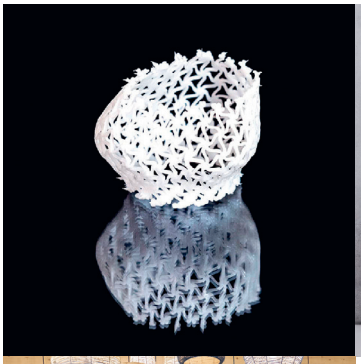
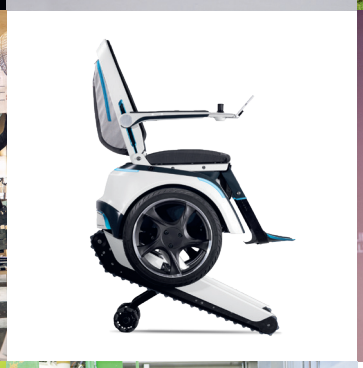
ETH zürich

ETH transfer





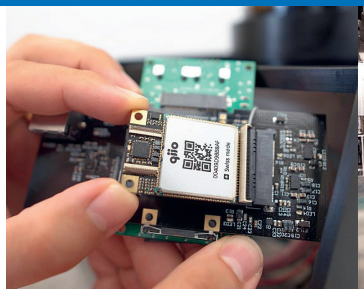







The Performance of Spin-Off Companies at the Swiss Federal Institute of Technology Zurich

Simon Hofer, Luca Fricker, Barbara Schmidt,
Dr Barbara Burkhard and Hanna Brahme



Dear reader

ETH spin-offs are highly important ambassadors for taking innovation from the laboratory into society at large. In recent years ETH has stepped up its support activities by launching new programmes partly based on insights from two previous studies on the performance of ETH spin-offs (Oskarsson & Schläpfer, 2008 and Pinter, 2015). Because this ecosystem is rapidly evolving, however, a follow-up study on the performance of these innovative companies has been conducted in collaboration with the University of St Gallen.

A review of the last few years reveals that the spin-off network is becoming increasingly complex and that many parameters can be investigated. I would therefore like to thank the authors and editors of this study for their input and insightful analysis. The four-and-a-half thousand direct jobs that our spin-offs have created and the equity value of close to CHF 5 billion that they have generated to date are evidence of research having been fruitfully transformed into business ideas. Another fact that stands out is that spin-offs founded by pioneer fellows have been acquired over three times more often than other spin-offs. Further interesting findings are the increase in female founders since 2007 and the rising percentage of spin-offs backed by business angels and venture capital. Overall the report indicates that ETH spin-offs are based on fundamentally sound and innovative ideas, have achieved substantial growth and contribute significantly to the economy.

Founding a company requires courage and hard work amid highly demanding business schedules. We therefore appreciate the time that spin-offs have invested in responding to our survey in great detail. We are also grateful to the team of experts who have extracted the relevant information from the data pool and summarised it in this report. We are convinced that you will discover fascinating facts, figures and trends while reading the report and that it will help us improve the support for future generations.

Prof. Dr. Detlef Günther
Vice President Knowledge Transfer and Corporate Relations

The Performance of Spin-Off Companies at the Swiss Federal Institute of Technology Zurich

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KEY FACTS

429

ETH Zurich spin-offs
1973 – 2018

4'448

direct jobs created, n=145
page 20

92.9%

five-year survival rate
page 38

3.6x

money multiple, n=128
page 34

4.8bn

equity value created, n=148
page 32

>3x

more frequent exits among pioneer fellows
page 43

889m

revenue generated in 2017, n=145
page 17

41

exits, n=429
page 41

1. Introduction

In addition to teaching and research, a so-called 'third mission' – making a direct contribution to the broader social and economic community – has become a central concern of universities (Degl'Innocenti et al., 2019). One of the most important goals within the third mission is the transfer of scientific knowledge and new technology. The pursuit of this goal involves a series of processes and instruments aimed at transferring research products to companies and the market. Among the various transfer strategies available, the creation of university spin-offs is an important means of creating value from scientific knowledge (Visintin & Pittino, 2014). In particular, university spin-offs have increasingly been recognised as potential drivers of job creation and innovation (Nörr, 2010). The establishment of university spin-offs is therefore an important mechanism for the commercialisation of scientific knowledge and thus for the overall contribution of universities to regional economic development and growth (Mathisen & Rasmussen, 2019; Bathel et al., 2010).

This third mission is also a key part of how ETH Zurich operates, as it seeks to contribute to the exploitation and dissemination of knowledge and new technologies throughout society. In order to fulfil this mission, ETH Zurich has invested carefully targeted resources in supporting entrepreneurial projects and transferring ETH Zurich technologies to the market. For example, ETH transfer was set up in 2005 as a technology transfer unit under the Vice President for Research and Corporate Relations, subsequently launching initiatives such as the Spark Award for the most promising patented innovation of the year, Pioneer Fellowships for the commercialisation of research findings, and the Innovation and Entrepreneurship Lab (ieLab) incubator. ETH Zurich helps start-ups to sharpen their business cases and to network and develop their technology and innovation for the market. Start-ups that meet the quality criteria receive the ETH Zurich spin-off label. An official spin-off from ETH Zurich commercially uses a technology, software or know-how developed at ETH Zurich, and at least one of the founders must have a connection to ETH Zurich (Spin-off guidelines, RSETHZ 440.5). The following report reflects on the performance of these spin-offs from ETH Zurich over the past few decades.

The main objective of this report is to analyse how spin-offs from ETH Zurich create value and thus contribute to the economy and society. Out of 429 spin-offs, 143 completed a survey conducted in autumn 2018. Together with additional information up to 31 December 2018, statistical analyses were carried out on the economic impact, finances and success of these start-ups. This is ETH Zurich's third in-depth spin-off report and follows the reports authored by Oskarsson & Schläpfer in 2008 and by Pinter in 2015. It is based on two master's degree theses submitted at the University of St Gallen by Luca Fricker and Simon Hofer.

First, the methodology used is explained. Secondly, the spin-off support provided by ETH Zurich is introduced. Then the findings are presented in four sections: human resources-related factors, impact on the local economy and innovation, financing and investment, and operational factors. The report ends with a final summary and conclusion.

2. Methodology

The basis for this study is the total population of 429 ETH Zurich spin-off companies that were created during the 46-year period between 1 January 1973 and 31 December 2018. Information on the entire population of 429 spin-offs was obtained from ETH Zurich's internal spin-off database and from extensive separate research of the Swiss commercial register, press releases and additional documents provided by ETH transfer. A survey enabled more granular information to be obtained from one-third of the population.

2.1. Survey

A survey designed to measure the performance and impact of ETH spin-offs (see Appendix B) was developed. On 8 October 2018, after a trial round involving ten selected spin-offs, ETH transfer officially distributed the questionnaire to a total of 412 founders for which valid contact data was available. It should be pointed out that 17 companies out of the population of 429 could not be contacted because either (i) their contact data was not available or (ii) they obtained their spin-off label after the questionnaire was sent out (i.e. between 9 October and 31 December 2018). We received 143 valid responses, i.e. a response rate of 34.7 per cent. We have no evidence that the proportion of omitted spin-offs (4.0 per cent) has produced a systematic bias.

To examine how the sample composition compares to the population, we conducted chi-square tests and calculated the correlation factor for the distribution according to sector, vintage and status ('exited', 'liquidated' and 'survived'). While each sample represents the population fairly in terms of sector distribution, the chi-square tests strongly reject the null hypothesis that the samples have the same composition as the population in terms of vintage and status (refer to Appendix A, Tables 1, 2 and 3 for details). Comparisons of expected and actual numbers of observation in the chi-square tables reveal a clear overrepresentation of recently incorporated spin-offs in all samples compared with the population. In terms of status there is a clear underrepresentation of liquidated spin-offs in all samples compared to the population. Both biases can be explained by the fact that older spin-offs, as well as liquidated spin-offs, were less likely to participate in the survey. These biases mean that we need to be cautious with extrapolations from the sample to the population. To account for the different status composition ('exited', 'liquidated' or 'survived') between the sample and the population, we extrapolated (1) the funds raised among the population by status and (2) the equity value created among the population by status. This extrapolation by status yields more accurate estimates for population than a regular linear extrapolation that assumes a similar composition and applies a single multiplier. Whenever extrapolations are made, this is explicitly mentioned in the report.

Given the sensitive nature of the survey – e.g. funding amounts, shareholding structure and financial key performance indicators (KPIs) – certain questions in the survey have fewer than 143 valid answers (e.g. 'Not allowed to disclose this information according to investment agreement'). Our own research of company websites, the Swiss commercial register, press releases, annual reports and information provided by ETH transfer for its portfolio companies enabled us to complete certain missing data points and – for specific questions – even add data points of non-respondents. The fact that (i) certain data points were not provided by the founders and (ii) certain data points were added manually by the authors needs to be considered. The omission in (i) mostly relates to well-funded and successful spin-offs that are often contractually bound to strict confidentiality, and (ii) partially compensates for the omission in (i). The inability to include some of the most successful spin-offs when estimating the financial return means that the bias yields more conservative estimates overall.

For each section of the findings we only consider the spin-offs for which we have complete data points. The sample size might therefore vary between different parts of the analysis and is indicated in each section.

2.2. Sector Definition

The Swiss standard for the general classification of economic activities is defined as the NOGA code. This nomenclature consists of five stages differentiating between 794 fields of activity, with each code consisting of six digits (Bundesamt für Statistik BFS, 2008). ETH Zurich and other technology transfer offices have developed their own nomenclatures to classify spin-off companies. The sectors used by ETH Zurich are the following:

- Advanced Materials
- Biotech Pharma
- Chemical Processes & Compounds
- Electrical Engineering & Electronics
- Information & Communications Technology (ICT)
- Mechanical Engineering & Aerospace
- Medical Devices
- Micro- & Nanotechnology
- Sensor Analytics
- Others (mainly consulting).

Further analysis includes the sectors used by ETH Zurich. They do not correspond specifically to the NOGA codes used by the Swiss government. ETH transfer uses between one and three different sectors to classify spin-off companies at the time it awards its spin-off labels. The first sector used by ETH Zurich is the main sector. To simplify the analysis process, all companies have been clustered into the primary sector. To facilitate understanding, here is one example of the methodology used. If company A belongs to the ICT primary sector and the Electrical Engineering & Electronics additional sector, and company B belongs to the ICT primary sector and the Medical Devices additional sector, they will both be classified as ICT. Furthermore, it is important to note that companies are only classified when they are recognised as ETH Zurich spin-offs. If a company changes its field of activity during its lifespan, its ETH Zurich classification will typically not be adjusted accordingly.

2.3. Definition of ‘Failure/Ceased Activity’

The present study will use the designation ‘Failure/ceased activity’ only for businesses denoted as ‘liquidated’ or ‘in liquidation’ in the commercial register. All companies indicating in the survey that their company had gone out of business are found in this category. This is a different definition compared with previous studies. Past studies have used the term ‘failure’ for all companies that have either been liquidated or ceased commercial activity. The term ‘commercial activity’ has been defined for past studies as 1) the company having employees, either full-time or part-time, and 2) regular revenues of CHF 10’000 or more per year (Oskarsson & Schläpfer, 2008). For this reason, explicit comparisons with previous studies might be difficult and the reader of the present study is required to exercise caution in making comparisons.

3. ETH Zurich Spin-Offs

Spin-off support at ETH Zurich goes back to the 1990s, when the university started to assist in the foundation of new companies based on research findings in order to help convert such findings into marketable products and, consequently, the creation of new jobs (ETH Zurich, 2018a). The success of these support efforts is shown in Table 1: the majority of spin-off incorporations took place after 2000. Ninety per cent of the total number of spin-off companies received the spin-off label in or after 1998. Several developments contributed to this increase. Recognising the importance of spin-offs as vehicles for transferring innovation from the institution to society, the ETH Law was revised in 2003 to include a new article 3a explicitly stating the objective of spin-off creation. The establishment of ETH transfer, which had many new competencies and was explicitly committed to providing spin-off support, helped achieve this objective. Although the number of companies receiving the spin-off label has remained fairly stable in the last four years, 2018 reveals an all-time high of 27 newly labelled spin-offs. This suggests that the growth trend could continue in the future.

Year of spin-off label	Total spin-off population		Survey respondents	
	#population	%population	#sample	%sample
1973–1997	44	10.2%	8	5.6%
1998	8	1.9%	1	0.7%
1999	16	3.7%	0	0.0%
2000	17	3.9%	4	2.8%
2001	10	2.3%	3	2.1%
2002	10	2.3%	1	0.7%
2003	10	2.3%	1	0.7%
2004	12	2.8%	3	2.1%
2005	9	2.1%	2	1.4%
2006	16	3.7%	3	2.1%
2007	21	4.9%	4	2.8%
2008	23	5.3%	11	7.7%
2009	24	5.6%	6	4.2%
2010	20	4.6%	4	2.8%
2011	22	5.1%	4	2.8%
2012	22	5.1%	8	5.6%
2013	24	5.6%	8	5.6%
2014	22	5.1%	12	8.4%
2015	25	5.8%	13	9.1%
2016	25	5.8%	18	12.6%
2017	25	5.8%	15	10.5%
2018	27	6.3%	14	9.8%
Total	432	100.0%	143	100.0%

Table 1: ETH Zurich spin-offs; spin-off labels by year for total population and survey sample size (n=432; n=143)

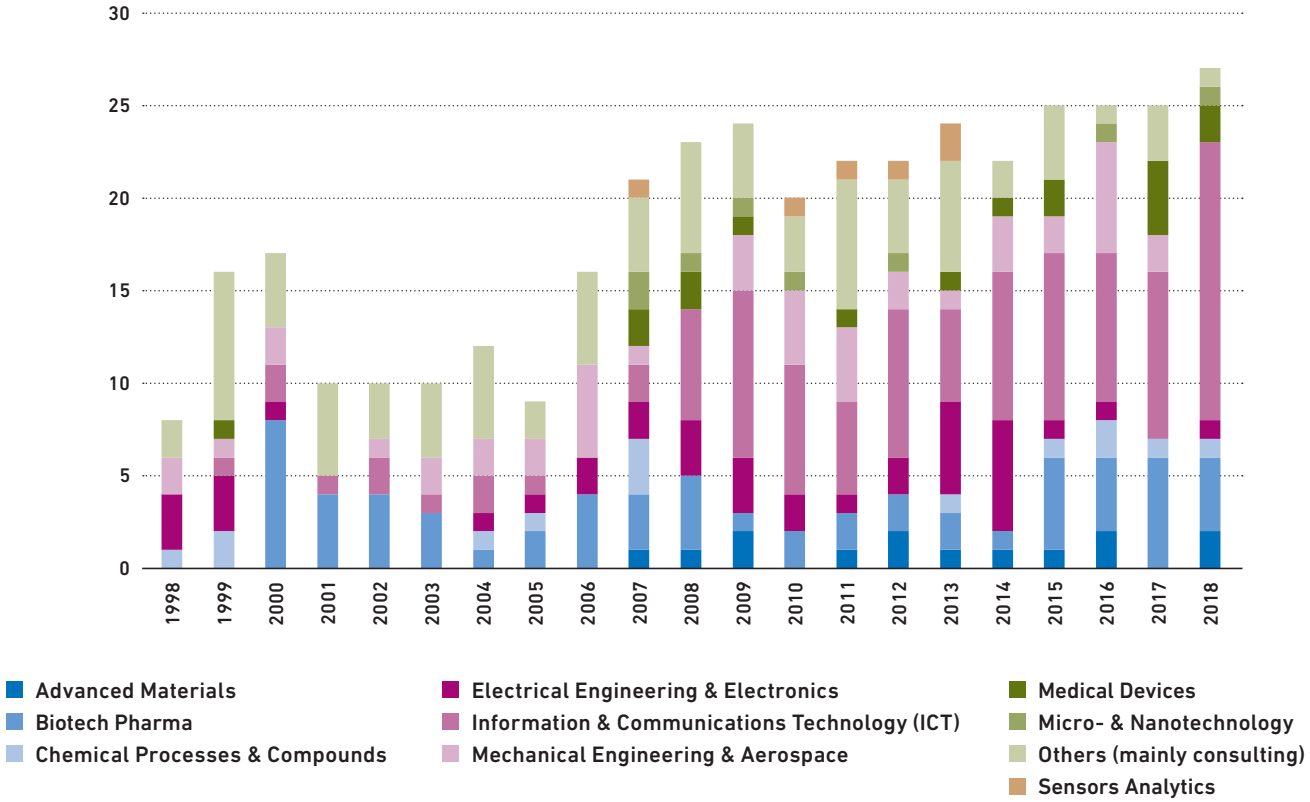


Figure 1: ETH Zurich spin-off labels awarded by sector and year (n=432)

Figure 1 shows the number of recognised spin-offs per sector and year at ETH Zurich over the last 20 years. The trend for ETH Zurich spin-offs is moving in the same direction as the Swiss start-up ecosystem as a whole. After it reached a peak in 2000, the number of new incorporations declined. However, since 2004/2005 the number of new spin-off companies has risen sharply, nearly tripling within the last decade. The Swiss Startup Radar has called the underlying phenomenon 'From the bubble to the boom', linking it to the dotcom bubble[1] in 2000. This revival and the resulting rise are also consistent with the data from the Swiss Startup Radar (Kyora, Rockinger & Jondeau, 2018), which report a growth factor of four between 2002 (69 Swiss start-up incorporations) and 2011 (281 incorporations) and a constant number of around 300 incorporations per year since 2011.

Most ETH spin-offs were founded in the ICT (n=107), Others (n=94) and Biotech Pharma (n=72) sectors. Similarly, Kyora et al. (2018) report that the largest proportions of start-ups in Switzerland are in the Others, Software and Life Sciences sectors. It is also interesting to note the trends over time among ETH spin-offs: the Life Sciences sector has remained almost constant while ICT has grown strongly since 2008, producing between six and nine new spin-offs every year and as many as 15 in 2018.

[1] The dotcom bubble, also known as the internet bubble, was a rapid rise in US technology stock valuations fuelled by investments in internet-based companies during the bull market of the late 1990s followed by a crash ending around 2001 with the result that most dotcom stocks had gone bust by the end of that time (Hayes, 2019).

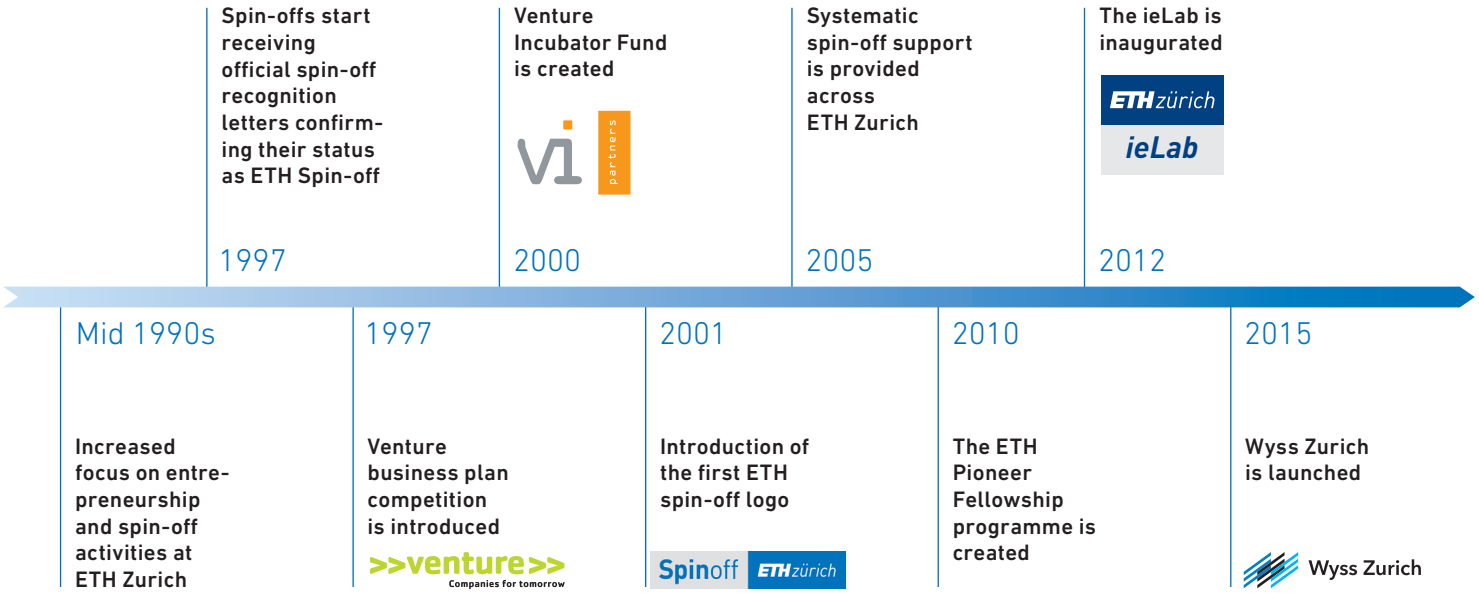


Figure 2: Timeline of ETH support activities[2]

3.1. Spin-Off Support at ETH

University support has been mentioned by Shane (2004) to be a key driver behind the success of university spin-offs. Shane develops three arguments to illustrate the ways in which university support can be beneficial to spin-offs: a continuing relationship between the university and the spin-off, a flexible approach to this relationship, and the presence of external liaison organisations that transform university research and technology into products and services. ETH Zurich offers various programmes and events in all of the three relevant fields mentioned to support young entrepreneurs. We will outline further the support structure of these programmes and summarise the impact that they have achieved. Figure 2 shows a timeline of all ETH support activities since the 1990s.

ETH transfer offers advice to aspiring entrepreneurs and plays an essential role in the development of spin-offs. ETH transfer also manages the Pioneer Fellowship programme. This is a combined financial and mentoring programme designed for students who intend to commercialise a highly innovative technology based on their own research at ETH Zurich. It is awarded to one or two individuals who receive CHF 150'000 over 12 to 18 months along with an extensive mentoring and training programme. Throughout the duration of the programme they are hosted in the ieLab. The ETH Zurich Foundation and ETH Zurich fund the programme jointly (ETH Zurich, 2018b) and it is made possible by donations. When asked for feedback, respondents in the spin-off survey indicated several ways in which support for ETH Zurich spin-offs could be improved (see Figure 3). By far the most frequently cited potential improvement was the wish to receive more funds at an early stage of development to carry out a proof of concept for the start-up idea. Overall, survey respondents consider funding-related improvements – both by ETH Zurich itself and by other sources through strengthening links with venture capitalists or business angels – to be the most relevant.

[2] Wyss Zurich is an incubator linked to ETH and the University of Zurich (UZH).

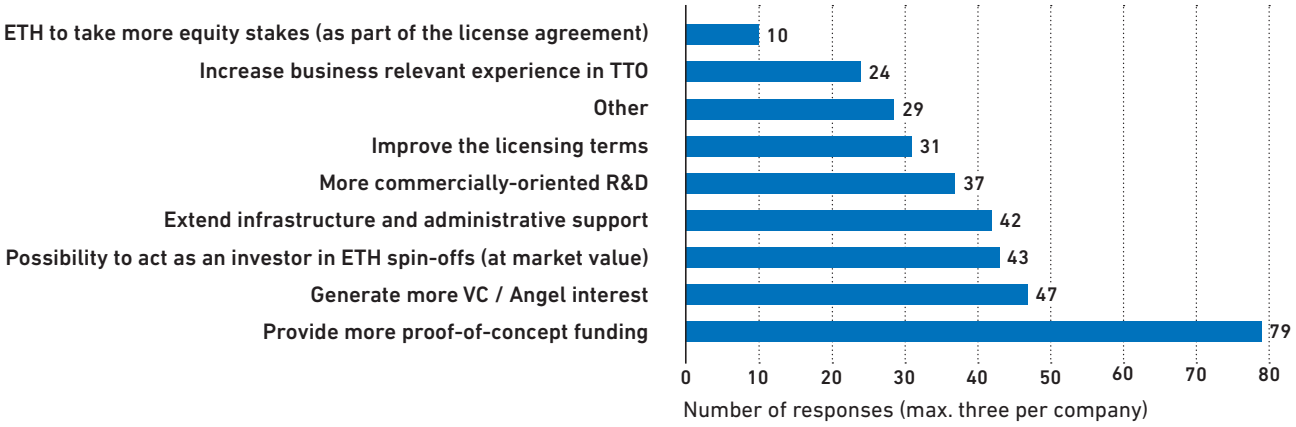


Figure 3: ETH transfer; feedback from spin-offs for improvements (n=143)

3.2. Community Events

Founders of acquired companies often make their networks, experience and financial resources available to the ecosystem to support the next generation of start-ups. Since the Swiss start-up ecosystem is still young, it is essential to organise events and provide platforms where entrepreneurs can meet.

ETH transfer promotes social platforms in various ways. According to the present study, one of the most appreciated events is the spin-off dinner, which takes place once a year in the Dozentenfoyer at ETH Zurich (see Figure 4). As one of the founders mentioned, "[the] spin-off dinner is an outstanding networking event that generated multiple key contacts from which we still profit years later."

However, demand for expanding the offering of community events is also high. Participants suggested *"facilitating interaction between spin-offs and students or large companies by inviting open innovation managers to ETH Zurich to look for joint projects"* or organising *"investor events where start-ups and investors can pitch with the main goal of inspiring existing and future founders to build the next Google rather than getting bought by it."*

In the meantime, community development has taken off with yet another highly dynamic drive involving student-based organisations such as the ETH Entrepreneurs Club and the ETH Juniors, which foster an entrepreneurial spirit throughout the institution and stimulate the foundation of start-ups from the bottom up. Complementing the intiatives launched by ETH Zurich, these student-driven activites offer great value to the ecosystem.

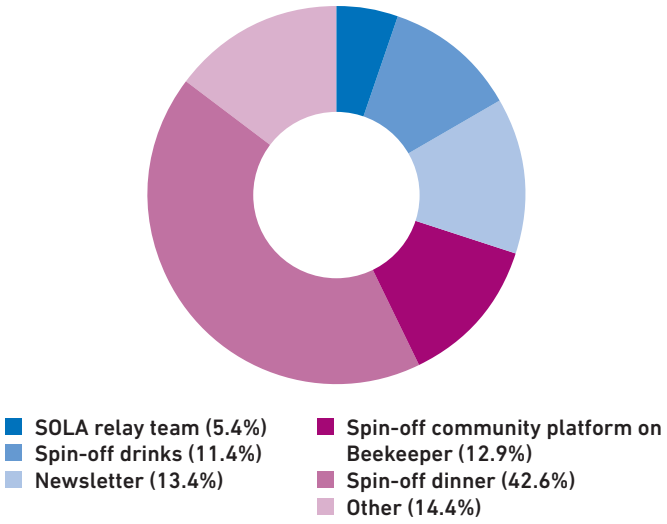


Figure 4: ETH transfer; feedback from spin-offs regarding the most helpful community events organised by ETH (n=143)[3]

[3] Beekeeper is a community online platform used by ETH for spin-off communications; spin-off drinks are held twice per year and are networking events that are more casual than spin-off dinners.

4. Value Created by ETH Zurich Spin-Offs

This analysis consists of four main sections. The first section covers human resources-related factors, such as founder team composition and diversity. The second section looks at the impact of ETH Zurich spin-offs on the local economy to provide insights into intellectual-property strategy and cooperations between spin-offs and industry. The third section focuses on financial topics, and the fourth section explores operational factors.

Within each section a general overview of the topic is presented to the reader. The results are then compared with statistics, with previous studies on ETH spin-offs and with findings from ecosystem reports on the Swiss and European start-up ecosystems.

4.1. Human Resources-Related Factors

Venture creation requires a wide set of skills and knowledge. Investors put the greatest emphasis on the quality of the management team when making investment decisions in the early stages (Mason & Stark, 2004). Because such teams are relevant to the success of any start-up, this study looks at ETH spin-off teams in terms of first-time versus serial entrepreneurs, educational level, educational background and demographic characteristics (nationality, gender). Afterwards, team diversity will be linked to the ability to attract funding in 4.1.4.

4.1.1. Single Founders (n=7) versus Founding Teams (n=136)

According to Schjoedt and Kraus (2009), there is a strong link between the performance of a new venture and the number of founders involved. One of the great myths in current entrepreneurship is the image of the lone hero being successful all by himself. This stereotype has been fuelled by stories about entrepreneurs such as Mark Zuckerberg and Elon Musk (Cooney, 2005; Klotz, Hmieleski, Bradley, & Busenitz, 2014) despite the fact that they too built their success on strong teams. According to the literature, entrepreneurial teams lead to higher performance than single founders because a team has more social and human capital at its disposal in dealing with the uncertainties associated with new venture foundation. Since teams tend to have a better performance record, venture capital firms also prefer to invest in teams rather than in single founders (Schjoedt & Kraus, 2009). This picture is seemingly confirmed by ETH Zurich spin-offs, where 95 per cent of all spin-offs have been founded by teams. These companies receive on average nearly seven times more funding than companies set up by a single founder, illustrating the advantage of a founding team. According to the underlying sample, entrepreneurial teams also have a higher probability of staying in operation (88.2 per cent, n=120) and a significantly lower likelihood of liquidating their business (4.4 per cent, n=6) compared with single-founder spin-offs.

4.1.2. Novices versus Serial Entrepreneurs

Serial entrepreneurs are individuals who have founded more than one venture as opposed to first-time entrepreneurs (novices), who are founding for the first time (Wright, Robbie, & Ennew, 1997). Serial entrepreneurship can be seen as a good predictor of future start-up success, regardless of the outcome of previous venture(s) (Shane, 2004). In our further analysis we will only differentiate between prior and no prior experience because the number of previously founded start-ups does not influence the survival rate (Delmar & Shane, 2006).

According to the European Startup Monitor (ESM), the proportion of serial entrepreneurs ranges from 49.5 per cent in Switzerland to as high as 61 per cent in the United States (Hensellek, Kensbock, Kollmann, & Stöckmann, 2016). 35.6 per cent of ETH Zurich spin-offs have at least one founder with prior experience of founding a company (see Figure 5). The proportion of serial entrepreneurs among ETH Zurich spin-offs is around 15 per cent lower than the overall proportion of serial entrepreneurs in Switzerland. There are a few potential explanations for this gap. ETH Zurich spin-offs

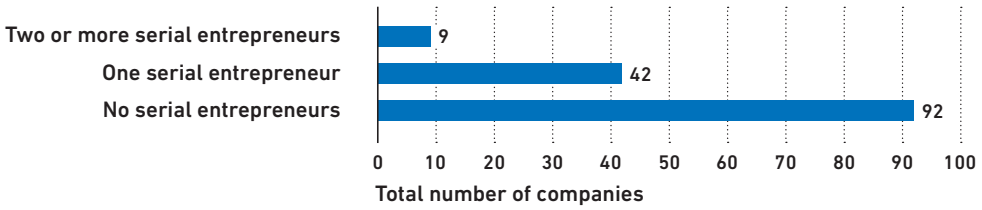


Figure 5: ETH Zurich spin-offs; serial entrepreneurs in the founding team (n=143)

are created based on research, with the founders typically growing into the role of entrepreneurs. They are often founded by first-time entrepreneurs as the founders come from an academic research background. Moreover, since ETH Zurich spin-off incorporations by students or staff are typically opportunistic, those entrepreneurs are less likely to found again. Serial entrepreneurs, on the other hand, typically report a family background, and there is a high similarity between the current and previous businesses (Westhead & Wright, 2015).

ETH Zurich spin-off founding teams with prior entrepreneurship experience have a slightly higher probability of staying in business and a lower probability of being liquidated. This finding is consistent with prior studies (Holmes & Schmitz, 1996; Headd, 2003).

4.1.3. Diversity in Entrepreneurial Founding Teams

Wright and Vanaelst (2009) find that there are both pros and cons with diversity. Access to a wider range of information and alternative points of view supports the case for heterogeneous teams. Team diversity can yield more creativity and greater potential for new innovations. On the other hand, diversity can also give rise to negative emotions, conflicts and ineffectiveness. Homogeneity might therefore make it easier to work towards a common goal.

This report examines the diversity of ETH Zurich spin-off teams based on four factors: gender, nationality, level of education and field of education. The results show that although the spin-off teams at ETH Zurich are diverse in terms of nationality and educational level, they are very similar in terms of educational background. However, it is not surprising that ETH Zurich spin-off companies do not exhibit a high degree of diversity in the field of education, since these companies are mainly founded by researchers and students from the natural sciences and engineering. In addition, the team diversity survey includes only founders in the present survey, while non-founding team members who could possibly contribute to this diversity are not taken into account in the evaluation. Academic research supports these findings: Nikiforou, Zabara, & Clarysse (2018) conclude that university spin-offs are generally more homogeneous than other companies in terms of educational background, industry experience and entrepreneurial experience, as these start-ups typically recruit their team from the university community.

4.1.4. Gender Diversity

Diversity, and specifically gender diversity, is an important issue when it comes to business and entrepreneurship. According to the Global Startup Ecosystem Report (GSER) (Startup Genome, 2018), there are several differences in the mindset of founders. However, gender diversity is not just a social debate – it is economically relevant as well. A McKinsey report states that companies in the top quartile for gender diversity on their executive teams are 21 per cent more likely to have above-average profitability than companies in the fourth quartile (Hunt, Prince, Dixon-Fyle, & Yee, 2018).

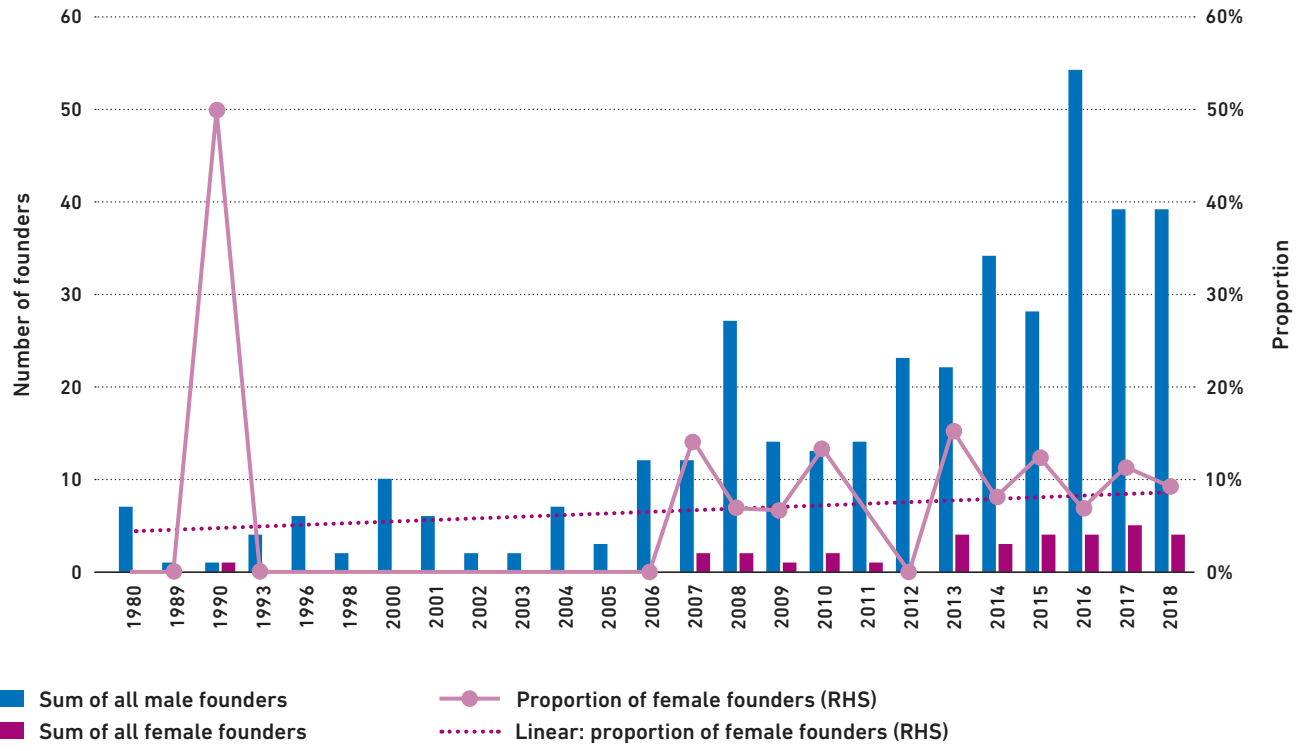


Figure 6: ETH Zurich spin-offs; founding teams' gender composition by year (n=143) (RHS = right-hand side)

The basis for this comparison is a total of 143 spin-offs, which were incorporated by a total of 415 founders, of which only 7.95 per cent (33) were female founders.

Since 2007 there has been a clear shift towards more women in founding teams (see Figure 6). The trend towards higher participation of women in start-up teams is also slightly positive, but major efforts are still needed to achieve an equal gender ratio. The Gender Action Plan developed in 2014 (ETH Zurich, 2014) could help to start closing the gap between female and male founders, although more concrete measures need to be taken to achieve gender equality not only at the educational level but also in the context of spin-offs.

Compared with the Swiss start-up ecosystem, spin-offs from ETH Zurich thus represent the male-dominated start-up sector to an above-average extent. The European Startup Monitor estimated the proportion of female founders in Switzerland to be 10.7 per cent in 2016, which is below the European average of 14.8 per cent (Hensellek et al., 2016). The lower proportion of female founders at ETH Zurich spin-offs can be explained by the low proportion of women at technical universities in general. According to Handelszeitung (Mair, 2017), there are fewer women studying computer science and engineering and they are more likely to get involved in start-ups in the life sciences, food or creativity sectors. This is confirmed by the numbers from ETH Zurich, where the proportion of female bachelor's and master's degree students was 31.4 per cent in 2017. The proportion of female PhD students rose slightly to 31.7 per cent from the year before, and the proportion of female postdocs exceeded 30 per cent for the first time in 2017 (Schubert and Storjohann, 2018). However, if the proportion of women at ETH Zurich (around 31 per cent) is considered in relation to the proportion of female founders (roughly 8 per cent), ETH Zurich performs better than the average for Switzerland as a whole (10.7 per cent), with women accounting for around 50 per cent of its total population. Thus, although women make up a lower proportion of graduates here, ETH Zurich seems to encourage the entrepreneurial spirit of its female students and employees.

Indications

	Average funding [CHF million]	#	BA / VC	Other funding sources
Total	4.1	129	85%	15%
FT including serial entrepreneurs	5.1	48	86%	14%
FT with no serial entrepreneurs	3.5	81	84%	16%
FT including females	1.4	25	70%	30%
FT with only male founders	4.7	104	86%	14%
Single founders	0.6	6	87%	13%
Founding teams (FT)	4.3	123	85%	15%
Nationality: homogeneous	4.7	48	83%	17%
Nationality: heterogeneous	3.7	81	86%	14%
Degree of education: homogeneous	4.6	47	94%	6%
Degree of education: heterogeneous	3.8	82	79%	21%
Field of education: homogeneous	4.2	66	81%	19%
Field of education: heterogeneous	4.0	63	89%	11%

Table 1: ETH Zurich spin-offs; equity funding and sources by founder team (FT) composition (n=129)

4.1.5. Ability to Attract Funding

All of the aforementioned human resources-related factors are combined in the ability to attract financial capital. This competence is essential to accelerate the technical development and thus the success of a spin-off. In addition, the capital is needed to hire the right people and procure the equipment necessary for technical development. (Shane, 2004)
Recent studies have examined how diversity amongst teams affects VC investments. Vogel et. al (2014) have been focusing on task-oriented diversity (e.g. education and experience) and relationship-oriented (e.g. age, nationality and gender) dimensions of team diversity. According to their study, both types of diversity are said to affect investment decisions positively. However, the results regarding relationship-oriented diversity are not unanimous, as previous studies have come to different conclusions. The findings of this ETH Zurich spin-off report are presented in Table 1 and discussed in the following sections.

Out of the 143 survey respondents a total of 129 companies provided information about contributions to equity-based funding, resulting in an average funding amount of CHF 4.1 million per company. Financing figures range from the lowest of CHF 10 thousand to the highest of CHF 56.1 million for a single company. While the smaller amounts have mainly come from the founders themselves, the larger investments have come from business angels (BAs) and venture capitalists (VCs). As we have calculated these figures on the basis of the respondents' data, they are expected to be well below the actual values for the total population (n=429). This topic is discussed further in Chapter 4.3.1 (Equity Funding History).

Seven companies reported to have been started by single founders, while 136 companies were founded by entrepreneurial teams. The average funding amount for companies started by single founders was CHF 0.6 million, while the average amount per company started by a founder team was CHF 4.2 million.

As outlined above, serial entrepreneurship is one of the drivers behind the success of a company. This fact is also reflected in the ability to attract funding. While companies including one or more serial entrepreneurs have been able to attract an average of CHF 5.1 million per company, the spin-off teams with no previous experience attracted only CHF 3.5 million per company.

The gender gap in spin-offs from ETH Zurich, which has been discussed in 4.1.3, is also reflected in the amount of funds received and thus contradicts the study by Vogel et al. (2014), which states that gender diversity among the relationship-oriented dimensions of team diversity improves a start-up's chances of receiving investment funding. Out of 30 companies, including at least one female founder, 25 stated that they had received equity-based financing, resulting in average funding of CHF 1.4 million. In contrast, start-up teams consisting only of male founders received an average of CHF 4.7 million. When interpreting these numbers it is important to consider that the majority of companies with female co-founders have been incorporated in the last few years (see Figure 6). This means that they may not have had time to raise as much money as older companies yet, because they are only in the seed or Series A stage.

Of particular interest is the fact that homogeneous teams in the other areas which were investigated further (nationality, level of education and field of education) on average received more funding per spin-off than heterogeneous teams. The survey results contradict the findings of Vogel et al. (2014) regarding both task-oriented (education) and relationship-oriented (nationality) diversity.

According to Shane's (2004) university status model, an entrepreneur with a higher university degree is more likely to launch a successful spin-off. Since external stakeholders cannot judge whether an invention will be successful, they usually reckon that entrepreneurs with a higher degree are a safer bet and are therefore more willing to invest money in these projects.

To analyse this theory, the highest university degree of one of the founders was considered for each spin-off. 142 spin-offs gave details of their founders' education. All companies without financial contributions were excluded from this comparison (n=14). Averaging CHF 5.6 million per spin-off, companies with a PhD as the highest level of education among their founders were able to raise more funds per spin-off than other types of degree (CHF 3.7 million for a professorship and CHF 1.0 million for a master's degree as the highest level of education), thereby contradicting Shane's university status model (see Figure 7).

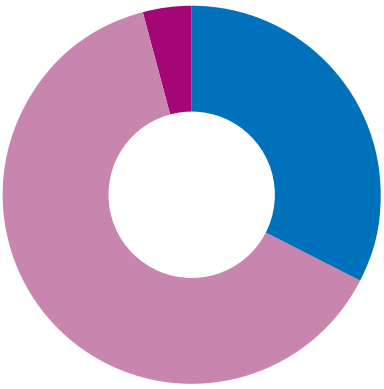


Figure 7: ETH Zurich spin-offs; equity funding by highest university degree among the founding team (n=128)

One important aspect to consider when interpreting these findings is the type of involvement that the different founding team members typically have in ETH spin-offs. While co-founders with a master's degree or PhD typically join the company as part of the operational team, professors' involvement is mostly limited to a minority shareholding, a seat on the management board, or a scientific advisory role. This also needs to be taken into consideration when comparing with the findings of Shane (2004) and Vogel et al. (2014).

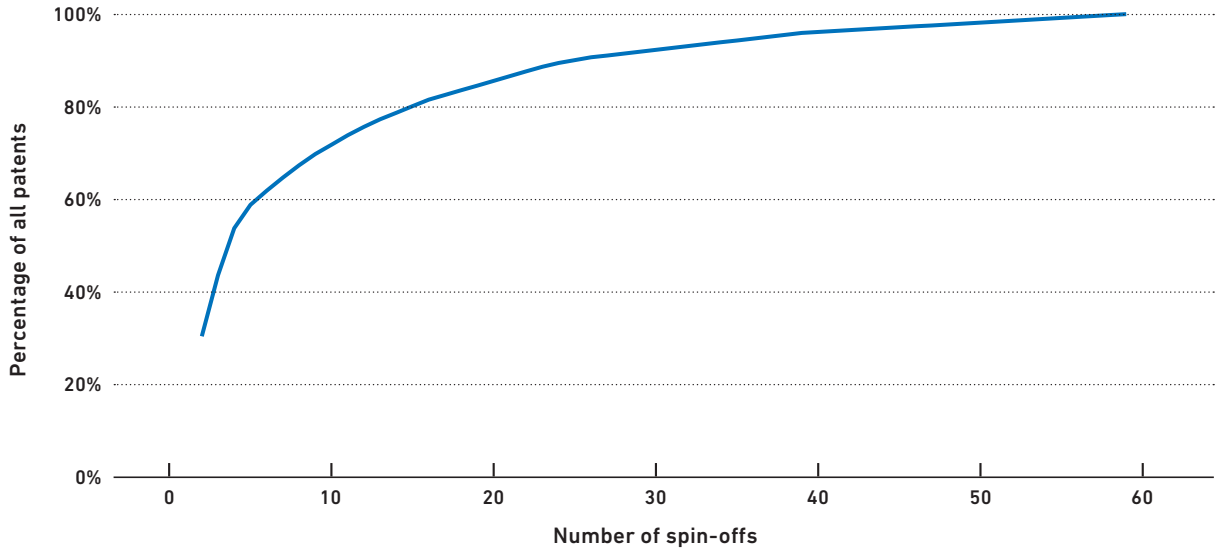


Figure 8: ETH spin-offs; distribution of patent families across companies (n=143)

4.2. Impact on Local Economy and Innovation

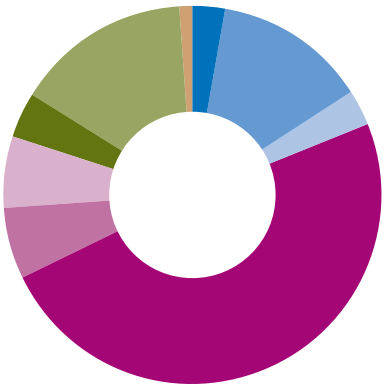
The establishment of a successful business depends not only on the team but also on the underlying idea of value creation. In 2017 a third of the total ETH spin-off population (n=145) generated revenues of CHF 889 million, creating significant value and impact on the local economy. Intellectual property and collaborations with external partners can have a significant impact on the success of a start-up from an early stage as they can help to accelerate technical development and realise the growth potential of the company. As a start-up grows, it has an impact on the local economy, for example by creating jobs. These topics will be discussed in the following chapters.

4.2.1. Patents and Other Intellectual Property

Intellectual property rights, such as patents, help to protect ideas, and the number of patents held by a spin-off may even reduce the likelihood of failure (Shane, 2004). All spin-offs were asked to indicate the number of patent families registered on behalf of the company, the number of patent families licensed by ETH and the number of patent families licensed by third parties. For all ETH spin-offs that participated in the survey a total of 493 patent families are registered in the name of the company. In addition, ETH spin-offs have licensed 74 patent families from ETH Zurich and a further 39 patent families from third-party institutions and organisations. These figures show a multiple of about 6.5x, which means that for each patent licensed by ETH Zurich, the spin-off filed on average about 6.5 patents in its own name.

Of the 143 companies that participated in the study, around 40 per cent of the repondents (n=58) reported that at least one patent had been granted or applied for on behalf of the company. With the total number of patents being 493, there is an average of 3.44 patents per company if you calculate them for all companies and 8.5 patents if you consider only those companies which mention that they have filed patents. However, of these 493 patents, 265 patents are associated with only three enterprises, as shown in Figure 8.

There are significant differences in the numbers of patents between the different sectors. Electrical Engineering & Electronics reports the highest number of patents, while the Others sector accounts for only one per cent (see Figure 9).



- Advanced Materials (3%)
- Biotech Pharma (13%)
- Chemical Processes & Compounds (3%)
- Electrical Engineering & Electronics (49%)
- Information & Communications Technology (ICT) (6%)
- Mechanical Engineering & Aerospace (6%)
- Medical Devices (4%)
- Micro- & Nanotechnology (15%)
- Sensors Analytics (0%)
- Others (mainly consulting) (1%)

Figure 9: ETH Zurich spin-offs; number of patents by sector (n=143)

The large differences between the sectors can be partly explained by the different sample sizes within each industry sector (see Figure 1). However, the different importance of patents for some sectors compared with others might also play a role. In industries where the ratio between the cost of counterfeiting and the cost of innovation is lower (e.g. machinery, electronics, pharmaceuticals), patents are likely to be more important. Moreover, patents tend to be relevant when research and development is very capital-intensive and uncertain (Orsenigo & Sterzi, 2010). The ICT sector has a relatively low proportion of patents, probably because software is protected by copyright and not always filed as a patent based on a computer-implemented invention. In addition, consultancy services, often offered by start-ups in the Others sector, are usually not patentable.

4.2.2. Industrial Collaborations

The European Startup Monitor (Hensellek et al., 2016) states that the willingness of established companies to cooperate with start-ups is an important factor in creating a vital environment for entrepreneurship. These findings show that almost three out of four start-ups participate in collaborations with established companies. At 86.5 per cent, Switzerland is slightly above this figure.

Of the 143 companies, 39.16 per cent stated that they had industrial partnerships that had contributed significantly to their progress and success. Spin-offs from ETH Zurich have benefited from industrial partnerships both financially and non-financially. The most frequently mentioned are financial contributions that assist in the completion of the first product/service, support and financing of pilot projects or support for one or more specific projects. Partners of ETH Zurich spin-offs are primarily large national or international companies. There is a diversity of different partners, with most of these partners being either technology companies or pharmaceutical companies. From an industry perspective, the spin-offs involving advanced materials, chemical processes and compounds, and micro-nanotech attach particular importance to cooperation with industrial partners.

The difference between the results of the European Startup Monitor and the present research could be explained by the way in which the question put to participants was framed. As participants in this survey were asked to indicate important contributions from industry partnerships, minor contributions may not have been indicated, apart from the fact that an accumulation of these minor contributions may have had a significant impact on the start-up's history. Furthermore, very young companies may not have been able to establish industry partnerships yet.

4.2.3. Location

We analysed the headquarters of all ETH spin-offs based on ETH transfer's internal database (n=419). The heat map in Figure 10 shows that the majority of spin-offs (75.7 per cent) are located in the home region of the parent university in the canton of Zurich. This fact confirms the argument that geographical proximity to the parent university offers an advantage in terms of access to academic knowledge and resources.

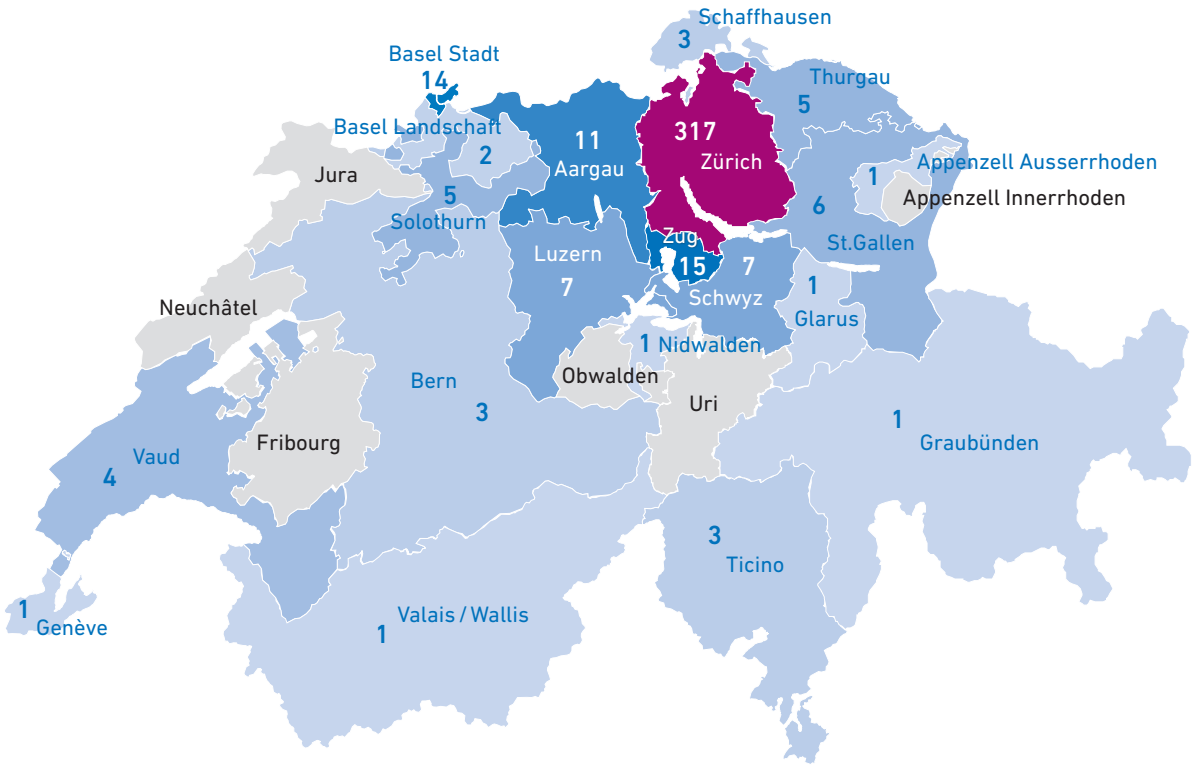


Figure 10: Regional distribution (n=418, of which 408 in Switzerland, 10 abroad); source: ETH transfer database

Further, close research collaborations with the former research labs might play a role in the choice of location. Deep roots in a particular region are also especially important for raising capital and recruiting the personnel needed to start a business (Dahl & Sorenson, 2012), both factors being essential for these spin-offs alongside support from ETH programmes (Grichnik, Vogel, & Burkhard, 2016). However, it should be noted that other factors such as geographical proximity to potential clients and the availability of highly qualified staff may also influence the choice of location.

As ETH Zurich and its Department of Biosystems Science and Engineering (BSSE) in Basel as well as other educational institutions have demonstrated their ability to generate valuable spin-offs, it will become more attractive for future founders to benefit from the growing start-up ecosystem in Switzerland. In turn, this ecosystem and the Swiss economy as a whole benefit from the fact that 97.4 per cent of all spin-offs still have their headquarters in Switzerland. Apart from the fact that these spin-offs are disproportionately located in the canton of Zurich and underrepresented in the canton of Vaud owing to missing EPFL spin-off data, the remaining distribution of spin-offs from ETH Zurich is similar to the distribution of all start-ups in Switzerland covered by the Swiss Startup Radar. Of the remaining 91 spin-off companies, the highest share is in Zug (3.68 per cent = 15 companies), followed by Basel-Stadt (3.43 per cent = 14 companies) and Aargau (2.70 per cent = 11 companies).

Figure 11 shows the three cantons with the most spin-off headquarters, besides Zurich, according to the ETH database. All four cantons have a high number of spin-offs from the Others sector. Since this sector consists of various sub-industries, this is not surprising. The spin-offs located in Zurich show a strong sectoral prevalence in the ICT sector. The canton of Zug is also predominantly populated by ICT spin-offs, while Basel-Stadt has a high proportion of biotech pharma companies.

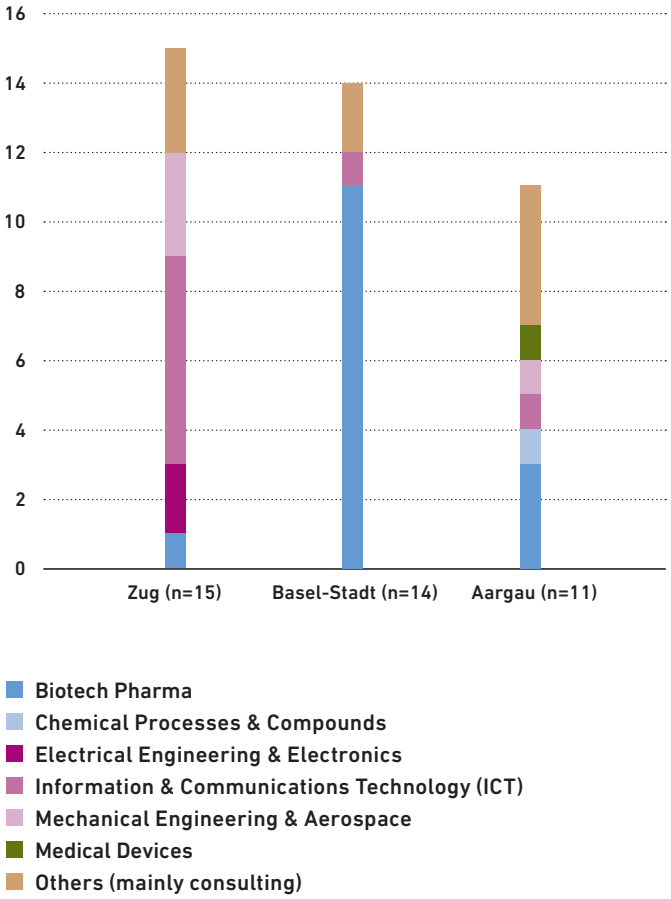


Figure 11: ETH Zurich spin-offs; canton of headquarters by sector (n=40) in Zug, Basel-Stadt and Aargau

It is important to note that the start-up ecosystem in Switzerland differs significantly from other markets in which most start-ups are located in the e-commerce sector. Switzerland is more focused on niche products and more complex innovations in robotics and financial software, which can be explained by the scientific complexity of research at ETH Zurich and the technologies developed through this research (Kyora et al., 2018).

The high rate of ICT spin-offs within the canton of Zug is not surprising. According to the Swiss Startup Radar, the canton of Zug makes an outstanding contribution to the Swiss ecosystem. Zug is only inhabited by 1.48 per cent of the total Swiss population but accounts for 2.87 per cent of the country's GDP and includes 4.61 per cent of all start-up companies within Switzerland (Kyora et al., 2018). Zug is able to attract foreign founders as a result of the excellent conditions that it offers. Incidentally, Zug is known as 'Crypto Valley' and provides around 3'000 jobs in the blockchain industry (Torcasso, 2018). Zug is the second-largest region for ETH Zurich spin-offs – mainly companies from the ICT and Others sectors – which is consistent with general findings from other reports.

The northwest of Switzerland is part of the international 'Bio Valley' cluster, which includes pharmaceutical institutions such as Roche and Novartis and also hosts a compact network of diverse medtech, biotech and nanotech companies (Grichnik et al., 2016). This fact is confirmed by the data collected, since Aargau and in particular Basel-Stadt show high proportions of spin-off companies in the life-science sector.

4.2.4. Job Creation

Job creation and job destruction are two crucial factors in terms of their impact on society. It is in the interest of the government and society as a whole that net job creation within an economy is positive. An important question concerns the role of start-ups in this cycle of creation and destruction. Looking at US industry, Kane (2010) claims that there would be no net growth in the US economy without start-ups. Mauldin (2017) also states that technology is a job-creating machine because technology start-ups initially only create jobs and do not destroy them. When analysing the ETH spin-off sample one needs to bear in mind that the analysed companies are at very different stages of their lifecycles and that the survey respondents incorporated their ventures in a time period spanning from the 1970s to the same calendar year that the survey was distributed. This heterogeneous sample composition has implications for several aspects of this report, including job creation.

All spin-offs were asked to state the highest number of employees since their creation. Of the total population, 143 companies reported valid responses, and two companies were added manually based on publicly available information. By 31 December 2018 the 145 spin-off companies from ETH Zurich had created direct jobs for a total of 4'447.6

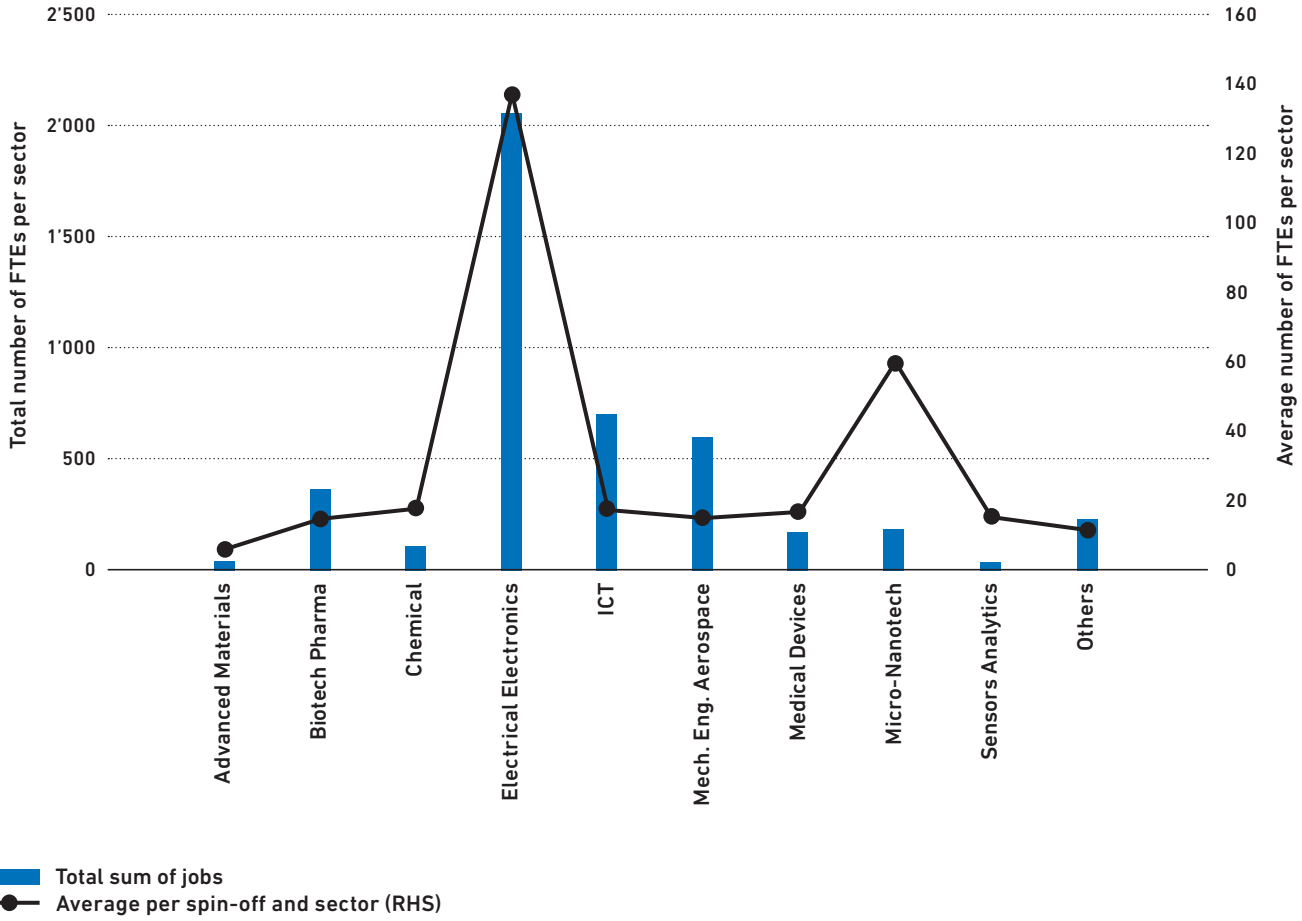


Figure 12: ETH Zurich spin-offs; jobs created per sector (n=145) (RHS = right-hand side)

full-time equivalents (FTEs). This figure equates to an average of 30.9 jobs per company, although there are considerable differences between sectors, as shown in the table below. As only one-third (n=143) of all spin-offs from ETH Zurich have reported valid results, total job creation is only an approximation and a clear underrepresentation.

4.2.4.1. Job creation per sector

The top three spin-offs have created 2'100 jobs over the years. The Electrical Engineering & Electronics sector accounts for the highest number of jobs created, with 2'054.7 jobs (46.2 per cent of the total amount of jobs), but includes only 10.3 per cent of all companies (see Figure 12). The result is average job creation of 137 jobs per spin-off for this sector. It is important to note that the two largest companies in the sector are distorting the average by contributing 1'740 FTEs. One of these two companies did not participate in the study but was included in the analysis with 1'010 full-time equivalents – based on its annual report – in order to get a better approximation of the overall level of job creation. Another company from the Mechanical Engineering & Aerospace sector was added with a contribution of 360 FTEs. ICT, which accounts for 28.3 per cent of the total spin-off population, provides only 697.9 jobs, representing an average of 17 jobs per company. The lowest average job creation is achieved in the Advanced Materials sector, where the average is 5.7 jobs per company.

According to the European Startup Monitor (Hensellek et al., 2016), Swiss start-ups have an average workforce of 13.5 employees and 2.6 founders, which is above the average European headcount of twelve (9.5 employees plus 2.5

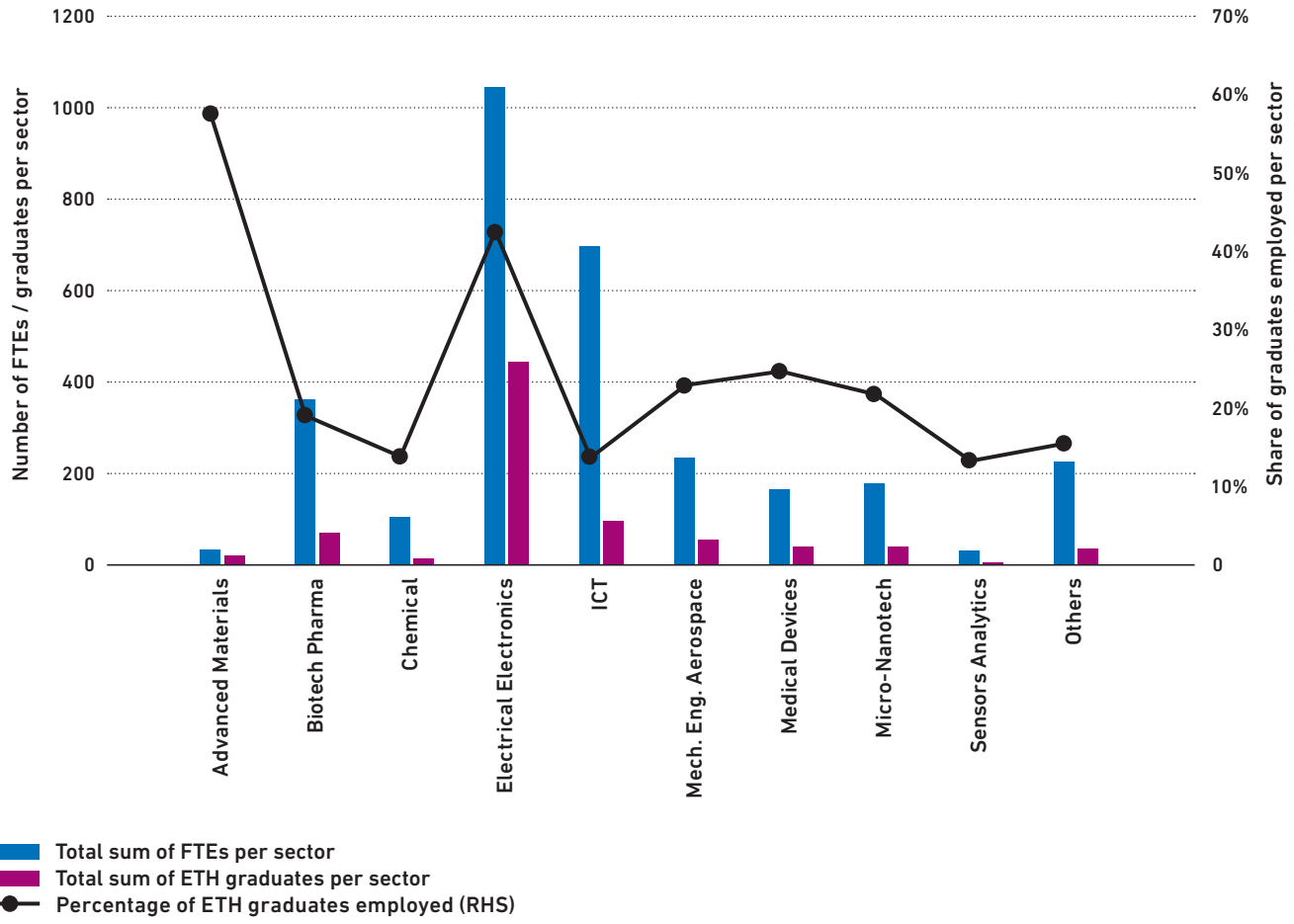


Figure 13: ETH Zurich graduates hired by spin-offs per sector (n=143) (RHS = right-hand side)

founders). With an average workforce of around 31 per spin-off (n=145), ETH spin-offs employ more than twice as many staff as the European average. If we do not take the three largest spin-offs into account, the result of 16.5 FTEs per spin-off company (n=142) is still above the average of Swiss and European start-ups. However, this comparison has to be seen in relation to the respective time span. The ETH spin-off study includes older and newer spin-offs, while the European Startup Monitor may have had a different time limit for what can still be considered a start-up, which might have an impact on the measurement of job creation. Although older companies employ the majority of today's workforce, early-stage start-ups are the main source of net new hires (Burkhard, 2015). ETH spin-off companies have created an average of 2.22 jobs per year over the last 18 years. If we compare this annual job creation with the Swiss start-up ecosystem for the same vintages as Grichnik et al. (2016), ETH spin-offs also perform better: they indicated annual job creation of 1.8 per new venture between 2011 and 2013 based on data from the Swiss Federal Statistical Office. From these figures it can be concluded that the creation of jobs by spin-off companies from ETH Zurich influences the Swiss economy and contributes substantially to the growth of this economy.

4.2.4.2. ETH Zurich graduates employed by ETH spin-offs

On average, ETH spin-offs hire ETH Zurich graduates for almost a quarter (24.54 per cent) of their jobs, although the employment rates of ETH Zurich graduates vary considerably between the various industries (see Figure 13). One explanation is the highly specific knowledge or expertise needed in some of these sectors. A good example of this is the

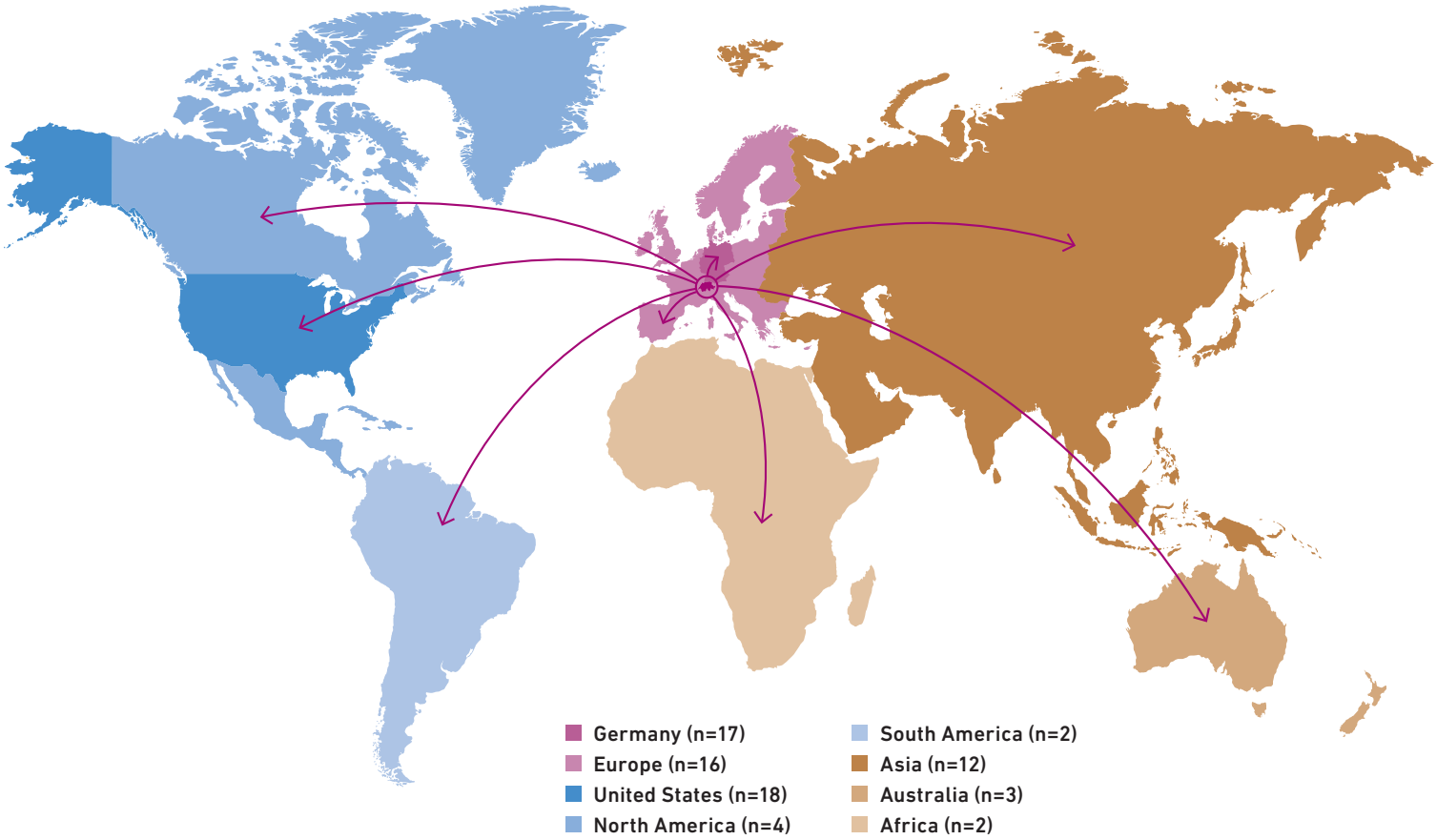


Figure 14: Global presence of ETH spin-offs (n=143)

Electrical Engineering & Electronics sector, where spin-offs have more than 100 employees on average, but still four out of ten employees are ETH Zurich graduates. In other cases, however, spin-off companies already have specific expertise from their founders, so companies are looking for people from other educational backgrounds to build a team with different skill sets. A good example here is the ICT sector, where an average of 17 employees work at each spin-off, but only 13.7 per cent of them (i.e. roughly two people) are ETH Zurich graduates. The large proportion of ETH Zurich graduates working in the Advanced Materials sector makes sense when compared with the average number of employees from the previous section. Since on average only around six people work in these spin-offs, about three of them are ETH Zurich graduates. This figure should roughly correspond to the size of the founding team. In addition, the low total number of employees indicates that these spin-offs – possibly due to their young average age – have not yet significantly expanded their human capital. It is important to note that some of the figures for this section may not be valid as the founders only gave approximate employment rates.

4.2.5. The Global Presence of ETH Spin-Offs

All ETH spin-off companies have been asked to indicate whether they have further branches located around the world. For this reason the world has been divided into eight regions. In addition to the six continents, the United States and Germany have been analysed separately in the survey because they were expected to be of particular importance to ETH Zurich spin-offs. As can be seen in Figure 14, the US, Germany and Europe dominate, which indicates the relevance of these markets for spin-offs and, at the same time,

Average yearly revenues in 2017 per sector	Non-pioneer fellows (n=40)	Pioneer fellows (n=29)
Advanced Materials	116'667	100'000
Biotech Pharma	250'000	23'108
Chemical processes & Compounds	165'364	50'000
Electrical Engineering & Electronics	400'000	345'400
Information & Communications Technology ICT	574'885	506'250
Mechanical Engineering & Aerospace	343'715	181'400
Medical Devices	300'000	–
Micro- & Nanotechnology	n/a	1'800
Sensors Analytics	10'000'000	55'000
Others	183'767	220'000
Average revenues across all sectors	**650'585**	**197'977**

Table 3: Average yearly revenues in 2017 per sector between pioneer fellows and non-pioneer fellows in spin-offs founded since 2010 (n=69)

their strategic approach to globalisation. Following them, Asia seems to be the most important region, while other areas are only marginally represented. Based on these findings, however, it is not possible to say how or to what extent these regions are relevant to ETH Zurich spin-offs, as no comparison was made with their value chains. Their importance may therefore lie in different areas such as resource acquisition, production, storage or distribution.

4.2.6. Comparison between Pioneer Fellows and Non-Pioneer Fellows

As briefly mentioned in section 3.1, the Pioneer Fellowship programme has been supporting promising deep-tech entrepreneurial projects since 2010. One way to evaluate ETH Zurich's spin-off support is to compare revenue generation between pioneer fellows and non-pioneer fellows. While 40 companies founded by non-pioneer fellows since 2010 generated a total of CHF 26 million in revenues in the 2017 financial year (an average of CHF 650 thousand per company), the 29 companies in the sample that were incorporated by pioneer fellows in the same time period generated a total of CHF 5.7 million (an average of CHF 200 thousand per company). What stands out when looking at the distribution of the support across sectors is that ICT projects are strongly underrepresented among supported projects. As a result, around half of all companies without Pioneer Fellowships are ICT companies, while only around 15 per cent of the companies with Pioneer Fellowships are ICT companies. All other sectors have relatively equal representation in both clusters, with a slight tendency for more Biotech Pharma and Electrical Engineering & Electronics in the Pioneer Fellowship.

The lower number of ICT projects in the Pioneer Fellowship programme has significant impact on the average revenues for these two clusters, as seen in Table 3. Except for an outlier for Sensor Analytics, ICT companies have the highest average revenues and, since they make up around half of the companies without a Pioneer Fellowship, that average is improved considerably. Of course, the high revenues from Sensor Analytics also contribute by raising the average for this cluster.

The skewed distribution of ICT and Biotech Pharma projects between the two groups can most likely be explained by the fact that the Fellowship is often awarded to projects with long development cycles. These projects are typically more dependent on funding, since the time to revenues is longer. The Fellowship is one of the tools meant to ensure that promising technologies can be effectively spun out of ETH Zurich, even with high development costs and investment needs.

4.3. Financing and Investment

Once a spin-off has been founded and the university patent or software has been licensed, it is essential to ensure sufficient liquidity to further develop the technology and bring the product or service to market. In order to avert failure, a start-up needs adequate financing for further product and business development. Since the development of higher-education technology can also cost millions, university spin-offs in particular are heavily dependent on external sources of finance. Because financing and the search for investment are so important for early-stage start-ups, this report further examines the financial situation for ETH spin-offs.

4.3.1. Equity Funding History

From the sample of spin-offs with complete fundraising information (n=131), 58 start-ups participated in a business angel (BA) or venture capital (VC) round and a total of CHF 570.8 million was raised in equity. In an extrapolation of the other 298 spin-offs from the total population, with 85 showing evidence of BA or VC financing based on press releases and additional documents from ETH transfer, it is likely that the funds drawn from ETH's entire spin-off population are well over CHF 1 billion.

In the sample of 131 spin-offs, BAs contributed a total of CHF 154.5 million (27.1 per cent) and VCs invested CHF 336.7 million (59.0 per cent) (see Table 4). The founders themselves brought in CHF 12.9 million (2.3 per cent), while family and friends contributed CHF 19.6 million (3.4 per cent). The remaining CHF 47.2 million (8.3 per cent) originated from other sources.

There is an uneven distribution of funds collected per spin-off, with the leading fundraiser in the sample absorbing 9.8 per cent of total funds and the top ten fundraisers accounting for 64.5 per cent of total funds. Despite an average equity per spin-off of CHF 4.4 million, the median is only CHF 350,000 because most spin-offs are not (yet) BA- or VC-funded. From a sectoral perspective, the spin-offs of Biotech Pharma attract by far the most capital, both aggregated at CHF 223.4 million and per spin-off at CHF 10.1 million (see Appendix A, Figure 1 for details). This will be related to the very high costs associated with the entire product development process, including expensive clinical trials.

As can be seen from Figure 15, the sample of 131 spin-offs at the time of foundation brought in CHF 27.1 million – an average of CHF 207'000 per spin-off – to which the founders contributed the most (CHF 9.2 million, or 33.9 per cent). By the time the first round after foundation is completed, the founders' contribution drops to only 2.1 per cent of the total financing for that round.

For those start-ups that have succeeded in obtaining venture backing, the largest contributions in round one come from BAs (CHF 41.9 million) and VCs (CHF 53.8 million). At CHF 10.7 million (CHF 157'000 per spin-off), significant contributions

Funding in CHF million	Founders	FFF	BAs	VCs	Other	Total
Non-BA/VC-backed spin-offs (73)	6.6	12.8	–	–	15.5	34.9
BA/VC-backed spin-offs (58)	6.3	6.8	154.5	336.7	31.7	535.9
All spin-offs from sample (131)	**12.9**	**19.6**	**154.5**	**336.7**	**47.2**	**570.8**

Table 4: ETH Zurich spin-offs; equity raised by source (n=131)

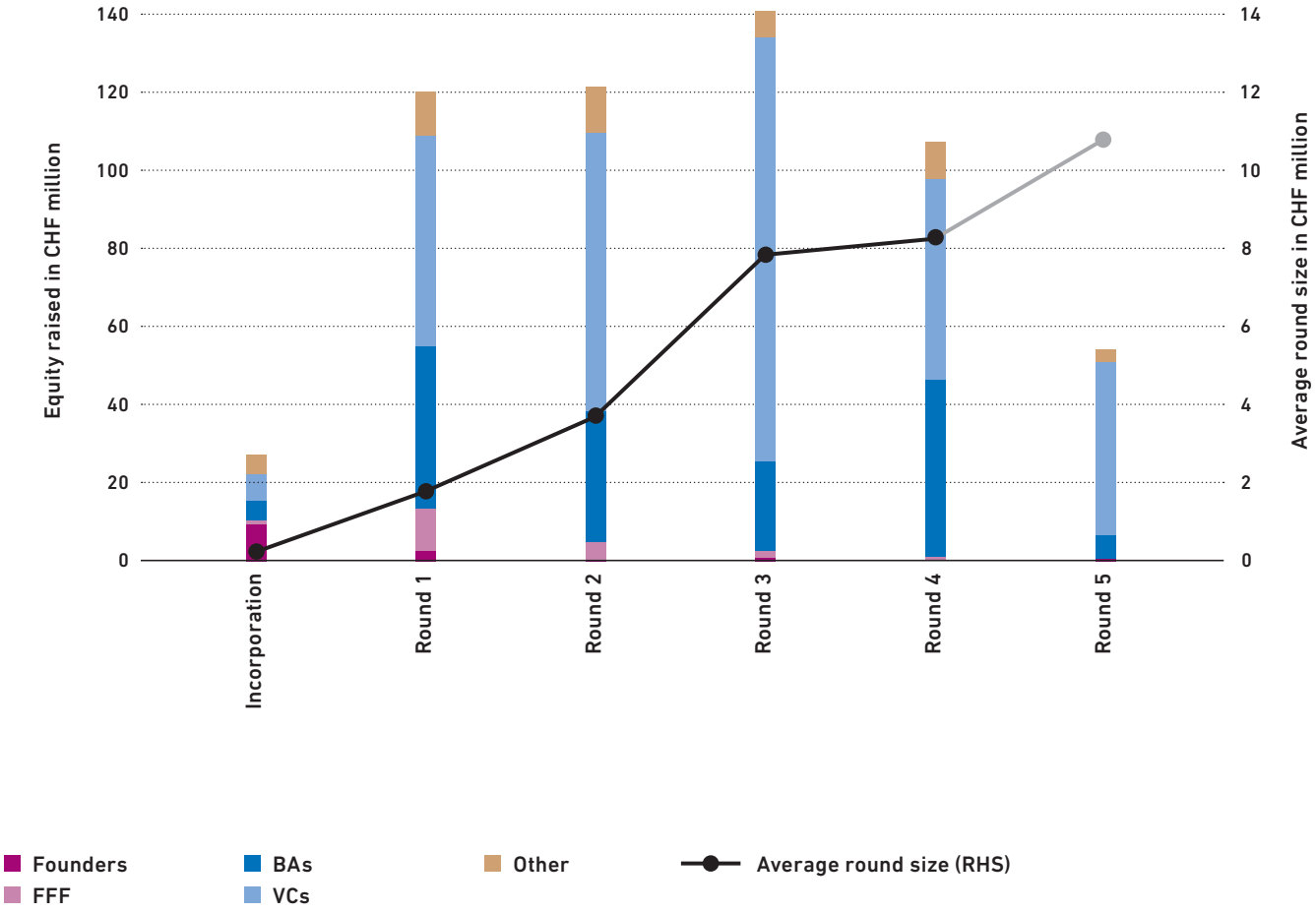


Figure 15: ETH Zurich spin-offs; equity raised by round and source (n=131) (RHS = right-hand side)
Averages for fewer than ten observations are greyed out

were also made in the same round by family members and friends – mostly for companies that did not receive BA/VC support. This contribution from the informal network (FFF) of early-stage start-ups in Switzerland is comparable to other studies (Oskarsson & Schläpfer, 2008). According to the Swiss Startup Monitor (Grichnik et al., 2016), the FFFs account for almost a fifth of all transactions but for only 4 per cent of the total volume. As these start-ups reach the growth stage, they are often able to attract external investors who become the major source of funding since they usually provide larger investments (Grichnik et al., 2016). Over the course of the rounds, shareholders' equity rose from an average of CHF 207'000 at the time of foundation to CHF 10.8 million five rounds later. The proportion of contributions from professional investors also rose with each round, reflecting the greater maturity of the companies concerned.

4.3.2. Funding from Non-Dilutive Sources

From non-dilutive sources, i.e. grants, fellowships and competitions such as CTI / Innosuisse, EU grants, Gerbert Rüf, the Hasler Foundation, etc., the sample (n=131) received a total of CHF 57.4 million, with an average of CHF 435'000 per spin-off and a median of CHF 100'000. The largest amount reported by a single spin-off from this category was CHF 8 million. The funds raised in equity capital (CHF 570.8 million) compared with the non-dilutive sources amount to a multiple of 10x, which shows that although non-dilutive sources have contributed considerable amounts, the private capital market is the dominant source of financing. The correlation between equity funds and non-dilutive funds raised is 16 per cent, indicating only a small connection between the two sources of finance. This could be due to the fact that the two sources substitute each other and thus reduce the correlative effect.

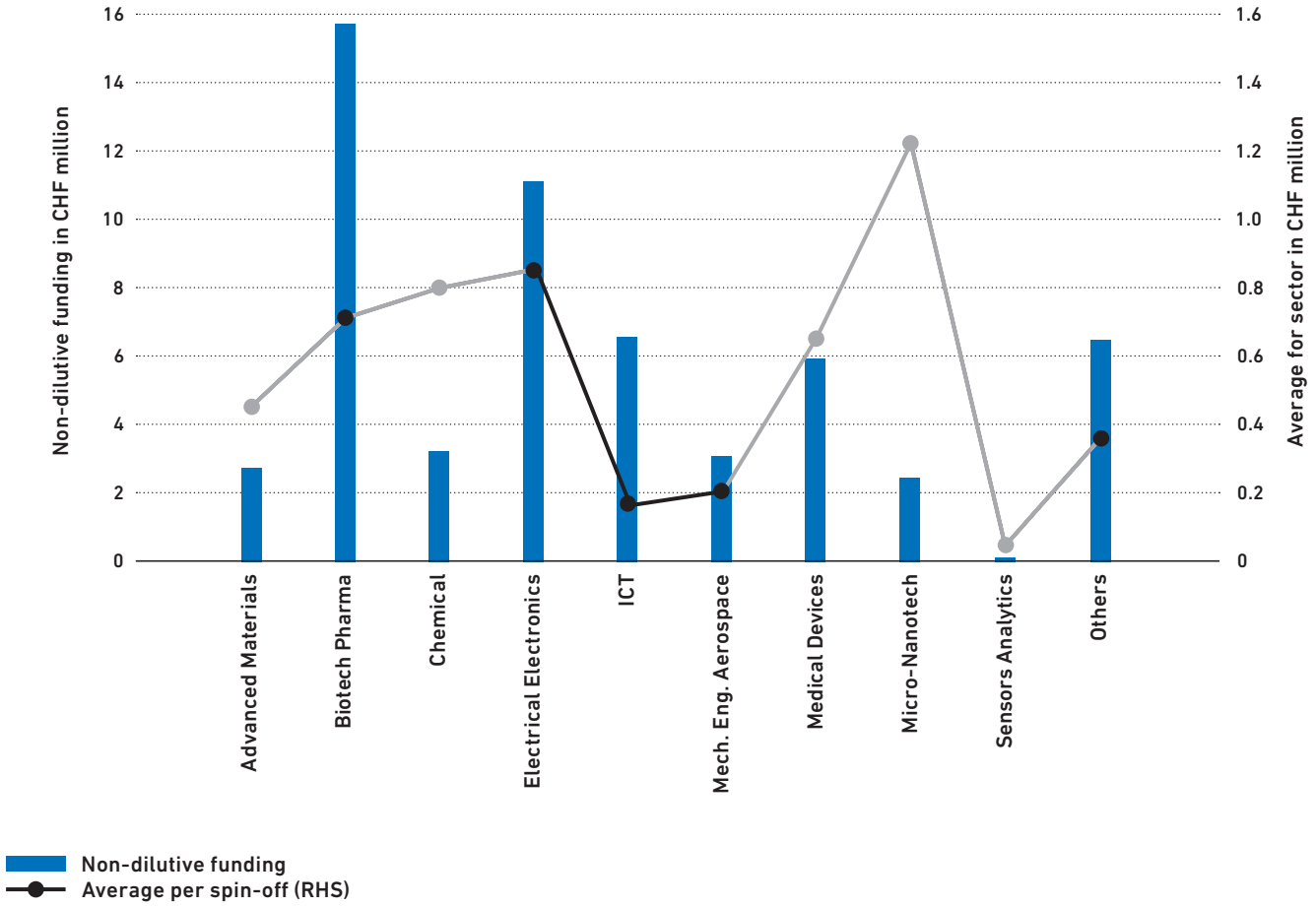


Figure 16: ETH Zurich spin-offs; non-dilutive funding by sector (n=131) (RHS = right-hand side)
Averages for fewer than ten observations are greyed out

Of all the industry sectors, Micro-Nanotech received the most financial support at CHF 1.2 million per spin-off, although no conclusions are possible here as there are only two observations from this sector in the sample. This sector is followed by Electrical Engineering & Electronics with CHF 856'000 in non-dilutive funds (based on 13 observations). Although Biotech Pharma companies were leaders in equity financing, they ranked fourth in terms of non-dilutive financing per spin-off but were number one in terms of absolute amounts (see Figure 16). The fact that 39.2 per cent (n=143) of ETH spin-offs cooperate with industrial partners also shows that paid pilot projects and other forms of industrial cooperation are another important source of financing.

4.3.3. Early-Stage Financing

Many of the spin-offs in the survey sample stated that they did not use VC financing. They use a funding strategy of reinvesting cash flow from customer projects rather than relying on external financing from investors. This is particularly feasible in industries where early paid prototypes or product sales / consulting are possible and investment costs are relatively low.

ETH Zurich spin-off founders contributed CHF 12.9 million (n=131) to their companies, ranging from CHF 10 thousand to CHF 1.45 million. With 372 founders involved in this sample, the average founder contributed CHF 34 thousand to the financing of a start-up. Family, friends and fools (FFFs) invested CHF 19.6 million, which equates to an average of CHF 137 thousand per spin-off across the entire sample (n=143)

Average total funding raised per sector	Non-pioneer fellows (n=57) [CHF million]	Pioneer fellows (n=33) [CHF million]
Advanced Materials	0.1	1.3
Biotech Pharma	5.5	1.3
Chemical processes & Compounds	0.3	1.1
Electrical Engineering & Electronics	1.4	1.3
Information & Communications Technology ICT	2.7	0.9
Mechanical Engineering & Aerospace	1.8	3.4
Medical Devices	1.1	1.1
Micro- & Nanotechnology	n/a	1.5
Sensors Analytics	0.2	1.3
Others	1.4	0.5
Average across all sectors	**2.3**	**1.5**

Table 5: Average funding raised per sector for spin-offs incorporated between 2010 and 2018 for pioneer fellows versus non-pioneer fellows (n=90)

or CHF 932 thousand if calculated only for companies that reported contributions from this stakeholder group (n=21). Two of the companies reported having received financing of CHF 6.5 million and CHF 6 million respectively, which is a very large amount for early-stage high-risk investments. Neither company has indicated any other third-party funding (BA/VC).

4.3.4. Comparison between Pioneer Fellows and Non-Pioneer Fellows

When looking at total funding raised there is a significant difference between spin-offs with Pioneer Fellowships and those without. The 33 companies incorporated by pioneer fellows raised a total of CHF 48.4 million compared with a total of CHF 132.7 million raised by companies incorporated in the same time period that did not receive the grant. This means that the spin-offs without a Pioneer Fellowship raised on average close to 60 per cent more funding than spin-offs supported by the Fellowship (see Table 5), which seems a bit surprising. One possible explanation for this is that pioneer fellows were able to delay the need for external financing thanks to the non-dilutive grant money. However, since the time window for this comparison is 2010 to 2018, it mainly captures the first few years after incorporation and it is not possible to draw any conclusions about the effects on fund-raising ability for scaling the companies in these two clusters.

4.3.5. Later-Stage Funding from Business Angels and Venture Capitalists

Based on an additional review of company websites and press releases as well as through feedback from ETH transfer, an effort was made to identify spin-offs that received venture backing by BAs or VCs across the total population (even among non-survey respondents). It is still likely, however, that a few transactions went unnoticed, which makes this a conservative estimate of the overall number of BA/VC-backed spin-offs.

Overall, evidence of business angel (BA) or venture capital (VC) backing was found for 33.3 per cent of all spin-offs (143 out of 429 spin-offs). This is more not only in absolute terms but also in relative terms compared with what was identified in the studies on ETH Zurich spin-offs by Oskarsson & Schläpfer (2008) and Pinter (2015), when 26.1 per cent and 30.8 per cent respectively received BA/VC funding. Wright & Fu (2015) found that in the top 25 per cent quartile of UK university spin-offs, 26.2 per cent were VC-backed and 6.1 per cent were angel-backed.

If we only consider the survey responses, 90 per cent of the BA/VC-backed spin-offs have investors from Switzerland, 30 per cent from Germany and 30 per cent from other parts of Europe. 20 per cent of the spin-offs are backed by US

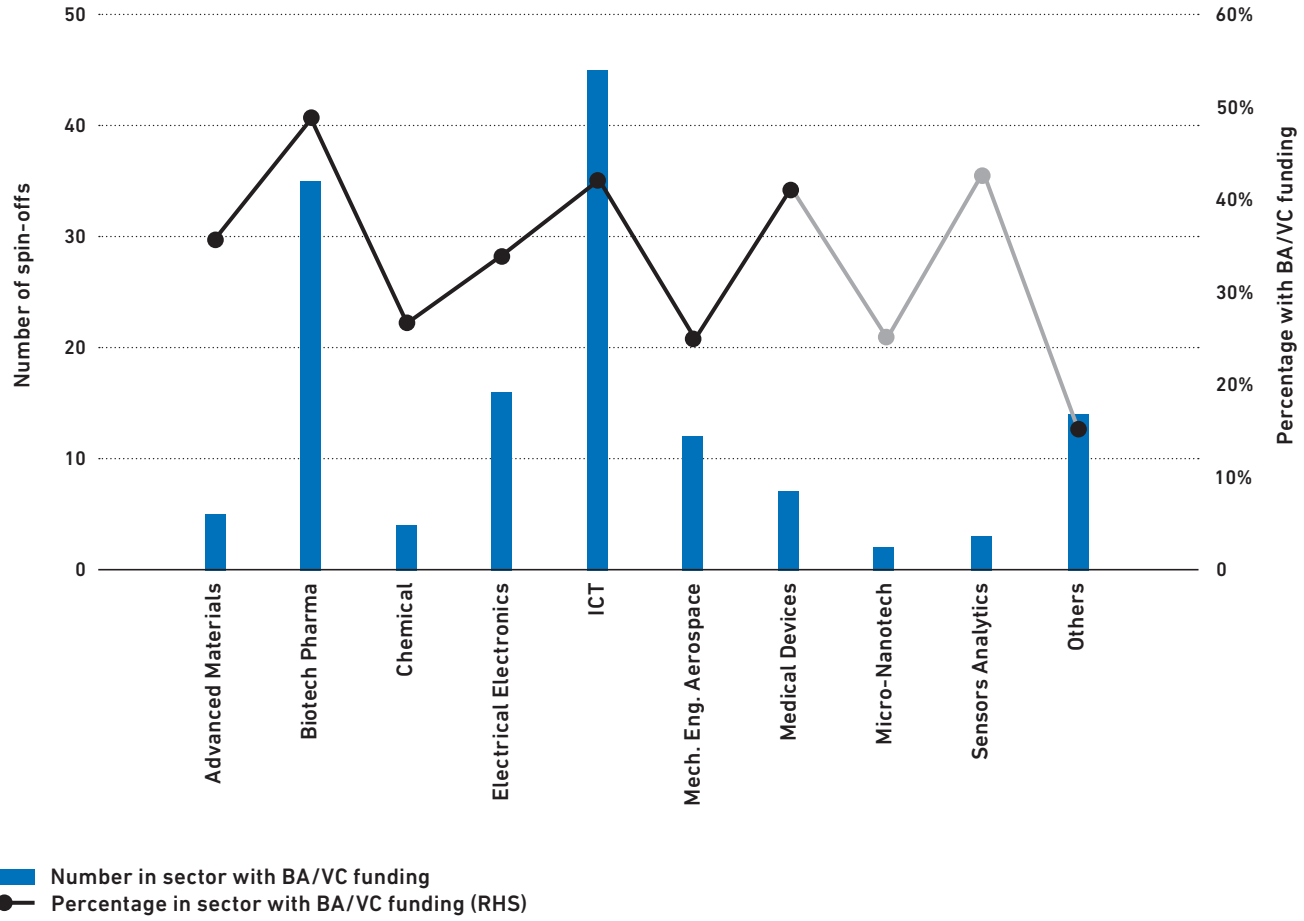


Figure 17: ETH Zurich spin-offs; BA/VC-backed companies by sector (n=429) (RHS = right-hand side)
Percentages for fewer than ten observations are greyed out

investors and 10 per cent by Asian investors. If we look at the sectors in Figure 17, ICT (45) and Biotech Pharma (35) seem to be the most popular sectors for BA and VC investments in both absolute and relative terms.

Of the sample used for the study, 131 spin-offs indicated their amount of fundraising. Of this sample, 58 spin-offs received funds from BAs or VCs averaging CHF 8.5 million per company. At the time of their foundation, nine spin-offs reported that they had received an average of CHF 1.3 million from BA and VC funds and, in the first round, 49 spin-offs had already received an average of CHF 2 million. The average amount of BA and VC financing per spin-off increased with each round and reached an average of CHF 10.1 million per spin-off in round 5 (n=5).

There is a significant time lag before BAs and VCs start supporting spin-offs, as the 58 BA/VC-backed companies needed an average of 767 days (more than two years) to complete their first investment round. This gap has widened by 1.5 months since the spin-off study conducted by ETH Zurich in 2008 (Oskarsson & Schläpfer, 2008). According to this study, spin-offs tended to be backed at a later stage, which resulted in a 'funding gap'. Because VCs seem to be more concerned about the quality and lack of experience in management teams of university spin-offs, they are more reluctant to back these companies at the seed or start-up stage (Oskarsson & Schläpfer, 2008). However, as we considered a funding round to be closed at the time the equity was sold, it is possible that spin-offs obtained BA/VC financing earlier

through mechanisms such as convertible loans[4] or, even more likely, financed their operations through non-dilutive sources such as grants. Convertibles are a common way for investors to invest in an early-stage start-up, especially in the US. Convertible loans are practical, quick, inexpensive and efficient and, at the same time, provide a legal option for founders who need money quickly.

4.3.6. Financial Return

As specified in the VC literature, financial returns are measured using two common indicators: the money multiple and the internal rate of return (IRR) (Lee & Cherif, 2019). The money multiple is simply the sum of returns over the sum of investments. In this study the investment is the sum of all equity raised by a company, and the return is the equity value either at the time of exit or – if no exit has occurred – the valuation on 31 December 2018. For example, a company that collected CHF 100'000 at the time of incorporation, CHF 1'900'000 in subsequent funding rounds and later sold for CHF 3'000'000 has a money multiple of 1.5[5]. Since we are interested in the overall performance of spin-offs, the combined money multiple is calculated as the sum of all returns for the entire spin-off sample over the sum of all investments for the entire spin-off sample.

The IRR is a discount rate that sets the net present value (NPV) of all cash flows from a given project to zero. In this study the cash flows correspond to the equity raised (outflow) and the equity value at the time of exit or – if no exit has occurred – on 31 December 2018 (inflow). In order to calculate the IRR, the equity value of the spin-offs must be measured. The equity value represents the value of a company available to its owners or shareholders. It is determined by identifying the ex-post return on equity invested. The equity of each company was valued individually and all shares were treated as ordinary shares in a slight simplification. By using the data from the survey, additional documents from ETH Zurich and separate research, it was possible to evaluate the equity of 148 spin-offs.

The present value of equity was calculated in line with the study conducted by Oskarsson & Schläpfer (2008):

- Initial public offering (IPO): Two spin-offs underwent IPOs on the Swiss stock exchange, and their share price at the end of the first day of trading served as the basis for our calculations.
- Reverse merger:[6] Two companies were listed on the Swiss stock exchange through a reverse merger, and their share price at the end of the first day of trading multiplied by the proportion of the merged company that belongs to the spin-off's shareholders is relevant for our calculations.
- Trade sale: 20 companies have been valued based on the price at which they sold a major equity stake (at least 30 per cent) to an acquirer.
- Financing events: The valuation of 28 companies is based on recent financing events with BA and/or VC involvement and factors in the post-money valuation as long as that financing round has not taken place more than 18 months prior to 31 December 2018 (in line with the International Private Equity and Venture Capital Valuation Guidelines).
- Multiples: Multiples were used to estimate the value of 53 companies for which data on revenues and earnings before interest and tax (EBIT) was available but which had not gone through an exit or a recent financing event. The multiples used were enterprise value (EV)/revenue and EV/EBIT. We used average industry multiples for global companies as listed in the NYU Stern Database and applied them to the latest yearly performance indicators at the time of the survey (2017 financial year). This rather conservative approach (instead of forward multiples and projected earnings) reduces the risk of exaggerating valuations and is

[4] A convertible loan is a short-term debt that converts into equity at a later stage. Instead of paying back the money with interest, start-ups 'pay' the investor in the form of equity. The conversion usually happens at the conclusion of a new investment round.

[5] Money multiple = $\frac{\text{CHF 3'000'000}}{\text{CHF 100'000 + CHF 1'900'000}}$

[6] In a reverse merger, a private company aquires a majority of the shares in a smaller public company, which is then combined with the purchasing entity.

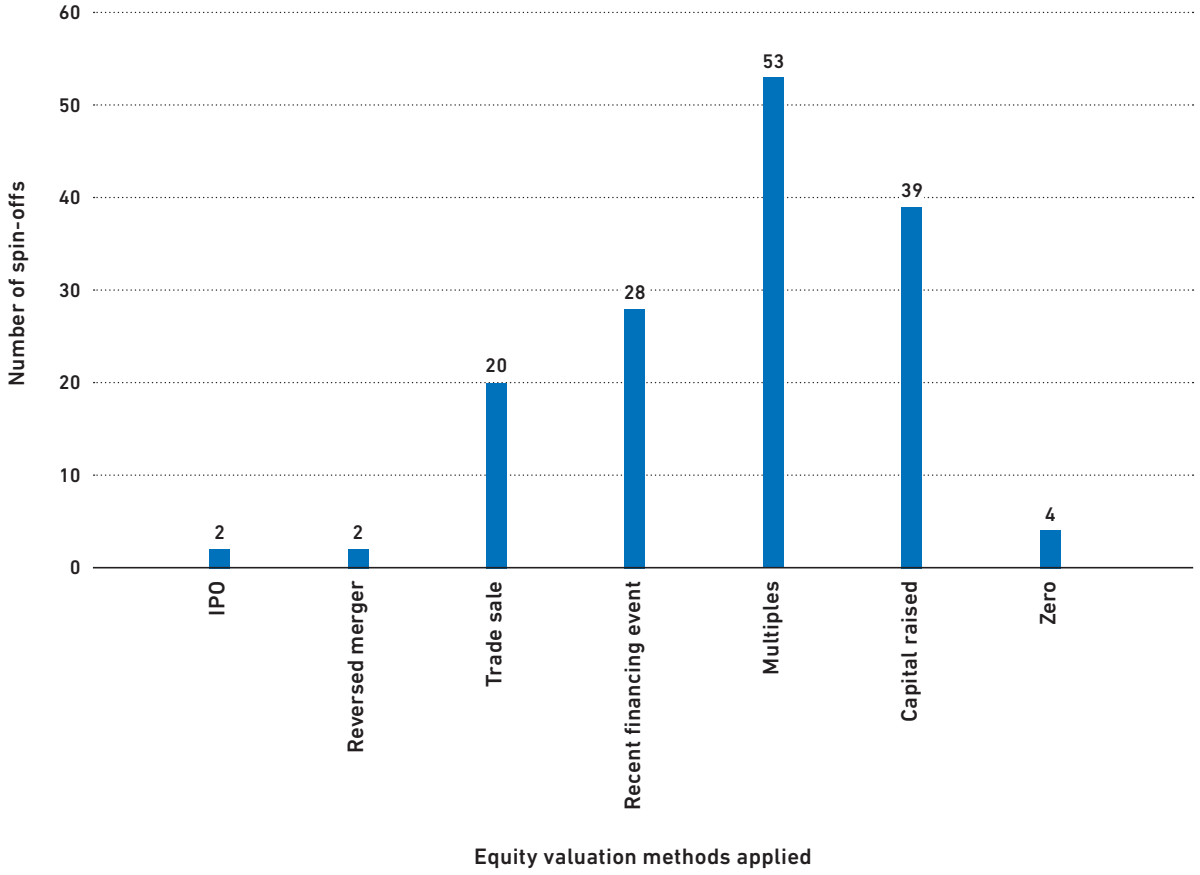


Figure 18: ETH Zurich spin-offs; equity valuation methods applied (n=148)

more appropriate in terms of fair value guidelines. Moreover, as the spin-offs valued on the basis of multiples are all private companies, a 30 per cent liquidity discount was applied to the value of the equity. This methodology was used in accordance with the 2008 study (Oskarsson & Schläpfer, 2008), which in turn followed a British Private Equity & Venture Capital Association (BVCA) recommendation of a minimum liquidity discount of 25 per cent.

- Zero: A zero value was assigned to four companies that had been liquidated.
- Nominal value of the capital raised: The nominal value of the intial investment and subsequent investments (all paid-up equity) are used as a benchmark for 39 spin-offs for which none of the above is available or appropriate.

Calculation of the 'pooled IRR' is based on the investments made in each company since its formation and the present value as at 31 December 2018 using the above method. All investments and valuations are aggregated ('pooled'), i.e. investments are added as negative cash flows in the year in which they were made, exits are added as positive cash flows in the year in which they were made, and the equity of the other spin-offs without exits is added as an inflow in 2018. Of the 148 companies for which the valuation was assessed, 128 also had valid funding information (29.8 per cent of the population, n=429) and could therefore be used in the multiples and IRR calculations (see Figure 19).

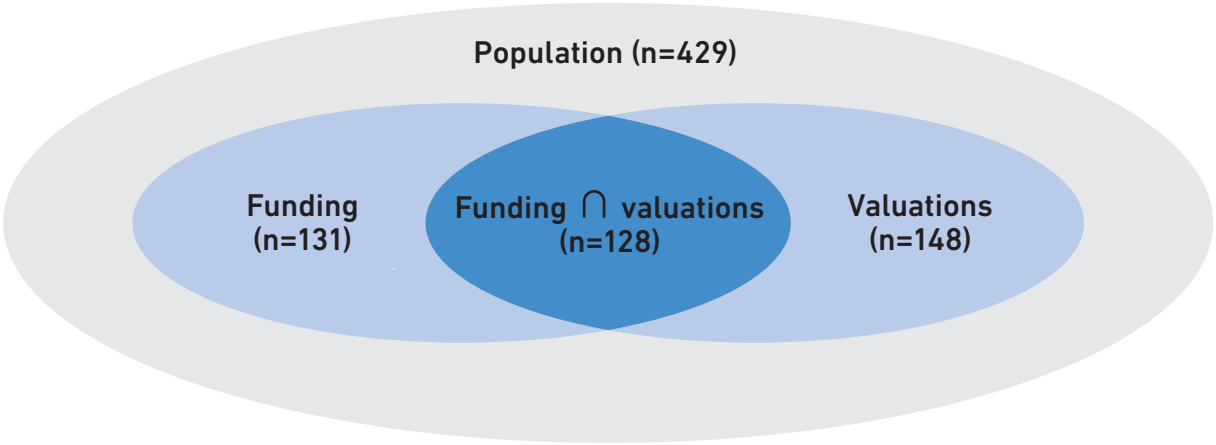


Figure 19: Venn diagram; spin-offs for which fundraising information was obtained and the equity value calculated

Only nine of the 41 spin-offs (22.0 per cent) that have experienced an exit are included. In particular, companies with institutional investors were reluctant to provide detailed fundraising information and therefore had to be excluded. Extrapolations for the entire population must thus be carried out with caution.

4.3.6.1. Equity value created

The sample (n=148) of spin-offs for which an equity value was calculated – 65 of which included a BA or VC round – produced an equity value of CHF 4.8 billion in total. In a projection of the 281 population spin-offs not taken into account, it is likely that the total equity value created in the population is in the range of CHF 9.4 billion. As shown in Figure 20, the total equity value is driven by a few large companies, i.e. the spin-off with the highest valuation accounts for 15.0 per cent of the total value, the top three for 37.9 per cent and the top ten for 74.1 per cent. Despite an average equity value per spin-off of CHF 32.4 million, the median is therefore CHF 2.6 million.

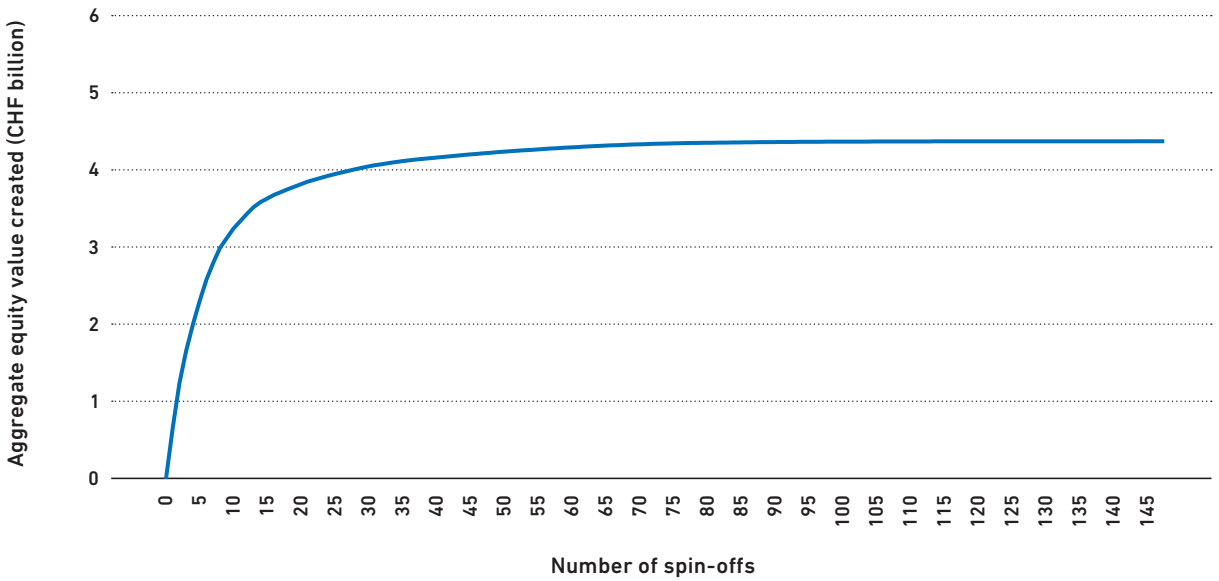


Figure 20: ETH Zurich spin-offs; aggregate equity value created (n=148)

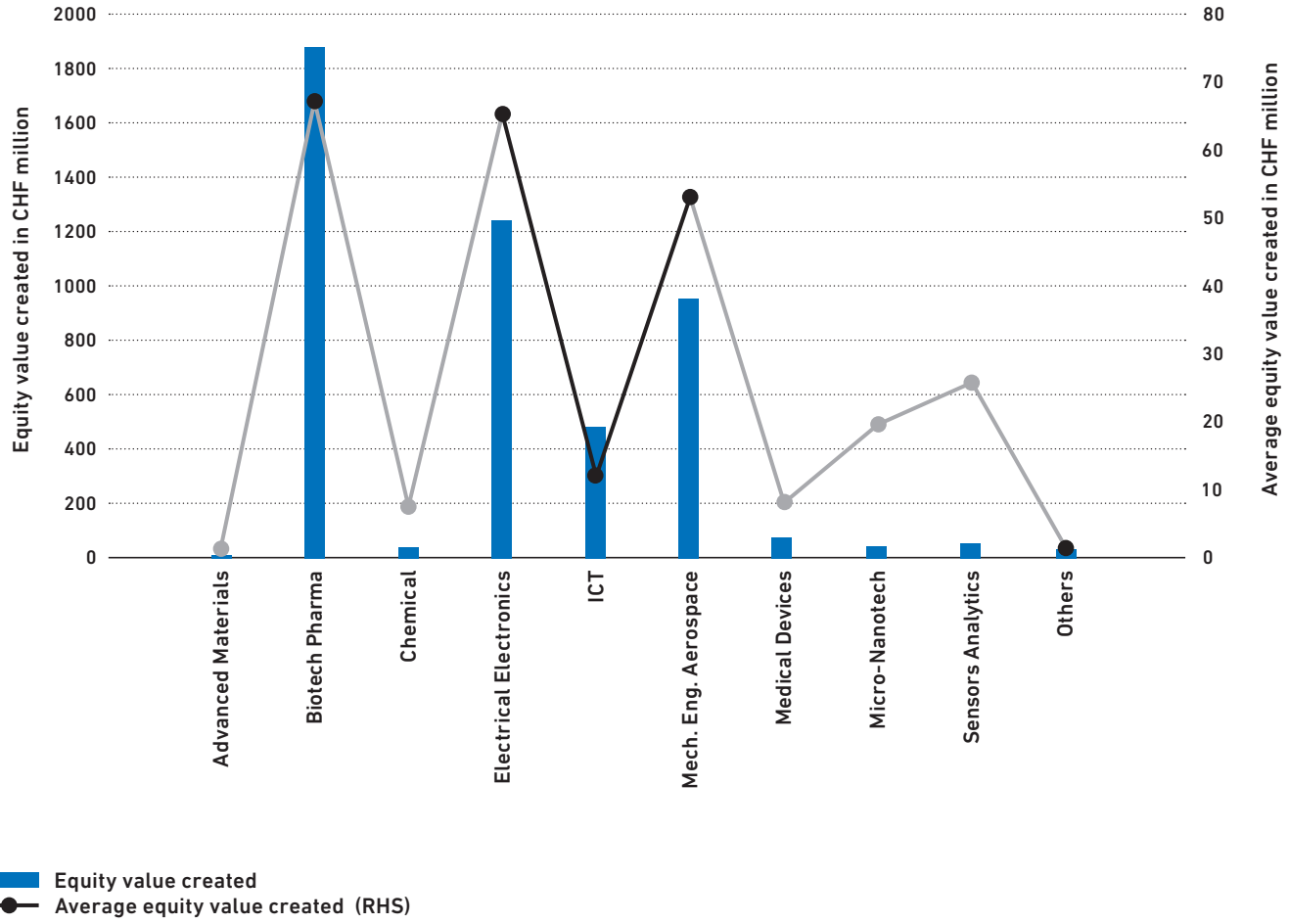


Figure 21: ETH Zurich spin-offs; equity value created by sector (n=148) (RHS = right-hand side)
Averages for fewer than ten observations are greyed out and not interpreted

Of the CHF 4.8 billion equity value, CHF 3.7 billion is being realised through exits (two IPOs, two reverse mergers and 20 trade sales), while the remaining CHF 1.1 billion reflects a current value that has not yet been realised (e.g. equity was valued using current financing events or multiples, but there was no exit event). The average exit valued the equity of the spin-offs at CHF 153 million (median of CHF 37.5 million), while the average company that did not experience an exit was valued at CHF 9.1 million (median of CHF 966'000). The average spin-off in which we found evidence of BA or VC support resulted in an equity value of CHF 56.5 million compared with CHF 13.5 million for non-BA/VC companies. This could be an indicator that BA or VC support increases the equity value of the company. However, it could also be that BAs and VCs invest predominantly in more valuable companies and that the investment per se has not increased the long-term equity value. Another point to consider is that the 'recent financing event' valuation method was used for many companies supported by BAs or VCs whereas, for companies not supported by BAs or VCs, 'multiples' and 'capital raised' were used more frequently, with the latter lowering the average valuation.

As can be seen in Figure 21, Biotech Pharma – which was also the strongest fundraising sector – has created the highest equity value both on an aggregate basis at CHF 1.9 billion and per spin-off at CHF 67.1 million. Electrical Engineering & Electronics and Mechanical Engineering & Aerospace are in second and third places respectively both in terms of the aggregate and per spin-off.

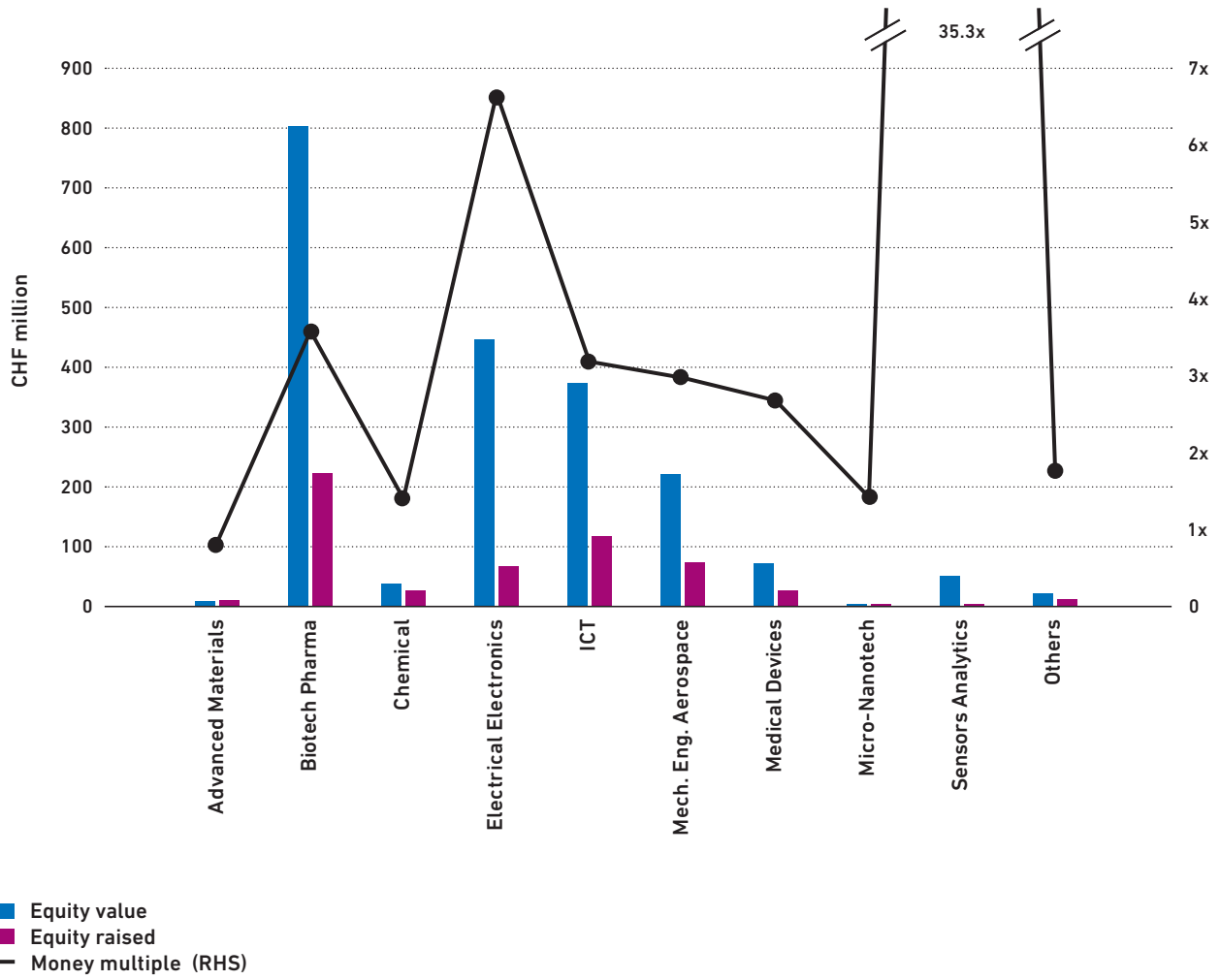


Figure 22: ETH Zurich spin-offs; absolute returns and money multiples by sector (n=128) (RHS = right-hand side)

Of particular interest is the large differences in average equity value created per spin-off from these three sectors compared with all other categories. The lower average equity value in other sectors with a comparable number of spin-offs such as ICT and Others can partly be explained by the different levels of funding: there is a correlation of 86.2 per cent between the amount of funds raised and the equity value created across all spin-offs. The statistics are also affected by some very large share valuations from certain exits. This is particularly pronounced in the Electrical Engineering & Electronics category, where two spin-offs represent around 80 per cent of the equity value created in the sector as a whole.

4.3.6.2. Money multiple

The 128 spin-offs for which calculations were performed achieved a combined money multiple of 3.6x. Since the sample contains only a small proportion of the total exits, this figure reflects a more conservative estimate of the actual money multiple for the population. Compared with the previous section, where the equity value was calculated on the basis of 148 spin-offs (CHF 4.8 billion), the sample of 128 spin-offs represents less than half (CHF 2.0 billion) of the total equity value owing to the lack of detailed fundraising information for some of the most valuable companies in the population. If only the nine companies with an exit are taken into account, the money multiple – in this case an exit multiple – is 5.7x. This is what mid-stage VCs normally aspire to with an investment. The expectation of exit multiples

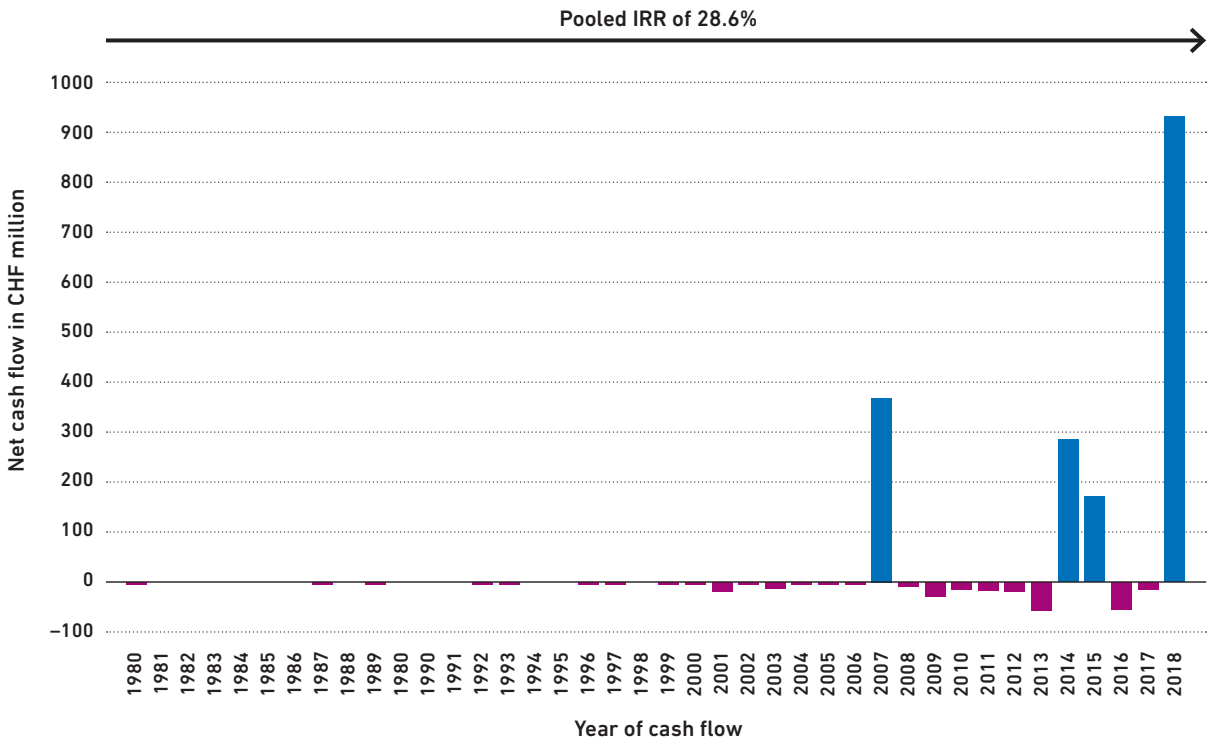


Figure 23: ETH Zurich spin-offs; net cash flows and pooled IRR (n=128)
The pooled IRR for all 128 spin-offs in the sample is 28.6 per cent. Positive net cash flows are grey and negative net cash flows are black.

usually decreases over the lifetime of a spin-off: while seed-stage investors seek a multiple of at least 10x, late-stage investors want 2x to 3x (Hower, 2011).

Looking at the absolute returns and money multiples per sector, as shown in Figure 22, Electrical Engineering & Electronics has the highest multiple at 6.7x. We are not considering Sensor Analytics here, which technically has a multiple of 35.3x but is based on only two observations and therefore has little statistical relevance. The only multiple smaller than 1x is in the Advanced Materials sector, although here too the statistics are based on only six observations and are therefore of little significance.

4.3.6.3. Internal rate of return

The pooled IRR as an indicator of value creation is particularly sensitive to the period it covers. In order to allow a fair comparison with previous studies, the pooled IRR over the last ten years is considered the most relevant. Schläpfer & Oskarsson (2008) found a pooled IRR for ETH Zurich spin-offs of 43.33 per cent in their study. Applied to the same time span of ten years, a pooled IRR of 55.5 per cent for 94 spin-offs between 2009 and 2018 was calculated.

If, instead, the pooled IRR for the sample of 128 ETH Zurich spin-offs spanning from 1980 (the incorporation of the first spin-off in the sample) to 2018 is calculated, the value is 28.6 per cent. In comparison, the public market equivalent (PME) calculated for the Swiss Market Index (SMI) yielded an IRR of 5.7 per cent. The ETH Zurich spin-offs are therefore outperforming the public market by a spread of 22.9 per cent. While this is an extraordinary return, it is important to note that the inherent risk associated with ETH Zurich spin-offs is significantly higher than for stocks traded on the SMI.

The pooled IRR for all 128 spin-offs in the sample is 28.6 per cent. Positive net cash flows are grey and negative net cash flows are black. Source: calculation using data from the survey and complementary information from ETH transfer.

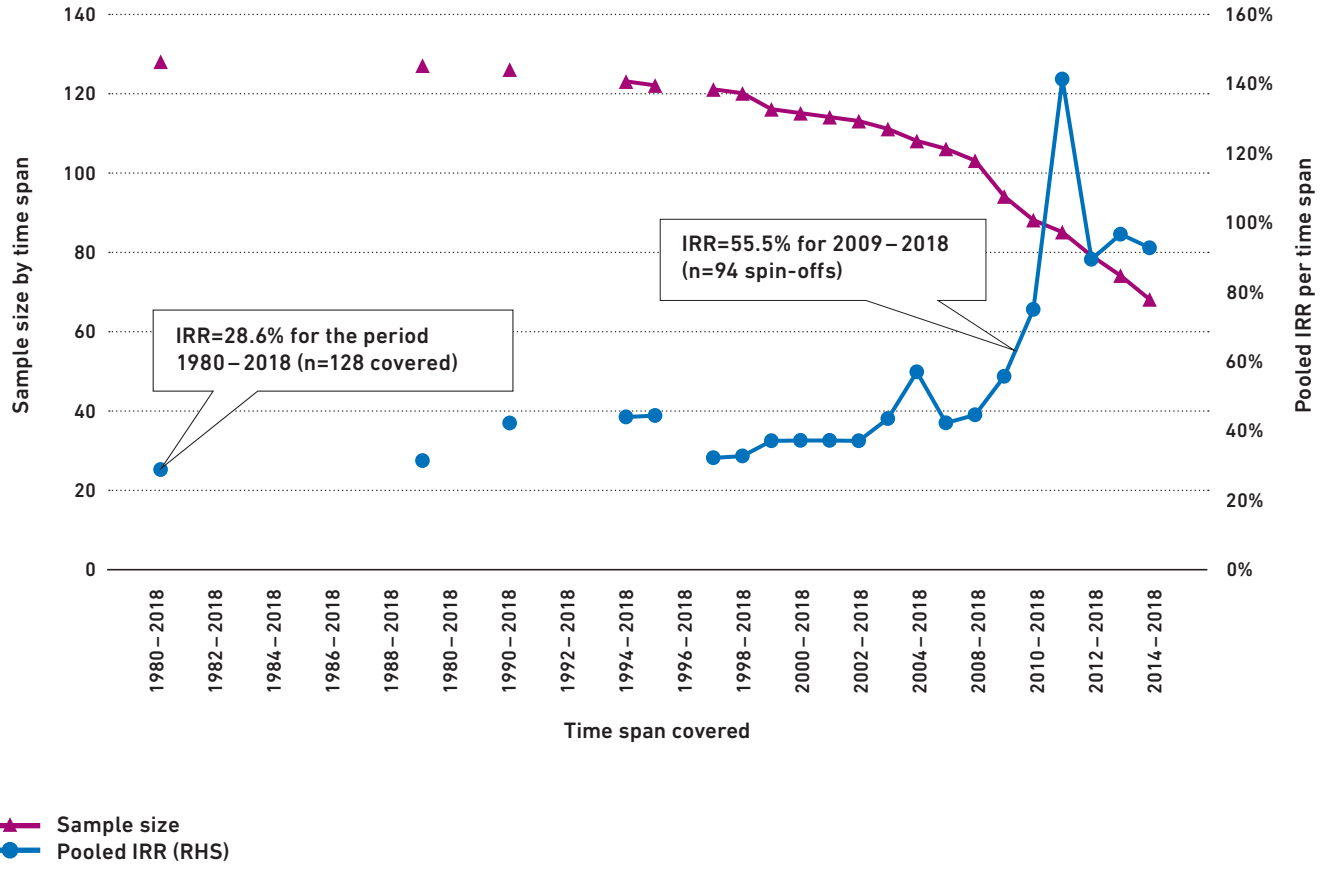


Figure 24: ETH Zurich spin-offs; sensitivity of pooled IRR based on period covered (from n=128 to n=68) (RHS = right-hand side)
The pooled IRR calculation is highly sensitive to the time span it covers.

As can be seen in Figure 23, the net cash flows before 2000 are marginal in comparison with the most recent decade and hence barely visible on the same scale. The net cash flows from 1980 to 1999 resulted in combined cash outflows of CHF 3.7 million, mostly in the form of capital invested at incorporation. The first positive peak in net cash flow in 2007 is the result of a major exit. The overall peak in 2018 is the result of the many companies that had their equity valued by multiples or recent financing rounds.

As already mentioned, the pooled IRR is particularly sensitive to the period it covers (see Figure 24). Although the 128 sample spin-offs since 1980 have generated CHF 2.0 billion in equity value as of today, the 85 spin-offs since 2011 that have created 'only' CHF 446 million in equity value are achieving a much higher pooled IRR of 141.3 per cent. This is because more return in less time is what drives up the IRR.

Given that ETH transfer started its spin-off activities in the 1990s, another interesting time window would be to consider the IRR for all spin-offs since 1993, thereby excluding the two spin-offs from 1980 and 1989 and resulting in a pooled IRR of 42.0 per cent for a sample of 126. In this sample of 126, only nine out of the 41 spin-offs with exits – arguably the most significant value drivers – are still represented. Since we do not have the required data to include most of the exit events in the pooled IRR calculation, the generated values are likely to be significantly below the true values for the spin-off population as a whole.

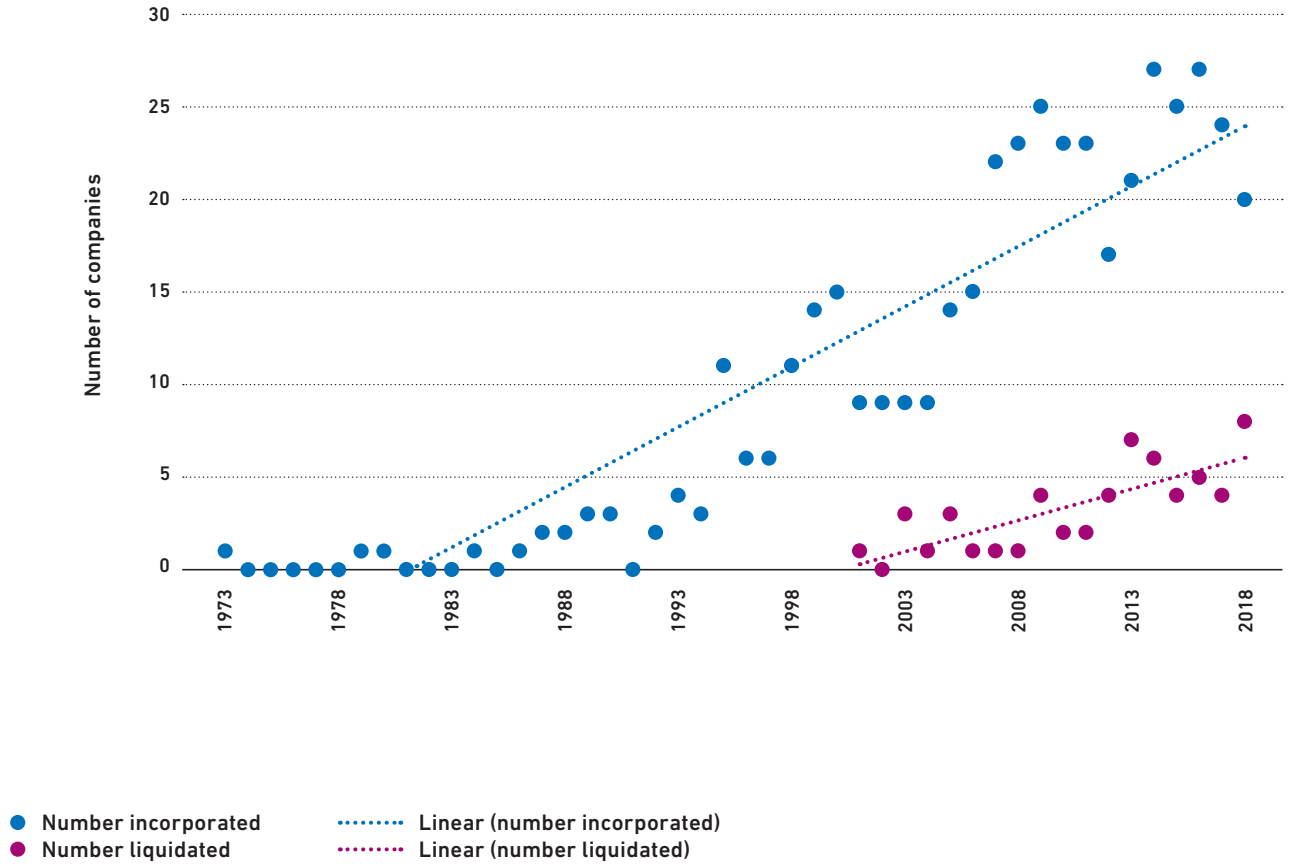


Figure 25: ETH spin-offs; number of incorporations and liquidations per year (n=429)

4.4. Operations-Related Factors

If a spin-off is successful, it has several options: these companies can either maintain their operations or make an exit, e.g. through an IPO or a trade sale. All of these options are explained in the following section. Unfortunately, not every start-up will be successful. In fact, most start-ups fail in the first few years of their existence, which is why this period – also known as the 'valley of death', where net cash flow is negative – will also be looked at in more detail in the following chapter.

4.4.1. Survival and Failure of ETH Spin-Offs

Information about incorporations and liquidations was obtained from extensive separate research of the Swiss commercial register.[7]

Figure 25 shows that out of the total of 429 spin-offs incorporated, 57 have been liquidated. The first liquidation that could be traced back through the Swiss commercial register happened in 2001. Since then, the number of liquidations has increased. This trend is explained by a similar rise in the number of spin-offs per year with a delayed impact on failure rates. Using only the number of liquidations as an

[7] In order to analyse the failure rates of spin-off companies from ETH Zurich, the date of their foundation had to be determined first. Since the date on which the label was awarded can differ from the date of incorporation by up to two years, the collection of this data was decisive.

indicator of failure, the 'total failure rate' among the population is 13.3 per cent (57 out of 429 spin-offs), resulting in an 'overall survival rate' of 86.7 per cent. This very cautious approach has been chosen so as not to define market activity on the basis of uncertain factors. One shortcoming of this proxy, however, is that it does not take into account companies that are no longer commercially active but have not been liquidated either.

In order to compare the results of this study with earlier ones, from now on only the timed failure rates since 1998 will be considered. Since then, a total of 362 companies have been founded. Of these, 51 firms have ceased trading, which corresponds to a rate of 14.09 per cent. Compared with the 2008 study, this failure rate has increased by 2.6 percentage points from 11.5 per cent (Oskarsson & Schläpfer, 2008). The overall survival rate for all enterprises with at least five years of activity is 92.9 per cent, while the survival rate for ten years of activity is 85.7 per cent (see Table 2).

Compared with the first study ten years ago (Oskarsson & Schläpfer, 2008), the five-year failure rate has decreased from 9 per cent to 7.1 per cent, indicating that ETH Zurich spin-offs now have a better chance of surviving early-stage development.

4.4.2. Valley of Death

The term 'valley of death' has been widely used in entrepreneurship and describes the lack of funding available within a given period. The money cycle is a critical point – especially

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Failures	Incorporated
1998	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	9.09%	9.09%	9.09%	9.09%	18.18%	18.18%	27.27%	27.27%	27.27%	27.27%	27.27%	3	11
1999	0.00%	8.33%	8.33%	16.67%	25.00%	25.00%	25.00%	33.33%	33.33%	33.33%	33.33%	33.33%	33.33%	41.67%	41.67%	41.67%	41.67%	41.67%	41.67%		5	14
2000	0.00%	0.00%	0.00%	0.00%	0.00%	7.69%	7.69%	7.69%	15.38%	15.38%	15.38%	15.38%	15.38%	15.38%	15.38%	15.38%	15.38%	23.08%			3	15
2001	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	14.29%				1	9
2002	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%					0	9
2003	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	12.50%	12.50%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%						2	9
2004	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%							1	9
2005	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%								0	14
2006	0.00%	0.00%	0.00%	7.14%	7.14%	7.14%	7.14%	14.29%	14.29%	21.43%	21.43%	21.43%									3	15
2007	0.00%	9.09%	9.09%	9.09%	13.64%	13.64%	13.64%	18.18%	22.73%	22.73%	22.73%										5	22
2008	0.00%	0.00%	0.00%	0.00%	8.70%	13.04%	13.04%	17.39%	17.39%	17.39%											4	23
2009	0.00%	8.00%	8.00%	8.00%	12.00%	12.00%	12.00%	16.00%	16.00%												4	25
2010	0.00%	0.00%	4.35%	13.04%	13.04%	17.39%	21.74%	26.09%													6	23
2011	0.00%	4.35%	8.70%	13.04%	13.04%	13.04%	17.39%														4	23
2012	0.00%	0.00%	5.88%	5.88%	11.76%	17.65%															3	17
2013	0.00%	0.00%	4.76%	4.76%	9.52%																2	21
2014	0.00%	0.00%	0.00%	0.00%																	0	27
2015	0.00%	4.00%	8.00%																		2	25
2016	0.00%	3.70%																			1	27
2017	8.33%																				2	24
Total	0.42%	1.97%	3.17%	4.57%	7.12%	8.44%	9.30%	11.19%	13.05%	14.26%	13.95%	12.97%	11.91%	16.10%	16.71%	16.86%	24.65%	30.67%	34.47%	27.27%	51	362

Table 2: ETH spin-offs; timed failure rates by vintage (n=429)

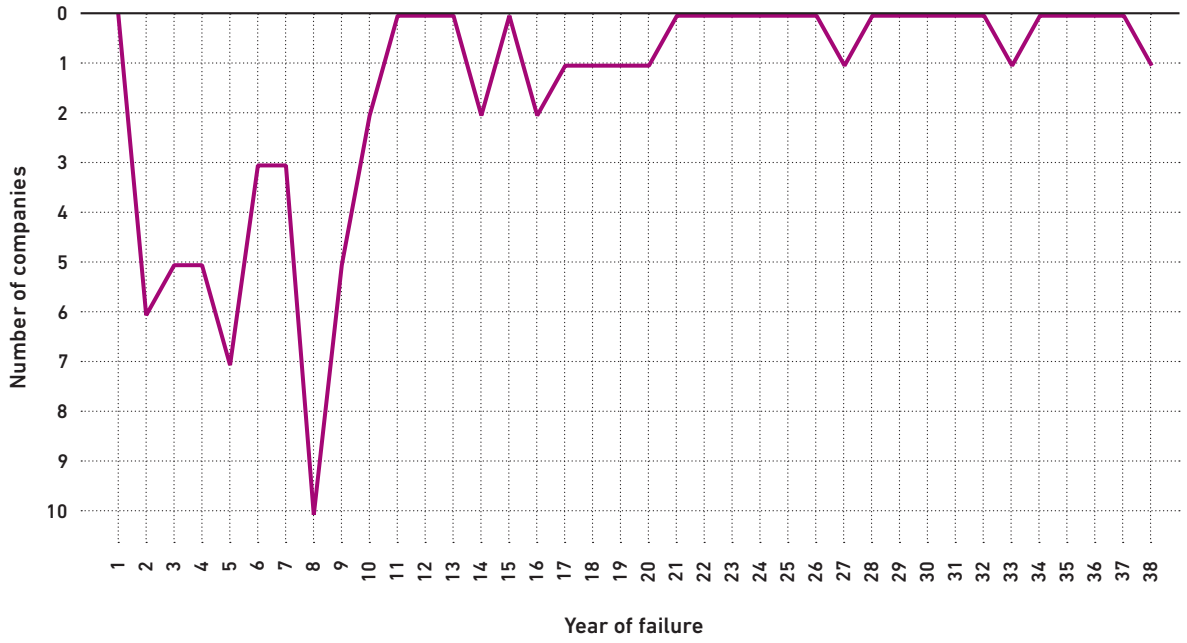


Figure 26: ETH spin-offs; amount of liquidations after x years (n=429)

at the beginning of a new business. During this phase it is difficult for start-ups to acquire financing, while the cash burn rate is high and thus increases the risk of failure.

The time between incorporation and failure was measured for the purposes of this analysis (n=57). These findings might differ from previous analyses because some of the past studies have used the label date, which can differ from the incorporation date by up to two years, and in addition the definition of failure varies, as explained in section 2.3. As can be seen in Figure 26, most of the failures in the underlying sample occurred within the first ten years after incorporation (77.2 per cent of all failed companies). While most failures happened in year eight, 40.35 per cent of all liquidations occurred within the first five years.
The average time to liquidation of ETH spin-offs is nine years, with extremes of 16 months at the lower end and 38 years at the maximum (the median is seven years). In terms of vintages, 1997 had the highest default rate, as five out of seven spin-offs had been liquidated by the end of 2018.

4.4.3. Survival Rate Comparison with the Swiss Start-Up Ecosystem

The Swiss Federal Statistical Office (FSO; 2018) has published the one-year to three-year 'timed survival rates' of all companies newly incorporated between 2013 and 2015 for Switzerland as a whole and for the canton of Zurich, where 337 of the 429 spin-offs have their registered domicile. As shown in Figure 27, the three-year survival rate across all ETH spin-offs is 97.4 per cent compared with 62 per cent for all new companies in Switzerland and 64 per cent for all new companies in the canton of Zurich. As the FSO has not yet published the official statistics for start-ups and liquidations beyond 2015, the four-year and five-year survival rates were forecast using an exponential trend curve that corresponds to previous findings by Oskarsson & Schläpfer (2008), when the FSO published five-year survival rates of below 50 per cent. The chart shows that even in terms of the five-year survival rate, ETH Zurich spin-offs exceed the average for Swiss start-ups by more than 40 per cent.

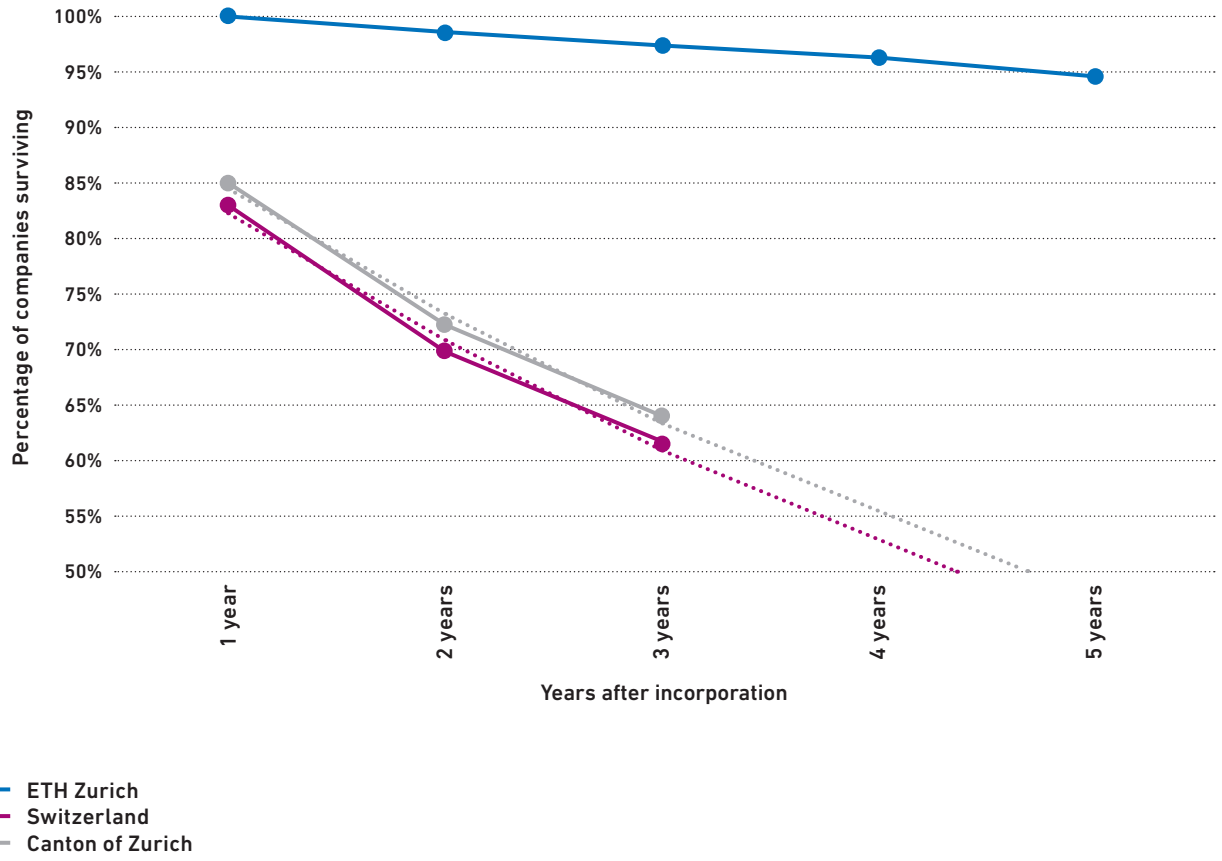


Figure 27: timed survival rates for all ETH spin-offs and for all incorporations in Switzerland and in the canton of Zurich

Spin-offs from ETH Zurich have a significantly higher survival rate than start-ups in Switzerland. These findings confirm research by Shane (2004) that spin-offs from universities have significantly higher survival rates than the average newly-founded small business. Universities' strong research base in conjunction with their solid technical proofs of concept and highly talented people is a possible explanation for this.

According to the Swiss Startup Radar (Kyora et al., 2018), the critical time frame for the liquidation of Swiss start-ups is in years five and six, when many companies are trying to enter the market. The reasons for failure are either a lack of demand for the specific product/service or a lack of funds for market entry and expansion. The results from ETH Zurich spin-offs differ slightly from the findings produced by Kyora et al. (2018). Only 18 per cent of all failures of ETH Zurich spin-offs happen during years five and six (seven companies and three companies respectively out of all 57 failures). Rather, the period from four to eight years after foundation is particularly susceptible to failures, as about half of all liquidations fall within this period (28 out of 57).

4.4.4. Survival Rate Comparison with University Spin-Offs

A good benchmark for Swiss spin-off companies is the market in the United Kingdom. Since the first study was conducted at the London Business School, previous comparisons were made with UK universities. Fu and Wright (2015) carried out a study involving British spin-off companies from different regions of the UK. They examined the survival rates of spin-offs by dividing universities into quartiles according to their position in the UK University League Tables. Both end-quartiles (top 25 per cent and bottom 25 per cent) had

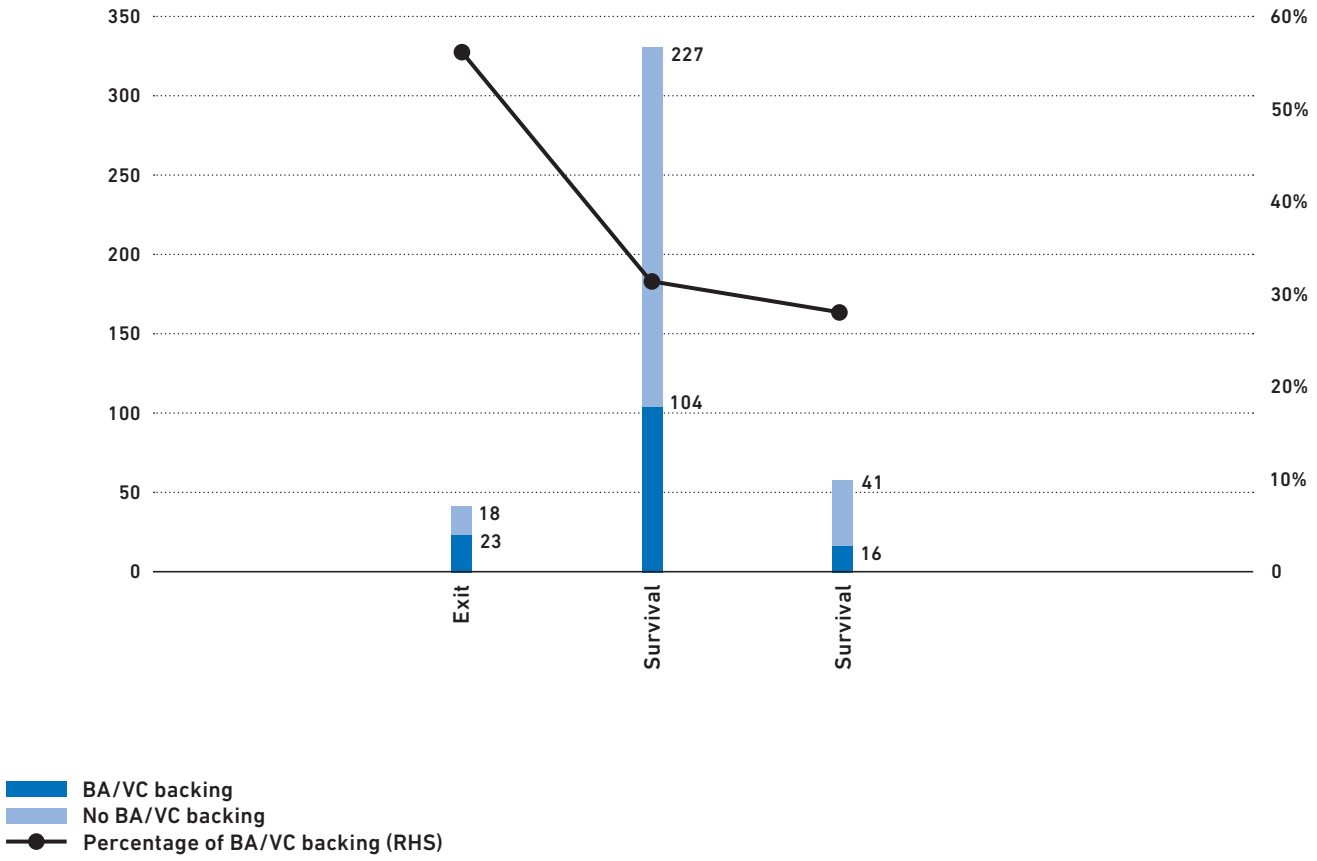


Figure 28: ETH spin-off population; outcome by BA/VC backing (n=429) (RHS = right-hand side)

similar survival and exit rates. While the spin-offs from UK universities generally have an overall survival rate of 67 per cent, the total survival rate for the ETH Zurich spin-offs is significantly higher at 86.7 per cent.

4.4.5. Exits

The ETH Zurich spin-off database and press releases enabled 41 exits of spin-offs to be identified – almost a tenth of the population (9.6 per cent). By far the most common type of exit was through a trade sale (37 spin-offs, representing 87.8 per cent of all exits). Furthermore, there have been two IPOs and two reverse mergers. Kyora et al. (2018) reported a slightly lower exit rate of 6 per cent for Swiss start-ups. However, the authors expect this rate to increase as the foundation of new ventures per year has tripled since 2005. Having achieved an exit rate of 9.6 per cent, ETH Zurich spin-offs also exceed UK university spin-offs, which reveal a total trade sale rate of 6.6 per cent and an IPO rate of 0.5 per cent in the top 25 per cent quartile and a rate of 2.0 per cent in the top 25 per cent to 50 per cent quartile (Fu & Wright, 2015).

As shown in Figure 28, the existence of BA/VC investments in exit companies was overrepresented and underrepresented in liquidated companies. This could be an indicator that BAs and VCs are particularly adept at identifying successful spin-offs. Another possibility is that spin-offs receiving BA or VC funds are more likely to survive and exit owing to their increased financial resources, managerial and industry expertise, and their networks. Shane and Stuart (2002) show that the chance of a successful exit is strongly correlated with the amount of venture capital funding received.

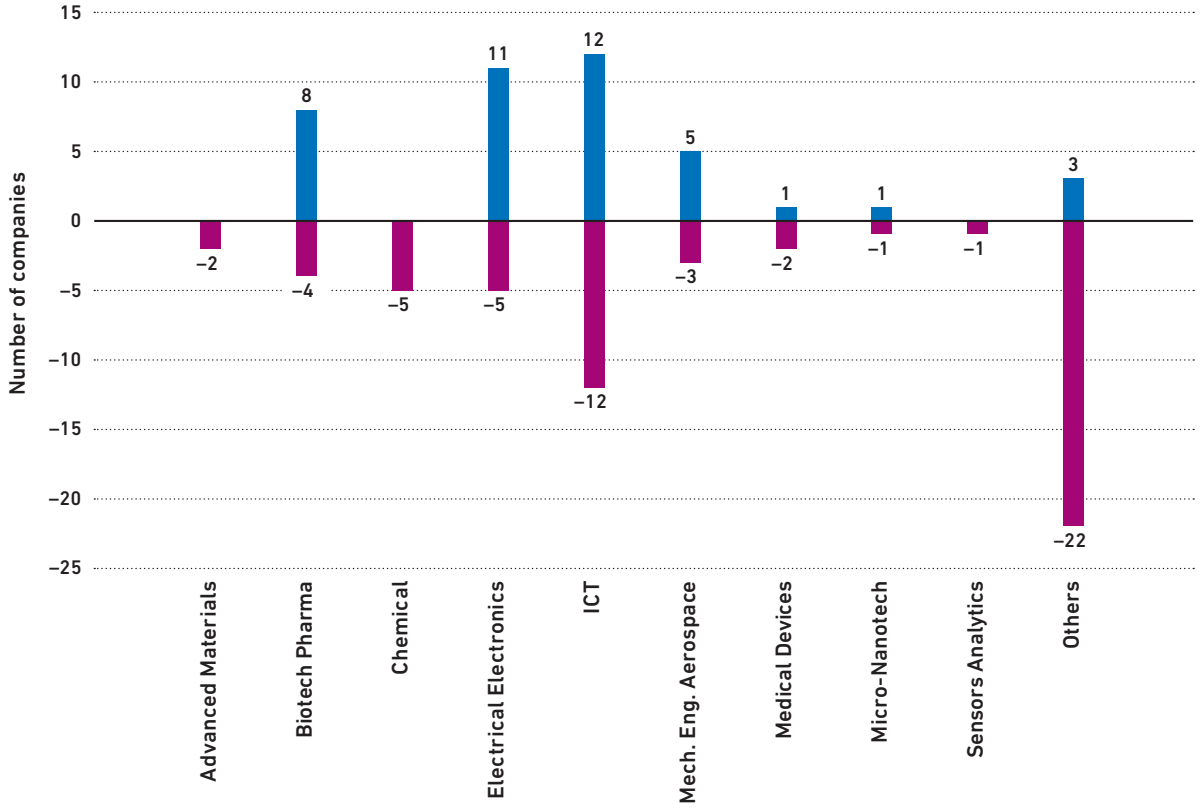


Figure 29: ETH spin-offs; liquidations and exits per sector (n=429)

The average time from foundation to the founders' exit was 7.4 years: one year at the lower end and 21 years at the upper end (median of six years). The time to exit also varies from sector to sector. While it took Biotech Pharma spin-offs an average of 8.6 years to exit, ICT spin-offs completed an exit after 5.4 years on average. These numbers are close to what the Swiss Startup Radar found, where entrepreneurs exited after an average of nine years, although significant variance around the mean was reported here (Kyora et al., 2018).

4.4.6. Exits versus Liquidations per Sector

In summary it can be stated that, within the total population of 429 companies, the rate for exits is 9.56 per cent and the total failure rate for the population as a whole is 13.28 per cent. The value for the number of failures is similar to previous studies, which found an aggregate failure rate for the total population of 11.5 per cent in 2008 (Oskarsson & Schläpfer, 2008) and 14.3 per cent in 2013 (Pinter, 2015).

From a sectoral point of view there are considerable differences. ICT (12) and Electrical Engineering & Electronics (11) have the most exits in absolute terms (see Figure 29). In terms of the number of start-ups per sector, Electrical Electronics also has the largest share of exits (23.4 per cent). While the ICT sector accounts for 21.05 per cent of all failures, only 11.2 per cent fail in terms of the sector's number of incorporations. Overall, most failures occur within the Others sector, which accounts for 38.6 per cent of all liquidations. In terms of the number of liquidated start-ups within the same sector, only the Chemicals sector has a higher failure rate (33.3 per cent).

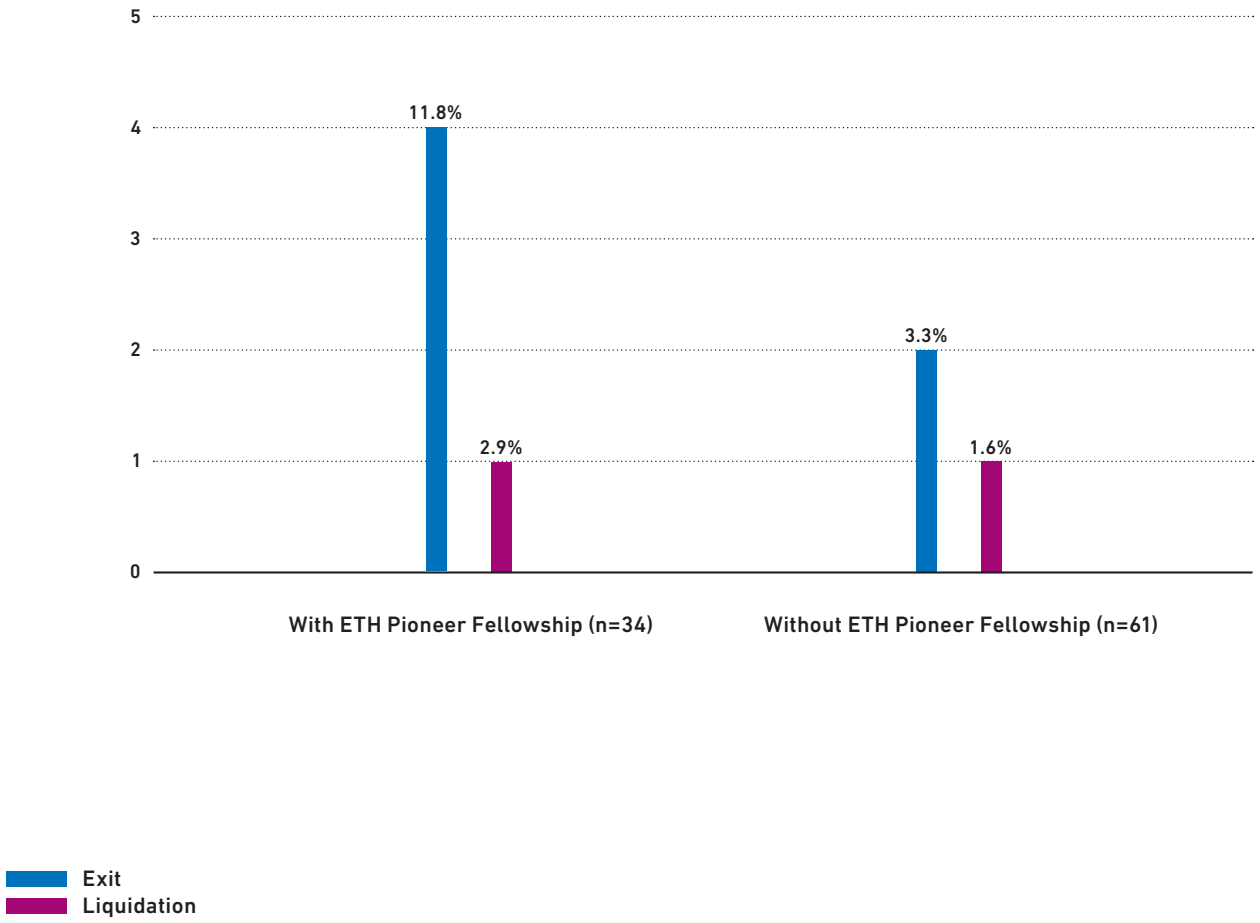


Figure 30: exits and liquidations of ETH spin-offs incorporated by pioneer fellows versus non-pioneer fellows between 2010 and 2018 (n=95)

Biotech Pharma, Electrical Engineering & Electronics, and Mechanical Engineering & Aerospace are the only industries with higher exit rates than liquidation rates. It is not surprising that the Biotech Pharma sector is one of the most frequently listed sectors to exit, as large pharmaceutical companies strive to keep their development pipelines full and therefore have to make acquisitions of smaller pharmaceutical companies. On the other hand, it is not surprising that the Others sector has such a high number of failures: since this sector consists mainly of consulting firms, these spin-offs usually do not carry out an exit.

4.4.7. Comparison between Pioneer Fellows and Non-Pioneer Fellows

In order to measure the impact of the Pioneer Fellowship programme on the survival rate, all participating companies incorporated after 2010 have been taken into account (n=95). While 34 companies have been awarded with the ETH Pioneer Fellowship, 61 companies did not receive this grant. Figure 30 shows that former pioneer fellows have a significantly higher proportion of exits (11.8 per cent) than non-pioneer fellows (3.3 per cent). This could potentially be attributed to the support provided in the programme.

5. Summary and Conclusion

In 2018, Switzerland was again ranked number one in innovation performance by the Global Innovation Index (Cornell University, INSEAD & WIPO, 2018). With its 429 spin-offs, ETH Zurich makes a significant contribution to Switzerland's innovative strength by transforming scientific knowledge and new technologies into marketable innovations. This report analyses the performance of ETH spin-offs and the success factors leading to them.

The section on human resources factors analysed the impact of various elements of a spin-off's diversity on its ability to attract finance. Most spin-offs are founded by male-dominated teams with members from the same educational background. The analysis shows that teams are able to raise seven times more funds than a single founder. However, start-up teams, including women, receive significantly less funding than teams that include male founders only. This is particularly evident in the differences in funding provided by BAs and VCs. Teams with entrepreneurial experience had an advantage when seeking investment from both BAs and VCs and other sources of finance. The findings are largely consistent with previous research.

The majority (95.1 per cent) of ETH Zurich spin-offs are still headquartered in Switzerland, with most spin-offs being deeply rooted in their home canton of Zurich (75.7 per cent). This is directly related to the impact of these companies on the local economy, as the survey sample has created a total of 4'448 jobs, or 31 jobs per spin-off. Representing almost half of the total number of jobs, Electrical Engineering & Electronics spin-offs create more jobs than any other sector, although they account for only 10.3 per cent of all companies. The Electrical Engineering & Electronics sector also has the largest number of patents, thereby contributing the most to local innovation.

One-third of the total population of 429 spin-offs have BA or VC financing. An extrapolation from the respondents and additional documents shows that the total financing acquired by these spin-offs could be well over CHF 1 billion. The Biotech Pharma sector is by far the strongest fundraiser, which suggests that investors are clearly very willing to finance companies in this sector. A significant proportion of the funds comes from external sources, with BA and VC investments accounting for 86 per cent of the total equity in ETH Zurich spin-offs. Spin-offs that have obtained financing from BAs or VCs are able to acquire 20 times more funding than the others. A total pooled IRR of 56 per cent has been achieved for the last ten years.

A total failure rate of 13.3 per cent has been calculated for all spin-offs and is based on 57 liquidations in the total pool of 429 spin-offs. The most critical time frame for failure is between four and eight years. The ETH Zurich spin-offs have a significantly higher five-year survival rate (93 per cent) than Switzerland as a whole. It takes an average of 7.4 years for the founders to exit a start-up through a trade sale or IPO. Electrical Electronics has the largest share of exits, which underlines the position of this sector's spin-offs as successful, high-impact companies. The Biotech Pharma sector also has a significant proportion of exits that exceeds the proportion of liquidations. This may be associated with the substantial fundraising opportunities mentioned above, as VCs and BAs expect a successful exit to maintain their profits.

When comparing ETH spin-offs supported by a Pioneer Fellowship with those spin-offs without one, we can observe that ICT projects are underrepresented among pioneer fellows, which means that lower average revenues are generated in the studied sample. Companies incorporated by pioneer fellows raise less financing than their peers during the first few years after incorporation, which suggests that grant money may delay the need for external funding. With 11.8 per cent of the companies incorporated by pioneer fellows experiencing a successful exit, the rate of exits is more than three times higher than for other companies incorporated in the same time period.

Overall, the findings of the survey and our additional research show that spin-offs from ETH Zurich perform significantly better than Swiss start-ups as a whole and also in comparison with spin-offs from universities in other

countries. This applies in particular to the high survival rates of spin-offs from ETH Zurich and also to their fundraising and job creation. In addition, ETH spin-offs on average hire more employees than start-ups in Switzerland and Europe overall. This contribution to the growth of the Swiss economy shows how beneficial these spin-offs are for the local economy and the innovative strength of Switzerland as a whole.

The limitations of the study result from the different methods and time frames used in our analysis. The figures can therefore only be compared to a certain extent with previous studies on spin-offs from ETH Zurich, as they may vary according to which years are being analysed. This is particularly relevant for the measurement of variables such as the pooled IRR or the survival rate. These limitations have consistently been discussed in the respective chapters.

This report has highlighted the innovative power and technological strength of ETH Zurich spin-offs as a key success factor. However, these start-ups require more support than the average Swiss start-up as they do not usually have the managerial or financial resources necessary to develop their original technology into a viable product. For this reason, the university's support structures in the form of units like ETH transfer are especially important. ETH transfer can, however, go beyond providing its present support. Spin-offs would like to have further proof-of-concept financing in future. By strengthening its support efforts in this area, ETH transfer could help close the funding gap and thus improve the opportunities to develop these start-ups further. Another important point is its strong network of BAs and VCs. ETH transfer could expand its international investor network and, in particular, strengthen its contacts with investors, focusing on specific industries in order to connect them with the relevant spin-offs. This will enable these investors to support spin-offs during the early start-up phase and to create the right conditions for the critical growth phase in which a funding boost is needed. It is also important to network ETH founders with management-focused founders in order to improve the expertise and skill sets of the founding teams, thereby sustainably increasing their chances of success.

6. Table of Figures

7. References

Baldegger, R., Alberton, S., Wild, P., & Gaudart, R. (2018). *Global Entrepreneurship Monitor 2017 / 2018: Report on Switzerland.*

Bhardwa, S. (2018). *https://www.timeshighereducation.com.* Retrieved from https://www.timeshighereducation.com/student/news/top-100-most-innovative-universities-europe-2018 on 3 May 2018.

Allgemeine Systematik der Wirtschaftszweige. Bundesamt für Statistik BFS. (2008). Retrieved from https://www.bfs.admin.ch/bfs/de/home/statistiken/industrie-dienstleistungen/nomenklaturen/noga.assetdetail.415633.html.

Burkhard, B. (2015). Who creates jobs? The role of start-ups in Swiss job creation. Retrieved from https://www.startupticker.ch/en/news/june-2015/who-creates-jobs-the-role-of-start-ups-in-swiss-job-creation on: 30 June 2015.

Cooney, T. (2005). Editorial: What is an Entrepreneurial Team? *International Small Business Journal 23(3),* 226–235.

Cornell University; INSEAD; WIPO. (2018). *The Global Innovation Index 2018: Energizing the World with Innovation.*

Dahl, M., & Sorenson, O. (2012). Home sweet home: Entrepreneurs' location choices and the performance of their ventures. *Management Science 58(6),* 1059–1071.

Delmar, F., & Shane, S. (2006). Does experience matter? The effect of founding team experience on the survival and sales of newly founded ventures. *STRATEGIC ORGANIZATION 4(3),* 215–247.

ETH Zurich. (2014). *Gender Action Plan (GAP).*

ETH Zurich. (2018)a. *ETH Zurich: Annual report 2017.*

ETH Zürich. (2018)b. ETH Pioneer Fellowships. Retrieved from https://www.ethz.ch/en/industry-and-society/entrepreneurship/pioneer-fellowships.html.

Grichnik, D., Brettel, M., Koropp, C., & Mauer, R. (2017). *Entrepreneurship: Unternehmerisches Denken, Entscheiden und Handeln in innovativen und technologieorientierten Unternehmen.*

Grichnik, D., Vogel, P., & Burkhard, B. (2016). *Swiss Start-up Monitor: The Swiss entrepreneurial ecosystem report 2015/2016.* The Swiss Start-up monitor.

Hensellek, S., Kensbock, J., Kollmann, T., & Stöckmann, C. (2016). *European Startup Monitor (ESM).*

Hunt, V., Prince, S., Dixon-Fyle, S., & Yee, L. (2018). *McKinsey&-Company: Delivering through Diversity.* McKinsey&Company.

Kamm, J., Shuman, J., Seeger, J., & Nurick, A. (1990, July 1). Entrepreneurial Teams in New Venture Creation: A Research Agenda. *SAGE journals 14(4),* 7–17.

Kane, T. (2010). *Kauffman Foundation Research Series: Firm Formation and Economic Growth: The Importance of Startups in Job Creation and Job Destruction.* Ewing Marion Kauffman Foundation.

Klotz, A., Hmieleski, K., Bradley, B., & Busenitz, L. (2014). New Venture Teams: A Review of the Literature and Roadmap for Future Research. *Journal of Management 40(1),* 226–255.

Kyora, S., Rockinger, M., & Jondeau, E. (2018). *Swiss Startup Radar 2018/2019.*

Mair, S. (2017). Startups: Warum der Schweiz die Gründerinnen fehlen. Retrieved from https://www.handelszeitung.ch: https://www.handelszeitung.ch/management/start-ups-warum-der-schweiz-die-gruenderinnen-fehlen-1385363 on 19 April 2017.

Mauldin, J. (2017). Startups Will Define The Future Of U.S. Employment. *Forbes.* Retrieved from https://www.forbes.com/sites/johnmauldin/2017/03/13/startups-will-define-the-future-of-us-employment/#7152b2f65f8d.

Mombelli, A. (2018). The best Swiss start-ups of 2018. Retrieved from https://www.swissinfo.ch/eng/innovation-awards_the-best-swiss-start-ups-of-2018/44377888.

OECD. (2008). *Compendium of Patent Statistics.*

Oskarsson, I., & Schläpfer, A. (2008). *The performance of Spin-off companies at the Swiss Federal Institute of Technology Zurich.*

Phalippou, L. (2008). The Hazards of Using IRR to Measure Performance: The Case of Private Equity. *Journal of Performance Measurement 12(4) ,* 55–66.

Pinter, V. (2015). *Overview and analysis of the performance of Spin-offs at the Swiss federal Institute of Technology Zurich and their effect on the Swiss Economy.* Zurich: ETH transfer.

Rasmussen, E., Mosey, S., & Wright, M. (2011). The Evolution of Entrepreneurial Competencies: A Longitudinal Study of University Spin-Off Venture Emergence. *Journal of Management Studies 48(6),* 1314–1345.

Sarasvathy, S., Menon, A., & Kuechle, G. (2013). Failing firms and successful entrepreneurs: serial entrepreneurship as a temporal portfolio. *Small Business Economics 40,* 417–434.

Schjoedt, L., & Kraus, S. (2009). Entrepreneurial teams: definition and performance factors. *Management Research News 32(6)*, 513–524.

Schubert, R., & Storjohann, R. (2018). *Gender Monitoring 2017/18: Report on the Gender Balance between Women and Men in Studies and Research at ETH Zurich.* Zurich.

Shane, S. (2004). *Academic Entrepreneurship: University Spin-offs and Wealth Creation.*

Staatssekretariat für Bildung, Forschung und Innovation SBFI. (2018). *Die Schweizer Forschung und Innovation im internationalen Vergleich – Aktualisierte Indikatoren 2018.*

Startup Genome. (2018). *Global Startup Ecosystem Report 2018: Succeeding in the New Era of Technology.*

Swiss Federal Institute of Intellectual Property. (2019). *Annual Report 2017|18.*

Bundesamt für Statistik. (2018). Über 80% der Unternehmen sind ein Jahr nach ihrer Gründung noch aktiv. *Medienmitteilung (10.12.2018).*

telegraph.co.uk. (2014). *https://www.telegraph.co.uk.* Retrieved from https://www.telegraph.co.uk/education/universityeducation/11299261/League-tables-the-top-universities-for-research.html on 18 December 2014.

Torcasso, D. (2018). Das Zuger «Crypto Valley» ist 44 Milliarden Dollar schwer. *Handelszeitung.* Retrieved from https://www.handelszeitung.ch/unternehmen/das-zuger-crypto-valley-ist-44-milliarden-dollar-schwer: https://www.handelszeitung.ch/unternehmen/das-zuger-crypto-valley-ist-44-milliarden-dollar-schwer.

Valero, A., & Van Reenen, J. (2016). The Economic Impact of universities: Evidence from across the globe. *NBER Working Paper Series.*

Vogel, R., Puhan, T. X., Shehu, E., Kliger, D., & Beese, H. (2014). Funding decisions and entrepreneurial team diversity: A field study. *Journal of Economic Behavior & Organization 107,* 595–613.

Westhead, P., & Wright, M. (2015, March 13). The habitual entrepreneur phenomenon. *International small business journal., Virtual Special Issue,* 1–16.

Wright, M., & Fu, K. (2015). University Spin-outs: What do we know and what are the policy implications? Evidence from the UK. *Journal of Innovation Management 3(4) ,* 5–15.

Wright, M., & Vanaelst, I. (2009). *Entrepreneurial Teams and New Business Creation.*

Wright, M., Robbie, K., & Ennew, C. (1997, May). Venture Capitalists and serial entrepreneurs. *Journal of Business Venturing 12(3),* 227–249.

Appendix A: Tables and Figures

Table 1. Chi-square tests for survey (n=143), funding (n=131), equity value (n=148) and return (n=128) sample vs population (n=429) based on their sector composition

Survey sample (n=143) vs population

	Sample		Population		Chi-Square Test	
Sector	#	%	#	%	Observed #	Expected #
Advanced Materials	6	4%	14	3%	6	5
Biotech Pharma	25	17%	72	17%	25	24
Chemical processes & Compounds	6	4%	15	3%	6	5
Electrical Engineering & Electronics	14	10%	47	11%	14	16
Information & Communications Technology ICT	42	29%	107	25%	42	36
Mechanical Engineering & Aerospace	16	11%	48	11%	16	16
Medical Devices	10	7%	17	4%	10	6
Micro- & Nanotechnology	3	2%	8	2%	3	3
Sensors Analytics	2	1%	7	2%	2	2
Others	19	13%	94	22%	19	31
Total	**143**	**100%**	**429**	**100%**	**143**	**143**

Correlation factor for sample & population: 92% **Chi-square p-value: 0.34**

Funding sample (n=131) vs population

	Sample		Population		Chi-Square Test	
Sector	#	%	#	%	Observed #	Expected #
Advanced Materials	6	4%	14	3%	6	4
Biotech Pharma	22	15%	72	17%	22	22
Chemical processes & Compounds	4	3%	15	3%	4	5
Electrical Engineering & Electronics	13	9%	47	11%	13	14
Information & Communications Technology ICT	40	28%	107	25%	40	33
Mechanical Engineering & Aerospace	15	10%	48	11%	15	15
Medical Devices	9	6%	17	4%	9	5
Micro- & Nanotechnology	2	1%	8	2%	2	2
Sensors Analytics	2	1%	7	2%	2	2
Others	18	13%	94	22%	18	29
Total	**131**	**92%**	**429**	**100%**	**131**	**131**

Correlation factor for sample & population: 92% **Chi-square p-value: 0.40**

Equity sample (n=148) vs population

	Sample		Population		Chi-Square Test	
Sector	#	%	#	%	Observed #	Expected #
Advanced Materials	6	4%	14	3%	6	5
Biotech Pharma	28	20%	72	17%	28	25
Chemical processes & Compounds	5	3%	15	3%	5	5
Electrical Engineering & Electronics	19	13%	47	11%	19	16
Information & Communications Technology ICT	40	28%	107	25%	40	37
Mechanical Engineering & Aerospace	18	13%	48	11%	18	17
Medical Devices	9	6%	17	4%	9	6
Micro- & Nanotechnology	2	1%	8	2%	2	3
Sensors Analytics	2	1%	7	2%	2	2
Others	19	13%	94	22%	19	32
Total	**148**	**103%**	**429**	**100%**	**148**	**148**

Correlation factor for sample & population: 92% **Chi-square p-value: 0.43**

Return sample (n=128) vs population

	Sample		Population		Chi-Square Test	
Sector	#	%	#	%	Observed #	Expected #
Advanced Materials	6	4%	14	3%	6	4
Biotech Pharma	22	15%	72	17%	22	21
Chemical processes & Compounds	4	3%	15	3%	4	4
Electrical Engineering & Electronics	13	9%	47	11%	13	14
Information & Communications Technology ICT	38	27%	107	25%	38	32
Mechanical Engineering & Aerospace	15	10%	48	11%	15	14
Medical Devices	9	6%	17	4%	9	5
Micro- & Nanotechnology	1	1%	8	2%	1	2
Sensors Analytics	2	1%	7	2%	2	2
Others	18	13%	94	22%	18	28
Total	**128**	**90%**	**429**	**100%**	**128**	**128**

Correlation factor for sample & population: 93% **Chi-square p-value: 0.39**

For all four samples, the chi-square test does not reject the null hypothesis that the sample has the same composition as the population in terms of sectors.
Source: calculations with data from survey and ETH spin-off database.

Table 2. Chi-square tests for survey (n=143), funding (n=131), equity value (n=148) and return (n=128) sample vs population (n=429) based on their 5-year vintage composition

Survey Sample (n=143) vs population

	Sample		Population		Chi-Square Test	
Vintage	#	%	#	%	Observed #	Expected #
1973–1978		0%	1	0%	0	0
1979–1983	1	1%	2	0%	1	1
1984–1988		0%	6	1%	0	2
1989–1993	5	3%	12	3%	5	4
1994–1998	3	2%	37	9%	3	12
1999–2003	9	6%	56	13%	9	19
2004–2008	24	17%	83	19%	24	28
2009–2013	29	20%	109	25%	29	36
2014–2018	72	50%	123	29%	72	41
Total	**143**	**100%**	**429**	**100%**	**143**	**143**

Correlation factor for sample & population: 86% **Chi-square p-value: 0.000003**

Funding sample (n=131) vs population

	Sample		Population		Chi-Square Test	
Vintage	#	%	#	%	Observed #	Expected #
1973–1978		0%	1	0%	0	0
1979–1983	1	1%	2	0%	1	1
1984–1988		0%	6	1%	0	2
1989–1993	4	3%	12	3%	4	4
1994–1998	2	1%	37	9%	2	11
1999–2003	9	6%	56	13%	9	17
2004–2008	19	13%	83	19%	19	25
2009–2013	28	20%	109	25%	28	33
2014–2018	68	48%	123	29%	68	38
Total	**131**	**92%**	**429**	**100%**	**131**	**131**

Correlation factor for sample & population: 85% **Chi-square p-value: 0.000002**

Equity sample (n=148) vs population

	Sample		Population		Chi-Square Test	
Vintage	#	%	#	%	Observed #	Expected #
1973–1978		0%	1	0%	0	0
1979–1983	1	1%	2	0%	1	1
1984–1988		0%	6	1%	0	2
1989–1993	4	3%	12	3%	4	4
1994–1998	8	6%	37	9%	8	13
1999–2003	13	9%	56	13%	13	19
2004–2008	24	17%	83	19%	24	29
2009–2013	27	19%	109	25%	27	38
2014–2018	71	50%	123	29%	71	42
Total	**148**	**103%**	**429**	**100%**	**148**	**148**

Correlation factor for sample & population: 86% **Chi-square p-value: 0.003**

Return sample (n=128) vs population

	Sample		Population		Chi-Square Test	
Vintage	#	%	#	%	Observed #	Expected #
1973–1978		0%	1	0%	0	0
1979–1983	1	1%	2	0%	1	1
1984–1988		0%	6	1%	0	2
1989–1993	4	3%	12	3%	4	4
1994–1998	2	1%	37	9%	2	11
1999–2003	8	6%	56	13%	8	17
2004–2008	19	13%	83	19%	19	25
2009–2013	26	18%	109	25%	26	33
2014–2018	68	48%	123	29%	68	37
Total	**128**	**90%**	**429**	**100%**	**128**	**128**

Correlation factor for sample & population: 84% **Chi-square p-value: 0.000001**

For all four samples, the chi-square test strongly rejects the null hypothesis that the sample has the same composition as the population in terms of 5-year vintages.
Source: calculations with data from survey and ETH spin-off database.

Table 3. Chi-square tests for survey (n=143), funding (n=131), equity value (n=148) and return (n=128) sample vs population (n=429) based on their status ('exited', 'liquidated' and 'survived')

Survey Sample (n=143) vs population

	Sample		Population		Chi-Square Test	
Status	#	%	#	%	Observed #	Expected #
Exited	12	8%	41	10%	12	14
Liquidated	4	3%	57	13%	4	19
Survived	127	89%	331	77%	127	110
Total	**143**	**100%**	**429**	**100%**	**143**	**143**

Correlation factor for sample & population: 99% **Chi-square p-value: 0.0007**

Funding sample (n=131) vs population

	Sample		Population		Chi-Square Test	
Status	#	%	#	%	Observed #	Expected #
Exited	12	8%	41	10%	12	13
Liquidated	4	3%	57	13%	4	17
Survived	115	80%	331	77%	115	101
Total	**131**	**92%**	**429**	**100%**	**131**	**131**

Correlation factor for sample & population: 99% **Chi-square p-value: 0.002**

Equity sample (n=148) vs population

	Sample		Population		Chi-Square Test	
Status	#	%	#	%	Observed #	Expected #
Exited	24	17%	41	10%	24	14
Liquidated	4	3%	57	13%	4	20
Survived	120	84%	331	77%	120	114
Total	**148**	**103%**	**429**	**100%**	**148**	**148**

Correlation factor for sample & population: 98% **Chi-square p-value: 0.00005**

Return sample (n=128) vs population

	Sample		Population		Chi-Square Test	
Status	#	%	#	%	Observed #	Expected #
Exited	9	6%	41	10%	9	12
Liquidated	4	3%	57	13%	4	17
Survived	115	80%	331	77%	115	99
Total	**128**	**90%**	**429**	**100%**	**128**	**128**

Correlation factor for sample & population: 100% **Chi-square p-value: 0.001**

For all four samples, the chi-square test strongly rejects the null hypothesis that the sample has the same composition as the population in terms of status.
Source: calculations with data from survey and ETH spin-off database.

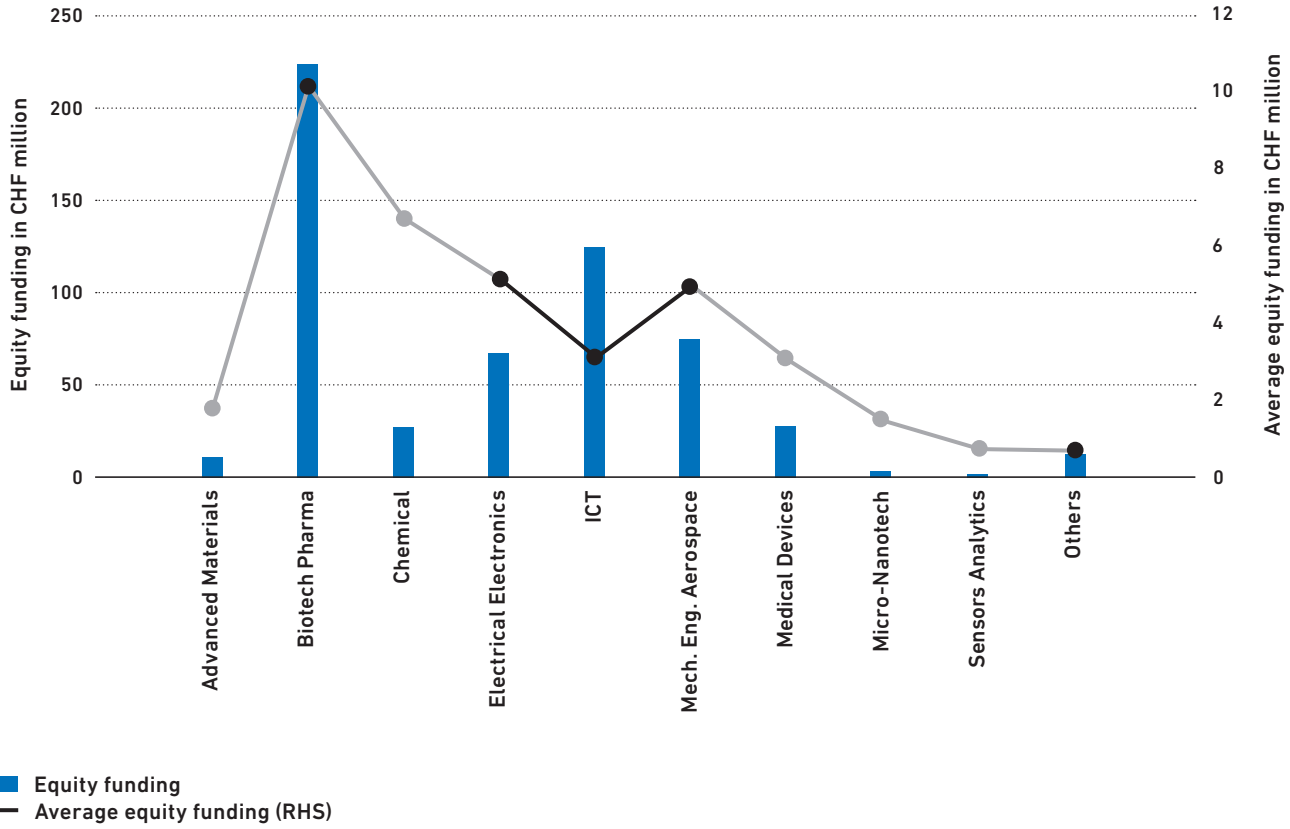


Figure 31: ETH Zurich spin-offs; equity funding by sector (n=131) (RHS = right-hand side)
Biotech Pharma is the sector with the most equity funding both in absolute and relative terms.
Averages based on fewer than ten observations are greyed out.

Appendix B: Survey

The survey was developed by Simon Hofer and Luca Fricker, two students at the University of St Gallen, in the context of their master theses, in collaboration with Hanna Brahme and Marjan Kraak from ETH transfer.

The survey was distributed officially through ETH transfer by email. It contained a study invitation letter from Detlef Günther from ETH Zurich and a link to the survey, which was hosted on the online survey tool Unipark (www.unipark.com). The study invitation letter and the print format of the survey can be found on the following pages.

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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Participation in a new study regarding the performance of ETH spin-offs

Dear spin-off founder,

In addition to research and education, the transfer of technology and know-how to society has become an important third mission and mandate for ETH Zurich. Spin-offs provide a vehicle of ever-increasing significance for this purpose. ETH Zurich is proud of its growing spin-off community and puts great effort into continuously improving its spin-off support. Our institution receives an increasing number of requests from governmental agencies as well as from society for detailed information regarding the performance and the impact of ETH spin-offs and we are therefore obliged to provide such information in a comprehensive manner. In order to fulfil this obligation and to better understand the factors for success or failure and to quantify the spin-off performance, we have initiated a new study covering the 400 ETH spin-offs to date. The study will be executed by Luca Fricker and Simon Hofer of the University of St Gallen with a mandate from ETH transfer's Spin-off Group (Silvio Bonaccio, Marjan Kraak and Hanna Brahme). The data collected will belong to ETH Zurich, will be treated confidentially, and only be presented anonymously. Both Luca and Simon have signed NDAs with ETH Zurich that ensure they are obliged to maintain strict confidentiality with regards to all data collected from ETH spin-offs as a part of the study.

We are very much depending on your help in this endeavour and we would be very grateful if you could take the time to share your data and own spin-off experiences. Your contribution will significantly aid the achievement of a complete picture of our ETH spin-off community. This in turn will help us to comply with the reporting requests and define actions to better support you, your colleagues and our future ETH spin-offs.

Should you have any questions regarding the execution of the study or how the data will be used, do not hesitate to contact Hanna Brahme (via email to spinoff-study@ethz.ch or phone: +41 44 632 81 36), who is responsible for the study.

With best regards,

ETH Zürich

Detlef Günther

1. What is the name of your company?
2. In order to get an understanding of the current operational status of your company, please let us know whether your company is active and if any of the events below applies
    a. Operating with _____ employees (full-time equivalent)
    b. Ceased activities, hibernation or liquidated in year
    c. Exit in year
    d. Other (please specify)
3. Activity ceased for one or more of the following reasons
    a. No market need
    b. Ran out of cash
    c. Not the right team
    d. Got outcompeted
4. What type of exit?
    a. Merger
    b. Acquisition
    c. IPO
    d. Other (please specify)
5. How much % of equity was sold for what price? (in case of an IPO, please use closing price of first day of listing)
6. Where is your headquarter located?
7. Where do you have branches? (Select if you have at least one office space in the country/region)
    a. Switzerland
    b. Germany
    c. Europe (other than CH and DE)
    d. US North America (other than US)
    e. South America
    f. Asia
    g. Africa
    h. Australia
8. Tell us a bit more about the founding team (For each founding member)
    a. Gender
    b. Nationality
    c. Highest education
    d. Field of education
9. Are any of the founders serial entrepreneurs?
10. How did the founding team get to know each other?
    a. Previous academic work
    b. Previous industry work
    c. Friends without prior work relation
    d. Entrepreneurship course
    e. Single founder
11. Does your company have an ESOP (Employee stock option pool)?
12. What was the highest number of employees (FTE) your company had during its lifespan?
    a. # Employees in total (FTE)
    b. # ETH graduates employed (FTE)

c. # ETH graduates in the management board
d. # ETH graduates in the board of directors

13. Indicate the equity-funds raised from each source and the corresponding # of shares received (please indicate for the field CHF the amount raised and for the field shared the amount of shares distributed per round. Furthermore the Rx stands for each round)

Round	Founders	FFF	BA's	VC's	Other	Date
CHF (R1)						
Shares (R1)						
CHF (R2)						
Shares (R2)						
CHF (R3)						
Shares (R3)						
CHF (R4)						
Shares (R4)						
CHF (R5)						
Shares (R5)						
CHF (R6)						
Shares (R6)						
CHF (R7)						
Shares (R7)						
CHF (R8)						
Shares (R8)						
CHF (R9)						
Shares (R9)						
CHF (R10)						
Shares (R10)						

14. Please list the key accounting indicators for the year 2017
    a. Revenue (CHF)
    b. EBIT (CHF)
    c. Profit after taxes (CHF)
    d. Equity at book value, 31/12/07 (CHF)
    e. Comments (optional)
15. Where are your investors based?
    a. Switzerland
    b. Germany
    c. Europe (other than CH and DE)
    d. US North America (other than US)
    e. South America
    f. Asia
    g. Africa
    h. Australia
    i. No investors involved
16. How many granted or pending patent families does your company have?
    a. # Registered in the name of the company
    b. # Licensed from ETH

    c. # Licensed from 3rd parties
17. What role does patents play for your business? (tick all that apply)
    a. Important to attract investors
    b. Necessary for the business
    c. Too expensive for the business
    d. Useful only in the beginning
    e. No relevance for the business
    f. Other (please specify)
18. Do you license out / sublicense out any patents to 3rd parties?
19. Does any of the following make up an important basis for your company? (tick all that apply)
    a. Software (developed at ETH or in the company), published under an open source license
    b. Software (developed at ETH or in the company), kept closed source
    c. Registered trademark
    d. Trade secret / confidential know-how
    e. Other (please specify)
    f. None of the above
20. Select all sources that significantly contributed to your progress (coaching, network, etc.) If significant contribution was only through funding, don't select
    a. Bridge Grant
    b. Pioneer Fellowship ETH
    c. ETH spin-off community
    d. Gebert Rüf
    e. Haslerstiftung
    f. Innosuisse (former CTI/KTI)
    g. Venture Leaders
    h. Venture Lab
    i. Venture Kick
    j. >>Venture>>
    k. ZKB Pionierpreis
    l. Wyss Zurich
    m. Other (please specify)
21. Please indicate the total amount of contributions from foundations, awards and other support mechanisms
22. On a scale from 1-10 how satisfied are you with the support from and interactions with ETH transfer? (1 means extremely unsatisfied and 10 extremely satisfied)
23. Through which of the following measures could ETH Zurich further improve its technology transfer? (Please tick the three most important ones.)
    a. More commercially oriented R&D
    b. Generate more VC / Angel interest
    c. Provide more “Proof-of-Concept” funding
    d. ETH to take more equity stakes (as part of the license agreement)
    e. Extend infrastructure and administrative support
    f. Improve the licensing terms (please specify)
    g. Increase business relevant experience in TTO
    h. Possibility to act as an investor in ETH spin-offs (at market value)
    i. Other (please specify)

24. What kind of community events have been the most helpful during the spin-off process and what events could improve the networking?
    a. Spin-off dinner
    b. Beekeeper platform
    c. Newsletter
    d. Drinks
    e. Sola relay
    f. Other
25. Did you have an industry partnership that significantly contributed to the progress of your spin-off? (If yes, please give some short information (including the financial contribution if available, e.g. "A pilot project with a pharma company contributed 100k CHF in funding")
26. Would you be available for a more in depth interview to help ETH Transfer improve its support programs? (If yes please enter the contact details for a follow up)