ETH TRANSFER

Linking Science and Business

Ingvi Oskarsson and Alexander Schläpfer

The performance of Spin-off companies at the Swiss Federal Institute of Technology Zurich

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Dear Reader,

Innovation is one of the key factors in the success of the Swiss economy. This is why transfer of research results, know-how and technology from academia to industry is important, and has only become more so over the years. ETH Zurich works constantly in pursuit of its mandate to conduct research that benefits society. Creating spin-off companies is one of the most successful ways to transform scientific discoveries into products that meet the market needs of today and the future.

By sharpening its focus on spin-off creation in the past decade, ETH Zurich has been able to establish an environment that fosters spin-off generation. Resources are and have been invested to raise the entrepreneurial awareness of students, and to stimulate and support the transfer of ETH Zurich technologies into market-competitive spin-offs. After such an intensive period of investment and growth, now seems a good time to reflect on the results of the past ten years.

We are very fortunate that the two authors, Alexander Schläpfer and Ingvi Oskarsson, bringing with them the professional edge of the Masters in Finance program from the London Business School, elected ETH Zurich to be their case study on the success and economic impact of spin-offs. ETH Zurich has nurtured the founding of 130 spin-offs in the last 10 years. The spin-offs have had a direct impact on the local economy, creating more than 900 direct jobs and a total pre-tax income of CHF 43 Mio in 2007. This resulted in about CHF 18 Mio of annual tax income. The total investment in these companies is close to CHF 170 Mio, with an estimated pooled internal rate of return (IRR) of more than 43 percent. These results are very encouraging. They strengthen our conviction to continue with our efforts in support of spin-off creation, and bolster our commitment to keep spin-offs market-relevant, if not cutting-edge.

This study, in book form, is the first publication to provide in-depth analysis of ETH Zurich spin-offs. We hope that this book will be yet another means of encouragement for students to become entrepreneurs and to found their own companies, and for universities to strongly support their own spin-off programs. It is hoped, too, that this study will convince Swiss policy makers to continue with, or to even increase, their efforts which have turned Switzerland into a thriving place for entrepreneurs and new company generation, and the promising location of many more to come!

Finally, we hope that this case study will entice much appreciated national and foreign investors to have an even closer look at the Swiss spin-off portfolio, and to deepen their investment in it.

We would like to thank the two authors for their enormous enthusiasm and surprising achievement that went far beyond the typical Masters thesis. Our sincere gratitude is extended to Zürcher Kantonalbank (ZKB), CTI Startup and the Swiss Private Equity & Corporate Finance Association (SECA) for their financial support that allowed publication of this study and the sharing of its exciting insights.

Sincerely,

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Thesis for the Masters in Finance Program (MSc Finance) at London Business School

Supervised by Prof. Francesca Cornelli

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1. Executive Summary

Commercialising University technology by creating spin-off companies is a widely practised method of technology transfer today. Nevertheless, there still seem to be some doubts about how effective this method actually is and whether it justifies the build-up in Universities of dedicated resources to pro-actively support the creation of such spin-offs.

With data from 130 ETH Zurich spin-off companies created from 1998 to 2007 and detailed financial information obtained by questionnaire from a subset of 82 spin-offs, we looked at three principal questions in our study: 1) how successful these spin-offs are compared to all start-up companies in Switzerland and compared to other University spin-offs internationally, 2) whether the creation of such spin-offs appears to be beneficial to the local economy and 3) whether a comparison to other University spin-off programs could identify potential areas of improvement for ETH Zurich. We were able to demonstrate that ETH Zurich spin-offs have significantly higher survival rates, create more jobs, attract more VC/Angel investments and provide higher returns on equity than the average of all Swiss start-up companies created over a similar time period. Compared specifically to spin-offs from leading UK Universities, the ETH Zurich spin-offs show higher survival rates, a slightly lower job-creation, a significantly lower proportion of Venture Capital (VC) or Business Angel backing (but higher average investments per spin-off that receives backing) and similar returns on equity. VC/Angel backing appears to be the key factor of growth and value creation as VC/Angel-backed spin-off companies create significantly more jobs, grow faster and founders experience significantly higher returns (and lower failure rates) if they are backed by VC's or angels than if not. With a raw pooled return of 37.5% p.a. (before fees and carry), the VC's/Angels that have invested in a 'hypothetical fund' of ETH Zurich spin-offs, made returns significantly higher than even the top quartile of US and European VC funds over the last decade and outperformed the Swiss Market Index by over 2000 bps p.a. during the same time period. On basis of a simple CAPM, we estimate that this portfolio of ETH spin-offs has experienced abnormal returns in the range of 20–25% p.a.

With annual revenues of approx. CHF 250 million, the 130 spin-offs have to date created close to 1500 direct and indirect jobs and generate annual personal and corporate income tax revenues to local and federal government of an estimated CHF 18 million p.a. Not directly quantifiable benefits include the formation of innovation clusters and the attraction of highly qualified students and faculty to ETH.

We have finally identified a set of recommendations for ETH Zurich mainly aimed at improving the ratio of VC/Angel backing among their spin-offs.

2. Background and Problem

The Swiss Federal Institute of Technology Zurich (ETH Zurich) is among the world's leading science schools and has been ranked in 2007 in the top 30 of Universities in the world both by the Shanghai Jiao Tong University's survey and by The Times Higher Education Supplement[1]. With a budget of over 1 billion Swiss Francs (CHF) a year it provides higher education to more than 12000 students at bachelor and post-graduate level and conducts cutting edge research with close to 5000 staff (FTE, including PhD's). The focus of its teaching and research is in Natural Sciences and Mathematics, Engineering Sciences, System-Oriented Sciences (Earth-, Environmental-, Agriculture- and Food Sciences), Construction and Geomatics as well as in specialized areas of Management and Social Sciences (e.g. Technology Management). Besides teaching and research, ETH Zurich considers the transfer of its technology to a wider application (and commercialisation) in industry and education as third major element of its mission. It expanded its technology transfer activities in the early 1990s, created a specialised group to manage the patenting and transfer of its technology in 1995 and formalised – in 2005 – the group's status as a distinct unit ('ETH transfer') with a dedicated budget and reporting to the VP for Research. ETH Zurich utilises the following methods of direct technology transfer: 1) research collaborations with industry or educational institutions, 2) technology licensing and 3) spin-off creation. While its first documented spin-off[2] company was incorporated in 1973, it is only over the last decade that ETH Zurich has been putting a stronger emphasis – and resources – on supporting the creation of such companies.

As for any other new initiative that it has been launching, ETH is interested in knowing whether the spin-off-program is meeting its objectives (i.e. the commercialization of its research and the creation of jobs for its graduates as well as for others) and shows a satisfactory performance. After it had undertaken, in 2004, a review of survival rates and job-creation in its spin-off companies, ETH transfer is now looking to conduct a more in-depth study into the performance and wider economic impact of its spin-offs. The objective stated for this new study therefore is twofold: first, to benchmark the performance of the ETH spin-offs with data samples from other Universities and to determine potential areas of improvement where there is a clear difference in performance and, second, to demonstrate – to the extent possible – the value and benefits created by these spin-offs to the economy as a whole.

[1] 27th in the overall ranking by Shanghai Jiao Tong, 42nd in THES overall ranking but 18th in THES 'Natural Sciences' and 13th in 'Technology' categories.

[2] For the purpose of this study we use ETH Zurich's definition of the term spin-off: 'A spin-off company of ETH Zurich is a newly founded company by ETH employees or graduates based on research results of ETH Zurich'. This definition is widely supported by academic literature and congruent with Scott Shane's (Shane, 2004) definition of 'a new company founded by current or former members of a University to exploit a piece of intellectual property created in that University.' UK academic literature sometimes refers to spin-offs as 'spin-outs', however, following the same definition as above. In contrast, 'Start-up's' are all newly created companies whether with or without University technology or University members participation.

3. Data and Description

3.1. Data

The basis for this study is a total population of 130 ETH Zurich spin-off companies that have been created in the 10-year period between Jan 1st, 1998 to December 31st, 2007[3]. ETH transfer has given us full access to its spin-off database as well as the data collected in the frame of the 2004 study. Furthermore, we had access to the paper documentation for each spin-off company, available at ETH transfer's offices on campus. Together with our own research of company websites, the Swiss company registry and telephone interviews with a large number of founders, we were able to verify – for the total population of 130 – survival rates, the number of employees, the number of companies with VC/Angel participation as well as the number of exits (IPO or trade-sale).

Furthermore, we conducted a survey by questionnaire – in particular to obtain specific data on equity funding and financial performance of the spin-offs. After a trial round with 8 selected spin-offs, we sent out a questionnaire on March 5th, 2008 to 115 companies and received – after follow-up – 74 responses with complete data. In addition, we have been able to fully research the equity funding of 8 companies that have either gone into bankruptcy or ceased commercial activity, giving us a total of 82 valid returns, i.e. a 63.1% response rate. In Table 1, Appendix 1 we show that the composition of this sample correlates very closely with the composition of total population in terms of outcome (survival/bankruptcy/inactive), sector representation and vintage representation and support this with a CHI-square-test and correlation factor for each criterion. Finally, in each case applicable, we have determined the specific parameters' standard error based on the sample size and mention the significance level of our findings separately.

For our analysis, we have then contrasted the data from ETH Zurich with data available in a number of other studies and publications, most notably in the following:

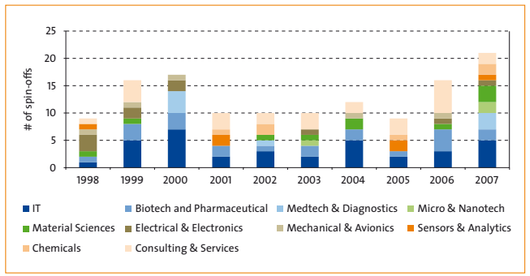
- two studies on the performance of UK University technology transfer offices and spin-off companies published by Library House in 2007 (Holi et al., 2007 and Franklin et al. 2007),
- the statistics on spin-offs published annually by the Higher Education Founding Council for England (HE – BCI surveys for the years 99/00 through 05/06),
- the Swiss Federal Office for Statistics annual data on new company incorporations in Switzerland as well as a specific study on new company survival- and job creation rates in Switzerland (Swiss Federal Office for Statistics, 2008),
- the European Venture Capital Associations's annual publication on PE/VC investment performance and activity (EVCA, 2008) and
- Imperial Innovation's annual reports and IPO prospectus.

[3] Following our strict definition of 'spin-off', we have excluded a hand-full of start-ups (i.e. newly created companies not using ETH Zurich technology) created by ETH Zurich graduates in the same time period.

3.2. Description

As shown in Graph 1 below, the total population of 130 ETH Zurich spin-offs is composed of 10 annual vintages (or cohorts) in each of which between 9 and 21 new spin-off companies have been incorporated.

Graph 1: ETH Zurich spin-offs, total population, numbers by year and sector



Source: data from ETH spin-off database

A comparison with data on new company incorporations in Switzerland from 2000 to 2006 shows that the year-on-year rate of change in new spin-off creation is fluctuating in the same direction as all new company incorporations although, due to the much smaller base, the fluctuations are much more pronounced among the spin-offs (see Graph 2, Appendix 1). This suggests that the variation in new ETH spin-off incorporations may be – to a good extent – influenced by the prevailing economic climate in Switzerland.

4. Literature review

IT/Technology (26%) and Biotech (16%) are the two sectors with the largest (and most regular) representation in spin-off creation, while Medtech, Chemicals and the various engineering sciences each make up between 5% and 8%. (see Table 1, Appendix 1 for details). Consulting and Services (20%) is a collection of service businesses in various sectors such as Architecture/Construction, Geology/Geophysics, Meteorology, Hydrology, Health and Business/Technology Management. IT and Biotech are the only two sectors in which spin-offs have been created every year and – until 2005 – these two sectors were actually driving the variation in number of spin-offs from year to year. As of 2006, the number of non-IT and non-Biotech spin-offs has started to increase above the previous average of 6–7 per year.

As explained above, the data of our survey sample of 82 spin-offs (questionnaire returns) from which we derive the financial performance indicators for this report is – to a large extent – congruent with the total 130 spin-off population (see Table 1, Appendix 1 for details).

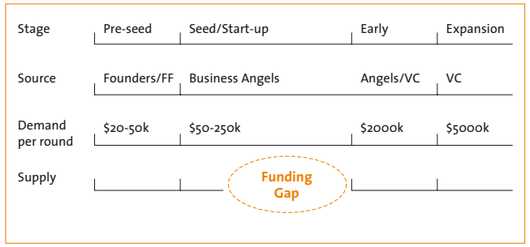
Although there are examples of University technology spin-offs dating as far back as to the 18th century (Shane, 2004, mentions the example of Professor Johannes Pickel who started in 1784 an acetic acid production based on his discoveries at Würzburg University in Germany), skepticism whether Universities should engage in creating spin-off firms to commercialise technology have been prevailing in academia – as well as among the institutions determining the Universities' budgets – still far into the 1970s in the US (Shane, 2004) and probably even longer in Europe. In the 1970s some of the leading science Universities in the US started to experiment with policies to promote spin-off creation and the 1970s saw also the first creation of university-linked Venture Capital funds (Shane, 2004). Along with these new dynamic, academia started taking an interest in 'academic entrepreneurship' and since the 1980s technology transfer as a whole and spin-off creation in particular has been widely researched (Shane, 2004, O'Shea et al., 2005).

The area of particular interest for our study is the performance measurement and the definition of performance indicators for spin-off success. Many publications focus on reviewing the success of universities' technology transfer program as a whole and measure success predominantly in the number of spin-offs created per year. Among the publications that deal more specifically with the performance of the spin–off companies, the most frequently used measure of success is survival rates. Shane (2004) references 7 different publications and we have separately reviewed data from 4 further studies (Mustar, 1997, Lawton Smith, 2006, Leung and Mathews, 2006, Clayman and Holbrook, 2006). Although these studies cover different time-spans and – likely – periods with varying economic conditions, the stated university spin-off survival rates are in the range of 70–90% and consistently higher than the survival rates of non-university start-up companies (Shane, 2004). We also looked extensively at literature appraising VC investment performance. Most authors do not use 'survival' as a benchmark but rather look at the four possible outcomes of portfolio investments ('IPO', 'trade-sale', 'still in portfolio' and 'failure') and develop – with empirical data – models based on the competing probabilities of these outcomes (Dean and Giglierano, 1990, Cochrane, 2004, Metrick, 2007). We have included a more detailed review of the data found in these articles under the heading 'failure rates' in the next chapter.

A second frequently used performance indicator is 'employment' or 'job creation'. Particularly the higher education governing bodies and national or regional enterprise development agencies understandably focus on this aspect of spin-off creation and sponsor studies such as the ones by UK's Library House already referenced above, (Holi et al., 2007 and Franklin et al. 2007) or the UNICO survey (UNICO, 2001) but also academia uses this metric (Shane, 2004, Lawton Smith and Ho, 2006) and – although numbers and measuring approaches vary widely, there is a general consensus that University spin-off companies create more direct jobs than the average small business founded in the same country. They also seem to create more qualified jobs and – as new technology companies tend to cluster – contribute more to local economic development through the creation of indirect jobs (Shane, 2004). Shane also shows that the transfer of technology to spin-offs creates more jobs than the licensing of technology to large existing corporations.

A third measure often discussed in literature is the spin-offs' ability to obtain Angel or Venture Capital investments (Shane and Stuart, 2002 Wright et al., 2006) and – if so – the amount of Venture Capital funding received (Lawton Smith and Ho, 2006, UNICO, 2004). Connected to that is the number or percentage of successful exits through IPO which – as Shane and Stuart (2002) show – itself is strongly correlated to the amount of Venture Capital funding received. Although VC's seem to have a greater concern with the quality and – in particular – the lacking experience of management teams in university spin-offs than with other companies they are backing (Wright et al., 2006) and are therefore reluctant to back university spin-offs at seed / start-up stage, the evidence in literature points to a significantly higher proportion (20 to 40 times more) of university spin-offs being able to obtain venture backing than the average small business (Shane, 2004, Wright et al., 2006). Spin-offs tend to get backed, however, at a later stage resulting in a so-called 'funding gap' in the seed/start-up stage as per the following illustration:

Illustration 1: The funding gap



Source: adapted from Sohl, 2003

At this point, Business Angels are the major source of equity capital and provide in the range of $50'000 to $250'000 per investment round which can secure 12–18 months of operation (Sohl, 2003). Once the spin-offs have VC backing, they manage to raise larger amounts and – not surprisingly – a substantially higher (10 times more) proportion of university spin-off companies experience an IPO than other start-ups (Lockett and Wright, 2005). Access to venture financing is therefore a key determinant of growth and value generation for new technology-based spin-off firms and new ventures that do not attract VC funding in the initial years are unlikely to do so in the future (Wright et al., 2006, Shane and Stuart, 2002).

So, why do 'academic enterprises' perform better than the average start-up company? De Coster and Butler (2005) have empirically shown that university spin-offs have normally an advantage with a better protected competitive position (cutting edge technology and IP protection through patenting) and they manage to satisfy better the market demand. De Coster and Butler explain the latter observation by the spin-offs conducting more systematic market research and preparing better business plans, indicating that the support services available to university spin-offs are more effective than those available to other start-ups. Mustar (1997) attributes the success to a generally more extensive support system (research funding, access to university laboratories, incubators and the network of academic and non-academic contacts) and Shane (2004) sees a distinct value in the 'university brand' that is normally associated to spin-off companies.

The fourth measure is financial returns: there is very limited literature specifically on returns in University spin-offs but the financial performance of VC investments has been the focus of several academic studies with the general premise being that Venture Capital investments have historically displayed high average returns and high risk (standard deviation) but observations of returns vary widely. Chen, Baierl, and Kaplan (2002) analysed data gathered by Venture Ecommics for a 40 year period from 1960 through 1999, but focused on liquidated funds. Their conclusion is that Venture Capital has had an annual arithmetic average return of 45% with a standard deviation of 115.6% over this period. The geometric average return (compounded average) is estimated around 13%. The correlation between VC and publicly traded equity is estimated to be close to zero (0.04%). The realised median annual IRR among the 148 funds they studied is only 8.5%, and the average is 9.99%. The maximum annual IRR they observed is 74%, and the minimum is –72%. Kaplan and Schoar, investigated the performance of 765 private equity funds from the Venture Economics database from 1987 through 2000. On average, they found that LBO-fund returns net of fees are slightly higher than those of the S&P 500, while VC-fund returns are lower on an equal-weighted basis, but higher than the S&P 500 on a capital-weighted basis. They concluded that these results combined with previous evidence on private equity fees, however, suggest that – on average – both types of private equity returns exceed those of the S&P 500 gross of fees. Ljungkvist and Richardson (2003), analysed a sample of 73 mature funds established from 1981 through 1993 and found an average IRR of 19.81% and a standard deviation of 22.29%. Moreover, they observe a 5–8% annual return above S&P 500 and 2–6% above the NASDAQ Composite for these funds. Cochrane studies data from the VentureOne database from 1987 to June 2000 and investigates VC returns based on the economics of individual investments in portfolio companies. He reports a mean log return of 15% for the whole dataset, compared to 15.9% for the S&P 500 over the same period. The standard deviation of the log return is 89%, much larger than the 14.9% standard deviation of the S&P 500 log return over the same period. This indicates that venture returns are very volatile, but he also finds that later stage VC deals have less volatility than early stage deals. Furthermore, Cochrane's model estimates the beta for VC fund returns at 1.7 and arithmetic returns (gross of fees) with a highly positive alpha (32% per year) over his sample period. Artus et al., investigated the performance of European Private Equity from 1985 through 2002, from a dataset from Thomson Venture Economics. Their study included a calculation of the internal rate of return based on cash flows of 201 funds. The funds which were selected had either been liquidated or had a small residual net asset value (lower than 12%). They report an average IRR for venture funds of 10.6%, and an excess-IRR return compared to the MSCI Europe of 4.4% for the average European Private Equity fund (including buy-out funds).

The final area of literature that we reviewed is around the question whether Universities should take equity stakes in their spin-offs or not. In a paper that has been widely referenced, Lerner (2005) takes a strong stance specifically against Universities taking large stakes in spin-offs. He mainly argues along the principal-agent dilemma that VC investors want the entrepreneurs to take a substantial stake and that – if a third party takes such a large stake – management's incentives are diluted. Another argument he puts forward is that Universities' Technology Transfer Offices (TTO) often act as trusted intermediary introducing to VC's good new business opportunities. If TTO's now themselves become investors and compete for good deals, their role as 'honest broker' will be undermined. Shane (2004) takes a contrarian's view arguing that creating spin-offs – and taking an equity stake in compensation for licensing the Universities' intellectual property (IP) is a more profitable way of transferring technology than licensing the technology to established companies. Feldman et al. (2002) see three major advantages in Universities taking equity. It 1) provides the University with an option on the patents true commercial value, 2) it aligns interests of University and entrepreneurs towards the common goal of commercialising the technology and it 3) may serve as 'certification function' that provides a signal to other investors and to the market that the university is confident of the technology's value.

5. Analysis

5.1. Failures and Survival

Of the total 130 ETH spin-offs incorporated since 1998, 9 have been liquidated and a further 6 have ceased commercial activity although they were still registered with the company registrar by December 31st 2007. We defined 'commercial activity' for the purpose of this study as 1) the company having employees, either full- or part-time and 2) regular revenues of CHF 10'000 or more per year. The population's aggregate failure rate[4] is therefore 11.5% (15 of 130 spin-offs).

The average time to failure for these 15 companies was 3.75 years with extremes of 9 months at the low end and 10 years in maximum. 7 of the 15 spin-offs have gone out of business during their first 2 years of activity while the remaining 8 were active for between 3 and 10 years. In terms of vintages, 1999 had the highest failure rate with 31% (5 of 16) as of Dec 31st 2007, followed by 1998 with 22% (2 of 9). 11 (73%) of the 15 failures have been incorporated in the period from 1998-2001 (see Table 2 below). This can partly be explained by simple statistics (i.e. if time-to-failure – TTF – values are more or less evenly distributed from 1 to 10 years, then the number of failure events will be higher in the older vintages where more TTF-values can occur) and partly with the above average absolute number in new spin-off creation in the years 1999 and 2000.

Table 2: ETH Zurich spin-offs, 'timed failure rates' by vintage

Failure rate, after										
Vintage	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years	10 years
1998	0%	0%	0%	0%	0%	0%	0%	11%	11%	22%
1999	6%	6%	13%	13%	25%	25%	31%	31%	31%	
2000	0%	6%	6%	12%	12%	12%	12%	12%		
2001	0%	0%	0%	0%	0%	20%	20%			
2002	0%	0%	0%	0%	0%	10%				
2003	10%	20%	20%	20%	20%					
2004	0%	8%	8%	8%						
2005	0%	11%	11%							
2006	0%	0%								
2007	0%									
Average	2%	6%	7%	8%	9%	13%	16%	18%	21%	22%

Source: own computation with data from survey and separate research

From a sector point of view, Biotech (4 companies / 27% of failures) and the Engineering sciences (Electrical/Electronics 2 / 13%, Material sciences, 2 / 13%) are slightly over-represented considering their proportion in the total sample while the IT spin-offs (3 / 20%) are slightly underrepresented. Counter to intuition, there is no clear evidence of the 'bursting of the tech-bubble' as only 2 of the 11 failed spin-offs incorporated in the 1998-2001 period were IT businesses. None of the total 20 spin-offs in Medtech, Chemicals and Sensors & Analytics have failed.

In 4 (27%) of the failed spin-offs, we have found evidence of VC/Angel participation. This is in line with the overall level VC/Angel participation in 26% (or 34 of the 130 total population) and also the sub-samples' failure rate in VC/Angel investments of 12% is equal to the populations overall failure rate. Hence, VC/Angels have not had a particularly good or bad hand in selecting spin-offs to back.

Although there has been much academic research into the topic, no precise estimates of failure rates in early-stage VC investment seem to be available. Metrick (2007) – in his extensive study of data from Sand Hill Econometrics' (SHE) database – has determined that, after 5 years from incorporation 6.3% of venture-backed start up firms had failed, 33% had experienced an exit (IPO or trade sale) and 60.7% were still in the VC's portfolio. After 10 years, 14.3% had failed, 61.2% of companies had experienced an exit and 24.6% were still in VC portfolios. However, SHE has labeled companies for which no status is available as 'still private', i.e. still in the VC portfolio and Metrick (2007) suggests that – as VC's ordinarily exit all their investments after 10 years (normal fund life) – most of the 24.6% listed as 'still in VC portfolios' may actually be failures that the VC omitted to report. He therefore determined the 'timed' failure rate after 10 years likely to be in the range of 30–40%. Dean and Giglierano (1990), in their study of 38 Silicon Valley based Venture Capital funds, report an average failure rate (presumably calculated as aggregate failure rate) of between 15% and 16%, however with large standard deviations of 18 percentage points in single round investments and 13 percentage points in multiple-round investments. Finally, Mason and Harrison (2001) report a failure rate (aggregate failure rate) of 34% in their study of 127 early-stage investments by UK Business Angels. In all above studies, 'failure' is defined as total loss of investment.

[4] for the purpose of this study, we distinguish between two different methods for calculating failure rates: the 'aggregate failure rate' is calculated for a sample/population of companies created over a series of years where the number of liquidated/out-of-business spin-offs by the end of the study period's last year is divided by the total number of spin-offs created over the study period. This method does not take into account the age of the companies. The 'timed failure rate' refers to the percentage of businesses liquidated within a specific number of years from their incorporation and therefore better reflects the age factor.

5.1.1. Spin-off survival compared to other Universities

The aggregate survival rate for ETH Zurich 1998-2007 spin-offs is 88.5% (115 out of 130). As shown in Table 3 below, we have compared this to spin-off survival rates published in 5 studies that we were able to access in our extensive research of academic publications. These studies all use the same method of calculating the aggregate survival rate and were conducted at either national- or university level. Again, ETH compares very favorably, particularly when considering that the only value higher than ETH's survival rates (Northern Ireland) is based on a quite small sample. Study durations of 8-10 years and even beyond are reasonably comparable as failure rates start to level off as of the 7th year of company existence.

Table 3: survival rates of university spin-offs in various countries and three universities

Country	Survival rate	Period	# years	sample size (n)	Source
USA	**68%**	1980–2000	21	3376	Shane, 2004
Canada	**73%**	1995–2003	9	301	Clayman and Holbrook, 2006
Hongkong	**79%**	1997–2004	8	56	Leung and Mathews, 2006
Netherlands	**83%**	1984–1992	9	92	Shane, 2004
France	**84%**	1984–1987	4	100	Mustar, 1997
Sweden	**87%**	1960–1993	34	30	Shane, 2004
N. Ireland	**94%**	1984–1995	12	17	Shane, 2004
University					
USA – MIT	**80%**	1980–1996	17	134	Shane, 2004
UK – Oxford	**81%**	1994–2002	9	83	Lawton Smith and Ho, 2006
ETH – Zurich	**88%**	**1998–2007**	**10**	**130**	**own survey**

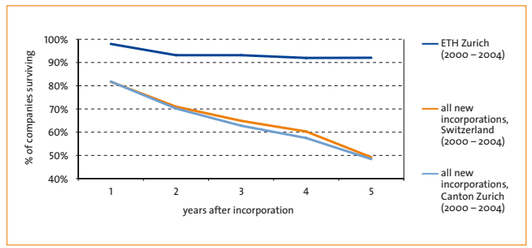
Source: own compilation from sources indicated above

The low survival rate in the US – where some of the most successful University spin-offs have been created – raises, however, the question whether a high survival rate is actually desirable or whether too strong a focus on creating 'surviving' spin-offs does not eliminate some of the potentially very successful ventures that may not look so promising or too risky.

5.1.2. Spin-off survival compared to all start-up companies in Switzerland

As already discussed in our literature review above, University spin-offs seem to have higher survival rates than the average newly incorporated small businesses (Shane, 2004). Lawton Smith and Ho (2006) provide evidence by comparing Oxford University's 80% (aggregate) survival rate with the 71% (timed) 3-year survival rate for UK businesses measured for all businesses incorporated in 2002. In the case of ETH Zurich spin-offs, this difference is far more pronounced. The Swiss Federal Office for Statistics (2008) published the 1 to 5 year 'timed' survival rates of all companies newly incorporated in the years 2000 to 2004 for Switzerland as a whole and for the Canton of Zurich (where 111 of the 130 spin-offs have their registered domicile). We have compared this data to exactly the same vintages of ETH Zurich spin-offs and Graph 3 below shows that ETH Zurich's spin-offs have a survival rate that is between 16 percentage points (for year 1 after incorporation) to 44 percentage points (for year 5 after incorporation) higher than the ones of all new companies in Switzerland and in the Canton of Zurich. Taking instead the average survival rates of all ETH spin-off vintages would show an only minimally different result, i.e. 40 percentage points difference in year 5 after incorporation.

Graph 3: timed survival rates for ETH Zurich spin-offs and for all new incorporations in Switzerland and in the Canton of Zurich



Source: own comparison with data from the Swiss Federal Office for Statistics

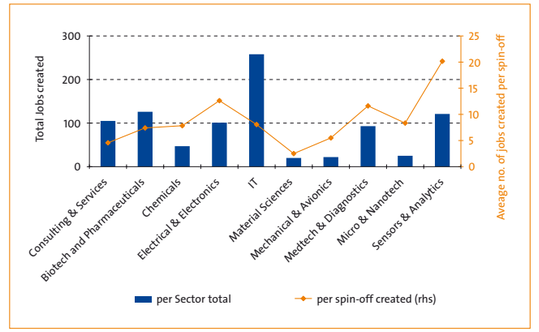
A sector-specific comparison for Biotech/Healthcare, IT and 'other services' (see Graph 3 in Appendix 1) consistently confirms these markedly higher survival rates of ETH Zurich's spin-offs versus the total of new incorporations in Switzerland over the same time period.

5.2. Job Creation

ETH Zurich's 130 spin-offs incorporated since 1998 have so far (by December 31st, 2007) created employment opportunities for a total of 918 persons. On average, every spin-off has therefore created 7.1 jobs[5] if we include those spin-offs that went out of business, or 7.98 jobs if we consider only the 'surviving' 115 spin-offs.

From a sector perspective, the most jobs in absolute numbers were created in IT (258) followed by Biotech/Pharmaceutical (126) and Sensors & Analytics (121). While IT and Biotech/Pharmaceutical are among the sectors with the highest number of spin-offs created, the job creation in Sensors & Analytics is largely due to the success of one particular spin-off – which is clearly visible in Graph 5 below where Sensors & Analytics is also the sector with the highest number of jobs created per spin-off. Spin-offs in the Consulting and Services group have created among the fewest jobs per company indicating that many of the businesses in this group are what may be called 'life-style businesses', i.e. businesses through which the founders seek the independence of being self-employed but do not necessarily create a large amount of other jobs. However, as we will show later, the variation in levels of job creation by sector seems to be driven rather by a difference in Venture Capital backing for specific sectors than by sector specific manpower requirements or job-creation dynamics. It would therefore be erroneous to conclude that specific sectors show a genuinely higher job-creation pattern and therefore merit a stronger support in view of creating more employment opportunities.

Graph 5: ETH Zurich spin-offs, total population, jobs created per sector, in total and per surviving spin-off company



Source: data from survey and separate research

5.2.1. Job creation compared to other Universities

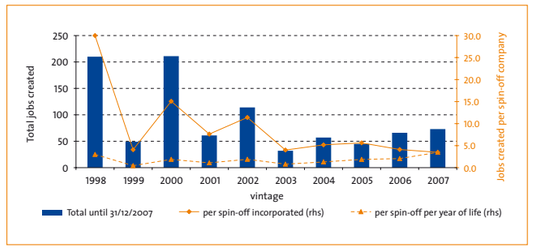
Data published annually by the UK's Higher Education Funding Counsel (HE-BCI survey, 2007) show that the 1145 (surviving) university spin-offs in the UK have created – until 2006 – 16'225 jobs, i.e. 14.2 on average per spin-off[6]. This ratio of job creation has been gradually improving from 12.9 jobs/spin-off since 2002, likely reflecting the improving macro-economic environment during this period but also the increasing average age of companies in the sample. Data from other countries show large differences and Shane (2004) references six studies that estimate University spin-off job creation in a range of 4.8 jobs in the University of Twente, NL to 83 jobs per spin-off in a countrywide analysis of the US, based on a study by the Association of University Technology Managers that covers spin-offs over a 20-year time period from 1980-1999. These differences may be explained by the variance in time-spans the samples cover, i.e. the longer the time-period, the higher the number of employees on average as the number of employees and company age are positively correlated. In the three studies referenced by Shane that cover comparable 9–10 year time-spans, each spin-off has created 4.8, 10 and 10.6 jobs

[5] In this chapter, 'jobs' signifies the number of persons employed rather than Full-Time Equivalents (FTE)

[6] HEFCE uses the same definition of spin-off as suggested in footnote 2.

respectively. In the case of ETH Zurich's spin-offs the positive correlation between age and job-creation is clearly visible in Graph 6 below where the older vintages (1998 – 2002) have – on average – created 13.6 jobs and the younger vintages (2003 – 2007) 4.5 jobs. Each spin-off has created on average 1.8 new jobs per each year of its life.

Graph 6: ETH Zurich spin-offs, total population, jobs created until Dec 31st, 2007 by year of spin-off incorporation (surviving spin-offs only)

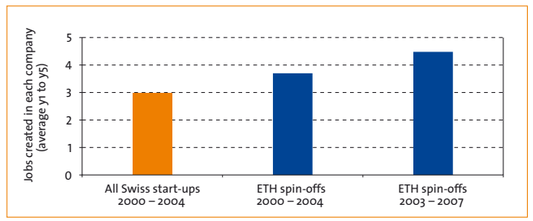


Source: own data obtained in survey and separate research

5.2.2. Job creation compared to all start-up companies in Switzerland

In the previously mentioned set of data of all new company incorporations in Switzerland published by the Swiss Federal Office for Statistics the average surviving start-up company has created 3.7 jobs after 5 years. Since ETH Zurich conducted a job count in 2004, we have two vintages to compare the 5-year job creation: the surviving spin-offs incorporated in 2000 had – on average – created 15.0 jobs by 2004 and the ones incorporated in 2003 had created 4.0 jobs on average by 2007. As shown in Graph 6 above, there are significant differences between the ETH spin-off vintages. Nevertheless, comparing the average job-creation over each of the first 5 years since company incorporation, we can say with 99% confidence that ETH spin-offs of the vintages 2004-2007 (Average 4.5 jobs, standard error of 0.36, n=64) have created more jobs than the average Swiss start-up company (average 3.0 jobs, n=37569) in the vintages 2000 – 2004. Given that this difference may, to a certain degree, be influenced by the prevailing economic cycle, we have also considered the data of ETH's previous study according to which on average 3.7 jobs have been created during the first five years among the 2000 – 2004 vintages. While the average here is still higher than the 3.0 of all Swiss start-up companies the difference is not statistically significant. (T-stat=0.7, standard error of 1.0, n=51).

Graph 7: Swiss start-ups and ETH Zurich spin-offs, average numer of jobs created in each company over the first 5 years of operation



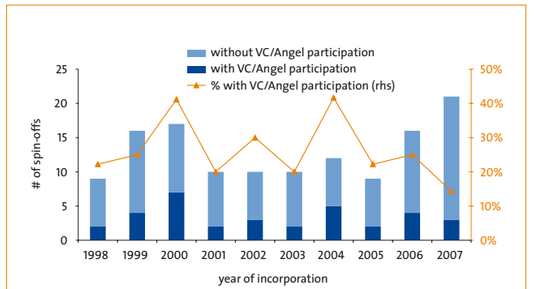
Source: Swiss Federal Office for Statistics, ETH database, own data collection

In our detailed survey of 82 spin-offs (the 'sample of 82 spin-offs'), we have further observed that each job is – on average – 0.81 Full-Time Equivalent (FTE) and that 42% of all spin-off employees are ETH graduates.

5.3. VC/Angel backing and exits

Among the total population of 130 ETH Zurich spin-offs, we have found evidence of Venture Capitalist or Business Angel backing in 34 companies (26.1%) with a total of 80 investment rounds. From a 'vintage' perspective, as shown in Graph 8 below, the years 2000 and 2004 have the highest number and proportion (40%) of VC backed companies while 2007 is – so far – the year with the lowest proportion (14%) but we will see later that VC's tend to invest, on average, only after two years from incorporation meaning that the VC-backing in the years after 2005 may still improve.

Graph 8: ETH Zurich spin-offs, VC/Angel backed companies by year of incorporation



Source: own data obtained from survey and separate research

Looking at the sectors in Graph 9 in Appendix 1, Biotech (10 VC/Angel backed spin-offs), IT (7) and Material Sciences (4) appear to be the most popular sectors in absolute while in relative terms, Biotech, Chemicals, Material Sciences and Medtech seem to stand the highest chances of obtaining VC/Angel backing.

In only 9 (7%) of the 130 spin-offs have the founders sold a major part of their stake and 6 of these were venture backed. The VC's exit rate is therefore 17.7% with one (2.9%) IPO and five (14.7%) trade-sales. Compared to the 5-year exit-rate of 33% observed by Metrick (2007) in his study of almost 12'000 VC investments mentioned above, these values seem low. The average time from incorporation to exit for the founders was 5.54 years.

Among our detailed survey sample of 82 spin-offs, 24 were VC/Angel-backed[7]. For these 82 companies, we obtained detailed data on 50 different financing rounds. According to this data shown in Table 4 below, Venture Capitalists and angels have provided equity totaling almost CHF 153.9 million. The founders, their family and friends as well as other investors have contributed an additional CHF 9.1 million equity to venture-backed spin-offs and CHF 6.4 million to the non-VC/Angel backed. VC's/Angels have contributed almost 91% of the total equity funding requirements for all 82 spin-offs in our sample.

Table 4: ETH Zurich spin-offs, sample of 82, equity raised

Total Equity raised (CHF)	Founders and others	VC/Angels	Total
Non-VC/Angel-backed	6'419'242		6'419'242
VC/Angel-backed	9'132'882	153'854'776	162'987'658
Total	**15'552'124**	**153'854l776**	**169'406'900**
%	9.2%	90.8%	

Equity raised per spin-off (CHF)	Founders and others	VC/Angels	Total
Non-VC/Angel-backed (58)	110'677		**110'677**
VC/Angel-backed (24)	380'537	6'410'616	**6'791'152**

Source: data obtained in survey

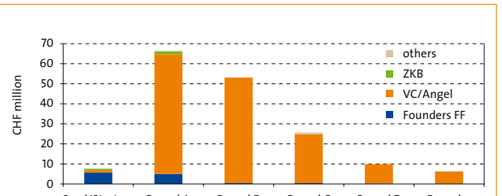
Nevertheless, there is a noteworthy time delay before VC's or angels start backing spin-offs and we have observed among 20 venture backed companies which have not managed to raise VC or angels money at Seed stage that it took them – on average – 723 days (almost 2 years) from their last financing round (by founders or others) to obtain their first Venture/Angel investment – evidence of the funding gap discussed earlier. This gap becomes even clearer when looking at the different rounds we observed in our sample of 82 spin-offs in Graph 9 below. In a total of 96 Seed and Start-up rounds, the spin-offs raised CHF 7.7 million of which CHF 5.6 million (74%) from founders, friends and family and only CHF 1.2 million (16%) from angels and VC's. Others – mainly Zürcher Kantonalbank (ZKB) – help to close some of that gap[8]. Interesting is also the surprisingly high level of founders/friends/families' participation in A-Rounds with total investments of CHF 5.0 million. 65% of these A-round investments by founders are made without VC/Angel-backing and have an average size of CHF 187'075. However, those founders (and family & friends) who have managed to raise a VC A-Round seem to take the opportunity to invest along with actually higher average investments (CHF 275'025). In general, it is striking how 'wealthy' and keen to invest the founders' personal networks in Switzerland are. According to Shane

[7] To be specific, of those 24 spin-offs, 13 had Venture Capital-backing, 8 had angel-backing and 3 both.

[8] ZKB invests in both, equity and convertible debt. Included here are only straight equity investments.

(2004), the average US entrepreneur raises only approx. $50'000 of equity from own savings, family and friends and UK numbers appear to be in a similar magnitude (Mason and Harrison, 2002b). Important for this study is however, the indication that the founders' personal networks seem to bridge some of the funding gap that is left open particularly by Business Angels.

Graph 10: ETH Zurich spin-offs, sample of 82, equity raised by round and source



Source: own data obtained in survey

5.3.1. VC/Angel backing compared to other Universities

Holi et al. (2007) have conducted a very detailed survey of the technology transfer and spin-off activities of 20 UK Universities with data covering a six-year period from 2001 to 2006.

As shown in Table 5 below, on average close to 60% of the 233 spin-offs created over these 6 years have obtained VC/Angel backing and this level of backing is even higher among the leading UK Universities such as Oxford, Cambridge, Imperial College and UCL. Compared to the average of the 20 UK Universities as well as of the 5 leading ones shown in the Table 5 below, the level of venture backing in ETH Zurich's spin-off is significantly lower (by 14.6 standard errors compared to the 5 leading Universities).

Table 5: ETH Zurich spin-offs, VC/Angel backing and Exits – comparison with UK Universities

Institution	Total Spin offs	with VC/Angel backing		Trade sale		IPO	
	#	#	%	#	%	#	%
ETH Zurich, 1998 – 2007	**130**	**34**	**26.2%**	**8**	**6.2%**	**1**	**0.8%**
ETH Zurich, 2001 – 2006	**67**	**18**	**26.9%**	**1**	**1.5%**	**0**	**0.0%**
20 UK Universities, 2001 – 2006	233	137	58.8%	8	3.4%	5	2.1%
University of Cambridge	30	20	66.7%	1	3.3%	0	0.0%
University of Oxford	24	18	75.0%	0	0.0%	1	4.2%
Imperial College	29	19	65.5%	1	3.4%	1	3.4%
University College London	9	6	66.7%	2	22.2%	0	0.0%
University of Edinburgh	26	15	57.7%	0	0.0%	0	0.0%

Source: own survey and data from Hori et al., 2007

As for exits, the picture is similar: in a comparable time-period (2001 – 2006) ETH Zurich's total population of spin-offs experienced significantly less exits by trade-sale and IPO than the UK University spin-offs did, as most of ETH Zurich's exits have concerned the spin-off vintages 1998 – 2000 (see Graph 10 in Appendix 1).

In order to eliminate a potential bias arising from having a significantly larger proportion of non-VC backed spin-offs, we re-set Table 5 above to show the proportion of exits specifically from VC-backed spin-offs (see Table 6 below) and note that – particularly for the 2001 – 2006 period covered by the UK study, ETH Zurich's VC-backed spin-offs have not yet experienced any exit while the UK samples of similar size have all experienced at least one exit. There seems an apparent problem with finding routes to exit for the ETH Zurich spin-offs: at least for IPO's, this may be explained by the specifics of the Swiss capital market, i.e. the lack of a separate exchange with a streamlined admission process for small growth stocks but with sufficient liquidity and international clientele (such as AIM in the UK).

Table 6: ETH Zurich spin-offs, VC/Angel backing and Exits from VC backed spin-offs only – comparison with UK Universities

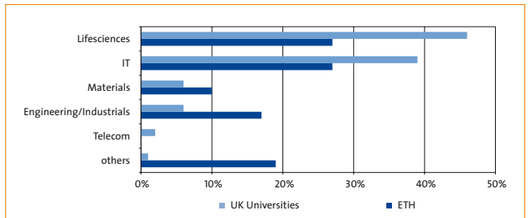
Institution	Total Spin offs	with VC/Angel backing		Trade sale (VC backed only)		IPO (VC backed only)	
	#	#	%	#	%	#	%
ETH Zurich, 1998 – 2007	**130**	**34**	**26.2%**	**5**	**14.7%**	**1**	**2.9%**
ETH Zurich, 2001 – 2006	**67**	**18**	**26.9%**	**0**	**0.0%**	**0**	**0.0%**
20 UK Universities, 2001 – 2006	233	137	58.8%	8	5.8%	5	3.6%
University of Cambridge	30	20	66.7%	1	5.0%	0	0.0%
University of Oxford	24	18	75.0%	0	0.0%	1	5.6%
Imperial College	29	19	65.5%	1	5.3%	1	5.3%
University College London	9	6	66.7%	2	33.3%	0	0.0%
University of Edinburgh	26	15	57.7%	0	0.0%	0	0.0%

Source: own survey and data from Hori et al., 2007

From an ETH point of view, the important question that this low proportion of VC/Angel backing raises is whether the spin-offs lack access to sufficient VC/Angel equity funding or whether a large proportion of them do not posses the characteristics that would make them interesting for VC/Angel investment. From the data above it is obvious, that ETH Zurich creates a higher number of spin-offs per annum than even the large UK Universities such as Cambridge and Oxford – as a matter of fact, more than double.

A comparison of the spin-offs' distribution by sector[9] in Graph 12 below, with data from another Library House Survey commissioned in 2005 by the British Venture Capital Association (BVCA study, 2005) shows that the UK Universities' spin-off activity is focused predominantly on Life Sciences (46%) and IT (39%), while ETH Zurich's spin-offs are far more diverse. Life Sciences, IT, Communications and – more recently – Cleantech are the four major areas of VC investment over the last years (EVCA, 2007). However, only half of ETH Zurich's spin-offs are part of these categories. Furthermore, almost 20% are in the category 'others' that barely attracts VC investments and in which – as we have determined earlier – a certain proportion of spin-offs are 'life-style' businesses that are not seeking Venture Capital backing by definition. This leaves Materials and Engineering Sciences which make up for almost 30% of ETH Zurich's spin-offs but are not main-stream areas of VC investment. Interestingly, as shown in Graph 8 in Appendix 1, ETH Zurich scores an above average (40%) VC/Angel backing in its Material Sciences spin-offs meaning that the area of real shortage of VC/Angel investments may be the Engineering/Industrials, i.e. Electrical Engineering & Electronics, Mechanical Engineering & Avionics and Sensors & Analytics.

Graph 12: comparision of spin-off's sectorial distribution, UK Universities vs. ETH Zurich



Source: BVCA, 2005 and data from ETH's spin-off database

These factors, however, cannot explain the whole difference. ETH still has a comparatively lower level of VC backing in the core sectors of VC investment, i.e. Biotech (40% of spin-offs are VC/backed) and IT (20%). One other area that may provide an explanation is the spin-off process itself. In the scope of this study, we cannot perform a detailed analysis of this process comparing ETH with the leading UK Universities, but we can briefly highlight some of the key differences that we observed in the spin-off support process under a separate header below.

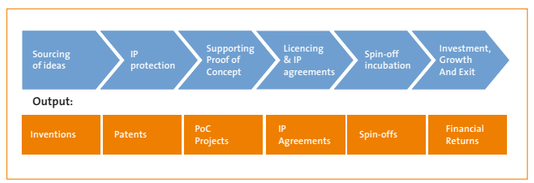
Before that, we briefly look at the average size of VC/Angel investments attracted by ETH Zurich's spin-offs to that attracted by the UK Universities. Here, ETH Zurich is fairing actually very well. Its average of CHF 6.4 million per VC/Angel backed spin-off is almost 20% above the £2.3 million (CHF 5.3 million) average for the 20 UK Universities and only two of them have attracted more institutional equity funding per spin-off than ETH Zurich: Cambridge, with an average of £5.5 million (CHF 13.0 million) and UCL, with an average of £4.3 million (CHF 10.1 million).

[9] To fit with the categories in the BVCA study, we have grouped ETH Zurich's sectors Biotech, Medtech and Chemicals to 'Life Sciences', Electrical Eng., Mechanical Eng. and Sensors to 'Engineering/Industrials' and Micro/Nanotechnology with Material Sciences to 'Materials'.

5.3.1.1. Key differences in the spin-off process – UK Universities vs. ETH Zurich

The leading UK Universities have entrusted their technology commercialisation activities to separate legal entities – e.g. Oxford University to ISIS Innovation Ltd., Imperial College to Imperial Innovations Group plc. and Cambridge University to Cambridge Enterprise Ltd. – which are either owned by the University or – as in the case of Imperial Innovations – are public (listed on AIM), with the University holding a minority interest. These dedicated organisations manage all aspects of technology transfer following the 6-stage process and generating the outputs as outlined in the following illustration:

Illustration 2: the generic technology trantfer process



Source: adapted from Imperial Innovations, 2007

Part of these organisations' mandate is their management of University Challenge Funds through which the Universities invest in spin-offs at Proof-of-Concept stage and/or at Seed stage while their dedicated technology transfer organisations act as investment managers. Imperial Innovations further manages two funds for third party investors (The Carbon Trust Incubator Fund and money made available under the Waste Resources Management Program of the UK Government). The University Challenge Funds each have a capital of £ 4–6 million / CHF 9–14 million and were allocated to the Universities starting in 1999 by the UK Department of Trade and Industry as part of an initiative to encourage spin-off creation. Challenge fund investments can reach £ 60'000 / CHF 140'000 per spinn-off at Proof-of-Concept stage and £ 250'000 / CHF 600'000 at Seed-stage and each of these funds currently holds between 50 and 80 equity investments in spin-offs (Cambridge Enterprise, Isis Innovations, Imperial Innovations, 2007). This system of University Challenge Fund is widely applied across UK Universities and explains why – on average – 80% of new spin-offs every year have equity participation (of various levels) by their University (HE-BCI, 2002–2007).

A striking feature of these University technology commercialisation organisations is their incubation support activities and – in particular – the active search and recruitment of experienced managers and non-executive directors to lead the spin-offs in which they hold a stake. Imperial Innovations, for example, continuously develops a pool of individuals that will potentially take leadership roles in their future spin-offs. They do this through an 'entrepreneur in residence' program as well as through supply relationships with recruitment firms (Imperial Innovations, 2007). Many of Imperial College's new spin-offs are lead by experienced managers (CEO's, Sales and BD) while graduates normally take technical roles. Cambridge and Oxford have similar, programs and maintain close relations to 'serial entrepreneurs' with whom they have successfully worked in previous spin-offs.

A final important task is the development of VC/Angel relations: both Oxford and Cambridge actively manage membership-based networks of potential investors (Isis Angels Network, Cambridge Enterprise Venture Partners) to which they regularly pitch new investment opportunities. They frequently hold events introducing research trends and new technologies bringing researchers, managers and investors together (Isis Spinners, Venturefest, Cambridge University Technology Venture Conference). Imperial Innovations (II) – after it has raised £25 million in its IPO in 2005 – is essentially acting as Venture Capital investor itself. It invests into Imperial spin-offs that have gone through its incubation program as well as in other companies. However, in its investments, it systematically seeks syndication by other VC investors and – in 2007 – managed to attract 2£ of third party investments for every 1£ of its own money (Imperial, 2007). II therefore relies on close relations to the VC/Angel community as much as Oxford and Cambridge do.

In ETH Zurich, the spin-off support process historically focused on developing IP licensing agreements with the spin-offs and facilitating relations with providers of infrastructure (Technopark, ETH IT department, etc.), research funding (through CTI) and – to a limited extent – equity capital. ETH Zurich has not invested into its spin-offs but has granted small loans (CHF 50'000 to 100'000) which – in two instances – it converted to equity as part of a capital restructuring.

More recently, ETH Zurich has increased its focus on spin-off support and now also provides consultancy (business plans, access to business networks/investors) and has started to take small equity stakes at start-up stage. ETH does, however, rarely invest cash but rather designs its technology licensing terms in a way that the equity stake partly compensates for the license fees payable. There is no actual University Challenge Fund at ETH[10] but – together with other Swiss Universities – ETH teams can take part in a bi-annual business plan competition organised by McKinsey with ETH Zurich and sponsored by 19 large Swiss corporations. The price-money of total CHF 150'000 (the winner receives CHF 60'000) is awarded to the teams personally, independent of them later creating a business or not. Separately – CTI – the Swiss Innovation Promotion Agency in the Federal Department of Economy provides research/Proof-of-Concept grants, business coaching, entrepreneurial training (through Venturelab) and supports a private initiative of a membership-based network of Business Angels, VC firms and other investors which organises pitching and networking events on a fairly regular basis. CTI's services are open to any start-up in Switzerland.

In 2000, McKinsey and ETH Zurich initiated the creation of Venture Incubator (VI Partners), a Venture Capital firm to support university spin-off's as well as other promising start-up companies with capital, coaching, consulting and networks and specifically with the objective to close an early stage funding gap they observed. Its VI Partners Fund raised CHF 101 million from 10 blue-chip companies based in Switzerland with the aim to invest into university spin-offs and non-university start-ups. Over the last few years, as many other VC firms in Europe, VI Partners however appear to be shifting their investment focus to later (expansion) stage.[11] Another, noteworthy source of start-up stage financing in this context is Zürcher Kantonalbank (ZKB) who offer mostly mezzanine/convertible loans of CHF 100'000 to max. 500'000 size that convert at a pre-determined valuation at ZKB's option. This facility is part of a start-up business support program under which ZKB invest every year a total of CHF 10 to 13 million.

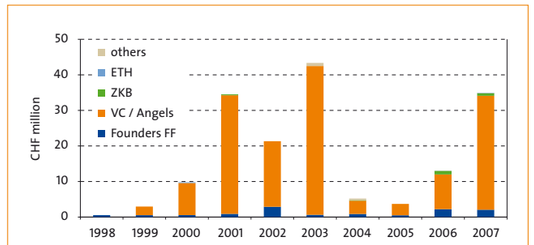
[10] The establishment of such a fund has been proposed by ETH transfer in 2006.

[11] According to VentureXpert, 4 of the 5 last investments by VI Partners were in expansion rounds (Endoart,/Apr.08, Silentsoft/Feb.08, Nemerix/Sep.07, Ganymed Pharmaceuticals/Apr.07)

5.3.2. VC/Angel backing compared to all start-up companies in Switzerland

Dr. Maurice Pedergnana, the Secretary General of the Swiss Private Equity Association (SECA) estimates that local and international Venture Capital firms and Business Angels invest into Swiss start-ups on average between CHF 50–60 million in Seed and Start-up rounds and CHF 70–80 million in expansion rounds per annum. SECA's annual reports (SECA annual reports) show that an average of 120 firms per annum have received seed/start-up/expansion funding over the last 5 years and – although not all SECA members may have reported their transactions, the number of start-up companies that receive VC/Angel backing per year is certainly lower than 200 indicating that the average investment per start-up may be just under CHF 1 million. ETH Zurich's 3-4 spin-offs per year that obtain VC/Angel backing therefore manage to raise more than 6 times as much VC financing as the average VC/Angel-backed Swiss company does. In fact, the total of ETH spin-offs may attract around 20–25% of all VC/Angel investments in Switzerland – if we linearly extrapolate[12] the data received in our survey as shown in Graph 13.

Graph 13: ETH Zurich spin-offs, sample of 82, equity raised by year and provider



Source: data from own survey

[12] Obviously, years 1998 and 1999 are not representative of the average equity raised by ETH Zurich spin-offs as the data sample starts with 1998 and – as mentioned before – spin-offs on average take 2 years to raise a first VC/Angel round. The average VC/Angel investment per year from 2000 to 2007 is CHF 18.9 million. In our sample we have 71% of VC-backed companies represented which could mean that all VC/Angel backed ETH Zurich spin-offs may have received equity investments of CHF 26–27 million per annum.

Furthermore, the sharp increase in VC/Angel funding raised by ETH Zurich spin-offs from a low in 2005 also seems to counter the trend of diminishing seed/early-stage investments in Switzerland (SECA, 2007) and in Europe as a whole (EVCA, 2007). Comparing performance in terms of exits by IPO and Trade Sale will likely not be very conclusive as the events are too few on both sides. Switzerland experiences every year between 8 and 12 IPO's and around 200 M&A transaction (SECA, 2007).

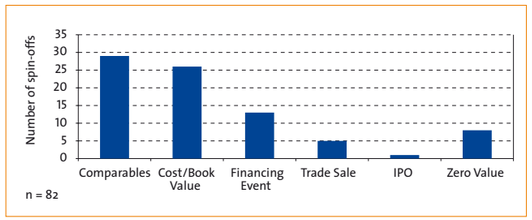
5.4. Return on equity

5.4.1. Methodology

We assessed the financial performance of the spin-offs in our sample of 82 by identifying the ex-post return to equity invested. Each company's equity was evaluated individually and we treated – in a slight simplification – all stock as common ordinary stock. In our questionnaire we had requested information about all financing events, trade sales and equity offerings as well as the key P&L performance indicators and balance sheet values for the financial year 2007. Our calculation of the IRR is based on the equity investments made in each company since its incorporation and the present value of the equity at date of exit or – if no exit occurred – on Dec 31st 2007 based on comparables, financing event, or cost of investment. More specifically, the equity value for the 82 spin-offs was determined as follows:

- Exits: one spin-off has experienced an IPO on SWX and the stock price at the end of the first day of trading serves as basis for our valuation. 5 further spin-offs have gone through a trade sale in which at least a substantial part of the equity was purchased by a third party. In this case, our valuation is based on the purchase price paid for the equity stake at the date of sale.
- Financing Events: the valuation of 13 companies is based on a recent financing event – usually a significant equity investment by a Venture Capital firm. According to BVCA guidelines, we use the implied post-money valuation of the latest financing round as long as that financing round has not taken place more than 18 months prior to Dec 31st 2007.
- Comparables: for 29 companies which have stable operations and steadily growing turnover and profits, but have neither gone through a trade sale, recent financing event nor an IPO, we use multiples to estimate the firm's value. The comparables utilised were: P/E, EV/EBITDA, EV/EBIT and EV/Revenues. We used average industry multiples for companies listed in Switzerland as obtained from the Capital IQ database and applied them to the current performance indicators (FY2007). This rather conservative approach (instead of forward multiples and projected earnings) reduces the risk of exaggerated valuations, but we also believe this approach is more in line with industry's fair-value guidelines. Moreover, as the spin-offs valued are all private companies, we applied a 30% liquidity discount to the value of their equity. For reference, the BVCA recommend a minimum liquidity discount of 25%. An overview of the multiples used is in Table 7 in Appendix 2.
- Cost: 26 companies for which none of the information above is available or appropriate, we use the cost of the initial investment and subsequent investments (all paid-in equity) as benchmark.
- Zero Value: the 8 spin-offs that either have gone bankrupt or have ceased commercial operations are assigned a zero value giving a negative return to equity-holders.

Graph 14: ETH Zurich spin-offs, sample of 82, method used for equity valuation



Source: data from survey

The 'Pooled IRR' for the portfolio of 82 spin-offs is calculated by combining/pooling all investments and the valuation, i.e. investments are added as negative cash flows to the year in which they were made, while exits are added as positive cash flow to the year they occurred, and the equity value of the other spin-offs is added to 2007. In Appendix 2, we have attached an example of the valuation of an individual spin-off, a fast growing profit generating biotech company. As it has made considerable progress since its latest VC round, we utilise industry-specific multiples to value it.

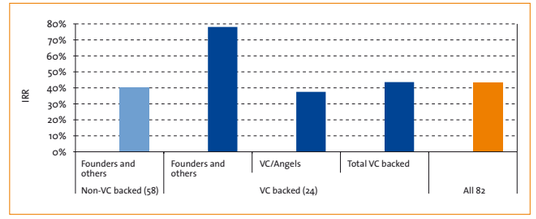
5.4.2. Equity Value Created

Over the period of 10 years from 1998 to year-end 2007, the 82 ETH Zurich spin-offs attracted CHF 169 million of equity investments by the founders of the companies, VC firms or angel investors. The absolute and accumulated return on these investments, calculated with the methods described above amounted to CHF 650 million at year-end 2007 representing a money-multiple of 3.84 over an average investment period of approx. 3.7 years. This absolute return is driven by few large 'caps' i.e. the spin-off with the largest valuation makes up for 36% of the total, the top 3 for 73% and the top 10 for 91%.
In terms of sectors, the highest absolute return was generated in Biotech and Pharmaceutical, followed by Electrical Engineering & Electronics and Medtech & Diagnostics (see Graph 15 in Appendix 1).
As noted earlier, 91% of equity investments in absolute numbers were made by VCs and Business Angels. With CHF 484 million, a much smaller part (75%) of the absolute returns accrued to VCs while founders and other investors claimed CHF 166 million (25%). 62% of these returns have effectively been realised through an exit. The average ownership stake of VC's at the time of valuation (exit or year end 2007) was 51% of equity on a fully diluted basis (including preferred stock and convertible debt) – there is however considerable variance among the companies as the standard deviation of ownership stake of VC firms is 27%. Our data reveals, as might be expected, that the ownership stake of Venture Capitalists increases as the companies go through more financing rounds. The average stake of VC's at exit, trade sale or IPO, was 61.3%.

5.4.3. Returns on equity

Using the methodology described above, our calculations result in a 43.33% pooled internal rate of return (IRR) for the sample of 82 ETH spin-offs. We calculated separately the returns for founders and for VC's/Angels. As per Graph 16 below, non-VC-backed founders experienced an IRR of 40.5% while the VC-backed founders, with 78.1%, almost double. VCs, who made most of the absolute returns, experience an IRR of 37.5% – the lowest relative returns. These returns are somewhat dependant on one large and highly successful transaction. Without it, the total IRR would be 25.1% and the VC's IRR 20.0% only.

Graph 16: ETH Zurich spin-offs, Return on Equity by investor category – Pooled IRR

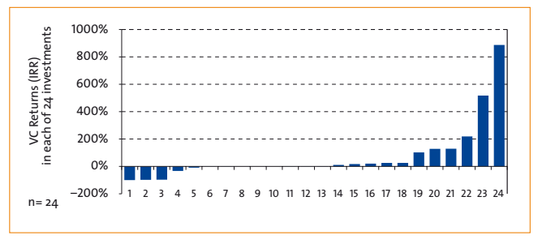


Source: data from own survey

5.4.3.1. The quality of returns in individual spin-offs

When examining the distribution of the IRRs for each investment in the sample of ETH Zurich spin-offs as shown in Graph 17 below, we notice that among the 24 companies in which they have invested, VCs/Angels experience 100% and higher IRR in 6 instances, between 10% and 100% IRR in 5 instances and negative returns in 5 instances. In a further 8 instances VC/Angel returns are zero because we valued the investment at the level of the most recent VC-round, meaning that returns can still go either way in the future. The 'fat-tail' to the right hand side obviously is the reason for the high positive pooled IRR. The maximum IRR observed in VC investments is 887%.

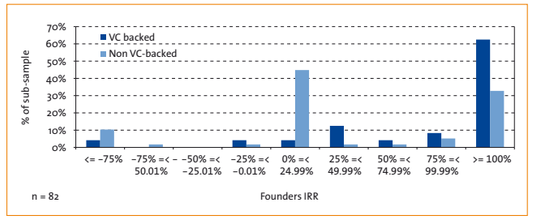
Graph 17: ETH Zurich spin-offs, VC's returns in each of 24 investments



Source: own calculations with data from survey

More surprisingly, the founders of VC/Angel backed companies experience in 8% of instances a negative IRR on their investment and none of them was actually a total loss! In 30% of their investments the IRR is between zero and 100%, and in 62% above 100% with a maximum observed IRR of 4887%. This seems to provide quite clear evidence that the founders' downside risk in spin-offs with VC-backing is very small while the upside potential for extraordinary returns is virtually unlimited. In contrast, non-VC backed founders experience relatively more events of zero or negative IRR as Graph 18 below makes clear.

Graph 18: ETH Zurich spin-offs, distribution of Founders' returns in VC-backed and non-VC backed spin-offs



Source: own calculations with data from survey

The obvious explanation is 'selection bias' i.e. the notion that VCs/Angels will back only firms that promise the potential of creating extraordinary returns but there will also be an element of 'self-fulfilling prophecy' in the sense that VC-backed firms do get more financial and better management/boardroom support than non-VC-backed firms and – therefore – they stand a better chance to thrive.

5.4.4. Returns compared with VC funds in the US and in Europe

The method described above – the pooled IRR – is the most common method in the venture industry to compare returns on invested capital of Venture Capital funds. Even though the portfolio of ETH spin-offs does not represent investments of one VC fund, average fund performance calculated by the same method present a convenient and interesting comparison to benchmark the overall performance of these spin-offs against the performance of the venture industry, particularly the performance of spin-offs which were backed by various VC funds. It is also common to benchmark fund performance by the so-called DPI ratio, i.e. realised multiple (distributions of cash or stock to investors/Paid-in-Capital), the so-called RVPI, i.e. unrealised multiple (residual value/Paid-in-Capital), and TVPI, i.e. total value multiple (DPI+RVPI/Paid-in-Capital).[13] Table 8 below compares pooled IRR and DPI of ETH spin-offs with the averages for the Venture Capital industry, based on data collected by EVCA[14] and by ourselves from VentureXpert as follows):

- Pooled IRR and average DPI of 695 European venture funds established 1980 – 2006. However, the pooled cash flows used for the IRR calculations are from 1980 until June 2007.
- Pooled IRR and average DPI of 1204 US venture funds established 1969 – 2006. However, the pooled cash flows used for the IRR calculations are from 1969 until June 2007.

As the data from VentureXpert is net of carried interest (the VC's share of profits), we adapt the returns on investment experienced by the VC's by calculating theoretical returns to limited partners (LP's) on the hypothetical 'fund' of spin-offs. This calculation assumes an average 20% carried interest on every deal and results therefore in a lower IRR and DPI. VentureXpert data is also net of GP fees. However, VentureXpert deducts the fees from the investment cash flows and therefore actually slightly overstates the fund returns to LP (because of the lower base). We therefore do not adjust for fees.

Table 8: European and US Venture Capital Fund performance (1969/80 to 2007) vs. returns observed in ETH Zurich's spin-offs

	Pooled IRR	Average DPI	Standard deviation	Numbers of funds
European Venture Funds	5.0%	0.61	28%	695
Europe Top 10%	16.5%	1.55	NA	70
US Venture Funds	15.8%	1.16	46%	1204
US Top 10%	37.9%	3.45	NA	120
ETH Zurich spin-offs (gross VC returns)	**37.5%**	**2.21**	**NA**	**1**
ETH Zurich spin-offs (theoretical LP returns)	**30.0%**	**1.77**	**NA**	**1**

Source: EVCA institute and VentureXpert

[13] David Bernard, EVCA Institute, Benchmarking Private Equity Performance, November 2007.
[14] David Bernard, EVCA Institute, Benchmarking Private Equity Performance, November 2007.

This comparison appears to indicate that the sample of ETH Zurich spin-offs generates an above average return. However, certain caveats need to be considered: the data above is collected over a long period of time, including several business cycles with quite different circumstances in financial markets. The high standard deviation, especially for the US data, also indicates a wide variance between individual fund performance and average fund performance over different time periods. We have therefore grouped funds into 10 cohorts based on their performance and it becomes evident that the performance of the ETH Zurich sample of spin-offs is slightly lower than the top 10 percentile of all VC funds in the US but clearly superior to returns experienced on by the top 10 percentile of funds in Europe during the last three decades.

We then narrowed this comparison to the time period in which the spin-offs were incorporated (1998 to 2007) in order to eliminate a possible bias arising from different economic conditions prevailing in earlier periods. As shown in Table 9 below, we looked at pooled IRR for the period of 1998-2007 of all US, European, UK and Swiss VC funds founded between 1998 until 2006.

Table 9: International Venture Capital Fund performance for funds created 1998 to 2006 vs. returns observed in ETH Zurich's spin-offs

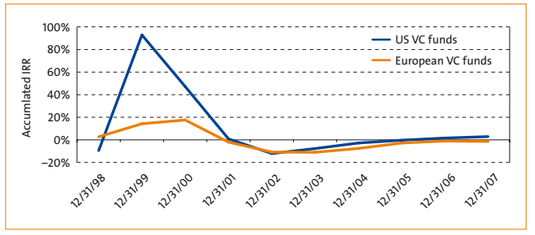
	Pooled IRR	Average DPI	Numbers of funds
European Venture Funds	–1.4%	0.26	439
Europe Top 10%	10.1%	0.49	43
US Venture Funds	2.9%	0.5	467
US Top 10%	19.2%	1.06	46
Switzerland VC funds	–1.2%	0.14	16
Switzerland Top 10%	–0.6%	0.29	2
UK VC funds	–3.6%	0.31	63
UK Top 10%	6.2%	0.31	6
ETH Zurich spin-offs (gross VC returns)	**37.5%**	**2.21**	**1**
ETH Zurich spin-offs (theoretical LP returns)	**30.0%**	**1.77**	**1**

Source: VentureXpert

The cyclicality of the Venture Capital business does indeed show in this comparison but actually to the favour of ETH Zurich's spin-offs. The pooled IRR and realised multiple for the sample of ETH Zurich spin-offs is extraordinarily high in comparison to the average and the top 10 percentile of funds in the VC industry created over the same period. However, two important aspects should be kept in mind. This data covers the period of the dot.com boom and subsequent bust. Also, it includes funds established in recent years, which predictably have mainly had capital outflows and only few exits yet[15]. How dramatic the impact of the dot.com bubble burst was on cumulative returns to US and European venture funds, is shown in Graph 19 below. We used pooled cashflows from the same set of data as used in Table 9 above.

Not only did valuations change dramatically when the bubble ended but investments in Venture Capital had been at all time high during the boom. One of the reasons why the performance observed in the sample of ETH Zurich spin-offs is so strong compared to venture funds in Europe and the US, is probably the fact that only 2 spin-offs or 11% of the total equity investments in that period represent 'dot.com' type of companies that lost significant value when the bubble burst.

Graph 19: returns of US and European VC funds 1998 – 2007



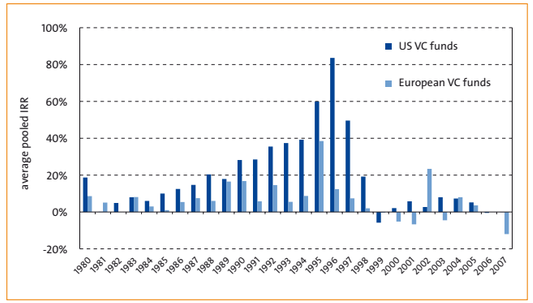
Source: data from VentureXpert

The next analysis in Graph 20 below shows the average pooled IRR for US and European funds calculated separately for each vintage year of funds. If we compare the sample of ETH Zurich spin-offs to these funds by vintage year, we see that the pooled IRR for funds established in the early and mid 90's in the US is comparable to the performance of those ETH Zurich spin-offs that were backed by Venture Capitalists. However, the spin-offs do much better than the funds established in the late 90's, presumably – again – because of the

[15] Although they are valued along the same fair value guidelines applied by us.

dot.com bubble and its devastating impact on returns to Venture Capital investments, particularly in the US. This entire analysis shows how cyclical the Venture Capital industry is and also helps to understand, why many Venture Funds have, over the last few years, scaled down their early stage investment activity and started to focus on expansion stage or buy-out transactions, 3i being a prominent recent example when it announced in March 2008[16] that it was withdrawing from seed- and early-stage investments altogether.

Graph 20: returns of US and European VC funds, by year of fund creation – 1980–2006



Source: data from VentureXpert

As a conclusion of this analysis of VC returns, we can say that a fund created in 1998 and which had systematically invested in ETH Zurich's spin-offs would have outperformed the average US and European Venture Capital funds by a margin. One of the main reasons for this significant out-performance is likely the comparatively higher diversification among the ETH Zurich spin-offs in terms of technologies (as shown in Graph 14 in Appendix 1) and – in particular – the relatively small exposure to the 'dot.com' bubble.

[16] Financial Times, March 26th, 2008

5.4.5. Returns compared to Swiss stock market returns

The SMI is Switzerland's key equity index. It represents about 85% of the free-float capitalisation of the Swiss equity market. Because the SMI is considered to be a mirror of the overall Swiss stock market, it is used as the underlying index for numerous derivative financial instruments. Consequently, we use the SMI index (Total Return) to compare the performance of the sample of ETH Zurich spin-offs to returns to capital invested in listed stocks over the same time period.

In the IRR model described above, we pooled all investments made in each year, and returns were measured as value of stock at exit, recent financing event or at year-end 2007. For our comparison with the stock market performance, we use this model to estimate the returns, as if the same amounts had been invested at the same time in the SMI index instead of in ETH Zurich spin-offs. We use the SMI year-end closing prices and returns are measured for each company in the year of exit (if occurred) or at year-end 2007. This calculation results in an internal rate of return of 10.31% by year-end 2007. The observed IRRs in ETH Zurich – spin-offs outperform the SMI Total Return Index by 27.23% (gross) or 19.68% (if calculated against LP theoretical returns).

To verify these large abnormal returns, we modelled the realised expected returns for VCs in the Swiss market over the period 1998-2007 with a CAPM. We used the annual returns of the SMI (Total Returns) and the 10-year Swiss treasury bill rates as risk-free rate. As we do not have sufficient data to regress for betas ourself, we test the model with two VC-fund betas observed in academic literature, the 1.7 as estimated by Cochrane (2005) and the 3.2 outlined by Driessen et al. (2008) who explain their higher beta with the fact that their time-series includes the years 2000–2003 which apparently amplified the covariance with market. As per Table 11 below our calculated average expected return E(R) for beta 1.7 is 8.49% and for beta 3.2 is 13.42% giving further credibility to our hypothesis above that the ETH Zurich spin-off portfolio contains alpha in the magnitude of 20–25%.

Table 10: CAPM for expected VC-returns in the Swiss market

Year		SMI – TR		E (R) with beta=	
	r_f	7774.10	r_m (lin)	1.7	3.2
1998	0.0270	8808.80	0.1331	0.2074	0.3665
1999	0.0304	9439.00	0.0715	0.1003	0.1621
2000	0.0392	10315.77	0.0929	0.1305	0.2110
2001	0.0338	8228.60	–0.2023	–0.3676	–0.7218
2002	0.0320	6043.47	–0.2656	–0.4738	–0.9202
2003	0.0265	7306.29	0.2090	0.3367	0.6104
2004	0.0274	7707.93	0.0550	0.0743	0.1156
2005	0.0210	10481.00	0.3598	0.5969	1.1051
2006	0.0251	12371.88	0.1804	0.2891	0.5221
2007	0.0293	12199.29	–0.0140	–0.0442	–0.1091
Average Return	**2.92%**		**6.20%**	**8.49%**	**13.42%**
Standard Deviation	0.0051		0.1866	0.3194	0.6041

Source: data from SWX and Swiss National Bank

5.4.6. Returns compared to other University spin-offs

Very limited data seems to exist publicly on returns to capital invested in university spin-offs. Consequently, we are not able to offer a general comparison of the performance of ETH spin-offs with similar university initiatives. However, we believe that a comparison with Imperial Innovations (II), the Technology Transfer organisation of Imperial College, is both relevant and interesting. II was established in 1986 with the aim to protect and exploit commercial opportunities arising from the research base of Imperial College, primarily in the fields of science, engineering and medicine. In 2006, II was publicly listed on AIM, but still has an exclusivity agreement (until 2020) with Imperial College to commercialise intellectual property that is developed within Imperial College's research departments. At the time of IPO, II had equity holdings in a portfolio of 58 spin-off companies, 21 of which are early stage and 37 at a more advanced stage. Approximately 60% of its spin-off companies are focused on the engineering and technology sectors.[17]

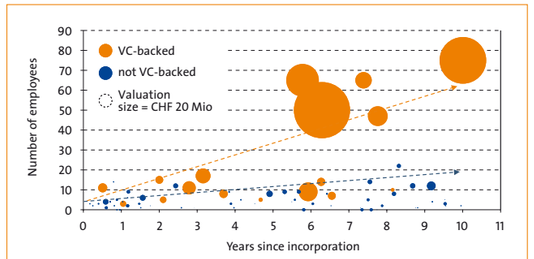
According to the prospectus published in 2006, the fair value (accounted for on the basis of BVCA guidelines) of II's portfolio was approximately £19 million and £31.5 million in July 31st 2005 and 2006, respectively. On July 31st, 2007, the fair value of the portfolio was £53.7 million[18] and by 31st, January 2008, it was £51.7 million. The publicly disclosed cash flow statements in the prospectus, and AR 2006 and 2007 also reported the investments made in its spin-off companies and proceeds from the sale of investments. By using the 2005 valuation of the portfolio, subsequent cash flows (before deduction of management fees and carry) and the valuation by January 31st, 2008 we calculated an IRR of 29.4% during this period. This is of course only a view over a 3.5-year time-window that does not account for the value creation prior to July 31, 2005 but it provides a rough benchmark. However, what we find particularly interesting is that II seems to experience similar above average returns to ETH Zurich's spin-offs with a similar portfolio of technologies, i.e. mainly bioscience and engineering technologies. It should also be noted that according to the 2006 and 2007 financials, 40% and 34% respectively of the fair value of investments was related to Imperial's shareholding in Ceres Power, which is a listed company.

[17] Imperial Innovations Group plc, Prospectus, July 2006
[18] Imperial Innovations Group plc, Annual Report 2007

6. Conclusions

The data collected in our survey and our separate research provides strong evidence that ETH Zurich's spin-offs are more successful than normal start-up firms and are strongly beneficial to the local economy. In line with observations internationally, ETH Zurich's spin-offs have significantly higher survival rates, create more jobs, attract more VC/Angel investments and provide higher returns on equity than Swiss start-ups on average. Among the spin-offs themselves, those with Venture Capital backing (investments) significantly outperform those without, in terms of job- and value-creation as Graph 21 below makes quite obvious. The bubble size gives an indication of the spin-offs valuation per 31st December 2007.

Graph 21: ETH Zurich spin-offs, sample of 82, job and equity value creation by VC-backed and non-VC-backed firms



Source: own compilation with data from survey

Furthermore, VC/Angel investors experience considerably higher returns than the average VC fund during the last decades in Europe and the US as we have demonstrated with data from VentureXpert. Returns are comparable to the performance of the top 10% percentile of US VC funds. We reviewed several studies in academic literature that have investigated the financial performance of VC investments and VC funds. The performance of our sample 'portfolio' has been considerably higher than the average returns reported in all of these studies. Our calculation shows an out-performance of the SMI Total Return Index by 19–27% and abnormal returns in the range of 20–25% during the 1998–2007 period.

ETH Zurich spin-offs returns are comparable to (and actually seem to exceed) the returns in Imperial Innovation portfolio of companies since its IPO until June 2007. Imperial is a UK leader in the field of technology transfer and commercialisation of technology.

The founders / entrepreneurs experience even higher returns than the VC's/Angels and significantly higher returns if they obtain VC-backing for their company than if not. In exchange, the founders give up majority control in their companies. As we have seen, VC's average stake at exit was 61.3% and the prospect of loosing control over 'their' spin-off appears to be a concern to many young founders, along with the fear of giving away that control too 'cheaply'. However the difference in achievable returns is so dramatic that giving up control should really not be an issue, unless the founders seek to create what we have called a 'life-style' business. Over a 7 year period – VC-backed founders / entrepreneurs make over 5x higher capital gains in absolute than their non-VC backed peers (i.e. 57x their initial investment vs. 11x). VC/Angel investments therefore appear beneficial to all parties involved making a very clear case for ETH Zurich trying to attract more VC/Angel interest in its spin-offs.

6.1. The value and benefits to the economy as a whole

As shown above, the 130 ETH Zurich spin-offs incorporated in the 10-year period from 1998 to 2007 have created direct employment for a total of 918 persons, or close to 8 jobs per surviving spin-off. In comparison, the average Swiss start-up company creates – over 5 years, which is the average age of the ETH spin-offs – less than half as many jobs (3.65). Many of these jobs are highly qualified (over 40% of the spin-off employees are ETH graduates) and offer part-time employment (the average job equals 0.81 FTE), requiring a flexible, well-educated and self-motivated workforce while providing very interesting career development opportunities in a highly dynamic work environment. With total revenues of close to CHF 250 million[19] and personnel cost of an estimated CHF 100 million (including social contributions), ETH Zurich's spin-offs out-source approx. CHF 120 million of goods and services and are likely to have caused the creation of at least additional 500 indirect jobs[20] at their suppliers and service providers.

A second major economic benefit is wealth creation: the average team of spin-off founders – along with family, friends and other private investors – invest equity of CHF 110'000 in their spin-off if they have no VC or Business Angel backing them and can hope – on average – for a return of 40.5% on their investment resulting in a capital gain of CHF 490'000 over a 5 year period. With VC/Angel backing, that gain would be 4 times more over the same period. Obviously, not every founder can expect to realise this level of returns but, surprisingly, about half can expect even higher returns and only approx. 12% risk a negative return. In total, the 130 spin-offs have so far created capital gains to the investing entrepreneurs of at least CHF 150 million[21] of which, however, only 60% were realised. At the same time, VC's and Business Angels have made – in total – capital gains of over CHF 350 millions.

Based on the data received in our survey we have attempted to quantify the tax-revenues to the Swiss Federal, Cantonal and Communal authorities generated by the 130 ETH spin-offs and estimate – for 2007 – taxes paid of close to CHF 18 million resulting from employees personal income taxes of CHF 8.6 million (see Table 11 in Appendix 1) and corporate income taxes of CHF 9.3 million on an estimated total pre-tax income of CHF 43 million[22]. This does not include taxation of institutional investors' profits and gains of those private investors that may be subject to capital gains tax.

Apart from their direct economic impact in job- and investor wealth creation as well as tax revenue generation, ETH Zurich's spin-offs also have a noteworthy indirect economic and social impact, for example as catalyst of high-tech cluster formation and in the attraction/retention of world-class faculty to ETH Zurich itself, to name two examples in a long list of likely benefits mentioned by Shane (2004). A detailed discussion of these benefits would, however, lead beyond the purpose and scope of this study.

6.2. Benchmarking performance with other Universities

Concluding on our comparison of ETH's Zurich spin-off program to the ones of other institutions of higher education and – in particular – to those of leading UK Universities for which we have found a large amount of relevant data, we can say that the ETH spin-offs are among the best in terms of survival rates but possibly create slightly less jobs – although the variance in data from other Universities does not allow for a clear-cut conclusion. Furthermore, a significantly lower proportion of ETH Zurich's spin-offs manage to obtain VC/Angel backing than in the UK. But those who do get backed, attract 20% higher investments than the average UK spin-off. A comparatively lower proportion of the total 130 spin-off population have experienced an exit through trade-sale and those spin-offs that have obtained VC/Angel backing are also being exited later than their peers in the UK. Along with the exceptionally high rates of return for both entrepreneurs and VC/Angel investors, this seems to indicate that the spin-offs that do get backed by Venture Capital are of high quality and attractiveness. It is therefore surprising that only a relatively low proportion of ETH Zurich's spin-offs get VC/Angel backing, counter to no-arbitrage theory that would suggest these abnormal returns will attract more VC/Angel interest and the ensuing competition for good deals would drive down returns. A possible explanation is – of course – the limited attractiveness of the Swiss VC market to international investors, partly for regulatory reasons[23], partly for lacking exit routes – in particular a liquid small cap exchange. However, we have identified two other possible factors that may explain the low level of VC/Angel backing. The first one being the portfolio of sectors that ETH Zurich's spin-offs cover. Only 54% of ETH Zurich's spin-offs are created in sectors (Lifesciences, IT) that can be regarded as mainstream area of investment focus for VC's. A further 10% is in Material Sciences and manages to attract a reasonable level of VC interest. The remaining areas – in particular Engineering Sciences – seem underserved by VC's and angels. However, one should not conclude that spin-offs in these areas are not desirable. As demonstrated by one specific spin-off

[19] Total revenues in sample of 82 is CHF 169 million. We have linearly extrapolated this.

[20] CHF 120 million (25om – 100m – 30m profits) of outsourced services & goods x 40% / 100'000 CHF per employee.

[21] with 90% confidence; average founders capital gain per spin-off is CHF 1.83 million with a standard-error of CHF 0.51 million.

[22] Total positive pre-tax income in our sample of 82 companies is CHF 27.2 million. We have linearly extrapolated that to reflect the total population of 130 spin-offs and applied a 21.5% corporate tax rate applicable for the Canton of Zurich.

[23] A London-based VC mentioned for example the taxation of stock-options grants to management as a major concern.

that saw its IPO last year (2007), there is the possibility for VC's to generate high returns in such niche-areas where there is less VC competition; provided – of course – the spin-offs' technology and the market-potential are outstanding. The solution may therefore be rather to seek interest specifically from Venture Capital firms that are prepared to take a contrarians view to the mainstream in terms of sectors and – if foreign VC's are approached – in terms of geographic focus.

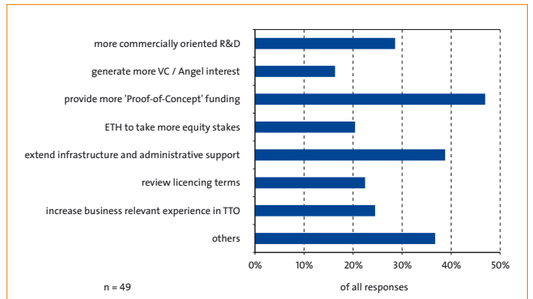
The second possible explanation to the comparatively low rate of VC/Angel backing is in ETH Zurich's spin-off process itself. When looking at the UK Universities that see an average of almost 60% of their spin-offs backed by institutional money, there are three striking differences:

- UK University Challenge Funds invest up to CHF 140'000 and CHF 600'000 at Proof-of-Concept and/or Seed-stage respectively in 80% of their spin-offs,
- UK Universities take a certain influence in the composition of their spin-offs management teams and assure that experienced start-up managers complement the young technical teams either at operational or board-room level,
- UK Universities manage their relations to the VC and angel community in a structured (membership-based, regular pitching events/technology days) manner and systematically seek to attract investment.

6.3. What process improvements do the spin-offs want to see?

In our survey, we have asked the spin-offs the question 'through which of the following measures could ETH further improve its technology transfer performance' and have given a selection of the 7 most widely cited measures to improve technology transfer (BVCA, 2005) plus a category 'other' under which respondents could state their own suggestions. Multiple selections were allowed. 47% of the respondents[24] that replied to this question, wanted to see an increase in Proof-of-Concept funding giving much credit to the 'funding gap' theory introduced above. A much smaller fraction (20%) would like ETH to take more equity stakes in its spin-offs and only 17% wanted ETH to generate more VC/Angel interest in the spin-offs, possibly confirming some of the founders' reservation against giving away control mentioned earlier.

Graph 22: ETH Zurich spin-offs, sample of 82, % of positive responses to the question: 'through which of the following measures could ETH further improve its technology transfer performance?'



Source: data from own survey

The other areas of improvement the spin-offs pointed at were 'infrastructure and administrative support' and 'more commercially oriented R&D'. In the category 'others' respondents could note down other suggestions and – among the various directions these suggestions took – the most frequent were requests for mentoring / coaching / training and access to experienced board-members, for developing more contacts with other spin-offs and entrepreneurs as well as for encouraging professors to spin-off more of their research results and technologies.

6.4. Should ETH invest in its own spin-offs?

ETH Zurich's recent policy of taking a small (3–5%) stake in exchange for reducing the normally applicable license fee or milestone payments, proves quite successful so far. The book-value of its currently held equity in 8 spin-offs stakes by Dec 31st 2007 was CHF 1.5 million and most of these stakes where taken in 2006 and 2007. ETH also has made a handsome return on its earlier investments that it already exited. Obviously it will take time to realise cash returns on these investments but their 'call-option' nature is evident. ETH Zurich's cost (and risk) against the equity stakes is zero if we do not consider the (already sunken) cost of obtaining patent protection for the IP licensed to the spin-offs. On the other hand, the potential upside is significant even considering dilution in future VC investment rounds as demonstrated by the 78% IRR the founders of VC-backed spin-offs have realised. This also suggests that it hardly makes sense for ETH Zurich to make cash investments in later financing rounds, i.e. to follow their initial investment. Returns would be lower and ETH Zurich would then carry a real downside risk on the cash invested which may be problematic in the context of ETH Zurich being a public institution. The question whether ETH Zurich should invest cash equity at seed-stage is more difficult to answer. As already outlined in our literature review, there is a case against Universities systematically taking large (>25%) equity stakes in their spin-offs as it reduces management's potential returns and, therefore, incentive and may undermine ETH transfer's credibility as 'honest broker' of good investment opportunities to VC's and Business-Proof of Concepts (Lerner, 2005). Managing equity stakes also requires professional resources whose cost may actually absorb the potential returns if the 'fund' size is small. For comparison, Imperial Innovations has 40 employees with total annual salaries (excluding stock compensations) of £3.5 million / CHF 8.2 million while it manages a fund with a NAV of £ 53.7 million / CHF 126 million by 31st, July 2007.

However, as shown above, there is a case of assuring that more Proof-of-Concept and Seed-stage equity financing is available to the founder teams with promising technologies. There appears to be a shortage today and – if that shortage could not be remedied through other sources – ETH may consider selectively investing itself.

6.5. Recommendations

We would like to close these conclusions with a brief set of recommendations that we want to share with ETH Zurich's technology transfer office, ETH transfer, who have launched us into this highly interesting project. These recommendations are not meant to be exhaustive but should rather point out the areas where we believe that action may yield the highest impact in ETH Zurich's already highly successful spin-off programme.

- Continue to take equity stakes at start-up stage where technology is promising, in exchange for part of the normally applicable license fees. Fee income under the traditional fee-based arrangements is – in most cases – quite small and offers little upside potential. In contrast, an equity stake does not provide any fee-income but has a significant potential upside by its option nature. As ETH Zurich is taking such equity stakes at incorporation, it can expect to realise the same levels of return as the founders in our sample of 82 spin-offs. ETH Zurich's real returns on the patenting and license administration cost incurred will depend – of course – on the valuation of ETH's stake at incorporation.
- Review the availability of Proof-of-Concept and Seed-stage funding to new spin-offs with all concerned parties (CTI, Venture Incubator and Business Angel networks). If availability cannot be improved, consider setting up an own small PoC/Seed-facility. The focus of such a facility should be, however, to invest (or to provide debt) in exceptional situations where there is a convincing case for the marketability of the technology, a strong management team and – still – no interest from among the VC/Angel community or other sources of financing such as CTI or ZKB. Such investments should focus on bridging the funding gap between incorporation and first VC/Angel round and ETH Zurich should clearly avoid to be seen as competitor in the investment process.
- Build a network of contacts among potential senior managers and board-members that could take positions in new spin-offs. Advise founder-teams with promising technologies to take on board experienced managers and/or non-executive board members. Consider creating a small 'entrepreneur in residence' rotational scheme of persons that could take up a management position in spin-offs.
- Educate potential spin-off founding teams of the clear benefits of having VC's and Business Angels backing their venture and experienced professional managers as members of their team. Review with founder their motivations

[24] of the 74 spin-offs that submitted a filled-in questionnaire – only 49 responded to this question. Some of those who did not respond wrote in cover-notes that their spin-off had been created nearly a decade ago and – since then – ETH Zurich had already made a lot of improvements.

for creating a spin-off and try to detect 'life-style' inclinations early. The creation of such 'life-style' businesses should not be generally discouraged but available support resources should be focused more on spin-offs that promise higher growth and value creation.

- Seek closer and more direct relations with VC's and particularly Business Angels, build a network of contacts internationally. Develop particularly good relations to those angels and VCs who also invest outside the mainstream technology areas (i.e. in electrical/electronics, sensors/analytics, mechanical/avionics, material sciences) or who have a specific application focus in which ETH Zurich's engineering technologies may be of interest (Engineering industries, Oil & Gas, Security, Clean-tech) including Corporate Venturing departments of large firms active in these sectors.

Appendix 1 – Graphs and Tables

Table 1: ETH Zurich spin-offs, composition of total population and survey sample

by Vintage	Total Population		Sample	
	#	%	#	%
1998	9	7%	8	10%
1999	16	12%	7	9%
2000	17	13%	10	12%
2001	10	8%	6	7%
2002	10	8%	7	9%
2003	10	8%	6	7%
2004	12	9%	6	7%
2005	9	7%	6	7%
2006	16	12%	9	11%
2007	21	16%	17	21%
Total	**130**	**100%**	**82**	**100%**
Correlation Total / Sample		0.82		Chi-square: 0.94

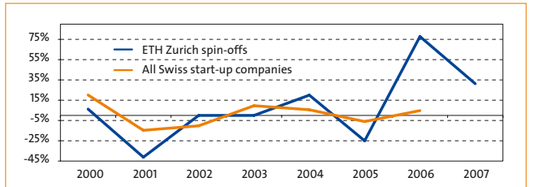
by Sector	Total Population		Sample	
	#	%	#	%
Biotech and Pharmaceutical	21	16%	11	13%
Chemicals	6	5%	4	5%
Electrical & Electronics	10	8%	7	9%
IT	35	27%	22	27%
Material Sciences	10	8%	6	7%
Mechanical & Avionics	5	4%	2	2%
Medtech & Diagnostics	8	6%	6	7%
Micro & Nanotech	3	2%	4	5%
Sensors & Analytics	6	5%	2	2%
Consulting & Services	26	20%	18	22%
Total	**130**	**100%**	**82**	**100%**
Correlation Total / Sample		0.98		Chi-square: 0.88

by Outcome	Total Population		Sample	
	#	%	#	%
Survived – no exit	106	82%	65	79%
Survived – trade sale	8	6%	8	10%
Survived – IPO	1	1%	1	1%
Liquidated	7	5%	3	4%
Not commercially active	8	6%	5	6%
Total	**130**		**82**	
Correlation Total / Sample		1.00		Chi-square: 0.65

by Equity investor	Total Population		Sample	
	#	%	#	%
No VC/Angel participation	96	74%	58	71%
With VC/Angel participation	34	26%	24	29%
Total	**130**	**100%**	**82**	**100%**
Number of VC/Angel rounds	80	100%	50	100%

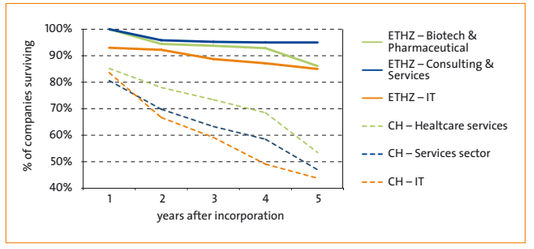
Source: ETH Zurich spin-off database, own survey and own research

Graph 2: year-on-year rate of change in ETH Zurich spin-off creation and Swiss new company incorporations from 2000 to 2007



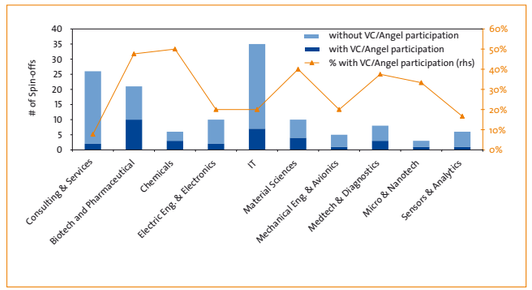
Source: Swiss Federal Office for Statistics, ETH spin-off database

Graph 4: timed survival rates by major Sector for total population of ETH Zurich spin-offs and for all new incorporations in Switzerland and in the Canton of Zurich



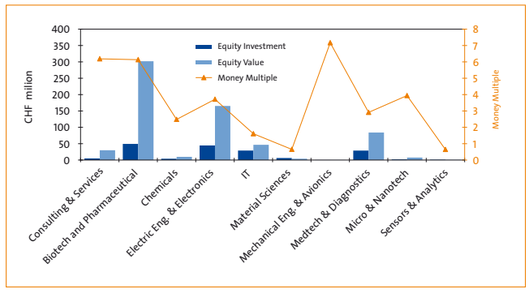
Source: own comparison with data from the Swiss Federal Office for Statistics

Graph 9: ETH Zurich spin-offs, total population, with and without VC/Angel backing, analysis by sector



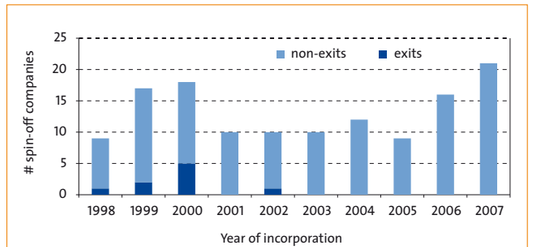
Source: own compilation with data from survey and own research

Graph 15: ETH Zurich spin-offs, sample of 82, absolute returns and money-multiples by sector



Source: data from survey

Graph 11: ETH Zurich spin-offs, total population, exits accomplished, by vintage



Source: data from ETH spin-off database and own research

Table 11: ETH Zurich spin-offs, total population, estimated personal income tax revenues

	# Employees	Average net taxable income (CHF)	Total Taxable Income (CHF)	Tax rate (Federal, Cantonal & Comunal)	Income Tax Revenues (CHF)
ETH Graduates					
FTE, sample of 82	226				
Persons, sample of 82	284				
FTE, 130 spin-offs	359	100'000	35'904'762	15%	5'385'714
others					
FTE, sample of 82	320				
Persons, sample of 82	392				
FTE, 130 spin-offs	508	70'000	35'550'000	9%	3'199'500
Total employees					
FTE, sample of 82	546				
Persons, sample of 82	676				
FTE, 130 spin-offs	**867**		**71'454'762**		**8'585'214**

Source: own compilation with data from survey

Appendix 2 – Valuation

Table 7: comparables used for valuation

Sector multiples (Swiss listed companies, as of 31/12/2007)				
Sector	Price/ Revenues	Price/ EBITDA	Price/ EBIT	Price/ Earnings
Electrical equipment	2.03	15.60	21.90	35.70
Semiconductors	1.38	10.10	20.20	31.30
Software & services	1.66	12.00	16.70	35.90
IT Consulting*	1.58	8.14	10.70	18.50
IT General	1.60	11.50	19.40	31.90
Energy equipment & services	3.93	14.50	21.90	31.30
Biotechnology	6.20	13.80	19.80	31.00
Life sciences tools & services	3.72	13.90	18.40	29.30
Technology Hardware & Equipment	1.54	11.40	20.30	33.30

* IT consulting multiple is an average multiple of listed IT consulting firms in Switzerland, Germany, France, Belgium, Italy and the Netherlands.

Source: CapitalIQ

Exhibit 1: example Valuation report for a Biotech spin-off

VALUATION REPORT

Company:	**NN**
Sector:	**Biotech & Pharmaceuticals**
Activities	**NN**

A. Book value of investment

Paid-in capital		
Total	CHF	22'000'000.00
Provision		

Implied value:	CHF	22'000'000.00

B. Financing Events (Implied Valuation)

	% of shares issued	Price	All Paid-in capital	Pre-money	Post-money
1. Incorporation	100%	50'000	50'000	0	50'000
2. Round (2002)	50%	2'630'000	2'680'000	2'630'000	5'260'000
3. Round (2002)	57%	10'200'000	12'880'000	7'752'763	17'952'763
4. Round (2003)	21%	6'200'000	19'030'000	22'771'963	28'971'963
5. Round (2006)	33%	5'600'000	22'000'000	11'369'697	16'969'697
6. Round					

Implied value:	CHF	16'969'696.97

C. Comparable companies _Life sciences tools and services

	Price/Revenues	Price/EBITDA	Price/EBIT	Price/Earnings	Market/Book
Sector Average	3.72	13.9	18.4	29.3	
Applicable multiple	3.72	13.9	18.4	29.3	

Multiple analysis

Financials 2007	35'000'000	6'000'000	5'000'000	5'000'000	0
Multiple	3.72	13.9	18.4	29.3	
Implied value	130'200'000	83'400'000	92'000'000	146'500'000	

Implied value:	CHF	79'117'500.00
		(with 30% liquidity discount)

D. Comparable Transactions

	Price/Revenues	Price/EBITDA	Price/EBIT	Price/Earnings	Market/Book
Transaction (1)					
Transaction (1)					
Multiple analysis					
Financials '07	35'000'000	6'000'000	5'000'000	5'000'000	0
Multiple					
Implied value					

Implied value:	#DIV/0!

E. Trade sale

	% of shares sold	# shares sold	Share price
Implied value:	NA		

F. Initial public offering

	% of shares sold	# shares sold	Price	Total value sold
Implied value:	NA			

List of abbreviations

AIM	Alternative Investment Market, London
AR	Annual Report
BD	Business Development
Bps	Basis points – one bp is equivalent to 1/100th of a percentage point
BVCA	British Venture Capital Association
CAPM	Capital asset pricing model, as put forward by Sharpe, Treynor Lintner and Mossin
CEO	Chief Executive Officer
CHI-square	Pearson's CHI-square (x^2) test
CTI	The Swiss Confederation's innovation promotion agency
DPI	Distributions to investors (of cash or stock) / Paid-in capital
ETH	Swiss Federal Institute of Technology ('Eidgenössische Technische Hochschule')
EV/EBIT	Enterprise Value / Earnings Before Interest and Taxes
EV/EBITDA	Enterprise Value / Earnings Before Interest, Taxes, Depreciation and Amortisation
EV/Revenue	Enterprise Value / Revenue
EVCA	European Venture Capital Association
Founders FF	Founders, Friends and Family
FTE	Full-Time Equivalent
FY	Financial Year
GP	General Partner (the manager of a fund)
HEFCE	Higher Education Funding Council for England
II	Imperial Innovation Plc
IP	Intellectual Property
IPO	Initial Public Offering
IRR	Internal Rate of Return
LBO	Leveraged Buy-Out
M&A	Mergers and Acquisitions
MSCI	MSCI Inc., a provider of capital market indexes and analysis tools
NAV	Net Asset Value
P&L	Profit and Loss (statement)
P/E	Price / Earnings
PE	Private Equity
PoC	Proof of Concept
rf	Return of risk-free investment (e.g. 10-year government bond)
rhs	Right-hand scale
rm	Return of stock-market (e.g. Swiss market index – total return)
RVPI	Residual Value / Paid-in capital
S&P	Standard and Poor's
SECA	Swiss Private Equity Association
SHE	Sand Hill Econometrics
SMI	Swiss Market Index
SMI-TR	Swiss Market Index – Total Return
TTF	Time-To-Failure
TTO	Technology Transfer Office
UCL	University College London
VC	Venture Capitalist, Venture Capital firm
ZKB	Zürcher Kantonalbank

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Undertaking efforts to help ensure the success of spin-offs is of priority interest to each of the study's sponsors:

Zürcher Kantonalbank

With its 'ZKB PIONIER' initiative, Zürcher Kantonalbank actively encourages the transfer of technology between academia and industry. ZKB PIONIER provides seed and start-up financing to spin-offs and innovative start-ups in and around Zurich. It is an important driver of growth and innovation, both of which are key elements for a thriving, sustainable Swiss economy.

S • E • C • A

The Swiss Private Equity & Corporate Finance Association encourages all spin-offs and start-ups to seek the early involvement of Venture Capitalists and Business Angels. Results of the study published here show that ETH Zurich spin-offs with VC or Angel backing, in comparison to those without, grow faster, generate higher returns and in turn create significantly more jobs. All of these factors are highly beneficial not only for spin-off companies, but for the Swiss economy as well.

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The Innovation Promotion Agency, CTI, is the governmental competence center for innovation in Switzerland. Its mission is to help turn scientific research into marketable products. With its 'venturelab' training program and 'CTI Start-up' coaching services, CTI directly fosters and supports new technology-based, high-growth start-up companies. Other activities include the funding of collaborative applied research and development projects between industry and universities, and the expansion of knowledge and technology transfer networks throughout Switzerland.

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