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**THE ROLE OF CAPITAL AND OTHER
FACTORS IN THE FORMATION AND
GROWTH OF FIRMS STARTED BY
UNIVERSITY RESEARCHERS**

by

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INTRODUCTION

During the first half of the eighties, the rate of formation and growth of spin-off companies started by researchers in Swedish universities have increased markedly. At the same time, several trends can be seen that could offer a partial explanation to the phenomenon: An increased interest of large firms to work closer to university research, a change in attitudes inside the academic world, and the growth of a Swedish venture capital industry, to mention some.

Aim and Scope of the Paper

This paper is an attempt to review the phenomenon and the factors behind it, and explore the impact of these factors.

The paper draws from several studies reporting empirical evidence from the Swedish scene. Because they differ in their focus, methods used, etc., the use of them in this paper has the character of casual observations. Thus, the results of the discussion in this paper are hypotheses for further testing.

We have chosen to review the following factors that could offer at least partial explanations:

- The interest from the market
- Attitudes inside the academic world, and generally, towards entrepreneurship
- The availability of capital, in particular the growth of a Swedish venture capital industry
- Other resources, e.g. science parks and incubators
- The role of examples.

THE RATE OF FORMATION AND GROWTH OF UNIVERSITY SPIN-OFFS

Researcher spin-offs have been surveyed on the Swedish scene in a study by Olofsson et. al. (1987). They surveyed technology-based companies started by university researchers during the eighties. The survey was made in fall 1986. The survey comprised companies started by researchers, including Ph.D. students, employed by the university at the time of start of the firm. Both firms based on original research by the founder(s), and those based on more general knowledge, were included. By the criteria used, companies started by bachelor and master students upon graduation were not surveyed. Neither were firms started by researchers in business administration.

To compensate for the fact that the sampling frames from different universities included very small firm to different degrees, a size criterion for turnover the second year was applied. After that, 90 companies started 1980-85 remained. The distribution over years is shown in Table 1, together with the growth.

TABLE 1

YEAR OF START AND GROWTH OF UNIVERSITY SPIN-OFFS 1980-85

Year	1980	1981	1982	1983	1984	1985
No. of starts	14	7	6	23	26	14
Turnover growth:						
2nd year-1986	35	29	31	77	84	
2nd-3rd year	10	81	42	86	84	
Employee growth:						
2nd year-1986	16	11	12	37	45	
2nd-3rd year	8	6	18	56	45	

Growth is compound annual growth in per cent, in fixed prices for turnover

Source: Based on data collected by Olofsson et. al. (1987)

As is clearly seen in Table 1, there is a marked difference between the two periods, 1980-82 and 1983-85 when it comes to both the rate of formation of firms and their growth. In the 1970's, the rate of formation of firms was much lower.

When it comes to differences between universities, comparisons are of course difficult to make. Response rates from different universities differed in the survey, but the main explanation for this fact is (probably) that the sampling frames to very different degrees contained companies started by students. Calculating the number of starts per year in relation to the outlay in science and technology (from statistics from The National Swedish Board of Universities and Colleges), the young university of Linköping has the highest rate in the period 1980-82, roughly double that of the next. In the period 1983-85, nearly all universities increased the relative rate, most notably so Lund and Umeå. (Source: Table 3 in Olofsson et. al., 1987.)

An international comparison can be made with Cambridge in U.K. Calculated in relation to the number of students in science and technology, Cambridge gets the number 0.76. The two Swedish universities most resembling Cambridge, Lund and Uppsala, get 0.91 and 0.89, respectively. For all Swedish universities surveyed, the number is 1.53. (For details, see Olofsson et. al., 1987, p. 611.)

FACTORS BEHIND THE INCREASE IN SPIN-OFF RATE AND GROWTH

Below, we briefly survey some of the trends on the Swedish scene during the eighties that underlie the phenomenon.

Interest from Industry

There is an ongoing trend that industrial firms show a greater interest in having closer contacts with research, above all technological research. Indications of this interest is the increased interest in forming boards of scientific and technological advisors, with researchers from universities, and the increasing number of adjunct professors.

There are several reasons for this increased interest. Technology is to a larger degree thought of as a basis for competitive power, not only in Sweden, and being updated on new technology is viewed as a more challenging task. In a 1984 survey of managers, "Keeping pace with new technologies" was rated no. 1 among top management problems (Hill, 1984).

Traditional fields of technology are integrated, and the unavailability of M.Sc. trained in integrated fields makes it more interesting to rely on outside rather than internal sources for knowledge.

Other reasons are that technology built into products is more complex (witness a car) and more hidden (integrated circuits). All together, the increased interest from industry to "work together" with universities is natural.

The hypothesis that the increased interest is a partial explanation behind the increased rate of spin-offs and their growth is compatible with the conclusion in a recent study by the Royal Swedish Academy of Engineering Sciences (IVA, 1987) that the main function of such firms is to be links between university research and the R&D and subsequent commercial applications of large industrial firms. In the survey mentioned earlier, a subsample was interviewed as to customers, etc. Four out of ten had large companies as their main customer group, and ten per cent sold mainly to research laboratories. Five out of ten stated their main operation as development for customers. Only two out of ten had an own product on the market, but an additional four out of ten had a product under development. (Olofsson et. al., 1987, p. 612.)

The trend shift in 1983, however, is not easily explained by the gradually increased interest from industry.

Attitudes in Universities

An important change that has taken place in the Swedish academic system has to do with the norms for undertaking non-academic or extramural activities such as consulting for industry. From a situation where reserachers were more or less expected not to engage in commercial work, the norms have changed. Not only do institutes of technology take part in the formation of science parks and set up organizations for contracted R&D work, they also actively promote spin-off activities. Some examples are:

- In 1981, Linköping University started a Center of Technology Transfer to perform contracted R&D and continuing education for industry
- In 1983, Chalmers Univerisity of Technology started Chalmers Innovation Center with a mission, among other things, to serve as an incubator
- In 1983, the largest science park in Sweden, Ideon in Lund, was set up, through efforts by a university-industry foundation, SUN
- In 1984, the foundation, STUNS, was started in Uppsala, and it it has been instrumental in setting up a research-connected development center for new firms

- In 1985/86, Chalmers Industriteknik which has a mission for Chalmers University of Technology which resembles that of The Center of Technology Transfer in Linköping went operative
- In 198X, The Royal Institute of Technology in Stockholm set up Teknikhöjden, serving as an incubator.

Attitudes also have to do with the attitudes and motives of researchers starting a spin-off company. The faster growth of later starts noted above has been ascribed to a smaller share of companies started "on the side", and, consequently, a larger share of more "serious" starts (Olofsson et. al., 1987, p. 615). The hypothesis is in line with the results in a study of fast- vs. slow-growing university spin-offs, that the motives of the founders is the factor with the largest explanatory value for differences in growth (Klofsten & Lindell, 1988).

The shift in attitudes inside universities correlates with a general shift in attitudes towards entrepreneurs and entrepreneurship in the 1980's in Sweden.

Venture Capital

During the late 1970's, the financing of small and medium-sized firms was much in focus for the debate on industrial development in Sweden. The general feeling was that there was a serious lack of venture capital for small and young firms.

From 1982 and onwards the situation changed drastically. A national OTC market was created in 1982, drawing on a favourable evaluation of the U.S. experiences, thereby creating one exit mechanism for the venture capital community in being as well as providing a risk capital market for companies not fulfilling the requirements of the Stockholm Stock Exchange. At the same time, tax laws of importance for non-listed companies were passed.

As a consequence, more than twenty nationally operating venture capital firms came into being during less than three years. At the same time, twenty to thirty regional and local risk capital companies were created with the purpose of becoming partners to small firms. The interest in investing in small and young companies was also reflected in the interest in established industry to develop relations to small firms with a technological base for their business idea.

To a large extent the influx of venture capital (about 1 billion SEK in total) meant a rather high visibility for technology-based spin-offs at the universities. It also meant that potential entrepreneurs got the opportunity to test their ideas on interested (and competing) financial parties.

Over the first years of operation (1982-84) 40 to 50 per cent of all investments made by the national venture capital firms were made in high tech companies. About 75 per cent were made in companies less than five year old. (Olofsson & Wahlbin, 1985, p. 191.) After 1985, however, there has been a change in the investment profiles of the venture capital firms, in the sense that they now have a much more cautious attitude towards investments in start-ups. There has also been a shake-out in terms of number of active venture capital firms, and generally speaking, it is the small firms that have left the market.

The venture capital firms are expected not only to provide financial resources but also management support, marketing resources, and accounting services, or at least to be helpful in finding these services.

The importance of the new venture capital firms for university spin-offs may be illustrated by the use of data from the Linköping scene. Out of 21 spin-offs that had a turnover of more than 1 million SEK in 1986, four had received venture capital. Of the remaining 17, seven have external equity capital, mainly from industrial firms. In addition, two have been bought up completely by other firms.

Other resources

In a recent study of technology-based spin-offs (Klofsten et. al., 1988) it was clearly stated by representatives of research-based spin-offs from universities that apart from capital, they felt that the main gap between resources needed and those available was for internal marketing knowledge.

Incubators and science parks represent another resource for spin-off firms. The evidence on their importance is mixed. In Lund, the start of the largest science park in Sweden coincides with the (also local) boom in rate of starts. In Linköping, a science park less than half the size of that in Lund was started in late 1984, i.e. after the peak in the rate of spin-offs. In Linköping, about two thirds of the firms are not situated in the park.

THE IMPACT OF FACTORS REVIEWED

The interest from the markets served by the spin-off firms is clearly a prerequisite for the increased rate of spin-offs. This increased interest, and the changes in attitudes inside the academic world, led to the start of the phenomenon in the early 1980's. More research results had a market potential, and attitudes were changed so that the step of starting a company was thought of as a possibility. At the same time, the lack of capital led to a large share of "companies on the side", and was probably a restriction to growth for firms needing capital.

Chalmers University of Technology has the longest history of spin-off activity, and this can be traced to the impact of one professor who actively encouraged researchers at his department to start firms based on their research. This example lends support to the notion that attitude changes play a role.

One might further speculate on why there was a pool of potentially commercializable research knowledge. The trend noted above, that industry is more interested in research results, is part of the explanation. Another part might be that the mix of research has changed. Given the fact that the expansion of technological research at universities has been funded to a large degree by grants from The National Swedish Board for Technical Development (STU), this assumption is not unplausible. The conclusion could be that in a sense, the universities "were ready" to take on an increased interest from the market.

Why then the boom 1983-84, and the change in growth for firms started those years? We feel that the boom in venture capital is an essential part of the explanation, but indirectly more than directly. As has been noted above, venture capital in the early years showed an interest in young technology-based firms. While the evidence from Linköping cited shows that they made investments in relatively few firms, they were in contact with many more, and in a sense, their interest brought university spin-offs to the attention of other investors - and perhaps to researchers not having started firms. The active interest from investors meant that it became easier to start and fund a "more full-fledged" firm than before, and more firms were started with "growth-related" motives (Klofsten & Lindell, 1988). At the same time, starters had access to a pool of experience in companies started earlier. As has been noted above, resources needed seem to be available, with the exception of capital and internal marketing knowledge.

Science parks and incubators may be part of the explanation of the peak rates locally at some places, but not generally.

DISCUSSION AND CONCLUSION

Some evidence suggests that the rate of spin-off has slowed down from 1986 onwards. (It is clearly so in Linköping.) If so, the peak years coincide with the peak years for risk-willing venture capital, and the down-turn in the rate of spin-off with the decreased interest from venture capital. Another explanation is that the peak years "draw out" what was there, and that we must wait for the pool of commercializable research results to build up. (If so, we might speculate on a "natural" cyclical character of the phenomenon.) Our general feeling leans towards the second explanation.

An interesting question is whether the firms started will continue to grow. The Cambridge experience is that the university spin-offs have continued to grow by spinning off "second-order spin-offs", etc, over time forming a significant economic phenomenon in the region. Since the rate of first-order spin-offs in Sweden is comparable to that in Cambridge - which is high for the U.K. - a similar growth in Sweden would be very interesting.

Available evidence is that some firms have indeed spun off other firms, while some have been bought up by established industrial firms. It is too early to draw any conclusions from what has happened. Some factors speaking against an avalanche effect are:

- The much smaller home market of Swedish spin-offs, meaning that for growth they have to make market investments abroad to a larger extent than U.K. firms. Indeed, such market investments may be the no. 1 hurdle to an expansion for many of the firms
- The general unwillingness of Swedish entrepreneurs to expand beyond a certain size (see e.g. SIND, 1985, p. 116 and Olofsson et. al., 1986). We do not know whether this is true also for the firms in focus here, but certainly there are quite a few founders who have a very cautious attitude towards fast expansion.

On the other hand, growth based on the knowledge in these firms may take place in the large industrial firms served by them. Particularly if they are bought up, their economic impact becomes less visible and harder to assess.

To summarize, the main prerequisite behind the increase in the rate of spin-offs by university researchers in the 1980's is the increased interest from the established industry to get access to research results with a commercial potential. This interest also explains the growth of such ventures as Chalmers Industriteknik and The Center of Technology Transfer in Linköping.

The first "step", from a rate close to zero in the seventies to the level in the early 1980's was precipitated by change in attitudes inside universities. The second step, the peak and change in character of starts 1983 and 1984, was precipitated by the interest from venture capital and other investors, and by role models. In the process, the role of venture capital was mainly to focus the attention on the possibilities; to a lesser degree to foster spin-offs and their growth by making equity investments in such firms. A larger proportion of firms were then started with growth ambitions, at least up to a point. One may speculate that the ideas behind these firms may have been there for a long time, but that the researchers involved had to have more incentives to be "drawn out" from the university world.

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