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Abhandlungen

Reasons for the Failure of New Technology-Based Firms: A Longitudinal Empirical Study for Germany

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Abstract

We analyzed the determinants for the business failure of German New Technology-Based Firms (NTBF) in different financial stages. This included a literature review and creation of a set of propositions for the determinants within the individual stages. On the basis of an empirical and longitudinal dataset including data of 82 NTBFs, we tested a subset of our assumptions. With this, we could prove that the technology, the market, the financing and the management competencies comprise important factors as identified in previous studies. Further, we proved that the factors differ in each investment stage as shown by the significance and the connotation of the correlations. The area of technology was not significant in the first investment stage but in the second. While the determinants proved to be the same in the market area, the connotations of the variables differ in the financial and human resource variables. We showed that the different financial states should be analyzed separately when determining factors of business failure.

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Insolvenzursachen in jungen High-Tech Unternehmen in Deutschland: Eine empirische longitudinale Studie

Zusammenfassung

In dem vorliegenden Artikel werden die Insolvenzursachen in jungen High-Tech Unternehmen in Deutschland in verschiedenen Finanzierungsphasen untersucht. Auf Basis einer umfassenden Literaturanalyse werden mögliche Insolvenzursachen für die einzelnen Finanzierungsphasen entwickelt. Mit Hilfe eines longitudinalen Datensatzes von 82 junge High-Tech Unternehmen wurde eine Untermenge dieser Insolvenzursachen empirisch getestet. Dabei konnten frühere Studien in Bezug auf die Technologie, den Markt, die Finanzierung und das Humankapital als wichtige Ursachenbereiche für das Scheitern von High-Tech Unternehmen bestätigt werden. Weiterhin lässt sich anhand der unterschiedlichen Signifikanzen und Vorzeichen der Korrelationen zeigen, dass sich die Insolvenzursachen in den jeweiligen Finanzierungsphasen unterscheiden. Die Variablen im Bereich Technologie sind in der frühen, ersten Finanzierungsphase nicht relevant, wohl aber in der zweiten. Während die marktbezogenen Variablen in allen Finanzierungphasen übereinstimmen, ändern sich die Vorzeichen in den Bereichen Finanzierung und Humankapital. Die longitudinale Analyse legt offen, dass sich die Insolvenzursachen in den einzelnen Finanzierungsphasen signifikant unterscheiden.

Keywords: Business Failure, New Technology-Based Firms, Venture Capital, Longitudinal Study

JEL Classification: L260, M130, G240, G330

I. Introduction

One third of all venture capital backed new technology-based firms (NTBF) in Germany fail (Bundesverband Deutscher Kapitalbeteiligungsgesellschaften, 2014). Most of these companies have to file for bankruptcy. While the goal of the German insolvency law is to keep the companies alive, in practice most of the companies cannot be saved (*Pinkwart/Kolb* (2008)).

On the one hand, business failure is a crucial element in a market economy (*Albach* (1985), *Pinkwart* (1992)). If the business model of NTBFs does not create enough value for potential customers, the business itself will fail. In addition, the technology might not yield the expected results so it is not necessary to continue working on it. The resources can better be used for more promising projects. If an NTBF fails, other companies can take over the market share which might lead to an increase of employment.

On the other hand, this might have a negative impact on the economy. The investors which are mostly venture capital funds (VCFs) lose their money and therefore cannot reinvest in other companies. A high percentage of the money for VCFs is provided also by banks and insurance companies which would lose their investment as well. In 2013, their share on all raised capital was 14.2 per cent (Bundesverband Deutscher Kapitalbeteiligungsgesellschaften, 2014). VCFs need to generate a high return on investment to attract new investors. If too many NTBFs fail, many VCFs will not survive. This can lead to a national shortage of risk capital, which hinders the creation of NTBFs. However, NTBFs are necessary as they have the potential to develop into SMEs and have a positive impact on the economy. In addition, NTBFs which go bankrupt cannot pay back their loans to credit institutes which leads to higher depreciations. Further, the job losses can have a negative impact on the economy. Also, the founders and the management team often experience the crisis of their company as a personal crisis (*Albach* (1985)). Identifying the reasons for business failure and systematically working against it could lead to less business failures and therefore strengthen the economy.

Previous research in this field identified two different research streams: the insolvency itself and the crisis process of young companies. In insolvency research, we look at the main determinants of bankruptcy on a company level (*Sauka/Welter* (2013), *Nehrebecka/Dzik* (2013)) or on an economical level (*Salman* et al. (2011)). The causes of organizational mortality depend on the initial resource endowments of the enterprises (*Brüderl/Schüssler* (1990)). In the crisis process research, the models explain how this development out of a crisis can happen (*Hauschild/Grape/Schindler* (2006)). Both research streams take a general view and do not focus on NTBFs. We want to combine both research streams in our study by taking a longitudinal perspective.

The field of failure especially in NTBFs is less discussed in literature (*Hall* (1992), *Albach/Pinkwart* (2003)). The main focus of previous studies lays on the success factors and the analysis of very successful companies (*Timmons/Bygrave* (1986), *Schefczyk* (2006)). Furthermore, longitudinal studies are missing. The period from the first funding of the company to the insolvency can be long. *Schmidt* (2002) describes that a new company goes through three phases. The first phase is the founding phase which ends with the actual start of the business. The second phase is called the establishment phase in which the company has to prove that it will be successful on the market. Predicting the end of this phase is dif-

ficult and *Schmidt* (2002) suggests that it might end 5 years after the foundation of the company. Similarly, *Albach* (1987) argues that for most companies, the highly probable chance of failing because of the liabilities of newness will end after 5 years. Until then, the revenue figures or clear signals from the market must have proven that the company can establish itself permanently on the market. The third phase is the norminalization phase. The establishment phase may be 1 or 2 years longer for NTBFs because they may have longer development cycles for their products. Therefore, a long-term view on these companies can lead to new results.

In addition, previous studies, especially in the field of venture capital, mainly rely on data collected through personal interviews obtained at a time during the founding process (*Bygrave* (2006)) and therefore lack in-depth knowledge. *Neergaard/Ulhoi* (2006) declared that too many analyses are based on convenient accessible and readily available secondary datasets, particularly in the field of venture capital research. We expect that this might be a challenge especially in the field of insolvency. This is a delicate subject in public, and it is possible that the interviewed persons were not honest in the interviews since they might be afraid to admit their own mistakes. Therefore, we collected an own dataset in Germany in consideration of the original written data like the business plan or the monthly reporting.

In this paper, we focus on the determinants which lead to the business failure of an NTBF. We highlight a longitudinal perspective taking the two financial rounds of the VCF within the development of the NTBFs into account. Only a few studies use a longitudinal perspective (*Rauch/Rijsdijk* (2013), *Puri/Zarutskie* (2012)). However, they solely rely on secondary datasets such as Thomson Venture Xpert or questionnaires. We use the original documents of the VCFs as well as the monthly reporting to get better results. In addition, we distinguish between the first and second financial stage and argue that the determinants of failure are different in each phase. We propose a framework of determinants and their influence on each investment stage and empirically test a subset of them.

II. Theoretical Framework

There are many reasons why an NTBF fails. A failure can rarely be tracked back to only one determinant but rather to a combination of multiple reasons. Nevertheless, previous studies identified factors which

have a high significance among bankrupt companies (*Pleschak* et al. (2002), *Egeln* et al. (2010)). The determinants which were identified by most studies are the technology, the market, the financing and the management competencies (*Thornhill/Amit* (2003), *Carter/van Auken* (2006), *Guggemoos* (2012), *Kulicke/Wupperfeld* (1996), *Pleschak* et al. (2002)). We will describe each of these areas in detail and explain why they may especially be important for NTBFs.

Further, we take a longitudinal perspective. The financing process of a VCF takes place in different stages which enables it to reevaluate the investment (*Witt/Brachtendorf* (2004)). The separate analysis of the different phases was also suggested by *Schmidt* (2002). While at the beginning, it might be most important to develop a product successfully, in later stages other factors like market acceptance might be more important. We therefore look at two different financing phases. The first phase is the so-called seed round. In the seed round, the NTBF will receive its first substantial funding, usually at least 1 million Euros. The second phase is called series A (*Katila* et al. (2008), *Hallen* (2008)). Often, the company by then fully developed their product and then needs additional funding to prepare for a market entry. The funding sum varies from a one-digit to a two-digit million Euros amount in the series A round.

1. Technology as an Area for Failure

Issues with the technology are a common cause for failure (*Schilling* (2002)). Especially NTBFs are dependent on reaching their technological milestones and developing their product or service to be able to enter the market. An extension of the development period might therefore lead to negative consequences. In many cases, this would imply higher development costs which the NTBF might not be able to afford (*Pleschak* et al. (2002)). Further, it is important that a technology can be developed for an actual service or product. Many technologies might be innovative and good but never result in a marketable product. To verify if the technology impacts business failures, we have to look at different variables.

First, we look at the development progress of the technology. If the technology is already developed further, it is less likely that it is not possible to create a product or service with it. Creating an actual product is one of the most crucial parts for NTBFs and some need many years until the products can finally enter the market. Therefore, a delay in the product development often leads to business failure (*Schilling* (2002)). We as-

sume that progress in the development of the technology has a negative impact on business failure in the seed stage, in the series A stage and thus in all stages.

The reaching of technological milestones might be an important factor for decreasing business failure. A VCF often agrees on different milestones together with the NTBF (*Repullo/Suarez* (2004)). Only if the NTBF reaches certain milestones, they will get paid a certain per cent of the whole investment sum. A VCF uses this as a control mechanism to make sure that the technological development will proceed as planned. We suggest that this variable differs between the investment stages. During the long development cycles of technological products, technological milestones are often only defined in later stages. We assume that the reaching of technological milestones has no effect on business failure in the seed stage and a negative effect in the series A stage as well as in the analysis over all phases.

Patents may help the NTBF to raise additional money and to have an inimitable protection for a specific region and time. Patents as such are an asset and a signal that the technology might be successful and enable a competitive advantage for the firms (*Teece* (1996)). We therefore assume that owning patents has a negative impact on business failure in the seed stage, in the series A stage and thus in all stages.

It might be important that the founders have developed the technology themselves rather than just using a technology which was developed e.g. by a research center. This way, the founders can better innovate and respond to the innovations of others (*Henderson* (1999)). We suggest that this has a special impact in the beginning of the financial stages. Here, the advantage of having good knowledge about the technology is the highest. In later stages, the founders have time to gain more experience with the technology. We therefore assume that the development of own technology has a negative impact on business failure in the seed stage, but not in the series A stage and also on all stages. Our propositions for the technology variables are summarized in table 1.

2. Market as an Area for Failure

Another reason for having to declare companies' failures can be found in the area of market entry, marketing and sales (*Wagner* (1994), *Dowling/Drumm* (2002), *Pleschak* (2002)). Often, NTBFs have superior products but fail to successfully enter the markets with them. Reasons are

often a lack of marketing and sales experience and an over-optimistic planning for customer acquisition in the early stage (*Hall* (1992), *Thornhill/Amit* (2003)). Further, NTBFs often rely on few big customers and if one of them backs out, the NTBF has no possibilities to compensate this (*Brüderl* et al. (1996), *Guggemoos* (2012)). Furthermore, external circumstances like the probability of a market decrease affect the development of a firm (*Zacharakis/Shepherd* (1999)). Moreover, setbacks in economic activity could cause difficulties for NTBFs to acquire new customers. To verify if the market impacts business failure, we have to look at different variables.

We first look at the marketing and sales skills. An NTBF faces liability of newness and smallness when entering the market. Therefore, a good sales and marketing strategy is crucial for business survival (*Hall* (1992)). It is especially important to get the first customers when no references from previous customers exist. We therefore assume that good marketing and sales skills have a negative impact on business failure in the seed stage, in the series A stage and thus in all stages.

In addition, the market risk is an important factor for business failure (*Dowling* (2002), *Pinkwart* (2002)). The entry of new competitors or of a competing product from an existing player can make it more difficult for an NTBF to win market shares. If a big player which already has an established network enters the market, this might significantly decrease the chances of success of an NTBF. We therefore suggest that having a high market risk has a positive impact on business failure in the seed stage, in the series A stage and thus in all stages.

Further, we look at market changes. If the market size decreases for example due to substitute products, the NTBF will compete within a smaller market. Also, the market could possibly decrease in a way that it becomes too small for the NTBF to make substantial profit. Market growth was identified as an important factor by *Lee* et al. (2001). We therefore suggest that negative market changes have a positive impact on business failure in the seed stage, in the series A stage and thus in all stages.

In addition, an economic crisis might have a negative impact on NTBFs (*Zacharakis/Shepherd* (1999)). Existing players often reduce their costs in these times and therefore do not invest in new, innovative products as they are developed by NTBFs. We therefore assume that an economic crisis has a positive impact on business failure in the seed stage, in the series A stage and thus in all stages. Our propositions for the market variables are summarized in table 1.

3. Financing as an Area for Failure

Financing is a common cause for failure including issues in getting further financing, miscalculations for the capital need and bad planning (*Davila* et al. (2003), *Headd* (2003), *Pleschak* et al. (2002), *Thornhill/Amit* (2003)). The expected return on investment is calculated by the VCF based on the evaluation of each NTBF and a bad evaluation reduces further financing. Most NTBFs are dependent on external financing until they have not only further developed their technology but also created a product or service based on it and brought it to the market. Therefore, the process of getting to the break-even point can be rather long. To verify if the financials impacts business failure, we have to look at different variables.

First, we take the financial planning into account. It is very difficult to estimate the costs and especially the possible revenues for the NTBF in the beginning. Therefore, the calculations are prone to errors. A too optimistic cost calculation or a less formal planning can lead to a business failure (*Perry* (2001)). The NTBF might have raised insufficient capital or run into liquidity problems due to unrealistic calculations. We therefore assume that a good financial planning has a negative impact on business failure in the seed stage, in the series A stage and therefore in all stages.

Further, we look at the risk of not getting co-investors. *Hsu* (2004) highlighted the importance and advantages of co-investors. Therefore, it should be easier for NTBFs to fulfill the required capital requirements when this is split among many investors. A failure to attract new investors is one reason for an NTBF to have to declare bankruptcy (*Carter/van Auken* (2006), *Head* (2003)). We suggest that the reason for not getting co-investors only becomes significant in later stages but not in the seed phase. Most VCFs are able to finance an NTBF at least for two rounds and also plan from the beginning that they have to invest in multiple rounds. We therefore suggest that the risk of not getting a co-investor has no impact on business failure in the seed stage, and a positive impact in the series A stage and over all stages.

In addition, the revenue development is an obvious factor for business failure. If the NTBFs do not manage to generate positive revenue, they will fail in the long run. However, this might not be significant in the seed phase. Most NTBFs need the seed phase to develop their product and enter the market in the series A phase. We therefore assume that the

revenue development has no impact on business failure in the seed stage, and a negative impact in the series A stage and over all stages.

Last, we take into account the evaluation by the VCF. The investment sum is based on the evaluation of the NTBF. If an NTBF is evaluated higher, it might attract more capital for their company shares. A high evaluation might have a positive effect on the capital base. We therefore assume that a high evaluation has a negative impact on business failure in the seed stage, in the series A stage and thus in all stages. Our propositions for the financial variables are summarized in table 1.

4. Management Competencies as an Area for Failure

Important reasons for the insolvency of an NTBF are mistakes of the management (*Carter/van Auken* (2006), *Headd* (2003)). Expert interviews revealed that it is often not the product or service but the team which leads to a failure. Existing studies state that 80 percent of the reasons for failure include the management team (*Pinkwart* et al. (2005)). To verify if the management competencies impact business failure, we have to look at different variables.

First, we look at the human resource risk describing that team members cannot be found for all positions. The completeness of the team is an important aspect (*Mellewigt/Späth* (2002)). When candidates for important positions like marketing or accounting are missing, the management might experience difficulties. Especially for NTBFs, it might be difficult to find suited/competent team members. On the one hand, they need highly qualified and specialized people, and on the other hand they cannot offer salaries as they are customary in the market. We suggest that the revenue development has no impact on business failure in the seed stage, and a negative impact in the series A stage and over all stages. We therefore assume that a high human resource risk has a negative impact on business failure in the seed stage, in the series A stage and thus in all stages.

The same may be a cause of failure when the members of the founding team change (*Carter/van Auken* (2006)). The remaining team might not have the capabilities to run the company alone and has to find a new team member. We therefore suggest that a change in the founding team can lead to business failure in a later stage. In an early stage, a change in the founding team might be better compensated. We suggest that a

change in the founding team has no impact on business failure in the seed stage and a positive impact in the series A stage and over all stages.

In addition, the capability to deal with conflicts is a crucial competency of the founding team. Ongoing conflicts can lead to a postponement of important decisions and might make it more difficult to follow through the plans of the company (*Egeln* et al. (2010)). We suggest that poor conflict handling skills can possibly lead to business failure. We therefore assume that high conflict dealing skills have a negative impact on business failure in the seed stage, in the series A stage and thus in all stages.

A lack of skills in the management within the business competencies is a cause for business failure (*Gaskill* et al. (2003)). The founders need the skills to make good financial projections and handle the accounting and legal aspects in the business. A lack of these skills can possibly lead to mistakes which later result in negative consequences. We therefore suggest that business skills impact business failure in the seed phase. In the series A phase, the team probably built up the missing competencies or was able to hire people who compensate this lack. We assume that business skills in the founding team have a negative impact on business failure in the seed stage and no impact in the series A stage. We suggest that overall, it might negatively impact business failure.

Literature shows that entrepreneurs of failed NTBFs have lower levels of education (*Lee/Lee* (2002)). Therefore, the academic education might be an important factor for NTBFs. For most of them, highly specialized technological knowledge is needed and this can be best obtained from academic institutions. We therefore suggest that higher education has a negative impact on business failure in the seed stage, in the series A stage and thus in all stages. Our propositions for the management competencies are summarized in table 1.

Table 1

Expected Correlations of the Areas of Failure for Each Variable

Variable	Model Seed Cases	Model Series A Cases	Model All cases
	Expected Correlation	Expected Correlation	Expected Correlation
Technology variables			
TECHNOLOGY DEVELOPMENT	–	–	–
MILESTONES REACHED	0	–	–
PATENTS	–	–	–
FOUNDER DEVELOPED	–	0	–
Market variables			
MARKETING	–	–	–
MARKET RISK	+	+	+
MARKET CHANGES	+	+	+
ECONOMIC CRISIS	+	+	+
Financial variables			
FINANCIAL PLANNING	–	–	–
CO-INVESTORS	0	+	+
REVENUE DEVELOPMENT	0	–	–
EVALUATION	–	–	–
Human resources variables			
HR RISK	+	+	+
CHANGES FOUNDING TEAM	0	+	+
CONFLICT HANDLING	–	–	–
BARGAINING SKILLS	–	–	–
BUSINESS SKILLS	–	0	–
OVERALL EDUCATION	–	–	–

+ positive correlation with business failure; 0 no correlation with business failure; – negative correlation with business failure

5. Hypothesis

We empirically tested a subset of our propositions which are outlined in table 1. Therefore, we developed the following hypothesis:

a) Technology

H1a: Technological determinants are significantly related to business failure in the seed stage.

H1b: Technological determinants are significantly related to business failure in the series A stage.

H1c: Technological determinants are significantly related to business failure in all stages.

We therefore take the variables MILESTONES REACHED and FOUNDER DEVELOPED into account.

b) Market

H2a: Market determinants are significantly related to business failure in the seed stage.

H2b: Market determinants are significantly related to business failure in the series A stage.

H2c: Market determinants are significantly related to business failure in all stages.

We therefore take the variables MARKETING and MARKET RISK into account.

c) Financing

H3a: Financial determinants are significantly related to business failure in the seed stage.

H3b: Financial determinants are significantly related to business failure in the series A stage.

H3c: Financial determinants are significantly related to business failure in all stages.

We therefore take the variables FINANCIAL PLANNING, COI-NVESTORS and REVENUE DEVELOPMENT into account.

d) Management Competencies

H4a: Management competencies are significantly related to business failure in the seed stage.

H4b: Management competencies are significantly related to business failure in the series A stage.

H4c: Management competencies are significantly related to business failure in all stages.

We therefore take the variables CHANGES FOUNDING TEAM, CONFLICT HANDLING and BUSINESS SKILLS into account.

III. Methodology

1. Sample

As described earlier, many studies in the area of venture capital and NTBFs are based either on secondary datasets or solely on surveys. Especially, longitudinal studies with original field-driven data are missing (*Neergaard/Ulhoi* (2006)). Therefore, we collected data from 125 NTBFs at 9 different public and private VCFs in Germany. In total, we had access to the data of 20 percent of the early state investments in Germany between 2005 and 2010 according to the statistics of Bundesverband für Kapitalbeteiligungsgesellschaften (BVK 2014). In the current study, we used data of 82 NTBFs because we had the complete data for all items we wanted to include only for them. The data were collected directly at the VCFs. We therefore had access to the original deal documents. Our study was one of only a few studies that were granted access to the original deal documents of the VCFs which makes our dataset unique.

We examined the decision and due diligence files as well as the monthly reporting. This includes for example the business plans, the investment committee papers, the due diligence documents (ranging from human resource due diligence to technology due diligence), qualitative reporting, financial statements and board meeting minutes. We supplemented our data with an interview with the supervising investment manager of the NTBF. We thus collected the survey data for all NTBFs at the same time. This ensured that we have data of different financing stages and can conduct a separate analysis for these phases. Half of the companies were still in the seed phase, while the other half were in the series A phase. In

addition, the investment managers answered the questionnaire prior to the bankruptcy or the depreciation of the NTBFs in most cases. So, we were able to match the results with the actual financial phase. This rich field of data sources enabled us to collect data about the whole development process of the participating NTBFs.

We used a combination of qualitative and quantitative data collection in our research project. We collected quantitative data (e.g. the financial figures) and qualitative data (e.g. descriptions about conflicts within a team of founders). To code the qualitative data, we created a code book. To ensure a high reliability of our approach, we used investigator triangulation. The data was separately encoded by three researchers. All of them were research associates and are doing research in the venture capital field. The researchers did three encoding rounds and revised the code book later to reach a higher agreement in the encoding (*Hruschka* et al. (2004)). Krippendorff's alpha was used as an intercoder reliability measure. After three encoding rounds, we received a Krippendorff's alpha of 0.9 or more for each item. This can be seen as a good value (*Krippendorff* (2004)). To prove the feasibility of our approach, we carried out a pre-test with 8 NTBFs from 4 different VCFs.

In our sample, 10 companies were insolvent. The average age of the NTBFs in our dataset is 4.5 years. Therefore, we look at the period of the first 5 years which was described as the significant period for potential failure by *Albach* (1987), *Schmidt* (2002) and *Egeln* et al. (2010).

2. *Measures and Variables*

a) Dependent Variables

We used business failure as the dependent variable. Therefore, we coded the NTBFs which ran out of business indicated by the declaration of insolvency with 1. We coded the NTBFs which are still operating on the market with 0. Therefore, our dependent variable is binary coded.

b) Independent Variables

In the area of technology, we took two variables into account. First, we assessed if the founders had developed their technology themselves. Having a deep know-how about the technology may be an advantage and

might help in tailoring the technology to customer needs. An important measure might be the timely accomplishment of technological milestones. If the NTBF fails to reach its milestones, this might indicate issues in the technology which possibly could lead to insolvency.

When we look at the market side, we focused on two variables. First, we measured the marketing and sales development of the NTBF. We know from expert interviews that especially NTBFs face difficulties in marketing their products because their focus of thinking is frequently constrained to technical details of the product. Often, the main management team consists of highly technology-orientated people. A lack of marketing and sales activity might lead to the bankruptcy of an NTBF. In addition, the market risk is an important factor. This variable captures the risk of competitors entering the market and of customers who might not accept the product.

Looking at the financing, the feasibility of the financial planning is the first variable. For being solvent, a realistic cost calculation is crucial. Therefore, an insufficient financial planning could lead to insolvency. Further, finding new investors is an important task for an NTBF. A high risk of not finding new investors can be an important factor for insolvency. In addition, the development of revenues might have an influence. If the company already manages to get revenues in an early stage, it might be less likely to fail. However, this may depend on the industry. In some industries like life science, the development cycles and therefore also the time before the first revenues can be made might be very long.

When we look at the human resource perspective, we focused on three variables. First, we look at changes in the founding team. If one of the founders leaves the team, important know-how may be lost and it might more difficult to succeed. In addition, it is likely that conflicts occur during the further development of the NTBF. Conflict handling skills may be crucial to successfully maneuver through these phases. Bargaining skills might also be important in dealing with stakeholders and attract further financing rounds. In addition, business skills might be important. The founding team has to know the basic skills of accounting, financial reporting and others to be able to successfully manage their business. A lack in these skills could possibly lead to insolvency.

c) Control Variables

We checked the firm age. Half of the new ventures in Germany go bankrupt within the first 5 years (*Schneck/May-Strobl* (2013)). Some NTBFs are successful in the first years but fail to attract long term customer relations which could eventually lead to a failure. Thus, a higher age may increase the chances of failure. Especially, venture capital-backed companies in the area of high-technologies often get sufficient capital for covering the operation costs for 2 or 3 years. Therefore, it is less likely that the company fails within this time period.

Further, we took into account the industry. The industry might influence the insolvency. For NTBFs from the area of life science, the likeliness of a fail is high, if the technology does not work as expected. The development of the technology is in most cases very expensive and has long life cycles. In contrary, NTBFs in the field of information technology can be much more flexible and quickly tailor their product or service to customer needs. We used the code 0 for the industries which can enter the market fast (information technology and telecommunication) and 1 for the industries which enter the markets slowly (material science, energy, life science).

The descriptive statistics of our variables can be found in table 2. A brief explanation of our variables can be found in Appendix A1.

d) Correlation and Multicollinearity

The independent variables in the four areas might correlate with each other. Therefore, we might expect a high degree of multicollinearity. We calculated the correlation matrix between the variables (Backhaus et al. 2006). In table 3, we can see that the amount of variables with a significant correlation above 0.5 is low compared to the amount of variables we use. Further, we calculated the variance inflation factor (VIF). The VIF for all significantly correlating variables is below 5. That means that our logit regression analysis should not be affected by multicollinearity in a significant way (*Hair* et al. (1998)).

Table 2

Descriptive Statistics

Variable	N	Mean	Std. Dev	Source of data
Dependent variables				
BUSINESS FAILURE	82	0.12	0.33	Financial reporting, annual statements, fund reporting
Technology variables				
FOUNDER DEVELOPED	82	4.04	1.08	Survey
MILESTONES REACHED	82	3.49	1.10	Survey
Market variables				
MARKETING	82	3.60	1.03	Survey
MARKET RISK	82	3.26	1.31	Survey
Financial variables				
FINANCIAL PLANNING	82	3.50	0.86	Survey
CO-INVESTORS	82	2.93	1.35	Survey
REVENUE DEVELOPMENT	82	3.77	1.08	Survey
Management variables				
CHANGES FOUNDING TEAM	82	3.17	1.33	Survey
CONFLICT HANDLING	82	3.27	1.16	Survey
BUSINESS SKILLS	82	3.44	0.98	Survey
Control variables				
AGE	82	4.48	2.13	Business plan
INDUSTRY	82	0.36	0.48	Business plan

Table 3: **Pearson Correlation Coefficients Part 2**

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
Dependent variables													
1. BUSINESS FAILURE	1												
Technology variables													
2. FOUNDER DEVELOPED	–0.082	1											
3. MILESTONES REACHED	–0.336**	0.337**	1										
Market variables													
4. MARKETING	–0.254*	0.224**	0.240*	1									
5. MARKET RISK	0.241*	–0.137	–0.121	–0.279*	1								
Financial variables													
6. FINANCIAL PLANNING	–0.477**	0.033	0.453**	0.229*	–0.071	1							
7. CO-INVESTORS	0.243*	0.002	–0.266*	–0.297**	0.450**	–0.116	1						
8. REVENUE DEVELOPMENT	–0.093	–0.119	–0.018	0.226*	–0.027	0.364**	–0.054	1					
Management variables													
9. CHANGES FOUNDING TEAM	0.093	0.295**	0.043	0.159	–0.159	–0.021	–0.034	–0.152	1				
10. CONFLICT HANDLING	–0.184	0.150	0.284*	0.466**	–0.144	0.470**	–0.233*	0.288*	–0.006	1			
11. BUSINESS SKILLS	–0.358**	0.043	0.290**	0.299*	–0.165	0.552**	–0.087	0.260*	0.065	0.569**	1		
Control variables													
12. AGE	0.244*	0.158	–0.060	0.050	–0.083	–0.201	0.133	0.004	0.164	–0.112	–0.179	1	
13. INDUSTRY	0.078	–0.041	0.093	–0.153	–0.068	–0.101	–0.045	–0.108	0.143	–0.111	–0.064	0.046	1

* Significant with $p < 0.05$ ** Significant with $p < 0.01$

IV. Results

1. Model Parameters

We ran logit regressions with BUSINESS FAILURE as dependent variable and tested three different models. The first model includes the NTBFs which only received a seed funding, the second one includes all NTBFs which had at least received also a series A funding. The last model includes all NTBFs. We had data for all variables for 82 NTBFs. For running logit regression, cases with missing values have to be removed. The results of our three regression models are shown in table 4. All three models are significant as shown by the –2 LogLikelihood-Value. In addition, the pseudo R^2 (*Cox/Snell* (1989)) show a high value (above 0.4) for all our models. Further, all models passed the Hosmer-Lemeshow test indicating a good fit of our models. The control variables were not significant in all our models. We therefore omitted them in our final models.

Table 4

Logit Regression with BUSINESS FAILURE as Dependent Variable

	Model Seed Cases	Model Series A Cases	Model All cases
Technology variables			
FOUNDER DEVELOPED	2.592	3.182***	–3.766
MILESTONES REACHED	–2.511	–2.530***	2.923
Market variables			
MARKETING	–0.291	–2.530***	–3.179**
MARKET RISK	7.554***	11.854***	2.820**
Financial variables			
FINANCIAL PLANNING	0.167***	–10.289***	–5.017***
CO-INVESTORS	5.710***	–1.438***	2.996***
REVENUE DEVELOPMENT	–1.560***	–0.075***	2.511***
Human resource variables			
CHANGES FOUNDING TEAM	–1.074***	9.241***	5.191***
CONFLICT HANDLING	12.916***	4.413***	6.594***
BUSINESS SKILLS	–10.260***	–4.922***	–5.509***
Model Variables			
–2LL	25.348***	35.34***	47.37***
Pseudo R^2	0.496	0.544	0.439
N	37	45	82

Standardized logit regression coefficients are displayed in the table.
* Significant with $p < 0.01$ ** Significant with $p < 0.005$ *** Significant with $p < 0.001$

a) Results Seed Phase

Looking at the seed phase, we found our technology variables to not be significant. Therefore, we have to reject H1a. The market risk is significant in the seed phase. It has a positive factor, meaning the company will be more likely to face business failure if the market risk is high. Therefore, the market plays a role in the seed financing and we can accept H2a. The marketing competencies do not play a significant role.

Looking at the financial side, the financial planning has a positive impact. That means surprisingly that a good financial planning does not hinder business failure. The risk of not getting new investors is significant. The risk has a positive factor, meaning that the higher the risk of not getting new investors, the higher are the chances that the NTBF goes out of business. The revenue development has a negative effect. The higher the revenues, the lower are the chances of an NTBF going out of business. We can accept H3a.

In the area of human capital, we found all variables to be significant. Changes in the founding team have a positive effect on business survival. A reason for this can be that changes in the early phase happen to include better suited people in the team (*Forbes* et al. (2006)). Surprisingly, the conflict handling skills have a positive connotation, meaning that management teams with high conflict handling skills are more likely to lead their company to business failure. A reason could be that the conflict handling skills were assessed by the investment managers in our survey. Possibly, they rated the skills higher for teams which had to solve more conflicts. Teams which worked harmoniously may not have needed conflict solving competencies. The business skills are an important factor in the seed phase. The founding team has to have the necessary competencies in accounting, financial planning and financial reporting. We can accept H4a.

b) Results Series A Phase

In the series A phase, we experienced different results. We found the internal development of the technology to be a significant factor in the area of technology. Surprisingly, the own development has a negative effect on survival. A reason for this is that NTBFs might focus too much on the technology and not on the marketing. Reaching milestones is important for avoiding business failure. A reason for this can be that the teams

already developed their technology further and now the technology has to work to create the actual product. We can accept H1b.

On the market side, we found marketing to be important. High marketing efforts lead to less failures. In addition, we found the market risk to be a highly significant factor. This result is aligned with the seed phase. The market side is significant and we can accept H2b.

Looking at the financing, we find the financial planning to be relevant. In the series A phase, the financial planning may shift more to a liquidation planning because the resources are limited for the further development. Now, the connotation changed and NTBFs with good financial planning are more likely to succeed. The risk of not attracting investors is significant but in a negative way. A reason for this can be that the NTBF already managed to convince investors twice and build a network with potential investors so it is easier for them to attract more financing. In addition, the revenue development is significant. A high development in revenues decreases the chances of failure. An explanation could be that an NTBF possibly grows too fast and then runs into challenges to scale their business model. The financial side is significant and we can accept H3b.

In the field of human capital, we found that all variables are significant. Changes of the founding team have a positive factor, meaning that more changes in the founding team could lead to failure. This was not the case in the seed phase. A reason for this can be that less changes in the founding team happened during the seed phase compared to the series A phase. It could, however, also imply that missing skills such as marketing and sales should be taken on board rather early to avoid the risks of changing the core team in the more critical series A phase. The conflict handling ability has a negative connotation as in the seed phase. Therefore, the same explanation as in the seed phase could apply. The business skills are an important factor in the series A phase. The founding team has to have the necessary competencies in accounting, financial planning and financial reporting. The human resource side is significant and therefore we can accept H4b.

c) Results Total Dataset

When we looked at the whole dataset, we found no technological variable to be significant. A reason for this can be that the NTBFs are pre-selected by pursuing an advanced technology. In most cases, we have com-

plex technical due diligence documents produced by external research institutions. This can also be backed up by the high amount of patents – 42 percent of the NTBF successfully filed patents. We therefore find no support for H1c.

Looking at the market side, we found the market risk to be highly relevant. This was also shown by the two subsets of data. In addition, we found the marketing efforts as relevant which was also shown in the series A phase. The market side is a significant factor for business failures. Both variables have the expected connotation. We can accept H2c.

Looking at the financing, we found the financial planning to be relevant. NTBFs with good financial planning are more likely to survive. The risk of not attracting investors is significant, meaning that a low risk leads to a higher chance of business success. In addition, the revenue development is significant. Surprisingly, a high development in revenue decreases the chances of survival. An explanation could be that an NTBF possibly grows too fast and then runs into challenges to scale their business model. We therefore can accept H3c.

Looking at the human resource side, we found all variables to be significant. Changes of the founding team have a negative factor, meaning that higher changes in the founding team could lead to failure. The conflict handling ability has a negative connotation as in the seed phase. Therefore, the same explanation could apply. The business skills are an important factor and high skills lead to a lower chance of business failure. The human resource side is significant and therefore we can accept H4c.

V. Discussion

We prepared a systematical overview of the reasons for business failures based on literature and created a list of proposed determinants of failure in the different financial stages. Testing a subset of the propositions, we showed that financial, human resources and market factors are the main determinants of the failure of NTBFs. Technology is less important. This is a surprising result because other studies identified the technology as important to a similar degree as financial and market factors (*Thornhill/Amit* (2003), *Guggemoos* (2012), *Kulicke/Wupperfeld* (1996), *Pleschak* et al. (2002)). A reason for this could be that the technology of the NTBFs in our dataset is already advanced in all cases and therefore, the differences are too low to measure significant values. This can be due

to the pre-selection of our dataset. All companies are VC-financed. This means that they all passed a complex technical due diligence process prior to the investment and had to defend their technology in various presentations.

When looking at the various financing stages separately, we found all four areas, i.e. technology, market, financing and human resources to be significant. In this, the significant variables are different in each case. This might possibly have led to a non-significant result for the overall model because some variables are only significant for a subset of the data. Therefore, the view on the data subset might be more important. This is also the advantage of a longitudinal approach compared to a point-in-time approach. In most cases, the interviewed people would tell that the NTBF had difficulties in all areas although only some areas have been relevant.

When we look at the technology, our suggested variables are only significant in the series A phase. The timely accomplishment of milestones was significant in the series A phase as well as the development of the technology by the founders. As described earlier, this can be attributed to the high pre-selection of our dataset.

In the market area, both of our variables were significant. The marketing and sales efforts were only important in the series A phase. This can be due to the fact that most NTBFs still focus on the product creation in the seed phase and start the marketing activities later. The market risk is important in all models. This is not surprising because if the market does not accept the product or service of the NTBF, it would have to be really innovative to be still able to survive.

Looking at the financial area, all of our variables were significant. The financial planning has a negative effect in the seed phase. It might be based on too many assumptions. We often saw that the first financial planning proved to be highly unrealistic. A reason for that could be that an investor wants promising financial projections before investing in NTBFs. Therefore, NTBFs possibly try to make the financial figures look better. Being able to attract new investors is significant in all phases. Most NTBFs have only few investors in the beginning and therefore have to build up a broader base of investors so that further financial rounds in which they need a higher financing could also be successful. Investors often use syndication in later financial rounds to share their risk (*Manigart* et al. (2006), *Tian* (2012)). The risk of not attracting new investors had a positive effect only in the series A phase. A possible reason for this can be

that the first investors are able to invest in the first two rounds. Afterwards, additional investors are needed. Surprisingly, a positive revenue development has a positive effect on a possible business failure in our last model. A reason for that might be either a too fast growth which can lead to scaling risks of the company or that many successful companies did not reach positive numbers in the first years (*Henderson* (1999)). A famous example which proves this is amazon. Amazon operated in the red for many years before it became one of the most successful US companies.

All of our variables we tested for the human resource side were significant. Changes in the founding team were negatively correlated in the seed phase. This might be easier to compensate as if someone leaves the management as in later stages. When a change takes place in an early stage, a new member of the management team has more time to work his way into the business and also more freedom to shape the business idea. The conflict handling skills were significant. Surprisingly, the factor was negative in all models meaning that a high conflict handling skill could be a determinant for business failure. A reason for this might possibly be that decisions must be made quickly and there is no time for conflicts. Another reason might be that investment managers only rated the conflict handlings skills high when several conflicts occurred. Therefore, the conflict handling skill might be a moderator variable for the number of conflicts that occur. The business skills are important in all phases.

With our study, we created new findings in the area of the determinants for insolvency in German NTBFs. The main contributions of this study are a literature review of the determinants of business failure and a categorization of their possible impact in different financial stages. Using a longitudinal dataset, we were able to show that the determinants differ in later financing phases. We encourage doing more research taking different financial stages into account.

VI. Limitations, Implications and Outlook

1. Limitations

This study has a number of limitations and possibilities for future research. First, the average age of our companies was 4.5 years. Referring to *Albach* (1987), *Schmidt* (2002) and *Egeln* et al. (2010), this time period is often determining the success or failure of startups. However, the relevant time span may rather be 6 or 7 years when looking at NTBFs be-

cause the product development cycles are longer. Possibly, a significant amount of the NTBFs in our dataset will still go bankrupt within the next two years. The bankruptcy of an NTBF will often be announced in the local news and in most cases can easily be tracked down by online research. Therefore, it might be possible to update the list of bankrupt companies in two years and run the model again. Maybe the results will then be even more significant.

Second, we focused on the perspective of the VCF in analyzing their data and conducting a survey with the investment managers. Possibly, some of the reasons for the failure were not seen by the VCF or not documented. Examples are internal conflicts in the founding team or personal problems of one of the founders which lead to a significant loss in the founding team which could not be compensated. Interviewing the founding teams could lead to new results in this field.

Third, we focused on German NTBFs and it is unclear if the results can be generalized for other countries. Similar studies in other countries would help to uncover if the determinants of bankruptcy are similar in European countries, Asia and the United States.

2. Implications

We identified the different areas for failure in the first two investment stages. As our results show, the areas differ in each investment stage. An investment manager supervising an NTBF therefore could support the company differently in each investment stage. This could lead to fewer failures and therefore positively impact the financing situation of NTBFs in Germany.

In the seed phase, the financial planning is highly relevant. Possibly, the investment manager can support the NTBF by introducing experiences from other companies or by bringing the NTBF together with other young high-tech companies to discuss challenges and best practices in the financial planning.

In the series A stage, the investment manager could help the team by using his network to introduce contacts to professionalize the marketing and sales activities. As it was identified in our study to be an important determinant for business failure, our survey among the investment managers showed that there is on average a low support in this particular area. In contrast, the investment managers answered that they supported

NTBFs highly in finding new investors which was also identified as an important determinant in the series A phase.

3. Outlook

We will perform a survey with the founding team of the NTBFs to be able to include their perspective also as described in the second example of the limitations. The VCFs may not always uncover all aspects about the failure of an NTBF to hide possible mistakes. We hope that we can make additional contributions to the field of NTBFs and venture capital by adding the perspective of the founders.

VII. Appendix A1 – Brief Explanation of our Variables

Table 5

Explanation of Variables

Variable	Explanation	Scale
Dependent variables		
Business failure	The business failed (coded as 1) or is still on the market (coded as 0)	Binary
Technology variables		
FOUNDER DEVELOPED	Indicates if the founders are involved in the development of the technology (1: very low involvement; 5: very high involvement)	Likert scale: 1 to 5
MILESTONES REACHED	Indicates if technological milestones were reached as indicated by the investment manager (1: mostly not reached; 5: mostly reached)	Likert scale: 1 to 5
Market variables		
MARKETING	The marketing development indicated by the investment managers (1: very bad development; 5: very good development)	Likert scale: 1 to 5
MARKET RISK	The market risk indicated by the investment managers (1: very low risk; 5: very high risk)	Likert scale: 1 to 5

Variable	Explanation	Scale
Financial variables		
FINANCIAL PLANNING	The feasibility of the financial planning as indicated by the investment managers (1: very bad planning; 5: very good planning)	Likert scale: 1 to 5
CO-INVESTORS	The risk of not getting new co-investors (1: very low risk; 5: very high risk)	Likert scale: 1 to 5
REVENUE DEVELOPMENT	The development of the revenues indicated by the investment managers (1: very bad development; 5: very good development)	Likert scale: 1 to 5
Management variables		
CHANGES FOUNDING TEAM	The changes happened in the founding team (1: very few changes; 5: very many changes)	Likert scale: 1 to 5
CONFLICT HANDLING	The conflict handling skills of the founding teams rated by the investment managers (1: very low skills; 5: very high skills)	Likert scale: 1 to 5
BUSINESS SKILLS	The business skills of the founding teams rated by the investment managers (1: very low skills; 5: very high skills)	Likert scale: 1 to 5
Control variables		
AGE	The age of the company in years calculated based on the date of foundation	Metric
INDUSTRY	Indicates if the NTBF is in an industry which can enter the market quickly (information technology and telecommunication) or in an industry which usually enters the markets in a later stage (material science, energy, life science).	Binary

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