University spin-offs in Sweden: a longitudinal study

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Abstract: *There have been few studies on the long-term performance of university spin-offs (USOs). This paper builds on previous empirical research into the performance of USOs and on the resource-based model of USOs. Several research issues are addressed including, in particular, the long-term performance of Swedish USOs, the distribution of the main types of business, the extent to which USOs have been in contact with support organizations, and by how much the potential growth of USOs has been achieved by the dissemination of technological knowledge to other businesses through patents, licences and other activities of the founder of the USO. The results of studies of 25 Swedish USOs, all started between 1962 and 1990 and with a median age of 25 years, confirm previous research on USOs which experienced limited growth. The analysis indicates that most of the USOs usually operate as 'simple' types of business, such as consultancy services; and that 60% have been in contact with support organizations.*

Keywords: *university spin-offs; spin-off development; spin-off performance; knowledge dissemination; Sweden*

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Our current knowledge of the long-term role and development of university spin-offs (USOs) is limited (Lawton Smith and Ho, 2006). Most empirical studies of USOs have been concerned with explaining the varying pattern of USOs between countries (for example, Clarysse *et al*, 2001), regions (for example, DiGregorio and Shane, 2003) and sectors (for example, Shane, 2004). Studies of the performance of USOs generally find that the businesses tend to be small and that growth rates remain modest in the first decade of their existence (Lerner, 2005). Lawton Smith and Ho (2006) investigated 114 Oxford University spin-offs and concluded that although they contributed to the county's employment (amounting to some 3.5% of the county's employment) most spin-offs remained small in terms of revenue and number of employees. The number of Oxford spin-offs and their growth rates remain very modest compared to what has been reported from Stanford University and Silicon Valley in the USA. However, while it is generally recognized that significant growth among technology- and science-based companies normally takes a long time, few studies, with some exceptions – for example, Lawton Smith and Ho (2006) – have been made of the long-term performance of USOs. Most studies on USO performance have been carried out on USOs less than 10 years old (Mustar *et al*, 2008).

During the last ten years, from 2000 to 2010, there has been increasing involvement of, and interest from, central and local government, in many countries, in stimulating the commercialization of university research. Public bodies were established with the aim of providing support and lowering the barriers to progress for university researchers seeking to develop new spin-off businesses. The impact of these measures in Sweden has not been investigated, however, apart from some studies on the role of the science park for companies based in such parks (for example, Lindelöf and Löfsten, 2003). In contrast, there is evidence of rapid growth occurring in the number of USOs in the UK following the introduction and implementation of government and other national initiatives to support new ventures (Lawton Smith and Ho, 2006).

This research project uses a database created for a comprehensive mapping of Swedish university spin-offs that was done in 1992 by Olofsson and Wahlbin (1993a). Some 124 Swedish USOs responded to a questionnaire seeking information on the background and development of the USO. The study covered USOs started between 1962 and the beginning of the 1990s. The present paper reports on a follow-up study of 25 of these Swedish USOs that have survived. It is pertinent to note the key observation by Olofsson and Wahlbin (1993b), that the USOs at that time accounted for a significant portion of the total value of sales in Sweden of commercial trade in 'technological knowledge' – that is, patents, licences and commissioned research and development, R&D, an indication of the importance of the role of Swedish USOs in transferring such knowledge from academia to the world of commerce and industry.

Our research, as reported in this paper, is based on and extends previous empirical research into the performance of USOs and on the resource-based model of USOs.

The questions we posed were:

(1) What is the long-term performance, in terms of size and rate of growth, of Swedish USOs; and is it in line with the results from previous research which show that USOs exhibit limited growth and remain relatively small (in terms of revenue and numbers employed)?
(2) What is the distribution of the main types of business in Swedish USOs, these types as proposed by Druihle and Garnsey (2004); and is there a tendency for the simpler forms of business type to be pre-eminent?
(3) To what extent have USOs been in contact with supporting organizations; and what effect have such contacts had in terms of growth?
(4) To what extent is the potential growth of USOs achieved outside the business, for instance by disseminating technological knowledge to other companies by means of patents and licences and other activities of the founder of the USO?

The remainder of the paper is organized as follows. First, we present the theoretical basis of our research, that is, 'resource-based theory and USOs'. We then present our definition of USOs and describe our current, empirical investigations, followed by presentation and discussion of the empirical results. Finally we present our conclusions and recommendations.

Resource-based theory and USOs

'Academic entrepreneurs' generally have very limited experience and knowledge with regard to commercial business and marketing activities: their knowledge and experience usually, and not unexpectedly, lies in the areas of research in science or technology (Druilhe and Garnsey, 2004). As a result, the most resource-efficient process for commercializing the technological knowledge that academic entrepreneurs have developed involves selling the knowledge in the form of contracted R&D or consultancy work. Commercializing the technological knowledge, in the form of new products or processes, would generally require much greater business-oriented knowledge and experience, and more resources and time, and would entail a much higher risk for the academic entrepreneur (Druilhe and Garnsey, 2004).

Druilhe and Garnsey have proposed four major business types:

(1) the 'simpler type' of consulting company;
(2) development companies;
(3) software companies; and
(4) product-based companies, the most advanced type of business.

Their study of Cambridge (UK)-based USOs revealed support for their resource-based model of USO development; and that 23% of their sample could be classed as the most advanced business type, that is, the product-based company. They concluded that, in some USOs, an academic entrepreneur might eventually overcome limitations in knowledge and experience and thus start a dynamic development process by means of which new opportunities are discovered and new resources are mobilized, with resulting expansion and growth of the USO (Druihle and Garnsey, 2004).

Vohora *et al* (2004) describe the dynamic process in terms of the resource needs of entrepreneurs. They describe the process as linear but conclude that it is punctuated by critical junctures at which the academic

entrepreneur (and/or the team of entrepreneurs) would need to make different forms of 'resource leaps' in order to develop the USO into more advanced forms of business having greater potential for growth. The critical junctures proposed by Vohora *et al* are:

(1) opportunity recognition;
(2) entrepreneurial commitment;
(3) credibility; and
(4) sustainability.

Before each of these occurs, the venture faces three generic problems, according to Vohora *et al* (2004), these problems all relating to a lack of resources of some kind: for example, scarcity of a particular resource, an insufficient level of social capital, or inadequacies in the internal capabilities of the business to use resources and knowledge.

Methods used

The term university spin-off is not used consistently in research (Lawton Smith and Ho, 2006). We will define it thus: 'legal entities and enterprises created by the higher education institutions or its employees to enable the commercial exploitation of knowledge arising from academic research'. In Sweden the intellectual property rights (IPR) to academic knowledge belong to the teacher: thus, a minority of USOs is created by the university itself. The normal procedure is that the employee will establish the business. Before 1994, Swedish universities were not permitted to invest in private companies and so none of the USOs in our sample, all of which were founded before 1992, is a university-owned spin-off. Although other investigations into USOs included student-founded spin-offs (see Druihle and Garnsey, 2004; Lawton Smith and Ho, 2006; Lindholm Dahlstrand, 1997), we chose to include only those spin-offs founded by university employees.

Our sample originates in a study of Swedish USOs carried out in 1992 by Olofsson and Wahlbin (1993a; 1993b). They sent out a questionnaire, which included questions on the background and development of the USO, to some 322 companies located near to universities in Gothenburg, Linköping, Luleå, Lund, Stockholm, Umeå and Uppsala. The 322 companies were identified with help from organizations such as technology-transfer offices, incubators and science parks, all of which had a direct relationship with the universities. The sample is therefore biased, in the sense that it almost certainly includes USOs having some kind of contact with one such supporting organization. However, the use of lists supplied by or with input from university-related supporting organizations is not without precedent, having been a feature of studies in Cambridge (Druihle and Garnsey, 2004) and Oxford (Lawton Smith and Ho, 2006) USOs, for example.

Olofsson and Wahlbin (1993a; 1993b) received 153 responses, of which 124 were from the relevant population, that is, a university spin-off, and had been established between the 1960s and the beginning of the 1990s. A first update of information about these 124 companies, using the Swedish official company database 'Affärsdata', was carried out in 2008 and it revealed that 40 (32%) of the population had not survived; 34 (27%) had been subject to restructuring, acquisition or merger; and 14 (11%) were either not active or were registered as sole proprietorship organizations. The remaining 36 (29%) businesses, listed as limited companies, were still in operation in 2008: the present paper focuses on these 36 survivors.

The database 'Affärsdata' was also used to obtain current data on turnover (that is, the income) and number of employees in each company. In February 2009 the Chief Executive Officers (CEOs) of the 36 companies were contacted with the intention of asking them to participate in a structured telephone interview in which the questions used in the original mapping in 1992 were asked. Questions about patents, technology diffusion, and use of supporting organizations were added to those from the original questionnaire. Of the 36 CEOs, it was not possible to interview 11: the remaining 25 companies only are therefore included in this study. These 25 USOs were started between 1962 and 1990 and their median age is 25 years.

Long-term performance, distribution of business types and use of supporting organizations

The Swedish sample confirms previous research on USOs: these companies experienced limited growth and remained, in most cases, relatively small in terms of turnover and staff employed. However, there are two exceptions: one, involved with computer technology ('Computer A'), which increased its workforce to over 100 employees; and the other, involved with biotechnology ('Biotech/pharma D') which increased its workforce to almost 700 employees. Both of these companies are still owned by the founder, who also serves as CEO and, in both companies, there has been a development from offering mostly consultancy services in 1990 to selling software (computers) and hardware (biotechnology) respectively in 2009. This transformation may have had some effect on the growth of the companies, and it could be assumed that the individual entrepreneurs concerned developed their resource bases and discovered new opportunities, making it possible for them to grow their businesses, the

process recognized by Druihle and Garnsey (2004). In addition, the biotechnology company is the only one that had used support organizations in order to extend its networks and, presumably, to extend its resource base.

However, 17 of the 25 companies have remained very small and, by 2009, still had no more than three employees. Of the 17, six have recently reduced the number of employees in anticipation of closing the business in the near future as a result of the planned, forthcoming retirement of the founders. The remaining six companies have grown to a size requiring between six and 21 employees only. The turnovers are correspondingly low, with the highest turnovers and growth rates being in the biotechnology and pharmaceuticals sectors, and the lowest in the energy and environmental industries. The energy and environmental industries are also those which tend to use consultancy companies more often, and this may explain the low numbers of employees.

As did Druihle and Garnsey (2004), we also found that the simpler types of business, such as consulting (11 companies) occur most frequently. In our sample the simpler forms are, however, closely followed numerically by the advanced types of business, that is, those dealing with hardware (10 companies). Software, which could be categorized as a 'medium complex' type of business, is the business activity of five of the USOs.

Regarding the consultancy companies, half of them have stayed essentially the same since 1990. The other half has tried different kinds of activities as part of their programmes of development and growth. They were involved, for 40–60% of their time, with hardware or software through the middle of the 1990s, but then went back to consultancy practice only. This pattern of development and growth, followed by a return to the original aims, objectives and activities of the business, can be found in all industries. It suggests that critical junctures (Vohora *et al* 2004) may not always initiate growth and resource development: they can also result in reconfiguration and ultimately abandonment of resources.

Regarding the use of supporting organizations, 15 of the companies (60%) have been in contact with such organizations. As previously mentioned, the largest company in the sample wanted to extend its network: the rest (14) applied for funding. Within this sample, contact with supporting organizations has had no effect on growth.

Data on the distribution of companies in different industries, their type of business, turnover, number of employees, growth rate, and use of supporting organizations are presented in Table 1.

Technology diffusion and possible growth in other companies

Our results generally support those from previous research on the performance of USOs and the resource-based model of USO growth. However, we also investigated whether or not any USO contributed to growth in other companies better positioned to make use of the opportunities created by new technology and knowledge. We studied four alternative mechanisms for technology transfer and possible growth in other organizations:

- the sale of licences or other IPR by the USO to other companies;
- the transfer of technology/knowledge not protected by patents or other IPR;
- the setting-up of other companies by the founder of the USO; and
- the transfer of IPR from continuing research done by the founder(s) of the USO.

The results of our investigations revealed that the sale of licences and other IPR from the USO were limited to eleven companies in the sample; and, in the same number of USOs, technology had been transferred once the technology was either no longer protected by patents or was not initially protected. More common was the situation in which the founder(s) continued to be active in research and/or started other companies, transferring new technology either through sales of licences (nine) and/or new companies (13). Only three companies did not appear to have licensed or transferred knowledge directly, indirectly or through its founder. All of these three companies were in the group of smallest companies in the sample. In contrast, the largest company in the sample, Biotech/pharma D, had transferred technology through all four means listed above. Table 2 summarizes the licensing, other transfer and founder activities.

While it is common for software companies and biotech/pharma-companies to sell licences, it is difficult to find any other consistent pattern in the transfer of technology and knowledge. In approximately half of the companies, the founder(s) seems active in other commercialization activities such as licences and/or the start-up of new companies. However, the responses indicate that the USO is not the only mechanism used for commercialization of a new technology. In some cases the technology is used, and presumably commercialized by other companies, by means of either licences or 'free' transfer. In addition, the existing, further-developed, or different technologies are commercialized through the founder(s) selling

Table 1. Distribution of sample USOs.

Industry	Company	Line of business	Turnover, 1990, 1,000 Euro (approx)	Turnover, 2007, in 1,000 Euro (approx)	Growth rate, 1990–2007 (%)	No of employees, 1990	No of employees, 2007	Growth rate, 1990–2007 (%)	Use of support organization
Telecom	A	Hardware*	675	360	–46	11	2	–82	Yes
Computers	A	Software**	840	14,300	1,702	8	133	1,662	No
	B	Software	5	76	1,520	2	2	0	No
Biotech/ pharma	A	Software	84	890	1,060	5	17	340	Yes
	B	Royalty admin.	510	190	–63	8	1	–87	Yes
	C	Hardware	1,513	1,530	0.9	8	6	–25	No
	D	Hardware	85	130,000	152,941	2	694	34,700	Yes
Energy/ environment	A	Consulting	0	270	27,000***	0	2	200	No
	B	Consulting	87	17	–81	2	1	–50	Yes
	C	Consulting	7	49	700	2	1	–50	No
	D	Consulting	2	62	3,100	2	1	–50	Yes
	E	Consulting	0	54	5,400***	0	0	0	Yes
	F	Software	3	31	1,033	1	0	–100	No
Industrial materials	A	Hardware	1	163	16,300	2	3	150	Yes
Tools/ machines	A	Hardware	1,680	3,830	228	18	21	117	Yes
	B	Hardware	680	3,760	553	15	9	–40	Yes
Others	A	Hardware	3	12	400	0	0	0	No
	B	Consulting	252	1,470	583	5	19	380	No
	C	Consulting	257	1	–99.9	1	0	–100	Yes
	D	Consulting	3	16	533	0	2	200	No
	E	50% consulting 50% hardware	86	345	401	3	3	0	Yes
	F	15% consulting 70% software 15% hardware	170	1,030	606	5	9	180	Yes
	G	Hardware	173	123	–29	4	2	–50	Yes
	H	Consulting	2	23	115	0	1	100	Yes
	I	Software	2	25	125	1	1	0	No

* Hardware includes products and other tangibles; ** Software includes service and other intangibles; ***Start-up 1990.

licences not held by the original USO or through other companies also started by the USO founder.

Conclusions and recommendations

As with those in other studies of USO performance (Lawton Smith and Ho, 2006; Lerner, 2005; Lindholm Dahlstrand, 1997; Mustar *et al*, 2008), most of the companies in our sample of Swedish USOs that have survived remain small even after, on average, 25 years of trading and despite contact with supporting organizations. We have also found that they tend to operate as 'simpler' types of business. In contrast, Druilhe and Garnsey (2004) found only 18% of their sample to be of the simplest type: however, in the UK it is not necessary for an academic to register a company in order to offer consultancy services, and this means that there are probably more consultancies among the academics than were accounted for in their sample. The fact that the IPR relating to academic knowledge belongs to the researcher in Sweden, in contrast to practice in most other countries, does not seem to have a significant impact on the growth of established companies.

Table 2. Licensing, other transfer of technology and founder activities.

Industry	Company	Line of business	Sale of licences from USO	Free transfer to other companies	Founders' sale of licences for other technologies	Founders' founding of other companies
Telecom	A	Hardware	–	–	–	–
Computers	A	Software	Yes	Yes	–	–
	B	Software	Yes	–	–	Yes
Biotech/pharma	A	Software	Yes	–	–	Yes
	B	Consulting	Yes	–	–	–
	C	Hardware	–	–	Yes	Yes
	D	Hardware	Yes	Yes	Yes	Yes
Energy/ environment	A	Consulting	–	–	Yes	–
	B	Consulting	–	Yes	–	Yes
	C	Consulting	Yes	–	–	Yes
	D	Consulting	–	–	–	–
	E	Consulting	Yes	Yes	Yes	Yes
	F	Software	Yes	Yes	–	Yes
Industrial materials	A	Hardware	–	–	Yes	–
Tools/machines	A	Hardware	–	Yes	–	–
	B	Hardware	–	–	–	Yes
Others	A	Hardware	–	Yes	Yes	Yes
	B	Consulting	–	–	–	–
	C	Consulting	–	Yes	Yes	Yes
	D	Consulting	–	–	–	–
	E	50% Consulting 50% hardware	–	Yes	Yes	Yes
	F	70% software	Yes	–	–	–
	G	Hardware	Yes	Yes	–	–
	H	Consulting	–	Yes	Yes	Yes
	I	Software	Yes	–	–	–

There is also some evidence that the business models of the companies change over time; but there are no clear indications that these changes could be a source of growth. With reference to the critical junctures framework proposed by Vohora *et al* (2004), we could also conclude that all of the businesses have managed to survive, if not necessarily experience growth to any significant extent. However, the generic problems that a venture faces at the critical juncture points proposed by Vohora *et al* (2004) do not seem relevant for the simpler types of business such as consultancies. Having a simpler business model often does not require resources other than personnel and, despite a shortfall in the internal capabilities needed to enhance performance, the consultancies have still managed to become sustainable and survive for some 20 years.

At this stage, we have no information from the 25 companies about how or why they have reached the position they are in today. Previous research has indicated that the intentions and ambitions of the founding entrepreneur are crucial for venture growth (see, for example, Shane, 2003) and that a successful company (in terms of growth) often starts in an 'aggressive' way (Carter *et al*, 1996); that is, the entrepreneur works actively on the development of the company. Given that an academic spin-off is often an outcome of research, and that the founder of the company often remains in contact with, or is still employed by, the academic institution, it may be that the ambitions for growth are not that high, or that it takes a lot more effort to grow the business than the founder is willing to expend. A related reason could be the policies, often restrictive, of universities with regard to leave of absence for academic entrepreneurs. More flexible policies might encourage a more determined effort by the researcher to grow the venture. Other reasons could be – as Druilhe and Garnsey (2004) also suggest – the lack of relevant networks and commercial awareness and knowledge, which may prevent the founder from building a strong management team able to convert research into a successful business proposition. In addition, we do not know how supporting organizations are used, and how the companies perceive the value of such support. We suggest that research, preferably by means of case studies, is needed to investigate this further.

Regarding transfer of knowledge and technology to other companies we can conclude that, apart from the

obvious case of selling licences and other IPR to other companies, it is also relatively common for other companies to copy and develop further the USO's technology if it is not protected or if initial protection has lapsed. Roughly half of the USO founders have continued to be active in research, often resulting in new technologies being licensed or becoming part of new business start-ups. Because we do not have any estimates of the value or size of these two types of knowledge transfer, that is through the sale or copying of IPR, and founders' continued commercial activities, we cannot draw any conclusions regarding the actual impact of this knowledge transfer to other companies. This would require additional research, either through case studies tracing the effects of USO-generated IPR entering other companies or through case studies focusing on the founders' other commercial activities, including commissioned R&D work. Our study indicates that there would be merit in pursuing both types of case studies.

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