345 ± 109	302 ± 164	337
Salaries/employee	207 ± 73	225 ± 47	216 ± 62	≈225
Other Measures				
Total employees	394	270	664	482 000
Average number of employees	16	14	16	30 125
Number of patents	39	19	58	≈3080
Average age of corporation (years)	13.25	8.25	11.0	

Some economic characteristics (averages) of the 44 manufacturing spin-offs in this study as well as corresponding data for 16 large Swedish industrial companies. For sales/employee, value added/employee and salaries/employee one standard deviation is indicated by ± xx. In 1994/95 a U.S. dollar cost 7 to 8 Swedish crowns and a German Mark cost about 5 Swedish crown.

Table 1

However, patents licensed by the spin-offs from other owners, for example their own employees and founders as well as from other firms, are not included in the list.

The number of Swedish patents owned by the 16 large industrial companies characterized in Table 1 was estimated from the number of patents they applied for annually (about 400 during the 1980s) multiplied by 0.7 (about 70% of patent applications from industrial firms being granted) and multiplied by 11 (the average lifetime of a patent in years). Significantly, the number of patents per employee is more than 10 times as great among the spin-offs (87 patents per 1,000 employees) as it is among the large industrial companies (6.4 per 1000 employees).

RESULTS FOR 44 SPIN-OFF FIRMS

Of the 44 spin-offs investigated, 21 or 48% owned at least one patent (and 23 owned no patent). Among the 24 Chalmers spin-offs, 15 or 63% owned patents while among the 20 other spin-offs only six (30%) owned patents. This difference in patent ownership is likely due to increased patent awareness in the Chalmers milieu compared to that of the other universities, since Chalmers University of Technology provided information, advice and academic courses in patenting early on.

According to statistics from the European Union, only 17% to 18% of SMEs (1-99 employees) in the Swedish manufacturing sector in general own patents. Thus, the frequency of patent ownership in the spin-off corporations is significantly higher than that of SMEs in general.

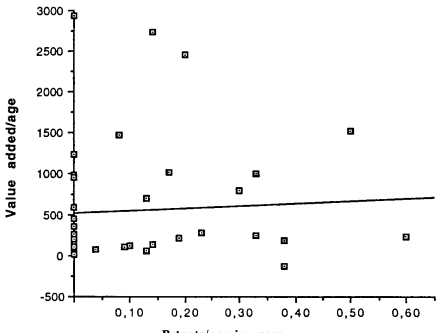
One spin-off owned 12 patents, one owned seven patents, two owned five patents each, one owned four patents, three owned three patents each, and three owned two patents each. The Chalmers spin-off firms owned 39 patents. The other spin-offs owned a total of 19 patents, of which 12 were owned by a single firm. Note that this data includes only patents that were both granted and still in effect when the Patent office data base was queried.

The patent class that occurred by far the most often was G physics, (18 patents). This was followed by B (performing operation), transporting, (13 patents); by A (human necessities, 12 patents, of which 11 are owned by one firm), and by H (electricity, 8 patents). Also represented were E (fixed constructions, 3 patents); F (mechanical engineering, lighting, heating, weapons, blasting, 2 patents), and C (chemistry, metallurgy, 2 patents).

It is interesting to note that while a great majority of the spin-off firms produce products consisting in large part of electric and electronic apparatus, there are far fewer patents in patent class H (electricity) than in patent class G (physics). A likely explanation for this is that it is often felt that electronics is developing so fast that patent protection becomes obsolete rather quickly. When a sensor is protected by a patent based on some physical insight however, the effective useful life of the patent is somewhat longer.

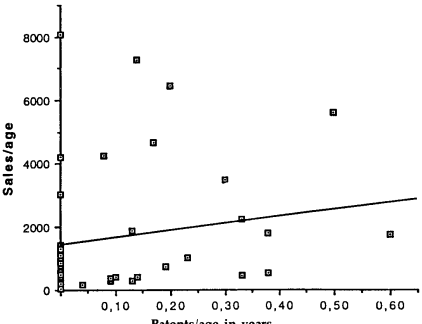
GROWTH IN VALUE ADDED AND IN TOTAL SALES VS PATENT OWNERSHIP (44 SPIN-OFFS)

The data on patent ownership was added to the spreadsheet so that the number of patents in effect owned by each spin-off and the length of time in years that each had been in effect was explicitly noted. Inspection of the data showed there is a weak positive relationship between patent ownership and economic growth in the firms. This is confirmed in the more sophisticated analysis summarized in Figure 1 based on value added and in Figure 2 based on total sales. As the regression lines in Figures 1 and 2 indicate, there is a positive but weak relation between the growth in value added and in sales in the spin-offs and their patent ownership. The amount of data is limited and the scatter is large, making the correlation coefficient low. On the other hand, this is what was expected and it is compatible with the maximum correlation coefficient 0.268 for profitability and patent ownership obtained by Scherer.



For 44 spin-offs, the annual value added/year in existence (in thousands of Swedish crowns per year) versus the numbers of patents/year in existence, showing a positive correlation $Y = a\,X + b$ *with* $a = 298 \pm 181, b = 510 \pm 114$ *and a low correlation coefficient* $r = 0.25$.

Figure 1



For 44 spin-offs, total annual sales/year in existence (in thousands of Swedish crowns per year) versus the numbers of patents/year in existence, showing a positive correlation Y = a X + b with a = 2242 ± 503, b = 1423 ± 317 and a correlation coefficient r = 0.57.

Figure 2

ECONOMIC VALUE OF PATENTS IN MANUFACTURING SPIN-OFFS

The above analysis indicates that patent ownership and spin-off growth are connected, although weakly. Patent ownership requires financial outlays, of course. According to a recent study of European patents, typical investments in an international patent application for the eight most often designated states amount to about 220,000 Swedish crowns, of which about 40,000 represent company internal costs, 50,000 patent attorneys' fees, 75,000 translation costs (six languages), and 55,000 official patent office fees. In addition, there is the cost of generating and developing the idea that is patented. We know little about this R&D cost in the present study. Thus, in the following we ask what is the return on investments in patent protection, of the order of 220,000 Swedish crowns per patent, rather than the return on R&D investments.

A way of determining the economic value of the patents is to use the regression coefficient obtained in the figures. The units of the coefficient of x (the number of patents per year of existence) from Figure 1 are annual value added /patent, which amounts to 298,000 ± 181,000 Swedish crowns. (The indicated uncertainty is one standard error as calculated according to Higbie based on the discussion by Mathews and Walker.)

At the average cost per patent of 220,000 Swedish crowns and taking into account that the average patent is 2.4 years old in this study this amounts to an annual aggregate patent investment of 5.3 million Swedish crowns. This is to be compared to the total annual value added in the 21 spin-offs owning patents, 116 million Swedish crowns, of which 17.3 ± 10 million Swedish crowns of 14.9% ± 8.6% can be attributed to patent ownership. Thus, patent costs amount to 4.6% of annual value added or not quite one third of the part of the spin-off firms' annual value added attributable to patent ownership. Of course the economic lifetime of typical patents is not 2.4 years, but probably between five and ten years (eleven years being the average lifetime of a patent in the Swedish patent office). Thus, an estimate is that the total expected value added attributable to a typical patent during its expected lifetime is of the order of 10 times the direct cost per patent in the European patent system.

Corresponding results are obtained from the regression coefficients in Figure 2. Total annual sales attributable to patents is apparently about 2,242,000 ± 503,000 Swedish crowns per patent. About 130 ± 29 million Swedish crowns, or just over 31% ± 7% of total annual sales, 418 million Swedish crowns in the 21 spin-offs owning patents, is attributable to patent ownership. This percentage is twice as large as the corresponding one for value added, which indicates that patents are more closely related to sales growth than value added growth, in agreement with a result reported by Scherer. The ratio of patent costs to annual sales is 1.3%, only 4% of the part of annual sales attributable to patent ownership. Again, these percentages should be reduced by a factor of three or so to take account of the patents' probable economic lifetime.

◄ Distribution ►

This data is not necessarily best analyzed under the assumption that the individual values are normally distributed, as has been done above. Instead, the individual values may be log-normally distributed, for example, a situation often found in connection with income distributions and the like. Therefore, the logarithms of the value added and of sales have also been regressed against patent ownership. A regression of the form $y = ax + b$ in the linear case can easily be shown to be equivalent to $\ln y = \ln b + \ln(1 + ax/b) \approx \ln b + (ax/b) - (1/2)(ax/b)^2 + \ldots$. Therefore, a second order polynominal fit has been used to describe the logarithmic regression.

The constant term and the linear coefficient were then used to obtain a and b for comparison with the results of the normal distribution analysis in Figures 1 and 2. For value added against patents (corresponding to figure 1) a ≈231 and

b≈222 with r= 0.34 while for sales against patents (Figure 2) a ≈ 811 and b ≈617 with r = 0.45. For the value added regression the correlation coefficient is higher for the log-normal analysis than for the normal distribution analysis while the opposite is true for the sales regression. Thus, it is unclear which analysis is the more appropriate here. The regression coefficients a and b are lower for the log-normal distribution regressions than for the normal distribution regressions, the reason probably being that the few very high data points do not distort the log-normal regressions as much as they do the normal ones. Thus, the estimates of the economic value of the patents in the previous paragraph are probably high or optimistic.

The uncertainties in the regression line slopes are disturbingly large, and the correlation coefficients are low, especially for the value added statistics, meaning that the margins of uncertainty in the above percentages, etc., are quite large. Further, discrepancies between the figures based on simple averages and the figures based on two types of regression analyses emphasize the fact that there is significant uncertainty in the results due not only to wide scatter in the data points but also to the skewness of the value distributions. The result obtained depends too strongly on how it is calculated, a difficulty often encountered in the study of highly skewed distributions.

DISCUSSION

On the whole, the results of the above investigation support the thesis that university spin-offs' investment in patent protection is a profitable undertaking. The above statistics apply only to the 58 patents that were in effect at the time the data was evaluated. A further 22 patents had been granted to the spin-offs but abandoned by them. Around 30 more patent applications had been filed by the spin-offs but had not resulted in granted patents. Thus, the 58 owned patents in effect amount to just over half of all the patent applications that the firms made. The hope is that the 58 patents correspond in some way to the firms' selection of the best patent applications. If the "second best half" of the patent applications had been followed up and the resulting patents kept in effect the average return on patenting investment would very likely have been lower than what was found above, making the average patent application a somewhat less attractive investment from the spin-off firms' point of view. It is not clear whether the spin-off firms or society in general would have profited by such increased patent vigor.

Patent awareness among Swedish university spin-off firms, and especially spin-off firms from Chalmers University of Technology, is significantly higher (based on a comparison with the European Patent Office data more than three times higher) than among small Swedish industrial firms in general or among small European firms in production industries in general. This is likely due to both higher levels of technical education among the spin-off firms' founders and directors and to specific efforts concerning patents and intellectual property, especially at Chalmers University of Technology.

If the patent frequencies for Swedish university spin-off firms are divided by three or four to bring them into parity with small (Swedish or European) industrial firms in general, then an expected result is that the apparent values of patents in small industrial firms according to the regression methods used here are expected to be three or four times as high as those given here for Swedish university spin-off firms.

It was found that the cost of patent protection amounts to about 4.6% of annual value added or about 1.3% of annual sales in the average spin-off. These numbers are quite high considering that typically in large Swedish industrial firms R&D expenditures including patent costs amount to 10% to 20% of annual value added or 3% to 6% of annual sales. A reason for these high numbers in spin-off firms is the high number of patents owned per employee, more than 10 times greater than in large Swedish industrial firms. Thus, if R&D costs can be kept very low patents appear to be good investments for the spin-off firms, although they are relatively expensive. In general, calculated in this manner patents are better investments in large firms than in small ones.

It is clear from Table 1 that there are more than ten times as many patents per employee in the Swedish university spin-off companies as there are in large Swedish industrial corporations. Regressions of the type used above applied to the patent statistics or large Swedish corporations then give patent "values" more than 10 times as large as for the spin-off companies. For small industrial firms in general the expectation is that the patent "values" should be about a half or a third as high as patent "values" in large industrial firms.

In the American studies of Sanders, Rossman and Harris and of Scherer the results of regression analyses are given in terms of corporate profit before or after taxes. A comparision with large Swedish corporations can be achieved by noting that corporate profit in this type of corporation in Sweden is roughly 10 percent of sales. Then it is easy to confirm that patents were two to three times more valuable to the American corporations in the 1950s and 1960s than they are to Swedish corporations in the 1980s and 1990s. This is not a result of corporate size. The average size of the corporations studied is twice as large in the Swedish sample as in the American one.

All the above serves to underline the fact that the apparent worth of a patent to a corporation depends considerably on the business environment and characteristics of the patent owner.

There is a further note of caution to be made here. The simple division of total sales, value added or profit by the number of patents owned gives apparent patent values several (3-10) times higher than the more correct regression analysis method used here.

CONCLUSIONS

The results of this investigation support the quite reasonable thesis

that patent ownership in small high-tech spin-offs is often associated with superior economic health in those spin-offs. The small number of spin-off firms investigated here does not provide a large data base, and the spin-off firms are a special segment of small high-tech firms in general, but it is gratifying that even this limited data supports the thesis, although with reservations. In economic terms it is justified to encourage small high-tech firms to protect their inventions and products with patents, even though patents can cost over 200,000 Swedish crowns. On the other hand, since the patent density in these university spin-off firms is much higher (more than 10 times) than in representative large Swedish industrial corporations, and the economic return on them probably much lower (based on the data cited in the introduction, probably about a third), it is likely best for university spin-off firms to (continue to) be very selective about what inventions should be protected by patents. It is more appropriate to encourage those university spin-off firms that do not own patents to re-think their attitudes toward patent protection than to encourage spin-off firms that have patent protection for their products to apply for more patents covering the same products.

Correspondingly, since the patent frequency is in Swedish and European small industrial firms in general is only a third or a fourth as high as it is in Swedish university spin-off firms, it is appropriate to strongly encourage small (high) technology-based manufacturing firms to invest in appropriate patent protection. This is especially true for manufacturing firms that do not own patent rights.

Obviously, with relatively large numbers of patents with relatively limited economic returns per patent small firms are sensitive to patenting costs. As has been pointed out, official fees for patents in Europe are much higher (about an order of magnitude!) than in the United States or Japan. Translation fees are also high (especially when no translations at all are necessary in the United States or Japan). One can ask whether it really is necessary to translate a patent into the official language of every country in which patent protection is requested. Surely, the great majority of those who study patent texts are both educated and intelligent people who have at least a passive knowledge of at least one of the main European languages. A reduction of the number of required patent translations should be encouraged.

In sum, patents cost a lot. They have more apparent economic "value" to large firms than to small ones. It would be good to reduce the cost to small firms of applying for and maintaining patents and it would be good to reduce the cost of patent translation to all firms, large and small.

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