Software Start-up Failure

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An exploratory study on the impact of investment

Arho Suominen[1], Sami Hyrynsalmi[2], and Marko Seppänen[3],
Kaisa Still[1], Leena Aarikka-Stenroos[4]

[1] VTT Technical Research Centre of Finland, Espoo, Finland
{arho.suominen,kaisa.still}@vtt.fi
[2] Pervasive Computing, Tampere University of Technology, Pori, Finland
sami.hyrynsalmi@tut.fi
[3] Industrial and Information Management, Tampere University of Technology, Pori, Finland
marko.seppanen@tut.fi
[4] Industrial and Information Management, Tampere University of Technology, Tampere, Finland
leena.aarikka-stenroos@tut.fi

Abstract. Studying new venture success and failure is central to understanding the dynamics of new venture persistence. Investments, would they be subsidies, venture capital or shareholder investments, are seen as a statement of venture quality, but also as a tool for rapid growth. This study is a exploratory study that focus on creating understanding on if investment serve as a explanatory factor to increased activity (revenue). This study address whether software start-ups differ if the company has early stage investments and what is this relationship with the company being active later. We use the set of over 1,000 Finnish companies founded during 2010–2013 as an empirical material for our inquiry. The results show that, invested companies are different than not invested companies, but revenues are higher for the latter.

Key words: software business; start-up; failure

1 Introduction

The development of start-ups has been regarded as important for creating economic wealth and technology transfer [1, 2]. Start-ups have been studied for decades; particularly, research on start-ups has focused on the various factors influencing their growth and development (e.g., [3, 4]), such as access to various resources [5] and overcoming the liabilities of newness and smallness [6]. However, a large portion of start-ups do not generate revenues for many years, and some start-ups never generate revenue [7].

Since the work Blank [8, 9] and Ries [10] in the beginning of 2000s, start-ups and entrepreneurship has become a hype. The software has been in the focal point of the recent hype due to a few superstars [11, 12], and the *scalability* of business that software offers. That is, services and products built on the top of software are easier to scale to the new regions, countries and markets than non-software based.

As famously has been stated, *"software is not like other businesses"* [13]. However, research have extremely seldom examined software engineering in the context of start-ups

[14]. In addition, software start-ups are infrequently researched [15, 16], whereas their importance for the economy is often emphasized. A recent development has started to move focus on software start-ups also in science. Software start-ups are also discussed in professional press as easily investment gaining companies, due to their inherent capability to scale their business.

However, to the best of authors' knowledge, no prior studies have assessed software start-ups from investment poing of view. Particularly trying to pin-point, if software start-ups that gain early stage investment see significant revenue gains within the early years of the company. This study focuses on the following question:

RQ Do software companies that gain investment yield greater revenues than companies with no investments?

To answer the presented question, we performed a quantitative analysis on Finnish software startups. We gathered a data set of over 1,000 companies, founded in Finland during 2010–2013, and their financial performance from Orbis database. We divided this group into companies that received investments and into the other companies. We also looked if the companies were still active, or not active for any reason.

The remainder of this study is structured as follows. Section 2 defines central concepts for this study. It is followed by the depiction of the used research approach. The fourth section presents results, and Section 5 discusses the findings with proposals for future inquiries. The final section concludes the study.

2 Background

Defining a *start-up* or a *software start-up* is not simple and a plethora of different definitions and views are in presented in research literature. A definition by Blank [8] and Blank & Dorf [17] states that a start-up is an organization searching for *"a repeatable and scalable business model"*. Focusing on the case of software, Unterkalmsteiner et al. [15] also define that a software start-up is one that develops a software-intensive product and service. This focuses our attention to companies that develop software-intensive products and services in search of a repeatable and scalable business model.

Software start-ups remain a little studied [14, 15]. Due to the increase in utilizing software, increasing software intensity, there is a demand for research. Particularly there is little on no research focusing on the financial performance of the software start-up companies. However, as pointed out by Paternoster et al. [14], software start-ups differ from more traditional start-ups. The characteristics of yearly stage software start-ups or start-ups altogether are similar, facing challenges of little accumulated experience, limited resources, multiple influences [14, 18]. The stages of early stage companies can be seen as somewhat stable and "systematic", even to the extent to form a model.

Crowne [19] described the evolution of a start-up to four stages. The start-up stage is the time when start-ups create and refine the idea conception, up to the first sale. This phase is challenged by the need to build up relevant skills and executive team to start production. The second stage, stabilization, start from the first sale to the point when new customers can be taken without overhead cost on delivering the product. The third stage, growth, starts with a stable product development process and lasts until market size, share and growth rate have been established. The last stage, maturity, is reached through the creating a robust product development becomes robust and predictable. The model built by Crowne [19] is software specific but contains elements that are universal, while simultaneously excluding many types of businesses. For software companies, however, there model is particularly fitting as there is an element of scalability that is frames software business. Paternoster et al. [14] writes that software start-ups often develop applications to tackle scalable markets. This highlights the importance of time-to-market, being fast-moving in uncertain markets and the need to cope with shortage of resources.

The history of software industry is short (see [20]). What is particular to the industry, is the fast pace of entry and exit. Software industry has also been met with high capital availability, even to risky ventures. This can be the results of the high scalability that increases potential returns, making for a interesting risk/reward ratio.

3 Research process

The sample selected for this analysis is a regional and temporal sample of software product companies. The companies of interest are Finnish, or registered in Finland, and ones that have been incorporated in 2010–2013. The region was selected due to the researchers knowledge of the specific dynamics in the Finnish innovation systems. The sample year is based on the start-up companies having a reasonable window to begin operations, gain revenue and make investments. The financial data used for the analysis is based on registered statements of a five year windows from the year of incorporation and the following four years. The data was searched from Orbis database by Bureau van Dijk, one of the most comprehensive databases of company financial information. The search was done on all active and inactive companies, with the Finnish national legal form of private limited company (*Osakeyhtiö* in Finnish) or Public limited company (*Julkinen osakeyhtiö* in Finnish).

Data was restricted by the NACE industrial classification of each company. If a company was labeled as a software product company was based on it belonging to NACE classes 6201. This selection of classifications is subjective, but in the authors perspective gives a reasonable vantage point to the software programming industry. That is, we believe these companies fulfill the requirement of software-intensive by [15], but also focuses clearly on programming activities. The final data contains 1,739 companies.

The database was used to gather relevant financial variables that could infer the performance of the companies. There has been a discussion on what would be practical variables to show the success of companies (see e.g. [21]). As the sample also included private limited companies, some often used variables that are available for public limited companies where out of reach for our analysis. This settled the analysis on using revenue (in thousands of euros), Total Assets and Return on Earnings (ROE) as indicators.

After creating the relevant variables, the analysis focused on the descriptive of the remaining sample. For the companies the cumulative operating revenue for the five year period was on average 646.33 k€ % ($s = 2949.08$, $n = 1,739$), Total Assets maximum value average 216.60 k€ ($s = 1388.29$, $n = 1,739$), and ROE 4.53 ($s = 32,33$, $n = 1,739$). All of the variables had a significantly high variance compared to the

Table 1. Average and standard deviation of companies grouped by Investment and No investment.

	average	std	N
Investment	388.14	1410.33	148
No Investment	1044.76	4068.03	876

average, suggesting that the data has outlier companies. The analysis further excluded companies that had no assets or the assets and ROE values were not supplied. This resulted in a significantly smaller sample with a operating revenue average 949.46 k€ % ($s = 3807.08$, $n = 1,024$), Total Assets maximum value average 367.84 k€ ($s = 1794.08$, $n = 1,024$), and ROE 4.53 ($s = 32,13$, $n = 1,024$). Outlier detection used in the process kept only the companies that are within ± 3 standard deviations from the mean value. For ROE, the method was significantly aggressive reducing 50 % of the sample, so ROE outliers were not taken into consideration. Rather the use of ROE variable as an explanatory variable should be seen critically. This limited the sample to only include 1,005 companies.

Two additional variables were created to the analysis. First, a variable "investment" was created by analyzing if the companies have had assets growth that is larger than cumulative revenue. Another variable is "status", which checks the companies current status active or non-active. Non-active is defined as a company that is dissolved or bankrupt. We used a kernel density estimation to draw distributions of revenue, comparing groups based the companies being either active or non-active. To estimate the similarity of distributions, we evaluate the null hypothesis that the two groups are drawn from the same distribution using Kolmogorov-Smirnov test. To finalize the analysis the data was cross-tabulated with the companies being investment or no investment with active or non active. This enables a qualitative analysis of the findings.

4 Findings and results

Companies with Investment are defined by a lower turnover than their other counterparts, as seen in the descriptive values given in Table 1. The deviations of both groups are relatively high, similar in ratio to the average. The group defined as no investment is significantly larger than the number of companies having investment.

Focusing on the distribution of the variables, we use the kernel density estimation to draw distributions. For cumulative revenue in Figure 1, the Invested companies have a more sharp pattern with the majority of companies having a smaller cumulative revenue than the no investment companies. Both distributions have a skewed profile, the no investment companies exhibiting a longer tail. The distribution of companies receiving investments is more sporadic. This suggests that companies with no investment gain smaller revenue. We analyze the distribution patterns using Kolmogorov-Smirnov test. Estimating the similarity of distributions, we evaluate the null hypothesis that the two groups, invested and no investment companies, are drawn from the same distribution. For cumulative revenue categorized by investment $D = 0.26$, $p < 0.05$, we can reject the null hypothesis that two independent samples are drawn from the same distribution.

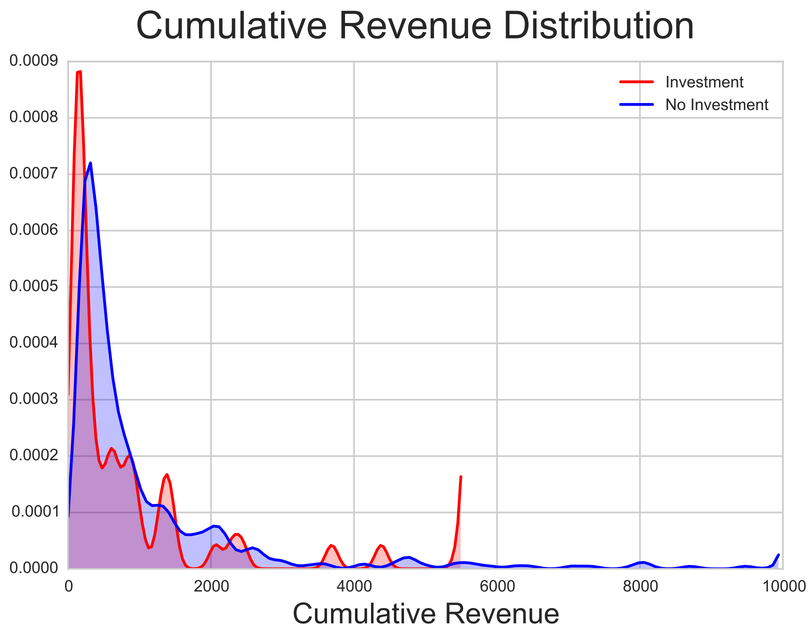

Fig. 1. Density distribution of cumulative revenue for two groups (investment and no investment).

Table 2. Average and standard deviation of companies grouped by Active and Non active.

	average	std	N
Active	977.76	3945.95	913
Not active	726.88	2384.64	110

This distribution can be looked into in more detail using box plot figure 2. This figure highlight the fact that in the no investment group, there are several high revenue yielding companies. This suggests that these companies have exhibited organic growth through revenues gained. We can also look at how cumulative revenues differ when looked at the categorical variable Status, that divides companies to active and non active companies. This distribution can be seen in the box plot in figure 3. The figure shows that the active companies have a broader revenue base, but the majority have low cumulative revenue gains.

This development can also be seen in the average and standard deviations of the groups. The two groups have an average cumulative revenue that is quite similar. Creating more insight to the box plot, we see that the active companies have a higher deviation, explained by the outliers with significant revenue gains, seen in Table 2.

For cumulative revenue in Figure 4, the not invested companies have a more sharp pattern with the majority of companies having little revenue gains. Some sporadic density patterns due exists, where not funded companies have been able to gain revenue. We analyze the distribution patterns using Kolmogorov-Smirnov test. Estimating the

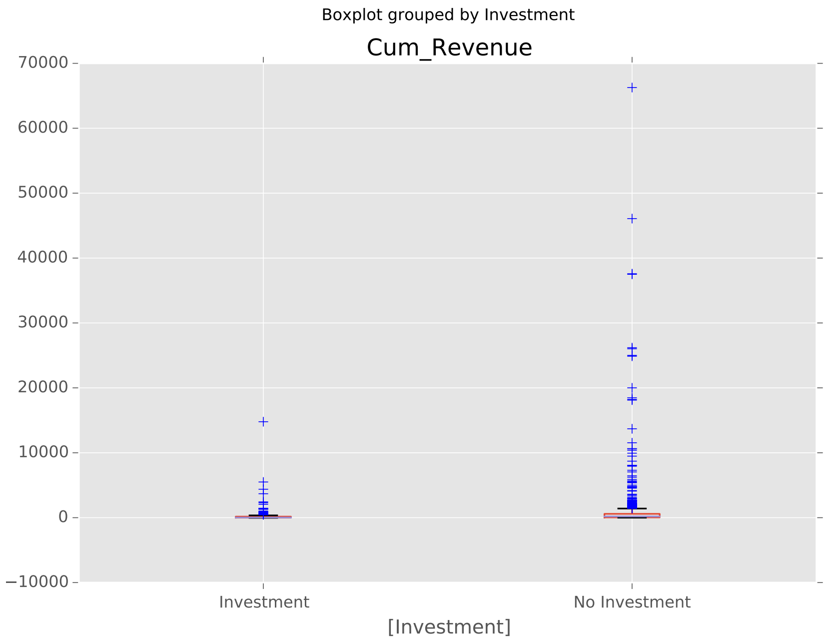

Fig. 2. Box plot of cumulative revenue (Cum_Revenue) in two groups (investment and no investment).

Table 3. Cross-tabulation of invested, not invested companies by active and not active companies.

	Investment	No Investment
Active	88	731
Not active	22	78

similarity of distributions, we evaluate the null hypothesis that the two groups, active and not active companies, are drawn from the same distribution. For cumulative revenue categorized by status $D = 0.11$, $p < 0.22$, we can not reject the null hypothesis that two independent samples are drawn from the same distribution.

Cross-tabulating the companies based on if they are invested, not invested companies by active and not active companies, we identify that the majority of the sample are no investment companies that are still active. Where roughly 10 percent of the no investment companies have become not active, some 25 percent of the invested companies have become not active. Focusing specifically on the invested not active companies , the revenue of these 22 companies are on average 749.32 k€ % ($s = 2795.60$, $n = 22$), which does not significantly differ from the not active companies overall.

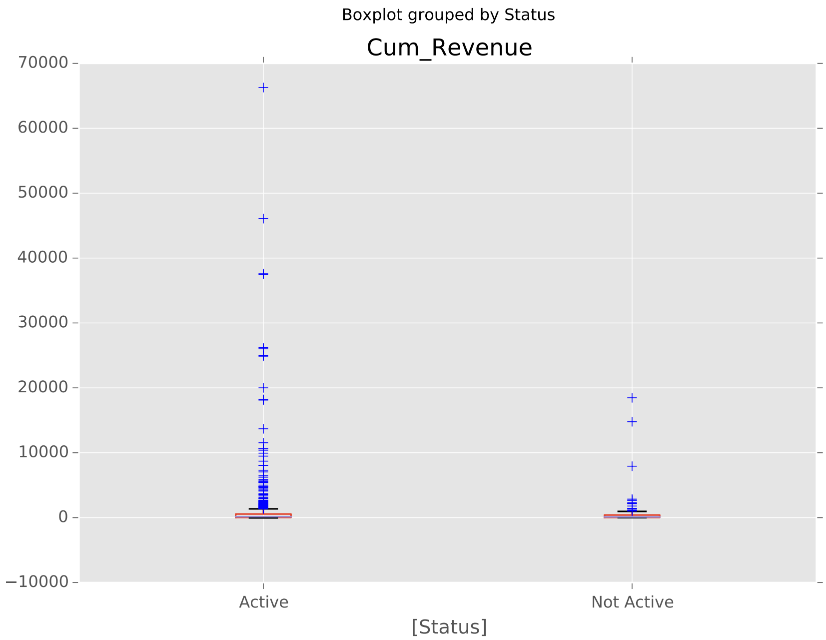

Fig. 3. Box plot of cumulative revenue (Cum_Revenue) in two groups (active and non active).

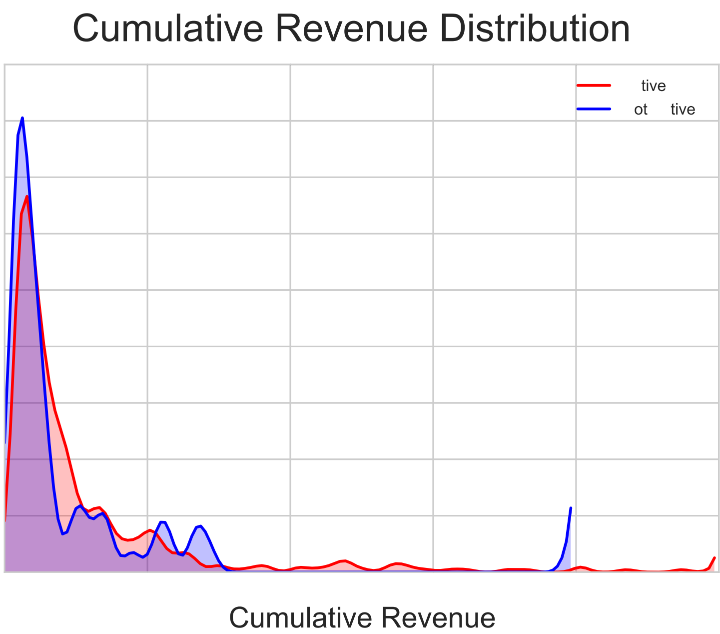

Fig. 4. Density distribution of cumulative revenue for two groups (active and non active).

5 Discussion, limitations and conclusions

This study was motivated by the ever-increasing interest towards software start-ups (c.f. [15]). We focus specifically in significant investment at an early stage is an explanatory variable in company success. This exploratory study made several findings. First, we found that invested and not invested companies are drawn from different distributions when looked through revenue gains. Second, not invested companies have higher revenue gains within the first five years. Third, not active and active companies can not be distinguished based on their revenue gains and fourth, a descriptive evaluation of cumulative revenue in the groups similarly shows little difference within groups.

This study seeks to create an exploratory understanding on why software ventures fail. Although we know that much of this explanation is in the details e.g. strategic decisions made, we could have expected some early findings being available through financial data. Our data of over 1,000 companies from three incorporation years create a robust sample. In this sample early hypothesis might have suggested that revenue gains for not active and active companies where from different distributions, but our results show that investment is the variable that explains differences. Interestingly, this difference is also opposite what common-sense would suggest.

A study by Thomson [22] provides a quantitative identification of the success patterns of 387 IPO'd firms between 1980–2005 and grown to 1 billion dollars in revenue. The study revealed three trajectories of exponential growth — four-, six-, and 12-year-trajectory to 1 billion dollar revenue. At the same time, remaining 5,048 companies did not achieved such growth or simply went out of business. Comparing our findings, we may derive a few questions (hypotheses) for further, qualitative research: Invested companies may be building their growth machine, and this slows down their revenue increase. Or, investors may require some changes to their current business models, and this change causes—likely temporary—slow down in revenue. Further, finding an applicable growth recipe may need some pivoting with business models, thus leading again slower growth. Or finally, findings from startup businesses suggests that extra money rarely helps but some shortage of money (resources in general) is needed to build a successful growth company.

Naturally, this study has some limitations. First, we limited our study on a single geographical area and the result can be biased by the special characteristics of Finland's business landscape. Naturally, there are special characteristics in the business landscape of Finland such as the uniqueness of the language, the penetration of university degrees in the population, and technologies good reputation in the post-Nokia era. Second, we used Orbis database as a source of empirical data for our inquiry and we are thus limited to the information that Bureau van Dijk is offering. Third, we created the value variable investment through a ratio of assets and revenue. The argument here is that investments, venture capital, loans, subsidies or shareholder money, will increase the assets of the company in its financial statements. The creation and ratios used to assign the value are up for discussion and can change the results. For example [23] noted that start-up growth largely translates to employment rather than fiscal variable and "we need to rethink the concept of growth for today's technology startups".

6 Conclusions

We studied the set of over 1,000 Finnish software companies founded in 2010–2013. We divided the companies to invested, not invested and active and not active companies, and used cumulative revenue to compare these two groups. The results show that invested and not invested companies are different groups with not invested companies having higher revenues. In addition not active and active companies can not be distinguished based on revenue as separate groups.

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