

The Financing of Entrepreneurial Ventures



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Declaration of Authorship

I, Alexander Huber, born February 26th 1987 in Munich, hereby declare that the submitted thesis is my own work. All quotes, whether word by word or in my own words, have been marked as such. The thesis has not been published anywhere else nor presented to any other examination board.

Hiermit erkläre ich, Alexander Huber, geboren am 26.02.1987 in München, an Eides statt, dass ich die vorliegende Dissertation ohne fremde Hilfe und nur unter Verwendung der zulässigen Mittel sowie der angegebenen Literatur angefertigt habe.

Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht.

Darmstadt, 29.11.2017

(Alexander Huber)

Abstract

Entrepreneurship and entrepreneurial activities influence the development and well-being of both economies and societies to a large extent. At the heart of all entrepreneurial activities are new ventures - vehicles which entrepreneurs use in order to exploit opportunities through the commercialization of newly developed products or services. In addition to the many obstacles entrepreneurs face when creating a new venture and entering new markets, the financing of these entrepreneurial initiatives becomes a large obstacle. In particular, uncertainties regarding market acceptance of the identified opportunity and thus survival and ultimately growth limit the financing options of new ventures notably. Further, the financing decisions made at the beginning of the entrepreneurial process have a lasting impact on the development of the new venture once a certain type of financing is acquired. Hence, securing the necessary financing is not only a major challenge for the entrepreneur at the beginning of the entrepreneurial career. The selection of the right amount of financing from the right source also influences the development of the new venture over and beyond the early days of existence.

In line with this argumentation and while acknowledging the limited number of financing options available to new ventures, venture capital is often identified as a viable option for firms during in their early stages of development. This form of financing is characterized to be provided by institutional investors that jointly invest financial means, experience, and networks into the firms they consider to be able to generate the desired growth in return. Given the large array of new ventures however, only a few are considered a potential investment, and thereof only a fraction receives the necessary funding. Regarding the latter group of investees however, a venture capital investment has empirically proven to positively influence new venture survival and growth, translating into increased performance of venture capital-backed over non-venture capital-backed firms. Given the fact that venture capital itself is a fascinating field of research but likewise of great importance for the financing of new ventures at the same time, this dissertation develops new empirical insights about the role of venture capital in the context of new ventures that were created in an academic context. Further, crowdfunding as a new means of entrepreneurial finance is analyzed against the background of its signaling value in the investment decision of venture capitalists.

The first empirical contribution uses a proprietary dataset of 98 German research-based spin-offs founded between 1997 and 2012 and assesses which firm-specific and system-inherent factors are decisive for the spin-offs' growth while drawing on the resource-based view of the firm as theoretical framework. Specifically, this dissertation aims to evaluate whether venture capital-backed research-based spin-offs outperform non venture capital-backed research-based spin-offs and whether a performance difference is explained by venture capitalists' scouting or coaching capabilities. The empirical findings suggest that a homogeneous educational background of the academic entrepreneurs is positively associated with the research-based spin-off's growth. Similarly, a training provided by the parent research organization intended to develop entrepreneurial skills and to establish a network to outside professionals as well as the commercialization of a novel technology have a positive impact on a research-based spin-off's growth. Concerning the involvement of venture capitalists, venture capital-backed research-based spin-offs show a superior employment and revenue growth compared to non-venture capital-backed research-based spin-offs. As a possible cause for this superior performance, the empirical findings support the view that this growth difference can be attributed to venture capitalists' coaching rather than their scouting capabilities.

The second empirical contribution addresses the increasing popularity of crowdfunding as a new means to finance new ventures. In particular, this dissertation assesses whether and how crowdfunding campaign-specific signals that affect campaign success influence venture capitalists' selection decisions in new ventures' follow-up funding rounds. By doing so, this empirical contribution relies on cross-referencing a proprietary dataset of 66,000 crowdfunding campaigns that ran on Kickstarter between 2009 and 2016 with 100,000 investments in the same period from the Crunchbase dataset. Using this approach, 267 new ventures with at least one crowdfunding campaign could be identified. While drawing on signaling theory and the venture capital and microfinance literature, the empirical findings reveal that a successful crowdfunding campaign leads to a higher likelihood to receive follow-up venture capital financing, and that an inverted U-shaped relationship exists between the funding received compared to the funding desired and the probability to receive venture capital funding. Further, the analyses provide statistical evidence that a special endorsement of campaigns by the crowdfunding platform provider as well as social media presence in the form of word-of-mouth

volume has a likewise positive impact on the receipt of follow-up venture capital. Interpreting these findings, this dissertation concludes that the results support the view that venture capitalists apparently rely on the decision of the crowd in order to evaluate the potential of the entrepreneurial initiative when selecting new investment opportunities.

Over and beyond the signals that a crowdfunding campaign produces and that are apparently factored into the investment decision of venture capitalists, this dissertation also elaborates on how the presence of a crowdfunding campaign itself, disregarding all its campaign-relevant aspects, influences the investment decision of venture capitalists in terms of their decision to form syndicates. For the purpose of this research question, this dissertation relies again on signaling theory and builds on the syndication literature. The overarching empirical finding is that crowdfunding seems to influence the syndication behavior of venture capitalists. For one thing, the presence of a crowdfunding campaign negatively influences both the likelihood of a syndicated investment as well as the number of syndicate partners. For another, the findings reveal that crowdfunding positively influences the formation of international syndicates. Hence, the results support the assumption that the importance of crowdfunding is also factored into the investment decision of venture capitalists in terms of their decision to syndicate.

This dissertation concludes with the major contributions for both theory and practice. In essence, the results derived provide novel insights about growth factors of research-based spin-offs by widening the focus of analysis. This is done by incorporating venture capital into the research scope so as to advance the resource-based view of the firm. Also, this dissertation shows that crowdfunding serves as a catalyst reducing the perceived risk in the form of information asymmetries related to new ventures. Thus, this dissertation advances signaling theory and also provides important implications for the microfinance and VC literature.

Zusammenfassung

Das Unternehmertum hat einen wesentlichen Einfluss auf die Entwicklung von Wirtschaft und Gesellschaft. Eine der essentiellsten Ausprägungen des Unternehmertums ist dabei die Gründung von neuen Unternehmen durch eine oder mehrere Personen um neue, zum Teil innovative, Geschäftsgelegenheiten in der Form von Produkten und/oder Dienstleistungen auf lokalen wie internationalen Märkten abzuschöpfen. Ungeachtet der zahlreichen Herausforderungen, mit welchen Unternehmensgründer in Folge des heterogenen Aufgabenspektrums vor, während und nach einer Unternehmensgründung insgesamt konfrontiert sind, ist die Finanzierung eines neuen Unternehmens mittlerweile eine der zentralen Herausforderungen die es für den Unternehmer zu bewältigen gibt. Aufgrund der großen Unsicherheit hinsichtlich der Erfolgsaussichten neuer Produkte und Dienstleistungen ist das Überleben und Wachstum einer Neugründung alles andere als selbstverständlich und auch ein wesentlicher Grund dafür, dass die Finanzierungsoptionen für Unternehmensgründer beschränkt sind. Darüber hinaus ist die Wahl der Finanzierung insofern von großer Bedeutung, da wissenschaftliche Erkenntnisse nahelegen, dass die Entscheidung über die Wahl einer bestimmten Finanzierungsform eine nachhaltige Auswirkung auf die Entwicklung des Unternehmens hat. Aus diesem Grund ist nicht nur die Wahl der Finanzierungsform eine große Herausforderung für den angehenden Unternehmer, sondern wird zudem durch die nachhaltige Wirkung derselben zu einer großen Herausforderung für Unternehmensgründer insgesamt.

Aufgrund der Unsicherheit über die zukünftige Entwicklung der Unternehmung und einer kurzen bis kaum vorhandenen Unternehmenshistorie einer Neugründung wird Risikokapital in Form von sog. Venture Capital Investoren oftmals als die am geeignete Form der Finanzierung gesehen. Diese Risikokapitalinvestoren zeichnen sich durch ihren professionell-institutionellen Charakter aus und bieten dem finanzierten Portfoliounternehmen nicht nur finanzielles Kapital, sondern vielmehr auch ein breites Spektrum an nicht-monetären Zusatzleistungen wie beispielsweise den Zugang zu Netzwerken. Zeitgleich ist die Akquisition von Risikokapital durch den Unternehmer aufgrund der hohen Anzahl an möglichen Neugründungen als Investitionsobjekt sehr kompetitiv und daher schwierig. Dies zeigt sich dadurch, dass nur wenige Neugründungen den selektiven Auswahlprozess eines Risikokapitalgebers überstehen, und davon nur

ein Bruchteil die notwendige Finanzierung nach einer detaillierten Prüfung erhält. Diejenigen Unternehmen, die den Selektionsprozess erfolgreich durchlaufen haben, weisen jedoch eine erhöhte Überlebenswahrscheinlichkeit und ein stärkeres Wachstum gegenüber denjenigen Unternehmen auf, die kein Risikokapital erhalten haben. Dahingehend bestätigen wissenschaftliche Ergebnisse, dass das Vorhandensein von Risikokapital eine positive Auswirkung auf die Leistungsfähigkeit und das Wachstum eines Unternehmens hat. Ausgehend von dieser Besonderheit von Risikokapital und dem damit verbundenen faszinierenden Forschungsfeld widmet sich diese Dissertation der Frage, welche Rolle das Risikokapital im Rahmen von Neugründungen im akademischen Kontext spielt. Zudem untersucht diese Arbeit, welche Auswirkung eine Schwarmfinanzierung auf die Selektions- und Investitionsentscheidung von Risikokapitalgebern hat. Der Fokus hinsichtlich der Investitionsentscheidung liegt dabei auf der Fragestellung, ob die Investitionsentscheidung eines Schwarmfinanzierungskollektivs die Entscheidung eines Risikokapitalinvestors beeinflusst und falls ein Effekt nachweisbar ist, inwieweit die Bildung eines Syndikats von Risikokapitalinvestoren durch das Vorhandensein einer Schwarmfinanzierungskampagne berührt wird.

Aufbauend auf dieser grundlegenden Fragestellung untersucht diese Dissertation anhand eines proprietären Datensatzes von 98 Ausgründungen aus dem akademischen Umfeld im Zeitraum 1997 bis 2012, sog. research-based spin-offs, welche Faktoren einen wesentlichen Einfluss auf das Wachstum dieser Unternehmungen haben. Im Detail untersucht diese Dissertation dabei, ob risikokapitalfinanzierte akademische Ausgründungen eine erhöhte Leistungsfähigkeit gegenüber nicht-risikokapitalfinanzierten akademischen Ausgründungen aufweisen und ob eine mögliche Leistungsdifferenz auf den Selektionsprozess des Risikokapitalgebers zurückzuführen oder bedingt durch seine aktive Teilnahme am Unternehmensgeschehen entstanden ist. Aufbauend auf der Resourcentheorie belegen die empirischen Ergebnisse dieses Forschungsbeitrages, dass ein homogener Bildungshintergrund des akademischen Gründerteams einen positiven Einfluss auf das Wachstum von akademischen Ausgründungen hat. Darüber hinaus zeigen die Ergebnisse, dass Schulungsmaßnahmen der Forschungseinrichtung mit der Zielsetzung der Generierung von unternehmerischen Fähigkeiten und Netzwerken einen ebenso positiven Einfluss auf das Wachstum haben. Die empirischen Analysen belegen zudem, dass die Kommerzialisierung einer innovativen Technologie einen ebenso

positiven Beitrag zum Wachstum der akademischen Ausgründung leistet. Das Vorhandensein von Risikokapital wirkt sich ebenfalls positiv auf das Wachstum aus. So zeigen die Ergebnisse, dass akademische Ausgründungen mit Risikokapital deutlich schneller wachsen als vergleichbare akademische Ausgründungen ohne Risikokapital. Die Analysen lassen den Schluss zu, dass diese gesteigerte Leistungsfähigkeit eher dem aktiven Mitwirken der Investoren im Tagesgeschäft und nicht der Fähigkeit der Investoren bei der Auswahl der Unternehmung geschuldet ist.

Über die Fragestellung der Rolle von Risikokapital bei akademischen Ausgründungen hinausgehend untersucht diese Dissertation ebenfalls, welche Rolle eine Schwarmfinanzierung bei der Selektions- und Investitionsentscheidung bei Risikokapitalinvestoren hat. Dies ist dem Umstand geschuldet, dass die Wichtigkeit von Schwarmfinanzierungen in den vergangenen Jahren deutlich an Volumen und Wichtigkeit zugenommen hat. Im Detail untersucht diese Dissertation, ob und welche spezifischen Eigenschaften einer Schwarmfinanzierungskampagne einen Einfluss auf die Selektionsentscheidung eines Risikokapitalgebers haben. Die Untersuchung basiert auf einem proprietären Datensatz bestehend aus 66.000 Schwarmfinanzierungskampagnen auf der Kickstarter Plattform im Zeitraum 2009 bis 2016. Diese Datenbasis wurde mit der Crunchbase Firmendatenbank mit ca. 100.000 Unternehmen kombiniert. Insgesamt konnten dadurch 267 Neugründungen mit mindestens einer Schwarmfinanzierungskampagne identifiziert werden. Aufbauend auf der Signaltheorie belegen die empirischen Ergebnisse, dass eine erfolgreich abgeschlossene Schwarmfinanzierungskampagne einen positiven Einfluss auf die Wahrscheinlichkeit einer Risikokapitalanschlussfinanzierung hat. Zweitens zeigen die Ergebnisse, dass es einen inversen U-förmigen Zusammenhang zwischen dem Verhältnis aus Finanzierungsziel und tatsächlich eingeworbener Finanzierung und der Wahrscheinlichkeit einer Risikokapitalanschlussfinanzierung gibt. Drittens kann diese Dissertation empirisch belegen, dass eine Hervorhebung einer Schwarmfinanzierungskampagne auf der Kickstarter Plattform ebenfalls eine erhöhte Wahrscheinlichkeit nach sich zieht, Risikokapital zu erhalten. Viertens zeigen die Analysen einen ebenso signifikant positiven Zusammenhang zwischen der elektronischen Mundpropaganda auf Facebook und der Wahrscheinlichkeit einer Anschlussfinanzierung durch Risikokapitalgeber.

Hinsichtlich der Investitionsentscheidung eines Risikokapitalgebers ein Syndikat zu bilden zeigen die Ergebnisse einen ebenso signifikanten wie negativen Zusammenhang zwischen dem Vorhandensein einer Schwarmfinanzierungskampagne und der Syndikatsbildung. Zum einen bestätigen die Ergebnisse, dass sich sowohl die Wahrscheinlichkeit einer Syndikatsbildung als auch die Größe eines Syndikats reduziert, wenn das Investitionsobjekt eine Schwarmfinanzierungskampagne abgeschlossen hat. Gegeben der möglichen globalen Aufmerksamkeit einer Schwarmfinanzierungskampagne weisen die Ergebnisse zum anderen nach, dass die Wahrscheinlichkeit eines internationalen Syndikats durch das Vorhandensein einer solchen Kampagne positiv beeinflusst wird. Ausgehend von diesen Ergebnissen kommt die Dissertation zu dem Schluss, dass sowohl das Selektions- als auch das Investitionsverhalten in Teilen durch die Entscheidung eines großen Kollektivs aus Unterstützern von Schwarmfinanzierungskampagnen beeinflusst werden. Ausgehend davon schließt diese Dissertation mit der Erkenntnis, dass eine Schwarmfinanzierung nicht nur eine neue und wichtige Form der Unternehmensfinanzierung darstellt, sondern diese auch einen wesentlichen und nachhaltigen Effekt auf mögliche Folgefinanzierungsrunden durch Risikokapitalinvestoren hat. Diese Dissertation schließt mit einer Zusammenfassung der wichtigsten theoretischen wie praktischen Erkenntnisse. Im Kern beziehen sich die wesentlichen Beiträge dieser Dissertation darauf, dass die Ressourcentheorie mit Schwerpunkt auf Wachstumsfaktoren akademischer Ausgründungen um die Berücksichtigung von Wagniskapital erweitert wird. Zum anderen zeigt diese Arbeit, dass Crowdfunding die Informationsasymmetrien zwischen Investor und Unternehmen reduzieren kann und somit einen wichtigen Beitrag zur Reduktion von Unsicherheiten im Investitionsprozess leistet. Diese Erkenntnis erweitert die Signalthorie um einen weiteren wichtigen Baustein.

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List of Abbreviations

%	Percent
abs	Absolute
b	Beta Factor
B2B	Business to Business
BIC	Bayesian Information Criterion
BMWi	German Federal Ministry for Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie)
BVC	Bank-affiliated Venture Capital
CAGR	Compound Average Annual Growth Rate
CF	Control Function
CVC	Corporate Venture Capital
e.g.	For Example
e.V.	Eingetragener Verein
EU	European Union
eWOM	Electronic Word-of-Mouth
EXIST	EXIST is a support program of the German Federal Ministry for Economic Affairs and Energy (BMWi)
FhG	Fraunhofer Gesellschaft
GDP	Gross Domestic Product
GEM	Global Entrepreneurship Monitor
GVC	Government Venture Capital
i.e.	Id Est
IL	Log Likelihood
IPO	Initial Public Offering
IT	Information Technology
IV	Instrumental Variables
IVC	Individual Venture Capital

JOBS	Jumpstart Our Business Startups Act
KfW	Kreditanstalt für Wiederaufbau
m	Million
MINT	Mathematics, Informatics, Natural sciences, and Technology
nbreg	Negative Binomial Regression
NTBF	New Technology-based Firm
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
p	Significance Level
RBSO	Research-based Spin-off
SD	Standard Deviation
SE	Standard Error
SIC	Standard Industry Classification Codes
TEA	Total Entrepreneurship Activity
TTO	Technology Transfer Office
USA	United States of America
USD	United States Dollar
USF	University-oriented Seed Funds
VC	Venture Capital
VIF	Variance Inflation Factor
w/	With
w/o	Without
WOM	Word-of-Mouth

1 Introduction

1.1 Research Topic and Motivation

The importance of entrepreneurship has increased tremendously given the fact that its contributions to market economies are considered indispensable in an environment as dynamic as the 21st century. Ever since the early days of Schumpeter (Schumpeter, 1934), entrepreneurs are considered agents of creative destruction “who introduce change to the economic landscape by constantly undermining and challenging established industry incumbents” (Acs, Autio, & Szerb, 2014, p. 1). Thus, the entrepreneur can be considered as catalyst or missing link between economic integration and growth (Alhorrr, Moore, & Payne, 2008). Given the particular importance of entrepreneurial activities for both the economic and societal well-being, a large array of benefits such as innovation (Acs & Audretsch, 1988; Kuratko, 2005), job creation (Blanchflower, 2000; Parker, 2009), or productivity increases (van Praag & Versloot, 2007) have been attributed to originate from entrepreneurial activities. However, the relationship between the technological process, innovation, and growth appears to have changed particularly in the 1990s as a result of the emergence of new and unprecedented technological opportunities that heavily rely on the introduction of the personal computer (and similar digital peripheral products), as well as the ever-increasing availability of the internet. As a consequence, innovation has become more market-driven, more rapid and intense, and more closely linked to scientific progress (OECD, 2000). An example for the changing landscape is provided by technologies such as the telephone or the radio which took about 75 and 38 years respectively to reach its first 50 million users. Instagram, a social media platform, on the other hand achieved twice the amount of active users and needed only 28 months (TechCrunch, 2017).

However, the terms entrepreneur and entrepreneurial activity are applied to a variety of contexts and are used synonymously for many activities that involve the engagement of one or more individuals, organizations, or activities (Acs et al., 2014). As Lumpkin and Dess (1996) point out, the concept of entrepreneurship evolves from various combinations of individual, organizational, and environmental factors. Hence, entrepreneurship can be defined as an activity that circumscribes a type of self-employment and/or new venture creation (Reynolds et al., 2005). Another dimension includes the cognitive attribute of one or more individuals in recognizing new and unprecedented

opportunities (Shane & Venkataraman, 2000). Given these dimensions and following Shane (2003), entrepreneurship can be considered an activity that involves the discovery, evaluation, and exploitation of opportunities in order to introduce new goods and/or services as well as ways of organizing through processes that previously had not existed or were not available to the individual.

Within the large array of activities that lead to, or benefits that result from entrepreneurial efforts, new entry is an essential part of the entrepreneurship activity and hence the central idea that underlies this concept. In other words, once the individual has discovered and evaluated a new opportunity, exploitation of the same is realized through entering a new or established market with a new or existing product or service (Lumpkin & Dess, 1996). The vehicle used through which the act of new entry is performed is an entrepreneurial entity in the form of a new venture, an existing firm or via internal corporate venturing (Burgelman, 1983). Given the focus of this dissertation on entrepreneurship rather than intrapreneurship, the formation of a new venture is thus at the heart of the entrepreneurial activity considered in remainder of this thesis, while the formation process itself is heavily influenced by a variety of parameters. As Gartner (1985) highlights, “the creation of a new venture is a multidimensional phenomenon; each variable describes only a single dimension of the phenomenon and cannot be taken alone. [...] entrepreneurs and their firms vary widely; the actions they take or do not take and the environments they operate in and respond to are equally diverse and all these elements form complex and unique combinations in the creation of each new venture” (Gartner, 1985, p. 697).

Combining the many definitions and dimensions just outlined, this dissertation refers to a new entrepreneurial entity as an independent and newly created legal entity founded by one or more entrepreneur(s) focusing on exploiting a newly identified commercial opportunity through the sale of a physical product or service while simultaneously aspiring survival and particularly growth. Given this definition, it has to be acknowledged that not all new firm foundations are referred to with this dissertation. For example, newly created entities that do not focus on growth are not considered. These firms are often referred to as lifestyle entities (i.e. a yoga boutique or a restaurant) and do not necessarily follow the idea of opportunity exploitation and growth. Further, company foundations that emerge from situations of unemployment are also

not considered. Lastly, partnerships such as tax, law, or doctoral offices are also beyond the scope of this dissertation. This exclusion restriction rests on two primary assumptions. On the one hand, the exclusive focus on new ventures with substantial growth entities is justified with the above-mentioned economic and societal advantages these firms offer. On the other hand, the restrictive focus is also necessary to interpret the findings of this dissertation in the context of the broader entrepreneurial finance literature elaborated on in more detail in the following section and which shares a similar focus (Achleitner & Braun, 2014).

Following the more detailed characterization of a new venture given the exclusion restrictions outlined, and considering the imperative importance of entrepreneurial entities for the technological progress and economic growth as outlined above, an increasing effort towards understanding the antecedents and consequences of entrepreneurial activities is observable when viewing the ever-increasing number of both theoretical and practical research contributions devoting their attention towards entrepreneurship. At the heart of the literature devoted to new venture creation are research contributions explaining the prerequisites and antecedents of entrepreneurial intentions that lead to new venture creation (e.g. Ajzen 1991; Aldridge and Audretsch 2011; and Parker 2009), as well as contributions that elucidate the requirements for survival and growth (e.g. Clarysse, Wright, and van de Velde 2011; Hayter 2016; and Santarelli and Hien Thu Tran 2013). This trend of understanding the concept of entrepreneurship from a pure research perspective is accompanied by multiple efforts that align the interests of the so called quadruple helix, a collaborative view including academia, the business sector, policy makers, and the civil society (GEM, 2017). In that regard, one perspective combines the views from both policy makers and universities who address the topic of entrepreneurship from various angles. For example, the introduction of government funding schemes in Germany (i.e. EXIST)¹ represent only a fraction of supportive means that have the intention to actively encourage and foster the creation of entrepreneurial activities and ultimately new venture creation (Federal Ministry for Economic Affairs

¹ EXIST is a program supported by the German Federal Ministry for Economic Affairs and Energy (BMWi) and aims at encouraging technology transfer activities from research institutions and universities to the private sector by commercializing new products and services. According to the BMWi (2017), the program supports students, graduates and scientists both with monetary and non-monetary aid.

and Energy, 2017). A further result of a more collaborative approach between policy makers and academia is the fact that universities nowadays complement their traditional activities of teaching and research with supporting schemes and newly developed curricula that address the topic of entrepreneurship both theoretically and practically (Munari, Pasquini, & Toschi, 2015). This approach translates for instance into new study courses offering a specialization or complete degrees in entrepreneurship. In addition, public and private research organizations as well as universities established so called technology transfer offices (TTOs), training programs, and other practically-oriented support schemes that are intended to smoothen and accelerate the process from research discovery to technology commercialization (Colombo, Mustar, & Wright, 2010). Further, the changing landscape of required skills and knowledge from the businesses' perspective is another critical viewpoint that is addressed when referring to the quadruple helix model. In particular, the mismatch of an increasing demand for math, science and IT-education and the currently available curricula is critical in order to allow young people to identify and exploit unprecedented opportunities. Lastly, the viewpoint of the civil society highlights for example the constantly low number of female entrepreneurs and encourages a higher participation rate of females in the entrepreneurship process (GEM, 2017). Hence, the collaborative perspective of the quadruple helix with the various stakeholders clearly allows to view the specific demands and supplies of skills and capabilities not in isolation but rather on a much broader and also more complex scale.

Yet, and despite the ever increasing amount of both theoretical and practical knowledge that explain the development and growth of new ventures as well as incentives from the various stakeholders involved that actively encourage the creation of new ventures and support their survival and growth, the concept of new venture creation is far from being understood. This is exacerbated when referring to the total entrepreneurship activity (TEA). Whilst innovation-driven economies such as the United States of America (USA), Australia, Estonia, and Canada have a relatively high proportion of the 16 to 64 year-old adult population who are in the process of having founded (nascent entrepreneurs) or currently founding a new business (new business owners) in the years 2016/2017, other nations lack far behind. Thereof, particularly the leading and presumably strongest economies in the European Union (EU), notably Italy, Germany, Spain, and France, show the lowest number of entrepreneurship activity amongst all

innovation-driven economies globally (GEM, 2017). This outcome is especially relevant given that these countries, notably Germany, contributed largely towards the growth of the common market within the EU. However, when considering the changing technological landscape in terms of innovation processes as mentioned before, it is only a matter of time until the competitive advantages developed during the past are fully exploited and other, likely new, market participants from countries outside the EU become large industry incumbents and replace the current market leaders. This viewpoint is particularly important for the German economy as it is often referred to be the engine of European growth and leading in many industries. Hence, combining the low level of the total entrepreneurship activity with the importance of a sustainable development of the German economy in the future, the prospects are far from optimal.

In that regard, figure 1 summarizes the absolute number of founders in Germany and also shows the founder ratio in comparison to the total population in the same period. Regarding the development of both indicators from the beginning of the 21st century to the recent past, a negative trend is indistinguishable. In particular, the trend shows that initiatives that are intended to foster entrepreneurship and growth are offset by a flourishing German economy paired with a strong demand for corporate employees (KfW, 2017c). Exceptions are periods after financial crisis, notably in the years after 2001, 2008/2009, and 2013. These years are characterized by market turmoil. Based on the countercyclical dynamics of new venture creation and economic downturns, both the founder ratio as well as the absolute number of entrepreneurs increased in the post-crisis period as a result of new opportunities that emerged - or simply as a result of a decreasing need for corporate employment. However, when considering the recent years of strong economic growth, the latest research evidence on causes and consequences of entrepreneurial activities, and the fact that public and private supporting schemes are well developed and available in a variety of forms, the ratio of founders relative to the total population as well as the absolute number of founders has reached its lowest level in the year 2016. This trend demonstrates an undeniable fact that the concept of entrepreneurship is far from being understood and that the above-mentioned advantages of economic- and societal well-being are at risk. As this dissertation develops a considerable contribution suited to entrepreneurial activities in a German context, and also provides new empirical insights relevant for German entrepreneurs as well as investors, the particular focus on Germany is justified.

Figure 1: Founder Ratio and Number of Absolute Founders in Germany

The figure shows the trend of the absolute number of founders (in thousands) as well as the ratio of founders in relation to the total population (in percent) in Germany in the years 2000 through 2016 (KfW, 2017a; KfW, 2017b).



Given this unsatisfactory trend regarding the decreasing number of entrepreneurs while referring to the ever-increasing amount of research contributions that explain antecedents and consequences of entrepreneurship, aspects that address requirements for survival and growth are often named simultaneously with one decisive resource important for the well-being of new ventures - financial capital. Put differently, in order to exploit the identified opportunity, a new venture requires financial capital in order to start business operations (Binks & Ennew, 1996; Cassar, 2004; Ebben & Johnson, 2006). Based on this central importance of financial capital, this dissertation focuses on the financing of new ventures as it is one of the crucial issues entrepreneurs face when forming a new venture. Furthermore, the focus on the financing of new ventures is insofar important given that the financing decision made at the beginning has a lasting imprint on the development of the new venture in the future (Berger & Udell, 1998; Cassar, 2004). Thus, from a practical point of view, understanding the financing decisions of new ventures is an important prerequisite regarding the new venture's development in terms of survival and growth. The latter is particularly relevant for the benefit for both the economy and society given that the advantages in terms of innovation, job creation, and societal well-being heavily depend on the success of the new venture as

outlined before. Additionally, from a theoretical point of view, the financing issue of new ventures is a major topic in the entrepreneurial finance research given that the causes and consequences of new venture financing are not well understood (Colombo & Murtinu, 2017; Denis, 2004). In other words, this dissertation explores the role of the financing of new ventures and develops new empirical insights from both a theoretical and practical perspective. In particular, a specific form of entrepreneurial finance is devoted special attention to - venture capital (VC). Thereby, this dissertation focusses on understanding the role of venture capital in regard to growth issues of new ventures within an academic context drawing on the resource-based view of the firm (Barney, 1991; Barney, Wright, & Ketchen, 2001; Penrose, 1996; Wernerfelt, 1984). Further, this dissertation also evaluates how new means of entrepreneurial finance such as crowdfunding influence the selection of new ventures by venture capitalists. Lastly, this dissertation elaborates on the question if and how crowdfunding influences the syndication behavior of venture capitalists. The latter research focus on crowdfunding draws on the theory of information asymmetries (Jensen & Meckling, 1976) as well as signaling theory (Busenitz, Fiet, & Moesel, 2005; Spence, 1973, 2002) and thereby provides novel insights to the microfinance and VC literature.

Given the general research topic and motivation in providing an advancement of the theoretical frameworks just mentioned, as well as developing novel practical implications against the background of new venture creation and VC financing, the core research focus of this dissertation is devoted to understanding if and how venture capital influences the growth of new ventures in an academic context as well as if and how crowdfunding as a new means of entrepreneurial finance affects the investment behavior of VC investors. Following this research question, this dissertation sheds light on the relevance of financing towards the survival and growth of new ventures in order to provide new insights that positively contribute to understanding the financing issues of new ventures. Ultimately, these findings shall support, both theoretically and practically, investors and entrepreneurs alike in their decision-making regarding the financing of new ventures in order to foster survival and growth, and ultimately ensure that the economic and societal benefits associated with entrepreneurial activities are less at risk.

1.2 Structure of the Dissertation

Based on the theoretical and practical contribution this dissertation aims to develop, the structure is set up as follows. Section 2 gives a detailed literature overview about means of entrepreneurial finance while focusing on the context of new ventures, venture capital, and crowdfunding. Further, the section also elaborates on the theoretical reasoning of the investment decision of venture capitalists against the background of signals of quality. Given the literature overview presented, this dissertation continues with developing three research questions that build the foundation of this thesis in section 2.

In section 3, the role of venture capital towards the growth of research-based spin-offs is elucidated in greater detail. The section starts with summarizing the theoretical and empirical findings that address the growth of new ventures that have emerged from an academic environment and discusses how various resources are, both theoretically and practically, related to growth. Further, the venture capitalist's role as coach or scout is discussed. Afterwards, the data and methodology are introduced as well as the empirical results presented and discussed. The section concludes with a summary of limitations and suggestions for further research on growth issues in the context of academic entrepreneurship.

Thereafter crowdfunding as a new form of entrepreneurial finance is devoted special attention to. In that regard, section 4 discusses the signaling value of crowdfunding in the venture capital investment context. The section addresses the value of crowdfunding campaign related signals towards the receipt of post-campaign venture capital funding. Further, the signaling value of a crowdfunding campaign itself is evaluated and analyzed against the background of the syndication behavior of venture capitalists. Following an extensive summary of the latest theoretical and empirical findings on VC selection and VC syndication, the data and methodology is introduced. Furthermore, section 4 presents the empirical results derived as well as discusses the findings in a greater context. Finally, section 4 concludes with the limitations of the findings and highlights avenues for further research in the area of the VC selection and syndication process while considering the ever-increasing importance of crowdfunding as a new means of entrepreneurial finance. Section 5 provides an overall conclusion and summarizes both theoretical and practical contributions of this dissertation.

2 Theoretical Background

Based on the theoretical foundation developed in the following section, three research questions are derived which represent the core of this dissertation. First however, a literature overview about the means of entrepreneurial finance and the role of venture capital is given. Thereafter, the investment process of venture capitalists in the context of new ventures is analyzed against the background of the theory of information asymmetries with particular attention devoted to signaling theory. Further, crowdfunding as a new means of entrepreneurial finance is introduced.

Based on these theoretical foundations, the respective research questions are derived. More precisely, the last section will elaborate on the role of a venture capital involvement in the growth of new ventures that have risen from an academic context. Second, a new form of entrepreneurial finance, i.e. crowdfunding, is considered and its signaling value is analyzed against the background of the allocation of post-crowdfunding venture capital financing. Third, the role of a crowdfunding campaign is evaluated regarding the syndication behavior of venture capital investors.

2.1 Literature Review on Entrepreneurial Finance

The development and growth of new ventures is subject to an array of factors, yet access to capital is key to the survival and growth of these firms (Binks & Ennew, 1996; Ebben & Johnson, 2006). Although means of entrepreneurial finance exist in a variety of forms, the sourcing of capital is nevertheless amongst the most challenging tasks an entrepreneur is confronted with when financing a new venture (Carter, Shaw, Wilson, & Lam, 2006; Neeley & van Auken, 2010).

In general, entrepreneurial finance research covers the financing issues of all entrepreneurial entities that are not publicly listed and that have growth ambitions. Thus, entrepreneurial finance research coverage is not limited to financing issues of new ventures only, but rather takes a much broader perspective (Achleitner & Braun, 2014). As a result, research on entrepreneurial finance considers a heterogeneous landscape of entrepreneurial entities with equally heterogeneous alternative ways of financing means. In order to classify the large array of both stakeholders and financial options available, Achleitner and Braun (2014) suggest analyzing the concept of entrepreneurial finance along two dimensions. The first dimension relates to the life cycle the firm

is currently situated in. The second dimension refers to the respective stakeholders involved. These two perspectives allow addressing the respective requirements of the involved parties while simultaneously paying attention to the specific financial circumstances the entrepreneurial entity is confronted with. Following Achleitner and Braun (2014), figure 2 summarizes the two dimensions along which research on entrepreneurial finance is concerned with and addresses the core issues of the respective stakeholders respectively.

Figure 2: Dimensions of Entrepreneurial Finance

The figure illustrates the two dimensions along which research on entrepreneurial finance is concerned with (Achleitner & Braun, 2014).

Perspective	Life cycle of the firm	Early Stage	Growth	Later Stage
		Seed Start-up	Expansion	Bridge Buyout
A. Entrepreneur		Entrepreneurial Finance (narrow definition) “How to receive the right sources of funding to finance the growth of my business?”		
B. Investor		Venture Capital	Buyout “How to successfully invest in a buyout of a company?”	
C. Asset Manager		Venture Capital and Buyout as an asset class “How to maximize returns as an asset manager in venture capital and buyout funds?”		

Within the first dimension, each life cycle is characterized by different financial needs as well as different sources of capital (Rossi, 2014). In the early stages of development, research commonly refers to the term new venture given that the entrepreneurial entity is not a legal entity (i.e. seed stage) or has just been legally created (i.e. start-up stage) (Achleitner & Braun, 2014). Hence, the early stage is characterized by new ventures that have no, or if at all, a very short history of existence. In addition, their product or service is still in its infancy (Grichnik, Brettel, Koropp, & Mauer, 2017). Further, following the opportunity recognition, market research is usually complete so that market entry (i.e. the commercialization of the opportunity identified) can be commenced. Once market entrance was successful, the growth phase describes the expansion of the business where the business model is scaled by entering new markets or developing

new products or services. For very successful entrepreneurial entities with a strong history of growth, the later stage circumscribes their need for additional finance drawing on, for instance, initial public offerings (IPO), or financing strategies of the established entrepreneurial entity to buy back shares from investors in order to gain independence with the use of dedicated (leveraged) buyout funds (Achleitner & Braun, 2014).

The second dimension addresses the perspective of the different stakeholders - the entrepreneur, the investor, and the asset manager. When regarding the perspective of an entrepreneur, the core question, independent of the life cycle of the firm, deals with the question of how to receive the right means of financing to support the (further) growth of the new venture. In that regard, the majority of entrepreneurs typically draws on personal resources in combination with financial means from family, friends, and fools first (Kotha & George, 2012). This is, at least partially, owed to the pecking order theory, a theoretical concept that is found to be also applicable for new venture creation (e.g. Achleitner, Braun, and Kohn 2011 and Watson and Wilson 2002). In the context of financing new ventures, the pecking order theory describes that entrepreneurs typically draw on internal resources with capital from family, friends, and fools first, and then choose external funding as the second preferred alternative given their unwillingness to give-up ownership and control of their new venture (Myers, 1984; Myers & Majluf, 1984). However, in case the new venture does not develop as intended and for instance ceases to exist, funds owed to family, friends, and fools are likely irrecoverable and the entrepreneur is both financially and morally indebted with his closer peers (Grichnik et al., 2017). Yet, and although entrepreneurs prefer internal over external financing, the financing of new ventures with exceptional growth ambitions but low levels of revenues and equally low levels of cash-flows is nevertheless challenging. In this context, bootstrapping circumscribes the ability of entrepreneurs to cover their financial needs by internally generated funds. Beyond the provision of capital by friends, family, and fools, Achleitner and Braun (2014) highlight for example the ability to generate sufficient cash through revenues or simply through the provision of private savings. However, the authors also argue that bootstrapping is rare and internally generated funds are largely insufficient in the context of new ventures with exceptional growth ambitions and/or high-tech oriented business models. In this circumstance, internally generated funds can hardly cover the financing demands during the first weeks of operation (Achleitner & Braun, 2014). In case internally generated funds are not

available or insufficient in quantity, debt or equity capital from external sources may serve as additional means of entrepreneurial capital (Berger & Udell, 1998).

When considering both the high risk of failure and the missing track record of first-time entrepreneurs as well as the unavailability of assets that may serve as collateral however, traditional debt financing provided by banks is unlikely an option for new ventures particularly in their seed and start-up stage of development (Jeng & Wells, 2000; Knockaert, Wright, Clarysse, & Lockett, 2010). A second alternative of debt-like financing is the provision of public funding schemes supplied by governments or government-sponsored institutions as outlined in the introductory section of this dissertation. Ullrich (2011) argues that the main rationale for the provision of public funding is the belief of policy makers that the pure provision of capital can alleviate the financial constraints of new ventures and thus positively support the creation and growth of new entrepreneurial entities. However, given that the landscape of public funding instruments is immense in quantity and largely heterogeneous in quality, a clear categorization is difficult to achieve (Achleitner & Braun, 2014). Hence, an in-depth discussion of the large universe of public-funding schemes in the context of entrepreneurial finance would go beyond the scope of this dissertation. Given the inherent shortcoming of new ventures in regard to risk-mitigating collateral combined with the large importance of new venture creation regarding the societal well-being and economic growth, this dissertation particularly focuses on the entrepreneur in the seed and start-up stages of development.

Within the second dimension, the perspective of the investor is dealt with, too. At its core, the investor's perspective deals with the question how a successful investment is identified. When considering the shortage of collateral and the high probability of new venture failure, a viable option is financing in the form of risk capital that may serve as a suitable alternative to internally generated funds for newly created ventures (Bertoni, Colombo, & Grilli, 2011; Croce, Marti, & Murtinu, 2013; Sapienza, 1992). This form of capital is particularly suited for innovative young firms with both, a high growth potential but also great risk inherent to the business model (Engel & Keilbach, 2007). Yet, two basic types of investors are commonly referred to in the context of new venture financing - business angels and venture capitalists. Despite the fact that no regulatory definition exists in regard to business angels and venture capitalists (Amit, Brander, &

Zott, 1998), both terms are often used interchangeably, and hence the definition of either is rather blurry.

Usually, the first type of investors, business angels, are individual investors who provide private equity capital to new ventures (Mason & Harrison, 1995). The business angel is typically a former executive of a large corporation or business owner having collected substantial experience that is, in combination with capital, invested in new ventures (Rosenbusch, Brinckmann, & Mueller, 2013; Sudek, 2006). Given their extensive experience, business angels normally invest in the seed and start-up stages of the newly created venture as their knowledge offers the biggest leverage and the price (i.e. value of the new venture) is low suiting their financial abilities (Elitzur & Gavious, 2003; Maxwell, Jeffrey, & Lévesque, 2011). Further, the non-monetary support in the form of experience is particularly important in the early stages of development. Said differently, the business angel's experience is positively related to new venture success (Brettel, 2004). However, business angels have a smaller financial scope compared to venture capitalists who invest larger financial resources of multiple lenders (Grichnik et al., 2017). In addition, due to the fact that business angels comprise a single investor, the available managerial expertise is limited to the entrepreneurial skills and capabilities of the same person or the network of business professionals this person has access to. Lastly, business angels frequently pursue non-economic objectives when supporting new ventures such as hedonistic and altruistic motives (Wright, 1998).

As such, a business angel's investment objective does not necessarily coincide with that of a venture capitalist, who can be considered the second type of risk capital investor suited for new ventures. Although the field of seed and start-up stage investments has traditionally been covered by business angels, the number of dedicated VC funds targeting new ventures is growing (Dimov, Shepherd, & Sutcliffe, 2007; Kim & Wagman, 2016). VC per se is a private equity financial intermediary, primarily suitable for firms being in the early and expansion stage and which do not only lack financial resources, but also managerial experience and a network of business professionals (Jeng & Wells, 2000). Based on definitions of prior literature, VC is characterized as an institutional (Bessler & Kurth, 2007), formal (Bruton, Chahine, & Filatotchev, 2009), and a professional type of investment (da Silva Rosa, Velayuthen, & Walter, 2003; Gompers & Ler-

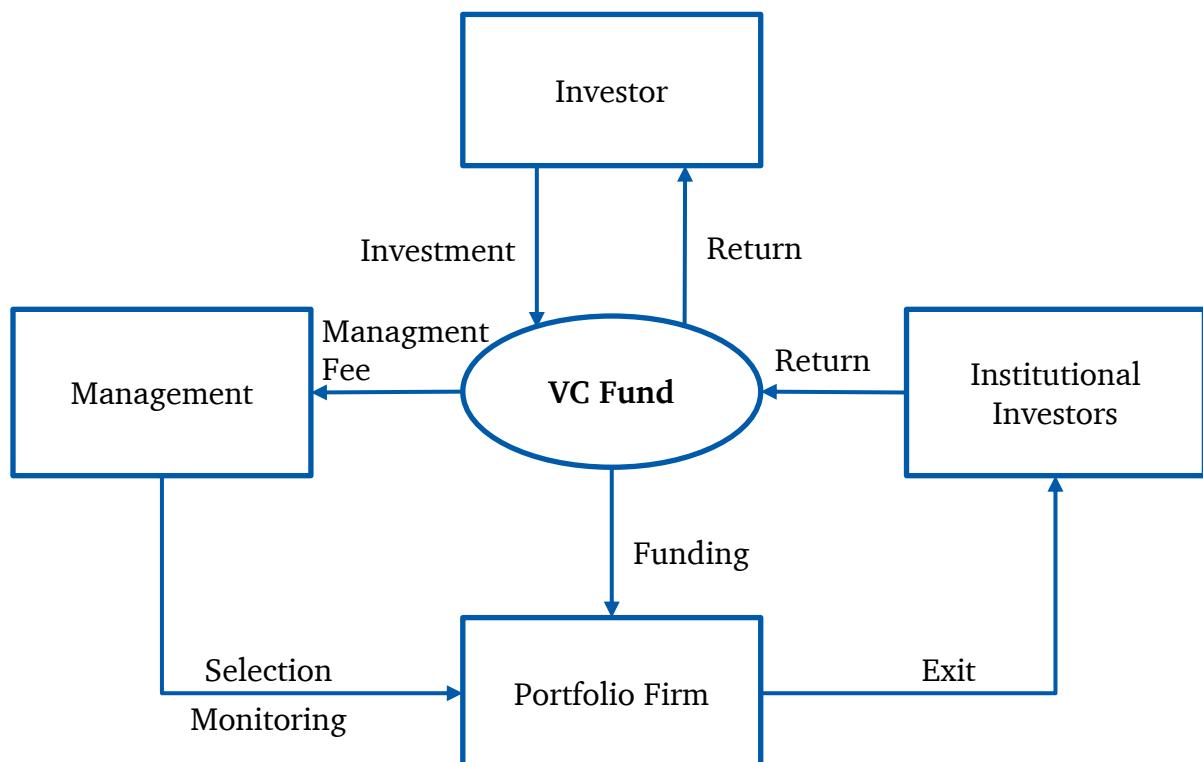
ner, 2001; Hellmann & Puri, 2000). Moreover, a venture capital investment is characterized with an active involvement in the new venture (Sahlman, 1990). Nowadays, forms of VC include corporate VC (CVC), bank-affiliated VC (BVC), governmental VC (GVC), and individual VC (IVC) (Bertoni, Colombo, & Quas, 2015). Hence, venture capitalists do either appear in the form of a corporate/government-backed investor or as an independent investment entity. In essence, CVC, BVC, and GVC are a subdivision of a larger non-financial corporation (e.g. Siemens Venture Capital (“Next47”), Google Ventures), financial corporation (e.g. CommerzVentures), or government institution (e.g. High-Tech Gründerfonds) investing in new ventures for financial and strategic reasons (Hopp, 2010; Keil, Maula, & Wilson, 2010). Individual venture capitalists on the contrary appear in the form of sole partnerships that raise capital from outside investors in return for the promise of wealth appreciation for the funds invested. Hence, venture capitalists act as a financial intermediary by investing and managing funds provided by large corporates or government institutions and third-party individuals such as pension funds and wealthy individuals. The objectives pursued with the investments are broad; risk diversification, capital appreciation and strategic investing are amongst the most important ones, however. Whereas corporate or government venture capitalists are rather structured as a subdivision in an organizational chart, the organizational structure of a VC fund is different and thus outlined in figure 3.

Following Geigenberger (1999), the investment vehicle (i.e. the VC fund) is formally managed by the fund’s management referred to as the general partners. During the inception phase of a new VC fund, the general partners collect capital from investors such as wealthy individuals, large corporations, or institutional investors such as family firms or pension funds. The capital providing individuals are referred to as limited partners. Once the capital collected corresponds to the planned size of the fund, the general partners then start to screen and select potential portfolio investments that coincide with the fund’s strategy that is defined when the capital is collected from the limited partners in a process called fundraising. Potential strategies might include a certain industry focus, a specific stage in the new venture’s life cycle or a certain valuation range of the portfolio firms at acquisition. Once the screening of potential portfolio firms is complete and the funds available are invested, the general partners commence to monitor the development of the investee firms. The holding period normally lasts between 3 to 14 years and is mainly characterized with an active engagement of the

general partners in terms of providing management support to the portfolio firm (Agarwal & Bayus, 2002; Cumming & Macintosh, 2001). The management support venture capitalists provide in addition to their financial support is commonly referred to as ‘smart money’ and includes various supporting mechanisms. Exemplary mechanisms are the installation of accounting systems, searching for consultants or key executives, as well as giving strategic advice (Arque-Castells, 2012; Balboa, Marti, & Zieling, 2011; Davila, Foster, & Gupta, 2003; Sørensen, 2007). Overall, these measures are naturally intended to foster a new venture’s positive development and thus avoid the risk of bankruptcy. The general partners receive a certain percentage (i.e. usually 2 percent) of the fund’s volume for their supervisory role in order to cover the administrative expenses related to the management of the portfolio firms. During or at the end of the fund’s predefined lifetime, the portfolio firms are sold and the proceeds are returned to the limited partners. Any profit in the form of capital appreciation of the funds invested is shared between the general and limited partners and distributed according to the agreements defined at the fund’s initiation.

Figure 3: Structure of a VC Fund

The figure illustrates the basic structure of a VC fund and its stakeholders along the investment process (Geigenberger, 1999).



Since the limited partners invest with the purpose of increasing their capital provided, the portfolio firms are meant to increase in value during the holding period as a result of accessing new markets and/or commercializing new products and services. Despite the important role of the new venture's management team itself, venture capitalists are also held accountable for the superior firm performance, measured with multiple dimensions of performance, of portfolio firms they invest in over those who did not receive VC financing (Alperovych & Hubner, 2013; Bertoni et al., 2011; Croce et al., 2013; Engel, 2002; Zacharakis & Meyer, 1998). As such, venture capitalists "can identify firms with hidden value and provide them with the necessary financing" (Bertoni et al., 2011, p. 1028). However, empirical evidence is inconclusive so far whether this superior performance is the result of inherent firm characteristics prior to a VC engagement or rather the result of VC-related post investment monitoring and coaching (e.g. Bertoni et al., 2011; Chemmanur, Krishnan, and Nandy 2011; and Croce et al. 2013). Thus, the prevailing question concerning VC investing is whether venture capitalists are scouting promising new ventures based on a reproducible manner that would also grow in the absence of VC (i.e. a selection effect), or if the superior performance of investee firms is attributable to the value adding services venture capitalists provide to the firms they have chosen to invest in (i.e. a treatment effect).

In line with this question, empirical evidence towards the treatment and selection effect of VC investments is versatile. For example, Croce et al. (2013) investigated a total of 696 firms and testify that VC-backed firms' productivity is not statistically different from that of non-VC-backed firms before their first round of financing. They state however, that productivity increases as a result of a VC involvement leaving them to believe that the investee firms' performance is attributable to a treatment effect rather than a selection effect. A similar conclusion is also supported by Balboa et al. (2011), Bertoni et al. (2011), and Colombo and Grilli (2010). They provide empirical evidence that the sales and employee growth of the firms investigated is the result of the involvement of VC. In line with those findings is the outcome of studies performed by Davila et al. (2003) and Engel (2002), however limited to an increase in employee growth and total factor productivity respectively that was deemed to be the result of a VC involvement. Further, Colombo and Murtinu (2017) investigate whether there is a performance difference of individual and corporate VC firms in terms of the portfolio firms' performance. Using a

sample of 259 VC-backed firms, they argue that investee firms of both types of VC investors increase their performance primarily in regard to their sales volume. The authors argue that this performance increase is the result of the involvement of either type of VC and not the result of a potential selection effect (Colombo & Murtinu, 2017).

On the contrary, Chemmanur et al. (2011) found in their study of 1,881 VC-backed and 185,882 non-VC-backed manufacturing firms that efficiency in both states, prior to and after a VC investment is higher for firms having received VC compared to those having not. This result clearly supports the hypothesis of the existence of a selection effect, too. However, they also find that growth in efficiency for VC-backed firms is higher compared to non-VC-backed firms. In this regard, venture capitalists apparently do select higher quality firms over others, allegedly being of lesser quality. Nonetheless, the value-addition provided by VC investments is not to be overlooked, thus supporting the existence of a treatment effect as well. Similarly, Di Guo and Kun Jiang (2013) compare the research & development and performance attributes of VC-backed over non-VC-backed firms in the case of China. Based on their analysis, both a higher performance of VC-backed over non-VC-backed firms is found in terms of financial as well as research & development performance prior to and after a VC investment. In addition, Baum and Silverman (2004) came to the same conclusion in their study on 204 new ventures in the biotechnology sector justifying the existence of both a treatment as well as a selection effect in VC financing. Noteworthy is the fact that all authors have used unequal samples in terms of size, industry allocation, time, and geographical area. This supports the indication that both, a treatment and/or selection effect could be determined over and beyond one random sample size, thus supporting the existence of an external validity of the hypothesis regarding the venture capitalists value-add claimed. Given the importance of this yet not thoroughly researched question however, a sizable part of this dissertation evaluates the role of a VC involvement in new ventures, too.

Irrespective of a potential treatment or selection effect that can be considered responsible for the superior performance of new ventures backed by VC over new ventures without VC, the VC fund is obliged to provide the return to its investors. Hence, those portfolio firms that have survived and grown during the time the fund was invested (i.e. 3 to 14 years), are sold to other financial institutions or corporations, or taken public via an IPO. This process of divestment is commonly referred to as “exit” (Grichnik et

al., 2017) and the funds collected are redistributed to the investors. During the time the fund is invested in the portfolio firms, the management of the fund is compensated for its non-monetary support by a so-called management fee, a flat percentage fee usually in the range of 2 percent of the fund's volume. In addition, the VC fund also receives part of the value increase of the investee firms from the time they are included in the fund until the exit. The actual percentage of the so called carried interest is subject to negotiation during the fundraising with the limited partners, has on average been around 20 percent of the capital gain generated.

A third type of investor considered within the second dimension is the buyout investor. In contrast to a VC fund, buyout funds primarily leverage the purchase of an established firm with the use of a high amount of debt capital, however. As a result of the debt financing instrument, the subject firm is required to have substantial cash flow in order to be able to return both principal and interest to the capital provider - a criterion that VC investors do not necessarily demand from new ventures (Rosenbusch et al., 2013). Another difference with regard to VC is that buyout funds normally assume control of the investee without assuming an active role in the firm (Sahlman, 1990). Despite the tremendous importance of business angels in the context of new venture financing and the importance of buyout funds for established firms, this dissertation will focus exclusively on venture capital funds and combine the perspective of the VC investor with the perspective of the entrepreneur seeking funding for a newly created venture in the seed and start-up stage of development. This viewpoint is of particular importance given the fact that the role of a VC investment in new ventures is not well understood (Baum & Silverman, 2004), and also in line with prior literature focusing on the perspective of both the entrepreneur and the investor in the early stages of a new venture's development (Bruton, Filatotchev, Chahine, & Wright, 2009; Gompers, 1999).

A fourth type of investor, however not considered by Achleitner and Braun (2014), is the individual investor characterized as a so-called "backer" in the context of crowdfunding. This individual investor, e.g. the average person, has only recently been given access to investing opportunities in new ventures based on the sudden but notable introduction of various forms of crowdfunding platforms. At its core, crowdfunding represents a relatively new means of funding that individuals and new ventures alike collect in the form of small amounts from a large group of individuals through the use of

online platforms acting as intermediaries (Agrawal, Catalini, & Goldfarb, 2013; Ahlers, Cumming, Günther, & Schweizer, 2015; Bruton, Khavul, Siegel, & Wright, 2015; Cholakova & Clarysse, 2015; Mollick, 2014). The success of crowdfunding as a serious alternative to the before-mentioned rather traditional forms of funding has particularly manifested after the financial crisis in the years 2008/2009. Ever since, the number of platforms, projects funded, and amounts invested have increased exponentially (Dushnitsky, Guerini, Piva, & Rossi-Lamastra, 2016). This increasing trend translated into more than USD 16 billion of funding provided via crowdfunding across the globe in 2014 and is expected to increase to USD 34 billion in 2015 (Barnett, 2017). On average, the author continues, the total investment volume provided by venture capitalists sums up to USD 30 billion per year. Hence, crowdfunding has established itself as a serious alternative to the traditional means of financing such as venture capital.

Today, various forms of crowdfunding exist, yet reward-based (e.g. Colombo, Franzoni, and Rossi-Lamastra 2015; Mollick 2014; Wessel, Thies, and Benlian 2015; and Wessel, Thies, and Benlian 2016), lending-based (e.g. Dushnitsky et al. 2016), and equity-based (e.g. Ahlers et al. 2015; Lukkarinen, Teich, Wallenius, and Wallenius 2016; Roma, Messeni Petruzzelli, and Perrone 2017; and Vismara 2016) crowdfunding campaigns have been subject to increased attention in the context of financing entrepreneurial initiatives lately. This is mainly owed to the fact that these forms of crowdfunding are simultaneously seen as crowd-investing as the supporting process strictly requires a certain return in exchange for the financing provided. This prerequisite is clearly in contrast to donation-based crowdfunding platforms that do not necessarily provide a material return in the form of interest (lending-based), capital appreciation (equity-based) or a product or service (donation-based). Donation-based platforms rather provide the opportunity for individuals to donate monetary support for the good cause by supporting, for instance, cultural projects (Dushnitsky et al., 2016; Mollick, 2014). Given this circumstance, the latter form is not in line with the traditional entrepreneurial finance perspective of new venture growth and shall therefore not be further considered.

In contrast, the remaining forms of crowdfunding suit to the context of entrepreneurial finance research as the financing motive clearly prevails. Hence, the individual and non-professional (i.e. amateur) investor using equity-, lending, and reward-based crowd-

funding platforms shall therefore represent an augmented group of investors to be considered within the discipline of entrepreneurial finance research. In particular, the reward-based model is the most popular form of crowdfunding amongst all forms (Dushnitsky et al., 2016). In this form, individuals (i.e. backers) provide financial means in exchange for a product prototype or token-item gifts such as coffee-mugs, t-shirts or Facebook likes (Antonenko, Lee, & Kleinheksel, 2014; Xu, Zheng, Xu, & Wang, 2016). According to Dushnitsky et al. (2016), the second largest form are lending based platforms. The lending concept circumscribes that individuals can support new ventures financially by expecting a predefined return similar to interest on a government bond. Lastly, equity crowdfunding platforms most closely match the view and objectives of, for instance, business angels and venture capitalists in the second entrepreneurial finance perspective. Using equity crowdfunding, individual investors can invest in new ventures directly in exchange for ownership or ownership-like equity instruments (shares, preferred shares, mezzanine capital). The latter form is however largely dependent on the legislative environment given that many countries nowadays have very strict investor protection laws and regulations (Vismara, 2016). As a result, pure equity crowdfunding platforms are rare and have only until recently gained importance. A reason for the increased importance are for example initiatives such as the Jumpstart Our Business Startups Act (JOBS) act in the United States that decreased investor protection regulations and hence, opened new investment opportunities for amateur investors (Roma et al., 2017). Despite the fact that equity and lending based platforms closely imitate the objectives of risk diversification and capital appreciation with new venture investing, these forms are nevertheless not available to a broad range of investors given the many legal restrictions to protect small and amateur investors still in place. Hence, given that reward-based platforms are available to a broad range of individuals and also mimic the entrepreneurial finance perspective in terms of growth as well as the investment objective of the individual investor in requiring a material return in exchange for his investment, this form is at the heart of this dissertation.

The last perspective of the entrepreneurial finance perspective concerns the view of the asset manager in assessing an investment in terms of how the returns of the investment can be maximized (Achleitner & Braun, 2014). Given that this dissertation will focus on the allocation of investments in the early stages of a new venture, the perspective of

the asset manager is beyond the scope of this dissertation and shall hence not be dealt with.

2.2 Investment Selection, Information Asymmetries, and Quality Signals

Referring to the above mentioned high risk of failure and the start-up nature of new ventures, information asymmetries play a crucial role between the investor and the investee when investment proposals are evaluated. Due to the fact that the entrepreneur possesses private information that the investor may find valuable in the decision making process, the available information to the investor is limited (Moss, Neubaum, & Meyskens, 2015). Private information represents for example the technical feasibility of the product or the entrepreneur's personal intent towards the venture's development (Stiglitz, 1990). Put differently, this problem of information asymmetry, a concept initially developed by Jensen and Meckling (1976) and formally known as the Principal-Agent theory, addresses in essence the availability of different amounts of information to the investor (i.e. the principal) and the investee (i.e. the agent) and the resulting implications this situation inherits. According to Amit et al. (1998), information asymmetries take the form of hidden information and hidden action. Hidden information is for instance related to the entrepreneur being more likely able to assess whether or not a newly developed technology will work as suggested. Hidden action on the contrary is based on the assumption that the new venture's management team may pursue other objectives with the growth of the venture compared to the investor during the time when both parties are dependent on each other.

In order to mitigate the investment risk ex-ante, a venture capitalist would usually go through multiple stages of venture screening in order to collect as much (private) information as possible and to support the decision for or against an investment (Rosenbusch et al., 2013). This investigative process normally begins with an intensive due diligence, a process in which the new venture's business plan and management team is intensively scrutinized (Fried & Hisrich, 1994; Zacharakis & Shepherd, 2001). Given the large array of information available, venture capitalists primarily focus on the entrepreneurial team, the target market including the product or service as well the investment risk that a new venture has compared to other available investment opportunities (Brettel, 2002; Petty & Gruber, 2011). Given the high number of new ventures seeking funding as well as the rigorous screening process of venture capitalists, about

90 percent of deals get rejected, and from the remaining ones, only a fraction receives the needed funding (Gompers & Lerner, 2004; Ferrary, 2010). Further, and with time being a scarce resource during a due diligence investigation process, Zacharakis and Meyer (1998) found that venture capitalists tend to face a negative correlation between fully comprehending the new venture as well as its products or services and the amount of information they receive. This finding is based on the assumption that the more information a potential investor receives, the less clear and understandable the investee becomes. Kunze (1990) even argues that if venture capitalists tried to analyze every potential information related to the new venture, a VC would never be fully confident about investing the available funds. This coherence will allegedly lead to venture capitalists judging the investment opportunity intuitively, resulting in decisions being made under the assumption of overconfidence (Gimmon & Levie, 2010; Zacharakis & Shepherd, 2001). According to Griffin and Varey (1996), this overconfidence takes either the form of overestimating the likelihood of a desired outcome (i.e. optimistic overconfidence) or by simply overestimating one's own knowledge during the decision-making process. Either way, the decision whether a new venture is worth investing leaves the area of a rational and reproducible decision-making rather aligned with gut feeling (Macmillan, Zemann, & Subbanarasimha, 1987). Another complementary evaluation process performed by venture capitalists in order to reduce information asymmetries is the provision of financial means in stages (i.e. 'staging'). Given that new ventures are subject to reaching agreed milestones in order to receive agreed resources, venture capitalists can withdraw their engagement as agreed milestones are not met and thus limit their investment risk (Dahiya & Ray, 2012; Gompers, 1995).

Based on the intensive due diligence that precedes a VC investment, venture capitalists would evaluate seminal signals that portray the potential and superiority of the new venture above others in order to reduce informational asymmetries ex-ante (Moss et al., 2015; Vismara, 2016). Particularly in the early stages of a screening process, signals are an important means to reduce initial information asymmetries between the investor and the investee (Busenitz et al., 2005). Nevertheless, a venture capitalist is unable to fully judge and comprehend all aspects of the investee before acquiring an ownership stake and receiving access to the new venture's internals. Although venture capitalists have means through which the risk of investment failure can be reduced as discussed above, it is in essence their experience and expert knowledge about the new ventures

they invest in which makes venture capitalists “better able to address information asymmetry problems than other financial firms” (Croce et al., 2013, p. 491). When early stage investments are screened, investors largely rely on signals that reduce information asymmetries and uncertainties about the future potential of the firm. In other words, decision makers such as venture capitalists often rely on informational cues in situations in which decisions have to be made in the absence of perfect information in order to assess what future outcomes to expect - the concept of signaling theory (Busenitz et al., 2005; Spence, 1973, 2002). Signaling theory describes efforts of the capital-seeking party (i.e. the entrepreneur) to reduce information asymmetries by providing information for the inherent quality and future development of a new venture to the capital-providing or assessing party (i.e. the venture capitalist). Hence, signaling theory circumscribes that entrepreneurs signal the quality and viability of their venture to a venture capitalist in order to stand out and suggest superior quality and ability compared to other capital-seeking ventures (Arthurs, Busenitz, Hoskisson, & Johnson, 2009; Busenitz et al., 2005; Connelly, Certo, Ireland, & Reutzel, 2011). In order to be valuable, “signals must be freely accessible (i.e., observable), understood in advance, and costly to imitate” (Hopp & Lukas, 2014, p. 638).

Empirical evidence towards the value of different signals in the context of VC investing is versatile. For instance, venture capitalists focus on the investee firm’s apparent characteristics in terms of products and services, the potential of the target market, the firm’s financial potential, as well as the management teams’ set-up (Petty & Gruber, 2011). Most importantly however, Petty and Gruber (2011) conclude that a good management team with sufficient business experience pursuing a promising business idea might already be valued as a good signal. Thus, human capital characteristics play an important role in VC decision making since human capital is also positively associated with venture growth (Baeyens, Vanacker, & Manigart, 2006; Knockaert et al., 2010; Zacharakis & Meyer, 2000). In essence, human capital refers to a set of skills, capabilities, and knowledge that individuals acquire during their formal education, on-the-job training, and job experience (Shrader & Siegel, 2007; Unger, Rauch, Frese, & Rosenbusch, 2011). Further, venture capitalists are in clear favor of product-oriented business models instead of service businesses that are fully dependent on their founding team (Munari & Toschi, 2011). The latter aspect is particularly relevant if the management team breaks up, or if the venture capitalist decides to replace the management team (Elitzur &

Gavious, 2003; Hellmann & Puri, 2002). Further, patents are commonly referred to have a strong and positive signaling value to outside investors (Conti, Thursby, & Rothaermel, 2013; Haeussler, Harhoff, & Mueller, 2014; Hoenig & Henkel, 2015). The value of patents is particularly relevant for new ventures since they allow the new venture to exclusively exploit a new technology providing them a competitive advantage (Hsu & Ziedonis, 2013). Lastly, venture capitalists can reduce information asymmetries concerning a new venture by mainly investing in ventures that have already been evaluated (i.e. undergone due diligence) by a preceding investor, such as business angels or other VC funds (Bertoni et al., 2011; Davila et al., 2003). This practice implies that prior investors had already assessed the new venture to be of high-quality what may reduce the perceived investment risk from a venture capitalist's perspective (Bonardo, Paleari, & Vismara, 2010; Lerner, 1999, 2002). In particular for early stage firms, third party signaling may be of large importance given the lack of other informational cues to be assessed (Plummer, Allison, & Connelly, 2016).

Although the task of signal evaluation is common practice, the scarcity and heterogeneity of signals in the context of new ventures may impose the difficulty that individual investors assess signals differently. In essence, investments in new ventures are characterized with greater information asymmetries compared to later stages firms (Kirsch, Goldfarb, & Gera, 2009) and investors are confronted with less reliable, selected, and unregulated information (Plummer et al., 2016). Given the scarcity of reliable signals as well as the need to have the few signals available objectively assessed from multiple perspectives, this dissertation strives to provide empirical evidence how the selection process is influenced while considering crowdfunding as a new means of entrepreneurial finance attesting the quality of a new product or service. Further, this dissertation will elaborate in more detail on the investment process regarding new ventures in an academic spin-off context as well as the role of VC in the growth process of these firms.

2.3 Development of Research Questions

2.3.1 VC Investments in Research-Based Spin-offs

In recent years, academic entrepreneurship has gained both momentum and the attention from academics, governments, and researchers at the same time (Urbano & Guerrero, 2013). An understanding of success factors of these important firms is essential in

order to develop policy measures that effectively support new venture creation from academics in terms of their survival and growth, and which foster technology transfer as well as the creation of jobs. These are firms founded by academics (i.e. current and prior researchers) who aim to fill the gap between scientific research and its commercialization by exploiting technological innovations in the form of marketable products or services (Colombo et al., 2010). Further, research-based spin-offs (RBSOs) are also very important regarding the transfer of knowledge from research organizations - both public and privately-sponsored - to the private sector (Czarnitzki, Rammer, & Toole, 2014; Festel, 2013; Fryges & Wright, 2014; Urbano & Guerrero, 2013; Wright, 2014). When considering the relatively few contributions that deal with the concept of academic entrepreneurship, one can conclude that not much research has been dedicated to this fascinating niche of the overall entrepreneurial activities. However, understanding the peculiarities of RBSOs is nonetheless essential since these new ventures have very special characteristics that distinguish them from regular new ventures. Amongst them is for example a homogeneous founding team and radically new technologies which encompass the possibilities to transfer their technologies into commercial products (Colombo & Piva, 2012). In addition, RBSOs often have large capital needs for the construction of prototypes and the frequently required testing facilities in the form of, for example, well-equipped laboratories. Given that the capital-intensive development and testing procedure cannot solely be covered by public funding or debt capital, and the fact that academic spin-offs often lack sufficient collateral, the available financing options are reduced notably (Jeng & Wells, 2000; Knockaert et al., 2010; Wright, Lockett, Clarysse, & Binks, 2006).

However, an exception to the scarce landscape of financing options still available is VC. In other words, VC is often the remaining financing option for academic entrepreneurs who have already completed initial research or developed first prototypes (Bertoni et al., 2011; Croce et al., 2013; Sapienza, 1992). In addition to the provision of equity-capital, a VC involvement may additionally entail management support such as the installation of accounting systems, searching for consultants or key executives, as well as giving strategic advice as previously mentioned (Arque-Castells, 2012; Balboa et al., 2011; Davila et al., 2003; Sørensen, 2007). As a result, acquiring VC can be a beneficial financing option for RBSOs when considering a) their resource-scarcity and b) their large capital need given the high-tech nature of their products and services. In line with

the generic advantages of VC, a large array of scientific research provides strong support that VC-backed firms outperform non-VC-backed firms (Alperovych & Hubner, 2013; Bertoni et al., 2011; Croce et al., 2013; Engel, 2002; Zacharakis & Meyer, 1998). However, the various findings are inconclusive so far whether this superior performance is the result of the inherent characteristics of the venture prior to a VC engagement or rather the result of VC-related post investment monitoring and coaching once the venture has become a portfolio firm (e.g. Bertoni et al. 2011; Chemmanur et al. 2011; and Croce et al. 2013).

Against this background, the empirical contribution of this dissertation is twofold. First, new insights on the peculiarities of RBSO-specific resources and their association with firm performance are generated by contributing to advancing the resource-based view of the firm (Barney, 1991; Barney et al., 2001; Penrose, 1996; Wernerfelt, 1984). Further, this dissertation seeks to identify if VC-backed RBSOs outperform non-VC-backed RBSOs and if so, disentangle the effects of RBSOs' growth by evaluating whether venture capitalists contribute to growth by choosing the right investment objects (i.e. selection effect) or by providing additional resources (i.e. treatment effect). Given the intended research scope addressing the role of VC towards the growth of RBSOs, the first research question is formulated as follows:

Research Question 1: What drives growth in research-based spin-offs and how is growth affected by VC?

2.3.2 The Signaling Value of Crowdfunding and VC Investing

As a result of dried-up financial resources after the global financial crisis in the years 2008/2009, crowdfunding became a popular source of funding for cultural and commercial ventures (Antonenko et al., 2014; Bruton et al., 2015). As above-mentioned, crowdfunding represents a relatively new means of funding that allows the individual, i.e. backer, to support new ventures in the form of small amounts through online platforms that act as intermediaries (Agrawal et al., 2013; Ahlers et al., 2015; Bruton et al., 2015; Cholakova & Clarysse, 2015; Mollick, 2014). Given the increasing popularity amongst amateur investors and entrepreneurs alike, crowdfunding turned into a viable source of entrepreneurial finance for commercially-oriented ventures, too (Schwien-

bacher & Larralde, 2010). For instance, 45 out of the 50 largest crowdfunding campaigns in 2012 turned into new firms after they had collected their first funds through individual investors (Mollick, 2014). Hence, crowdfunding may trigger the establishment of new ventures and also serve as initial bridge-financing to support entrepreneurs in reaching first milestones during the development of their business models (e.g. construction of prototypes) (Bruton et al., 2015). However, follow-up costs for the actual commercialization of the product, including costs for patenting or production ramp-up, usually exceed the funds collected with a crowdfunding campaign. In particular, technology-intensive products often have a lengthy development process and consume much of the required capital up-front (Achleitner & Braun, 2014). Thus, in case the new venture cannot compensate those expenses by internal financial means, the founding team is obliged to find a way to fill the so called ‘equity gap’, a financial shortcoming of a new venture that has to be covered by alternative sources of funding (Murray, 1999). Given that entrepreneurial initiatives lack sufficient collateral regarding the provision of debt-capital from traditional lending institutions, the available financing options are limited in the early stages of these firms (Jeng & Wells, 2000; Knockaert et al., 2010). In this context, risk-capital such as venture capital is often the natural next financing option for young ventures with first prototypes and/or sales and promising market outlooks (Bertoni et al., 2011; Croce et al., 2013; Sapienza, 1992). In addition to the provision of financial capital, an important advantage of a VC involvement is the managerial support (i.e. ‘smart money’) that comes along with the financing (Arque-Castells, 2012; Balboa et al., 2011; Davila et al., 2003; Sørensen, 2007). Beyond the advantages VC offers to new ventures in their seed and early stages of development, investments in these firms are characterized particularly by high information asymmetries and uncertainties regarding survival and future development (Clarysse & Moray, 2004; Colombo, Grilli, & Verga, 2007; Knockaert et al., 2010; Lockett, Murray, & Wright, 2002). In order to mitigate the investment risk ex-ante, venture capitalists seek informational cues that support their assessment for or against an investment proposal. This setting is in line with signaling theory, assuming that information asymmetries can be reduced by signals that are observable and accessible before a decision is made (Spence, 1973; Spence, 2002). Although scholarly work highlights a variety of signals such as the human capital of the venture (Petty & Gruber, 2011), patents (Baeyens et al., 2006; Knockaert et al., 2010; Zacharakis & Meyer, 2000), or a product-oriented business model (Munari &

Toschi, 2011), signals in the context of crowdfunding as informational cue have not yet been thoroughly assessed in this context. When considering recent examples, however, crowdfunding seems to matter in the allocation of VC. A striking example thereof is Lifx, a crowdfunded hardware new venture that raised a record financing round led by Sequoia Capital with USD 12m investment after it had raised USD 1.3m in a very successful Kickstarter campaign (CB Insights, 2014). This example demonstrates that a venture capitalist's decision-making may be influenced by the funding decision of many individuals (i.e. the crowd) in order to infer whether the venture and its product or service is worth investing (Agrawal, Catalini, & Goldfarb, 2016; Mollick & Nanda, 2016). Against this backdrop, the focus lies on the question if and how a crowdfunding campaign influences the decision-making process of venture capitalists. Drawing on signaling theory and the microfinance literature, this dissertation seeks to advance signaling theory by assessing if signals relevant for non-expert investors such as the crowd have an equal value to expert investors such as venture capitalists and thus ultimately reduce information asymmetries between the investor and the investee. Despite the fact that both crowdfunding and VC have been subject to increased academic attention (Xu et al., 2016), research evidence on a combined view of these two forms of entrepreneurial finance is scarce. Hence, this dissertation derives the second research question as follows:

Research Question 2: If, and how, are signals of a crowdfunding campaign factored into the investment decision-making process of venture capitalists?

2.3.3 The Signaling Value of Crowdfunding and VC Syndication

Given this initial intuition about crowdfunding and its positive signaling value towards venture capital investors in post-campaign financing rounds, this dissertation additionally focuses on a particular niche of the financing process - the syndication behavior of venture capital investors. Taking this view is of particular importance given the fact that many venture capital investments are organized in syndicates in order to better assess the investment risk ex-ante (Ferrary, 2010; Hochberg, Ljungqvist, & Lu, 2007; Manigart et al., 2006; Wang & Zhou, 2004). In this context, syndicates comprise a joint equity investment of at least two venture capitalists (Hopp & Lukas, 2014; Terjesen, Patel, Fiet, & D'Souza, 2013; Wright & Lockett, 2003). When joining a syndicate, its members

take advantage of an increase in deal flow, possible portfolio diversification, and reputation gains that would otherwise be inaccessible (Altintig, Chiu, & Goktan, 2013; Bygrave, 1987; Hopp & Lukas, 2014; Sahlman, 1990). Yet, the most striking motivation to join a syndicate is based on the fact that an investee's potential and investment risk is evaluated from multiple perspectives (Altintig et al., 2013; Bygrave, 1987; Lehmann, 2006). When evaluating the potential of a new venture, the amount of information available to the assessing party (i.e. the syndicate members) is limited and largely subject to observable cues that can have the potential to reduce information asymmetries between the investor and the investee. As above-mentioned, empirical studies highlight for example that the human capital of the venture (Petty & Gruber, 2011), the availability of patents (Baeyens et al., 2006; Knockaert et al., 2010; Zacharakis & Meyer, 2000), or the business model (Munari & Toschi, 2011) have a significant impact on the investment decision of venture capitalists. Yet, these signals tell little about the market acceptance of the product or service and thus the market potential of the venture is still unknown. In this regard, few empirical studies have devoted their attention towards the role of crowdfunding in the post-campaign financing of new ventures (e.g. Mollick and Kuppuswamy 2014 and Roma et al. 2017). Additionally, VC syndication in particular, with a few exceptions (Dimov & Milanov, 2010; Lehmann, 2006; Manigart et al., 2006) has received relatively little attention. Furthermore, research on a combined view of both the crowdfunding literature and VC syndication is, to the best of the author's knowledge, still missing. In light of this research gap, this dissertation focuses on the question if, and how, a crowdfunding campaign influences the syndication behavior of venture capitalists while drawing on signaling theory and the syndication literature. Hence, this dissertation derives the third research question as follows.

Research Question 3: If, and how, does a crowdfunding campaign influence the syndication behavior of venture capitalists?

3 Research-based Spin-offs and the Role of VC

This first empirical contribution intends to develop an understanding of financing issues of new ventures that have emerged from an academic context. In order to elaborate on the research question one derived before, the analyses rest upon a proprietary dataset of 98 German research-based spin-offs founded between 1997 and 2012 and assess which firm-specific and system-inherent factors are relevant for the spin-offs' growth while simultaneously drawing on the resource-based view of the firm as theoretical framework.² For one thing, this research aims to evaluate whether venture capital-backed RBSOs show a superior performance over non venture capital-backed RBSOs and if a possible difference in both revenue and employment growth can be explained by venture capitalists' scouting or coaching capabilities. Using a variety of well-respected econometric approaches such as the instrumental variables and control function method, the empirical results find for example that a homogeneous educational background of the academic founders is positively associated with RBSO growth. In addition, the results show that a training provided by the parent research organization intended to develop entrepreneurial skills and to establish a network to outside professionals has a positive impact on RBSO growth. Likewise, the analyses also find that the commercialization of a radically new, instead of an incrementally new innovation, has a positive impact on the growth of RBSOs. Concerning the involvement of venture capitalists, venture capital-backed RBSOs show a superior employment and revenue growth compared to non-venture capital-backed RBSOs. The results support the view that this

² This empirical contribution has been presented at various conferences and has been accepted for publication at **The Journal of Technology Transfer**. The conference contributions are as follows: Bock, C., Huber, A., & Jarchow-Pongratz, S. (2015) - Growth of VC-Backed Research-Based Spin-Offs – A selection or a treatment effect. **Economics of Entrepreneurship and Innovation**, Trier – Germany. Bock C., Huber, A., & Jarchow-Pongratz, S. (2016) - Growth Factors of Research-based Spin-offs and the Role of Venture Capital Investing. **Interdisziplinäre Jahreskonferenz Entrepreneurship, Innovation und Mittelstand („G-Forum“)**, Leipzig – Germany. Bock, C., Huber, A., & Jarchow-Pongratz, S. (2017) - Growth Factors of Research-based Spin-offs and the Role of Venture Capital Investing. **Economic, Technological and Societal Impacts of Entrepreneurial Ecosystems**, Augsburg – Germany. Bock, C., Huber, A., & Jarchow-Pongratz, S. (2017) - Growth Factors of Research-based Spin-offs and the Role of Venture Capital Investing. **Academy of Management Annual Meetings**, Atlanta (Georgia) – United States of America.

superior performance can be attributed to the venture capitalists' role as coaches rather than scouts. The remainder of the empirical contribution is structured as follows. Sections 3.1 and 3.2 give a literature review to develop an understanding of the RBSOs' characteristics and their influence on performance. Further, this contribution identifies gaps in the prevailing literature and derives a coherent set of hypotheses. In section 3.4, the sample is introduced and the methods used for the empirical analysis are outlined. Thereafter, section 3.5 presents the empirical results as well as a discussion followed by a summary of the limitations and suggestions for further research (section 3.5 and 3.6). Section 3.7 concludes this empirical contribution.

3.1 Literature Review on Academic Entrepreneurship

Universities and public research institutes disseminate their scientific insights in the form of technology licensing, research co-operations with industry partners, or through the formation of RBSOs (Landry, Amara, & Rherrad, 2006). In particular, RBSOs became a popular and important instrument to achieve the universities' and public research institutes' "third mission" (Munari et al., 2015). This term circumscribes the dedication of universities and public research institutes to entrepreneurship and business-related activities that exceed their regular mission of providing teaching and research respectively. Another factor why these institutions increase their efforts towards actively encouraging entrepreneurial activities within is given by Bray and Lee (2000) and Feldman, Feller, Bercovitz, and Burton (2002). The authors for example argue that research organizations, both public and private, have the opportunity to increase income beyond the receipt of public funds through equity holdings from spin-offs they create. A third important aspect Bray and Lee (2000) and Feldman et al. (2002) name is that the institutions can foster prestige and legitimacy through the creation of RBSOs. Beyond the advantages of RBSO creation for the institutions themselves, the development of knowledge spillovers in the form of RBSOs is also a valuable instrument to transfer technological innovations from research organizations to the private sector (Czarnitzki et al., 2014; Festel, 2013; Fryges & Wright, 2014; Urbano & Guerrero, 2013; Wright, 2014). These knowledge spillovers lead to for example the commercialization of new products or processes, an increase in innovative solutions and behavior, and ultimately job creation as a result of the new firms created (Colombo & Grilli, 2010; Criaco, Minola, Migliorini, & Serarols-Tarres, 2014; Minniti, 2008; Knockaert et al., 2010).

In order to develop a better understanding of RBSOs, the discipline of entrepreneurship research provides a large array of insights on the causes and consequences for instance why and especially when academics decide to become entrepreneurs (e.g Goel, Goktepe-Hulten, and Ram 2015 and Guerrero, Urbano, Cunningham, and Organ 2014), or how the ecosystem surrounding the research institution influences the founding process of RBSOs (e.g McAdam and McAdam 2008). In addition, many studies also address the question which and how RBSO-specific resources influence the academic spin-offs' survival or development in terms of for example growth (e.g. Klofsten and Jones-Evans 2000 and Stam, Arzlanian, and Elfring 2014). When regarding the multi-faceted literature covering this specific field of entrepreneurship, a variety of overlapping definitions can be found. For example, common to the definitions of research-based spin-offs is that at least one founder of the RBSO is a (former) employee of the research institution (Bonardo et al., 2010; Clarysse, Wright, Lockett, Mustar, & Knockaert, 2007; Colombo & Piva, 2012). A second criterion often applied is that the technology transferred to the newly established spin-off has to be researched and developed within the parent research organization (Carayannis, Rogers, Kurihara, & Allbritton, 1998; Steffensen, Rogers, & Speakman, 2000). Given these commonly accepted boundary conditions used to better define RBSOs, this dissertation refers to RBSOs as firms that have emerged from an academic environment which meet the major criteria just outlined. This clear definition is essential since RBSOs can be considered a subgroup of NTBFs as they are commonly prevalent in the high-tech sector. Yet, both firm-types differ. For one thing, RBSOs are primarily founded by academics that are better educated and have an in-depth technological background. For another, academic entrepreneurs possess the skills and networks relevant for their career in academia, whereas their experience from prior industrial and entrepreneurial activities is very limited or not existing at all (Agarwal & Shah, 2014; Colombo, Croce, & Murtinu, 2014; Lockett, Wright, & Franklin, 2003; Murray, 2004; Wright et al., 2006). Thus, while NTBFs are normally founded by business professionals without a history of research experience, RBSOs are founded by academics who are primarily science-oriented. A third criterion often named is that the technology invented often follows a problem-solving research-perspective (i.e. basic or applied research) whilst not being ready for commercialization or meeting the demand of customer needs at the time the RBSO is created (Clarysse, Wright, Lockett, van de

Velde, & Vohora, 2005; Colombo et al., 2014). This is in clear contrast to NTBFs as they usually commercialize a product or service that has a predefined and intended use.

Based on the fact that academic entrepreneurs often lack the basic business-relevant capabilities, outside support is often named a prerequisite for their survival and growth. In line with this important basic condition and in order to smoothen the spin-off process and increase the RBSO's chances of survival and growth, many research organizations created supporting schemes for their spin-offs as outlined in the introductory section of this dissertation. Amongst them are technology transfer offices, training programs, and other support mechanisms (Colombo et al., 2010). A clear understanding of the causes and consequences of these supporting schemes is however very important as they are costly to implement and important regarding the recipient's development. When acknowledging that the majority of studies focus on NTBFs, one has to admit that simultaneously only a small amount of scientific research is devoted towards understanding the before-mentioned peculiarities of RBSOs as a subgroup. Thus, the knowledge of factors being decisive for the survival and growth of these firms is still fragmentary or missing at all. In order to shed light on this issue, this empirical contribution provides novel insights about growth factors of RBSOs by analyzing RBSO-specific resources concerning the founding team or resources provided by the ecosystem. Against this background, it has to be acknowledged that a firm's resource base is crucial in developing a competitive advantage necessary to survive and grow. Another important aspect is related to the fact that the available resources at firm foundation have a long-lasting effect on its development and performance (Colombo & Piva, 2012). Hence, this empirical contribution relies on the resource-based view of the firm (Barney, 1991; Barney et al., 2001; Penrose, 1996; Wernerfelt, 1984). This framework allows to generate an understanding how RBSO-specific resources affect the development of a competitive advantage in order to survive and grow.

3.2 Overview of Research-based Spin-off's Resources and Hypotheses

In order to view the concept of academic entrepreneurship in terms of RBSO creation and growth, Mustar et al. (2006) give a comprehensive overview of RBSO-specific research. Based on an extensive literature review, the authors develop a categorization of particular resources available and unavailable to RBSOs. In particular, Mustar et al. (2006) suggest to categorize the RBSO-specific resources into human, social, financial,

and technological capital. They argue that these categories are well suited for studying RBSOs since they offer the right degree of preciseness while being mutually exclusive. Given that the categorization is well-respected and the categories derived are also suitable for the objective of this study, this dissertation uses the suggested categorization of RBSO-specific resources for the purpose of this empirical contribution.

3.2.1 Human Capital

Within their first categorization, Mustar et al. (2006) focus on the human capital of the academic founding team. By definition and as before-mentioned, human capital refers to a set of skills, capabilities, and knowledge that individuals develop during their education, on-the-job training, and job experience (Shrader & Siegel, 2007; Unger et al., 2011). Human capital is often referred to have the largest impact on firm success amongst the resources a founding team can employ. In line with that, Colombo and Grilli (2010) and Shane and Venkataraman (2000) explain that human capital in the form of knowledge, skills, and capabilities allows the founding team to discover and exploit business opportunities. Said differently, without the right mix of knowledge, skills, and capabilities, entrepreneurs are not able to spot changing trends in markets and exploit the existing opportunities thereof. Another argument that supports the importance of human capital is based on the fact that it also affects business planning and the development of a strategy. Hence, once the entrepreneur possesses the adequate and right amount of human capital to exploit the identified opportunity by developing a suitable strategy, the new venture's success is positively influenced (Baum, Locke, & Smith, 2001). Third, knowledge also helps to acquire relevant resources such as financial means or physical assets which are necessary for the new venture to grow (Brush, Greene, Hart, & Haller, 2001). In line with that and based on a meta-analytic study on human capital and firm performance, Unger et al. (2011) highlight that founding teams with heterogeneous human capital are more efficient than founding teams with homogeneous human capital when the management of a new venture is considered.

Although the human capital is amongst the most important resources for a new venture's growth, it has surprisingly received only little attention in the literature concerning RBSOs (Criaco et al., 2014; Nielsen, 2015). However, understanding the human capital resources of RBSOs is crucial since RBSO founding teams are very likely homogeneous and would thus not be subject to the advantages resulting from heterogeneity

just outlined. The homogeneous nature of RBSOs results primarily from the founding members often sharing a similar educational background and career path within a research organization while working as a scientist in a research group. Hence, academic entrepreneurs are rather homogeneous considering both, their research experience within the research organization but also considering their non-existent experience in management tasks. Second, the academic founders' in-depth technological knowledge is often based on a scientific career in the field of engineering or natural sciences. Thus, if scientists decide to become entrepreneurs by commercializing their newly invented technology in the form of an RBSO, the founders will likely be homogeneous regarding their academic career, too.

The particular human capital base of RBSOs is also confirmed by studies that address their specific context. In line with Unger et al. (2011), some studies find that heterogeneity in terms of prior education and professional experience has, in multiple contextual settings, a large positive influence on a new venture's development (Knockaert, Ucbasaran, Wright, & Clarysse, 2011; Visintin & Pittino, 2014). One reason Knockaert et al. (2011) mention is that a heterogeneous management team is more likely capable of realizing changes in a new venture's environment and is better equipped to positively anticipate these changes. Based on this argumentation, the RBSO's homogeneous founding teams are less likely prepared to react to changes in the RBSO's environment due to a lack of adequate experience in areas not related to the technology invented (i.e. accounting, marketing, etc.). Based on that, the following hypothesis is derived.

Hypothesis 1a: Homogeneity amongst academic founders has a negative influence on the RBSO's growth.

On the contrary, a founding team with a homogeneous educational background can also be beneficial to the RBSO's development as the very specific high-tech developments involve a deep technical understanding and background of the founding team members (Tsui, Egan, & O'Reilly, 1992). Academic entrepreneurs with a similar educational background commonly share a collective 'mindset' (Knockaert et al., 2011) based on similar knowledge and experience in their specific field of research (Beckman, Burton, & O'Reilly, 2007; Ruef, Aldrich, & Carter, 2003). In RBSOs, this common ground is likely to prevail since scientific research groups often comprise academics from the same or a similar discipline while working on research projects in a specific area (i.e.

biotechnology). In addition, an equal educational background amongst scientists eases communication since all team members share a common understanding and vocabulary. Thus, founders who share a similar educational background are also likely to share a mutual understanding and respect which leads to better team integration (Amason & Sapienza, 1997). Further, founders with unequal educational backgrounds may pursue varying objectives with the new venture created. For example, founders with a business-oriented degree might give more priority to business-oriented goals aiming at selling products fast in order to develop profit whereas founders with a research-oriented degree such as engineering or a similar one may be more focused on technology development leading to team conflicts (Meyer, 2003). In other words, a homogeneous founding team can be beneficial in the complex high-tech environment in which RBSOs operate so that a technological understanding is crucial considering successful product development. Based on that, the following hypothesis is derived:

Hypothesis 1b: Homogeneity amongst academic founders has a positive influence on the RBSO's growth.

3.2.2 Social Capital

The second resource category suggested by Mustar et al. (2006) deals with the social capital of the founding team. Brush et al. (2001) defines a firms' social capital to consist of its contacts to industrial and financial partners. According to Nahapiet and Ghoshal (1998), social capital can be distinguished from human capital by referring to the network of people outside the firm. Beyond the importance of human capital, social capital is seen as another elementary resource important for entrepreneurs (Hayter, 2016). In line with this, Stam et al. (2014) argue that network diversity of small firm founders has the strongest impact on firm growth considering different aspects of social capital such as the network size or the strength of the network. In line with that, Scholten, Omta, Kemp, and Elfring (2015) find in their empirical study on 70 university spin-offs that a broad network of the founding team has a significantly positive influence on employee growth. Likewise, Walter, Auer, and Ritter (2006) found in their study on 149 university spin-offs a positive relation of networks on a firm's sales, the realized competitive advantage, and its perceived quality of customer relationships.

The knowledge contribution provided by external partners is certainly one reason for the positive effect of social capital on firm performance. Thus, the more contacts the founders have in their network, the more information can be used and exploited in order to build a competitive advantage (Batjargal, 2003; Huang, Lai, & Lo, 2012; Yli-Renko, Autio, & Sapienza, 2001). Based on these findings, strong network alliances are crucial for RBSOs in order to expand their businesses.

However, when referring to the latest research on RBSOs, these firms are characterized to have a rather homogeneous social capital (i.e. network) with a majority of ties in the academic community and only a few connections to industry professionals (Agarwal & Shah, 2014; Colombo et al., 2014; Lockett et al., 2003; Murray, 2004; Wright et al., 2006). In order to alleviate this inherent shortcoming of academic founders, research institutions often adopt measures to mitigate the RBSO's suboptimal resource endowments regarding their network ties. Thereof, one measure to foster stronger ties to partners outside academia is certainly the provision of support schemes (Mosey & Wright, 2007). These allow the academic entrepreneurs to artificially create important network contacts with professionals from outside academia and establish ties to them through specially designed venues. These support schemes often take on the form of trainings and events that help extend the academic entrepreneur's network to for example accountants, consultants, investors, or a variety of knowledgeable industry experts. In addition, these trainings teach a basic understanding of entrepreneurship and management. In other words, these supporting schemes are undertaken to increase the founders' managerial competencies and their personal network. In accordance with the empirical findings of the positive role of social networks towards firm survival and growth, the following hypothesis is derived:

Hypothesis 2: Supporting schemes offered by the parent research organization intended to develop a broader social capital for the RBSOs have a positive effect on the RBSO's growth.

3.2.3 Financial Capital

The third resource category important to RBSOs are the financial resources available to the academic founding team. Mustar et al. (2006) define financial resources as the

amount and type of financing available to the entrepreneur necessary to fund for example business operations. The authors distinguish between capital, bank loans, subsidies, and reserved profits.

Within the context of academic entrepreneurship, the related inventions are often the result of basic research, resulting in a technology being in a seed or start-up stage when spinning out (Colyvas, Crow, Gelijns, Mazzoleni, Nelson, Rosenberg, & Sampat, 2002; Jensen & Thursby, 2001). Given this high-tech nature, RBSOs are typically capital-intensive and need large amounts of financing before actually entering the market, generating revenues, and ultimately retaining profits. Hence, RBSOs usually start with an incumbent technology requiring large efforts and a costly and lengthy development process in order to create a marketable product or service and start generating profits. For example, RBSOs in the early development stages need capital to develop first prototypes, fund costly laboratories and laboratory equipment, or conduct product testing using state of the art facilities. Given this immense burden that academic entrepreneurs have to overcome before generating first revenues, the founders' private financial resources are often insufficient in order to cover the costs for these financial deployments (Wright et al., 2006). Given the high risk involved with new ventures in general and new technologies in particular, debt financing is not an option in the seed and early stages of RBSOs since they lack assets that might serve as collateral (Grilli & Murtinu, 2015; Jeng & Wells, 2000; Knockaert et al., 2010; Revest & Sapiro, 2012). As a result, academic entrepreneurs have two alternative sources of financing available: subsidies or equity investments.

Nonetheless, private investors such as venture capitalists are often hesitant to invest at this stage due to high transaction costs, information asymmetries, and uncertainties concerning the successful transfer of a highly innovative technology to a marketable product or service (Clarysse & Moray, 2004; Colombo et al., 2007; Knockaert et al., 2010; Lockett et al., 2002). As a result, subsidies as well as funding from the parent research organization are likely the only real alternative to fill the funding gap when creating an RBSO and spinning out. However, the allocation of subsidies can be subject to a lengthy approval process involving multiple individuals and the amounts provided then are often not very high and thus insufficient. In order to circumvent the potentially exhausting process of gaining funding from various public and private sources, public

research institutes can support their spin-offs by investing equity directly. This unique circumstance may have two advantages for the academic entrepreneur. For one thing, the equity financing acts as bridge-financing intended to overcome the financial gap in early development stages and stimulate growth. For another, it can serve as a quality signal to outside investors, such as for example venture capitalists (Bertoni et al., 2011; Gubitta, Tognazzo, & Destro, 2016). Unfortunately however, research on the effect of equity from universities and public research institutes towards the performance of the awardees is limited (Munari et al., 2015). Nightingale et al. (2009) are an exception while studying the effect of government-backed and university-oriented VC schemes in the United Kingdom using empirical data. Their findings attest a positive, yet modest impact of university-oriented seed funds (USF) on firm performance. Further Munari et al. (2015) find in their study on 1,497 new ventures that those backed by USFs perform better in follow-up funding rounds and in acquiring capital by syndicates. Further, the authors find that new ventures are more likely to attract follow-up funding once they are backed by internally managed USFs that have a connection to a university with a high scientific reputation.

Yet, a pure equity engagement by a USF cannot be compared to the structure and objectives of an independent investment fund. As mentioned before, the financial means provided by the research institutes mainly serve as the initial spark to fill the equity gap in order to accelerate technology commercialization. The intention is not however, to aim for substantial capital provision with the funds provided. Thus, the provision of financing by a research institute may translate into optimized research processes, faster development of new products and services, as well as market access and commercialization, which in turn positively affect the growth of the RBSO. Based on that, the following hypothesis is derived:

Hypothesis 3: A financial investment from the parent research organization has a positive effect on the RBSO's growth.

3.2.4 Technological Capital

When referring to the heterogeneous landscape of RBSOs and their varying technological resources such as R&D capabilities, the degree of innovation, and the scope and quality of the product or service, one can conclude that their technological resources

have been less explored in literature (Mustar et al., 2006). Understanding the role of technological resources and firm growth is of particular importance for RBSOs, however. The technological innovations that are commercialized by RBSOs are often the result of a problem-solving research-perspective but at the same time do not necessarily meet customer needs at the time when the firm is founded (Baum & Silverman, 2004; Colombo et al., 2014). This is owed to the fact that academic entrepreneurs work in an environment of basic or applied research. In other words, many such academic inventions may just meet the demand of a specific group (i.e. lightweight products in the automotive sector), while other inventions require that existing market participants adapt to the new technology (i.e. additive manufacturing instead of milling). In addition, many scientific endeavors may be so radical in nature that they are disruptive and need a lengthy development phase until first use-cases are found so that the new technology can be scaled. As a result, RBSOs may have the potential to develop groundbreaking innovations on the one hand, while facing the challenge of finding applications for their innovations on the other (Gruber, Macmillan, & Thompson, 2013). In line with this argumentation are Schoonhoven, Eisenhardt, and Lyman (1990) who state that the more radical an innovation is, the higher the technological uncertainty when transferring the invention to a usable product or service.

Empirical studies on the innovation-performance relationship of small and medium-sized enterprises show inconclusive results, though (Rosenbusch, Brinckmann, & Bausch, 2011). For instance, Clarysse et al. (2011) found in a study on 73 university spin-offs that the degree of newness of the technology is negatively associated with firm growth. The authors give as explanation that the development and commercialization of a novel technology requires extensive time and major effort to understand the customer's need and thus satisfy various interest groups so that generating first revenues is not the foremost activity performed by the academic entrepreneur. Thus, RBSOs face the challenge to find potential users that believe in the benefit of the (radically) new technology and who are willing to complement or even replace their existing technology. Thus, the more radical the invention is, the more difficult it will be for the RBSO's founders to convince potential users. Based in this argumentation, the following is hypothesized:

Hypothesis 4a: A higher degree of novelty of the technology commercialized has a negative effect on the RBSO's growth.

On the contrary, RBSOs often develop radically new technologies that have the potential to complement or even substitute other prevailing technologies existing on the market. These radically new technologies are often referred to as being disruptive. An example thereof is the rise of applications for additive manufacturing (i.e. 3D-printing) in the recent past. For example, traditional processes such as milling and casting have been around for years and are the workhorse-processes of many industries. However, with the availability of new technologies concerning laser-guidance and computer programming, these processes face a serious competitor once the end-users have thoroughly considered all the (dis-)advantages that come along with the new technology. In that regard, Clarysse et al. (2011) find that a broad scope (i.e. applicability) of a technology is positively associated with growth as more potential customers can use the new invention as would be for example the case of additive manufacturing. In addition, Aspelund, Berg-Utby, and Skjevdal (2005) found in their study of Norwegian and Swedish technology-based new ventures that a greater degree of innovativeness leads to a higher probability of survival. Aspelund et al. (2005) argue that incremental inventions in contrast to radical inventions offer only a minor competitive advantage to the firm. Technologies that are less radical are more likely to find imitators, which in turn will diminish the initial competitive advantage of the new invention. On the other hand, highly radical innovations raise the entry barriers for potential competitors and leave the RBSO more time to exploit the value of the product or service. Hence, the following is hypothesized:

Hypothesis 4b: A higher degree of novelty of the technology commercialized has a positive effect on the RBSO's growth.

3.3 Overview of VC Investing in Research-based Spin-offs

As mentioned before, venture capitalists typically support entrepreneurs who have already completed initial research or developed first prototypes and have a certain history regarding sales (Bertoni et al., 2011; Croce et al., 2013; Sapienza, 1992). When referring to the literature on entrepreneurial finance, both theoretical and empirical findings argue that firms backed by venture capitalists outperform their non-VC-backed peers (Alperovych & Hubner, 2013; Bertoni et al., 2011; Croce et al., 2013; Engel, 2002;

Zacharakis & Meyer, 1998). Yet, the causality for this finding is not solved to the last extent. Two primary views exist in that regard. First, the increased performance of VC-backed over non-VC-backed firms may be the result of a venture capitalist simply scouting promising firms that would also grow in the absence of VC (i.e. scout function). The contrary viewpoint argues that a VC investment also inherits a coaching function by providing management services that go beyond the provision of pure equity. For example, venture capitalists support the professionalization of the internal organization of the firm, i.e. installing a suitable governance structure or the introduction of stock option plans as part of their coaching role (Hellmann & Puri, 2002). Thus, a VC involvement is beneficial to the investee in terms of a management team professionalization leading to increased chances of survival and growth (Alperovych & Hubner, 2013; Bertoni et al., 2011; Croce et al., 2013; Engel, 2002; Zacharakis & Meyer, 1998). Hence, the coaching role may also serve as an explanation why VC-backed firms demonstrate a higher performance compared to firms without such support.

When referring to the peculiar characteristics of RBSOs, high information asymmetries between the venture capitalist and the founding team are of particular importance. These are for example characterized by a high uncertainty about the technology or the product's market potential as well as a founding team lacking commercial skills. Said differently, when referring to the often developed platform technologies that do not necessarily target a specific user group, the success of the technology is difficult to assess ex-ante. Hence, venture capitalists may hesitate to invest in RBSOs (Knockaert et al., 2010; Munari et al., 2015; Munari & Toschi, 2011). An investment in RBSOs can on the other side be attractive for VC investors. First, they possess experience in screening the future growth potential of new ventures so that they dispose of the abilities to pick the most promising investments given their extensive experience (Amit et al., 1998; Chan, 1983). Second, venture capitalists can influence an RBSO's development after having invested by e.g. taking a seat on the board and influencing the new venture's strategy. Amongst the first to disentangle the growth of VC-backed firms into a treatment and selection effect were Davila et al. (2003) and Engel (2002). As above-mentioned, Engel (2002) confirmed - based on a sample of 1,074 German new ventures - that firm growth is rather the result of the financial involvement and the services provided by the venture capitalist than the firm-specific characteristics before a venture capitalist's involvement. Davila et al. (2003) came to a similar conclusion concerning employee growth. They

state that the VC-backed firms' employment growth is larger compared to the employment growth of firms without VC after their first round of VC financing. Further, they find that the employment growth of VC-backed and non-VC-backed firms show no difference before VC is allocated. A further confirmation of a coaching effect was also supported by Balboa et al. (2011), Bertoni et al. (2011), and Colombo and Grilli (2010). The authors link the sales and employee growth of the firms investigated to the active involvement of venture capitalists rather than their ability to select firms with outstanding characteristics.

Over and beyond the existence of a coaching effect, Baum and Silverman (2004) came to the conclusion that the superior performance of VC-backed over non-VC-backed firms is the result of both a scouting and a coaching effect. Their study refers to a sample of 204 biotechnology firms. The authors find for instance that venture capitalists act as scouts by investing only in firms with a strong technology. However, they continue, venture capitalists also act as coaches at the same time by providing important management skills to the entrepreneurs. Further, Chemmanur et al. (2011) found in their study on 1,881 firms that the efficiency, measured by total factor productivity, for VC-backed firms prior to and after receiving financing was higher than that of non-VC-backed firms. The authors deem this finding to venture capitalists being able to screen and select better-performing firms. Further, the authors also find that efficiency growth for VC-backed firms is larger compared to similar non-VC-backed industry-peers. Summarizing these studies who try to disentangle the value increase by venture capitalists into a scouting or coaching effect, the majority of studies confirms that it is likely the venture capitalists' ability to influence firm performance rather than their ability to pick firms that would also grow in the absence of VC. However, this phenomenon has not been investigated in the context of RBSOs. Hence, this empirical contribution aims at disentangling the causality of a venture capitalist's involvement in RBSOs and its effect on RBSO growth.

3.4 Data and Research Methodology

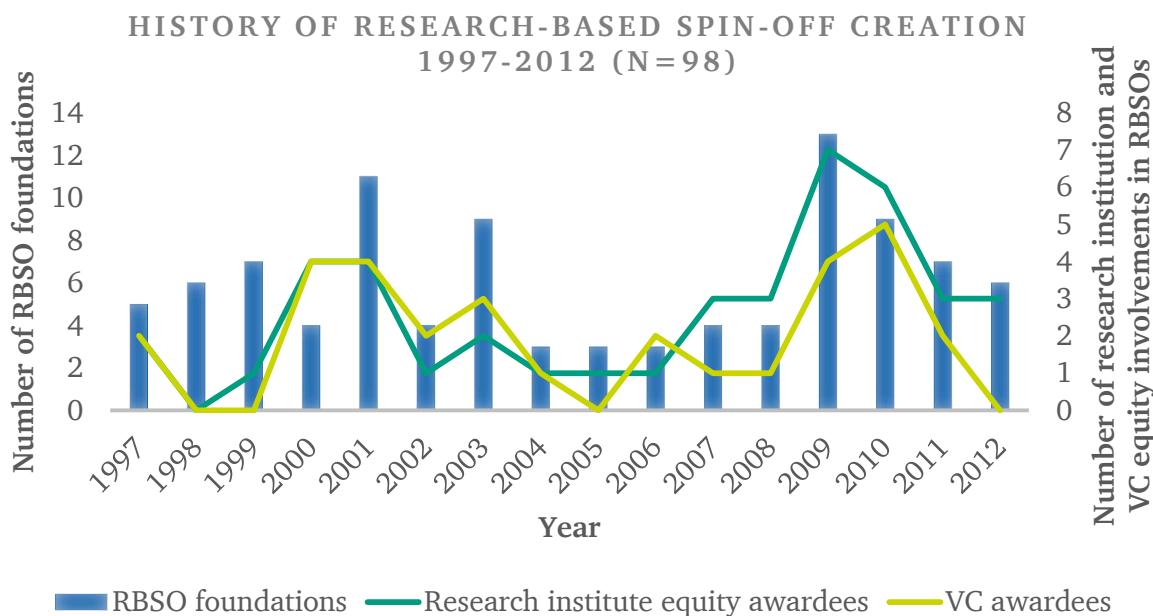
3.4.1 Dataset and Descriptive Statistics

In order to answer the first research question derived and to test the hypotheses just outlined, this empirical contribution rests upon a sample of 98 German RBSOs founded

in the period 1997 through 2012 that spun out from the ‘Fraunhofer Gesellschaft’, a German public research organization. Based on a study by Acatech (2010), the ‘Fraunhofer Gesellschaft’ accounted for a total of 432 RBSOs as of 2007 and is thus the institution with the highest number of spin-offs amongst the largest public research institutes in Germany.³ Beyond the high number of spin-offs, the ‘Fraunhofer Gesellschaft’ is also amongst the largest public research organizations in Europe providing applied research in the areas of health, security, communication, mobility, energy, and the environment (Fraunhofer, 2016). Figure 4 indicates that the number of RBSOs created peaked in the years 2001 and 2009, each representing years when the economy slumped due to major market turmoil. Further, the number of VC equity awardees follows the number of research institute equity awardees. The latter circumscribes the number of equity contributions the ‘Fraunhofer Gesellschaft’ has invested into its own RBSOs. The highest level of equity investments provided by the ‘Fraunhofer Gesellschaft’ peaked in the year 2009 and declined notably thereafter.

Figure 4: History of Research-based Spin-off Creation

The figure shows the trend of the absolute number of RBSOs created, the number of research institute equity awardees, and the VC equity awardees in the period 1997 through 2012.



³ The largest public research institutes in Germany include the Fraunhofer Gesellschaft zur Förderung der angewandten Forschung e. V., the Max-Planck-Gesellschaft zur Förderung der Wissenschaften e. V., the Helmholtz-Gemeinschaft Deutscher Forschungszentren e. V., and the Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz e. V.

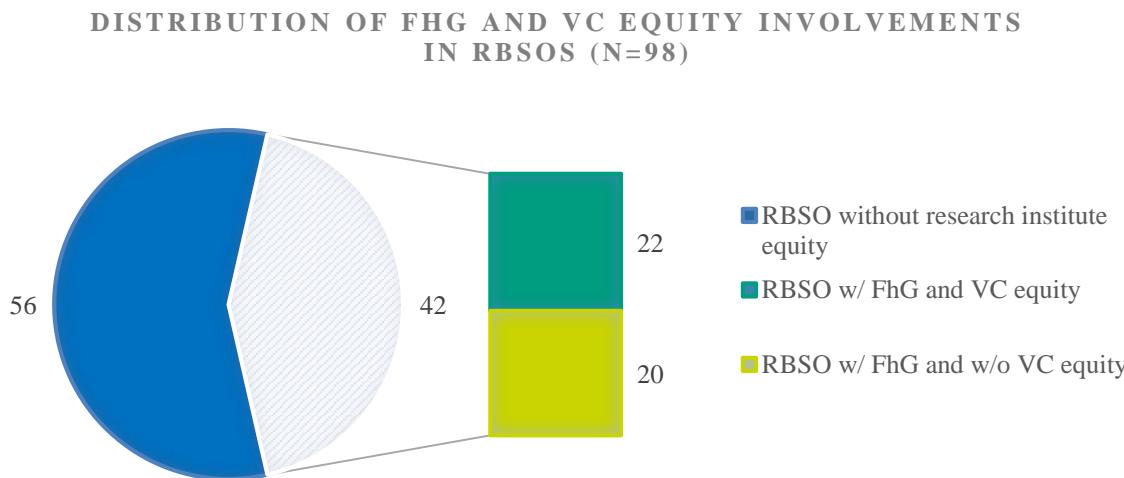
With the help of Fraunhofer Ventures, the research institute's TTO, detailed firm-relevant data on 243 spin-offs could be collected using a questionnaire. The questionnaire was developed in order to fit to the context of RBSOs and collected information concerning the RBSO in general (i.e. business sector, founding year), the financing history (i.e. forms of financing such as subsidies, VC, and other), information about the academic founding team (i.e. number of founders, educational background, or professional experience), as well as information concerning the business model, the technology transferred, and the competitive environment (i.e. use of patents, number of competitors). The questionnaire was sent directly to the founders of the 243 identified spin-offs. The founders and the top management teams were directly addressed and asked to answer the survey as these individuals can best judge the aspects considered in the survey. In order to increase the response rate, the data collection process comprised important elements recommended by the 'Total Design Methodology' of Dillman (2000). In cooperation with Fraunhofer Ventures, an introductory letter explaining the context, the timeline, and the main purpose of the study and stressing the importance of the respondents' input concerning the improvement of Fraunhofer's spin-off process was sent. The questionnaire was distributed mid-April 2013 using both e-mail and physical delivery and non-respondents were reminded using e-mail and telephone contact until the end of the survey period in May 2013. Finally, this procedure helped to receive answers from 100 respondents, corresponding to a response rate of about 41 percent. This response rate is rather high contacting founders and top management team members in the context of research-based spin-offs and technology transfer (see e.g. similar contexts and comparable or lower response rates in the surveys of Aldridge, Audretsch, Desai, and Nadella 2014; Grimm and Jaenicke 2015; Munari, Rasmussen, Toschi, and Villani 2016; and Sellenthin 2009). Having used elements such as a well-structured cover letter and reminders as suggested by Dillman (2000), and having the additional advantage of the 'Fraunhofer Gesellschaft' supporting the project, the response rate is very satisfactory. After excluding two incomplete questionnaires, the final sample comprises 98 RBSOs.

All firms in the sample comply with the definition of an RBSO as outlined before. In order to verify the answers received and to mitigate potential single respondent bias, this dissertation additionally controlled and complemented the quality of the answers

with an internal spin-off database provided by Fraunhofer Ventures. This complementary database, comprising the entire population of spin-offs from the ‘Fraunhofer Gesellschaft’, ensures that fundamental data provided by survey respondents (firm age, the number of founders, outside investors, etc.) is verified. The surveyed firms operate in a variety of industries and have received either equity finance from the research organization, from venture capitalists, a combination of both or have no investor at all. Overall, the sample comprises 31 RBSOs having received VC. More information about the financing of the RBSOs is provided by figure 5. The figure illustrates that 56 RBSOs indicated that they have not received an equity investment from the ‘Fraunhofer Gesellschaft’. On the contrary, 42 RBSOs indicated to have received an equity investment from ‘Fraunhofer Gesellschaft’. Thereof, 22 RBSOs indicated to also have received VC and 20 RBSOs did not.

Figure 5: Distribution of FhG and VC Equity Involvements in RBSOs

The figure shows the allocation of equity investments provided by the ‘Fraunhofer Gesellschaft’ as well as equity investments from venture capitalists in RBSOs.



When regarding the distribution of the business model, 73 RBSOs indicated to follow a product-oriented business model and only 25 indicated to provide a service (figure 6). When regarding the reduced sample of RBSOs that have received a VC equity financing (i.e. 31 RBSOs), the distribution remains unchanged. In other words, 27 out of 31 RBSOs and thus the overwhelming majority follows a product-oriented business model. In addition to the distribution of the business model, table 1 reports the number and ratio of VC-backed and non-VC-backed RBSOs across industries.

Figure 6: Business Model Distribution amongst RBSOs

The figure shows the allocation of product- and service-oriented business models of the RBSOs regarding the total sample as well as the RBSOs having received VC.

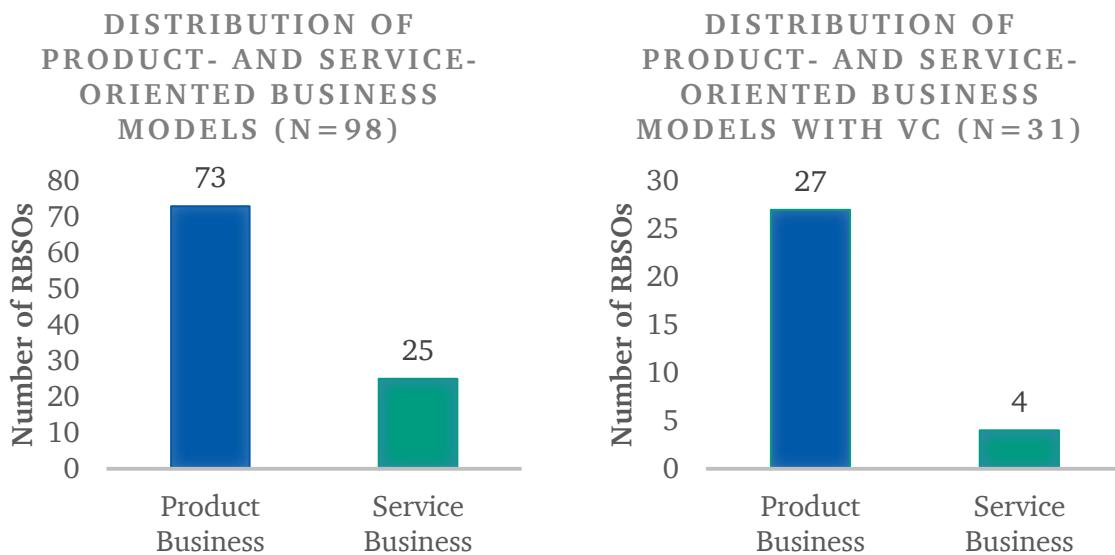


Table 1: Industry Overview of VC-backed and non-VC-backed RBSOs

The table shows an overview of industry affiliation separated by the total sample (column 1), RBSOs with VC (column 2) and RBSOs without VC (column 3).

Industry	All RBSOs		VC-backed RBSOs		Non-VC-backed RBSOs	
	N. of firms (abs.)	N. of firms (in %)	N. of firms (abs.)	N. of firms (in %)	N. of firms (abs.)	N. of firms (in %)
Biotechnology	5	5%	5	16%	0	0%
Commerce	1	1%	0	0%	1	1%
Consulting	9	9%	0	0%	9	13%
Energy	11	11%	5	16%	6	9%
Construction/ Architecture/Planning	2	2%	0	0%	2	3%
Mechanical-/Automotive Engineering	23	23%	7	23%	16	24%
Electrical Engineering/ Telecommunications	17	17%	8	26%	9	13%
Chemicals/ Pharmaceuticals	6	6%	0	0%	6	9%
Marketing/Media	1	1%	1	3%	0	0%
Research	3	3%	0	0%	3	4%

Environment Water	4	4%	1	3%	3	4%
IT/Internet/Web2.0	9	9%	2	6%	7	10%
Medical Technology	7	7%	2	6%	5	7%
Total	98	100%	31	100%	67	100%

3.4.2 Variables and Methods

To investigate which resources influence the growth of RBSOs, the employee and revenue growth rates of the respective RBSOs are calculated. Both employee and revenue growth rates are expressed as the compound average annual growth rate (CAGR) covering the period from the year the RBSO has been founded in to the survey date. These measures are often used as proxies for firm growth in the context of studies focusing on new ventures as well as RBSOs (e.g. Colombo and Grilli 2010 or Visintin and Pittino 2014). The use of these measures is appropriate since an increase in employees attests growth even if the RBSO does not generate any revenues from sales of its products or services given the sometimes lengthy development process outlined before. Further, an increase in employees results in growing managerial complexity which is also considered a proxy of firm growth in the entrepreneurship literature (Delmar, Davidsson, & Gartner, 2003). Considering revenue growth, this measure is a direct indicator of market acceptance for the RBSOs (Clarysse et al., 2011). The use of two independent measures of firm growth adds robustness to the results.

Independent and Control Variables

In addition to the dependent variables used, the independent and the control variables are summarized in table 2. In order to analyze the resource type ‘human capital’, the educational background of the academic founding team is used. The survey allowed the respondents to choose from the following educational categories: MINT (Mathematics, Informatics, Natural sciences, and Technology), law, business, and the subject “other”. Using that information, a dummy variable *Educational Homogeneity* was generated. The dummy variable was coded with the value of one if all academic founders share a similar educational background. If the educational background was heterogeneous however, the variable was coded with the value of zero. The resource category ‘Social capital’ comprises the two dummy variables *TrainingI* and *TrainingII*. While *TrainingI* focuses

on the process of technology transfer and coaches academic entrepreneurs about basic concepts of entrepreneurial activities (i.e. firm foundation, technology commercialization), *TrainingII* aims at developing entrepreneurial and managerial skills as well as strong network ties in order to find financial investors such as venture capitalists. Each variable was coded with a value of one if the founding team participated in the respective training and zero otherwise. As afore-mentioned, the parent research organization has the possibility to invest equity in their RBSOs directly alleviating the academic founding team from financial constraints when spinning out. In order to depict whether or not the ‘Fraunhofer Gesellschaft’ provided equity to the academic founding team, the variable *PRO-Equity* was used in order to account for the third resource category, financial capital. The variable was coded to take the value of one if the research organization invested equity in the RBSO and zero otherwise. The last resource category covered is related to the technological capital. Hence, a dummy variable *Noveltechnology* was employed indicating whether the academic founding team developed a technology that is free of competition and absolute novel to the market when the RBSO was created. In case this technological prerequisite is met, the variable *Noveltechnology* was coded with the value of one and zero otherwise.

In addition to the independent variables used, this dissertation also controls for several effects that might influence the RBSOs’ growth in addition to the independent variables. First, the RBSO’s age as well as the number of academic founding team members is accounted for using the variables *Firm Age* and *Founders* (e.g. Criaco et al. 2014 and Scholten et al. 2015). The variables show the RBSO’s age and number of founding members as a numeric value respectively. Second, the respective economic condition is controlled for with the variable gross domestic product (*GDP*). The variable measures the average GDP development from the new venture’s foundation to the survey date in order to accommodate possible positive or negative trends in the economic development that would provide an alternative explanation of RBSO development such as a growth or a decline in sales. Third, the dummy variables *B2B* and *Patent* take the value of one in case the RBSO generates its revenues primarily with business partners (instead of private consumers), or if the RBSO commercializes a patented technology and zero otherwise. Fourth, the dummy variable *Product Business* indicates the value of one in case the RBSO follows a product-oriented instead of a service-oriented business model.

Fifth, the founders' prior experience in entrepreneurship is controlled for with the variable *Entrepreneurship Experience*. The variable represents a numeric value between zero and five, whilst five indicates the highest level of knowledge for entrepreneurship experience and zero indicates the lowest level. Sixth, the variable *High-Tech* is employed in order to account for the industry in which the RBSO operates. The variable takes the value of one if the RBSO operates in the following industries: Biotechnology, Chemicals/Pharmaceuticals, Electrical Engineering/Telecommunications, Medical Technology, or IT/Internet/Web2.0 and zero otherwise (see Colombo et al. 2014; Kile and Phillips 2009; and Tether and Storey 1998 for a similar classification of high-technology industries). Lastly, the receipt of VC is controlled for with the dummy variable *VC-Equity* taking the value of one in case the RBSO received VC and zero otherwise. A summary of variables used is outlined in table 2.

Table 2: Definition of Variables

The table describes the independent and control variables used.

Variable	Description
Dependent Variables	
Employee CAGR	Variable indicating the compound average annual employee growth rate from RBSO foundation until 2012
Revenue CAGR	Variable indicating the compound average annual revenue growth rate from RBSO foundation until 2012
Control Variables	
Firm Age	Variable indicating the age of the company in the year 2012
Founders	Variable indicating the team size at firm foundation
GDP	Variable indicating the average GDP of the period the RBSO has operated in until 2012
B2B	A dummy variable indicating the value of one if the RBSO generates revenues primarily with B2B customers and zero otherwise
Entrepreneurship Experience	Variable indicating the level of entrepreneurship-related experience within the founding team
Patent	A dummy variable indicating the value of one if the RBSO's technology is protected by a patent and zero otherwise
Product Business	A dummy variable indicating the value of one if the RBSO follows a product-oriented business model and zero otherwise
High-Tech	A dummy variable indicating the value of one if the RBSO operates in the High-Tech industry and zero otherwise
Inverse Mill's Ratio	Variable controlling for a potential selection bias of venture capitalists

Independent Variables

Educational Homogeneity	A dummy variable indicating the value of one if the founding team shares an equal educational background and zero otherwise
TrainingI	A dummy variable indicating the value of one if the founder(-s) was/were granted participation in the training and zero otherwise
TrainingII	A dummy variable indicating the value of one if the founder(-s) was/were granted participation in the training and zero otherwise
PRO-Equity	A dummy variable indicating the value of one if the RBSO received equity from the parent research organization and zero otherwise
Noveltechnology	A dummy variable indicating the value of one if the RBSO introduced a more radical technology to the market and zero otherwise
VC-Equity	A dummy variable indicating the value of one if the RBSO received venture capital and zero otherwise

Instrumental Variable

Average IPO USA	Variable indicating the average amount of IPOs in the USA from RBSO foundation until 2012
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Econometric Methods

In order to analyze which resources influence the growth and development of an RBSO, three approaches are used. First, a multivariate regression analysis (OLS) is employed to account for the effect the independent and control variables have on RBSO growth. Since VC finance is likely endogenous to RBSO growth, this dissertation abstains from using the dummy variable *VC-Equity* within the set of covariates when using OLS. This is owed to the fact that the presence of endogeneity, if not adequately controlled for, might result in inconsistent estimates. Hence, in order to account for the endogenous nature of VC investing and to avoid generating inconsistent estimates, a two-step instrumental variables (IV) approach is used (see Colombo and Grilli 2010 for a similar application of the IV method). In order to use the IV approach correctly, this dissertation first estimates a selection equation by calculating the RBSO's probability to receive VC. Thereby, this dissertation empirically verifies if RBSO-specific resources (i.e. the selection equation) have an effect on the receipt of VC. In the selection equation, all independent variables that serve as proxies for the categories of human, social, financial, and technological capital are included. Given that these variables are supposed to have a positive influence on firm growth, they should also be appealing to venture capitalists (Colombo & Grilli, 2010). In addition, the above-mentioned control variables that have empirically proven to affect the receipt of VC for new ventures are added. For example,

the dummy variable *Product Business* is included since the investment risk can be judged by looking at the product's characteristics (Petty & Gruber, 2011). In other words, a physical product is more likely to decrease the risk of uncertainty from a venture capitalist's perspective compared to a service-oriented product, which VC investors are less in favor of (Munari & Toschi, 2011). In addition, the dummy variable *Patent* is also included. The availability of a patent may serve as a positive signal to venture capitalists (Haeussler et al., 2014), since it allows the academic founding team to exploit its competitive advantage while being protected from the entrance of new rivals (Hsu & Ziedonis, 2013). Further, the academic founders' entrepreneurship related experience is also accounted for with the variable *Entrepreneurship Experience*. Finally, the RBSO's age (i.e. *Firm Age*), the number of academic founders (i.e. *Founders*), whether or not the RBSO operates in a high-tech industry (i.e. *High-Tech*), the economic condition (i.e. *GDP*), and whether or not the RBSO serves business clients (i.e. *B2B*) is accounted for in the context of the VC investment decision. In addition, the IV approach also requires the use of a so-called instrumental variable. In order to meet this essential criteria of this method, the instrument used represents the average number of initial public offerings (IPO) in the USA (*Average IPO USA*) from RBSO foundation to the survey date. Since IPOs are the most preferred exit route for venture capitalists, the number of IPOs in a well-developed and liquid financial market such as the USA may serve as 'heat' signal that also influences VC investing in Germany (see for example Di Guo and Kun Jiang 2013 for a similar argumentation). In other words, this dissertation assumes that an increased IPO activity in the financial markets of the USA affects local VC firms to invest in new ventures with the intention to generate similar exits. Further, it is argued that although the average number of IPOs in the USA is related to the German VC activity regarding RBSO investing, the growth of RBSOs is independent of that measure. The latter relationship is an important criteria that has to be satisfied in order for the IV approach to generate valid results (Di Guo & Kun Jiang, 2013). In order to test whether the variable *Average IPO USA* is a good instrument, the commonly accepted rule that the F-Test after the first stage needs to exceed the value of 10 and has to be significant is followed (Staiger & Stock, 1997; Stock & Yogo, 2005). In case the F-Test exceeds 10 and is significant, the null hypothesis can be rejected that the instrument is "weak". Further, it is also tested if the instrument is relevant (i.e. correlated with the

endogenous regressor *VC-Equity* and uncorrelated with the remaining variables). Therefore, the underidentification test is referred to following Kleibergen and Paap (2006). If the test statistic is significant, the null hypothesis of irrelevance can be rejected and it can be concluded that the variable *Average IPO USA* is correlated with *VC-Equity* and uncorrelated with the remaining independent and control variables.

Based on the variables mentioned, the predicted probabilities for both VC-backed and non-VC-backed RBSOs to receive VC (*VC-Equity (predicted)*) are calculated based on their individual combination of resources. In a second step, the proxy variables for RBSO growth are regressed on the set of the previously mentioned control and independent variables (i.e. the growth equation) as well as the newly created coefficient (*VC-Equity (predicted)*) from the first-stage IV regression (Heckman, 1978, 1979). The latter variable provides an estimate of the experimental average treatment effect (i.e. intercept effect) how a predicted VC participation influences RBSO growth (Colombo & Grilli, 2010).

In addition, a control factor is added that accounts for the fact that the receipt of VC is non-random and that the selection process may be based on factors being unobservable. To account for that unobserved heterogeneity in the VC investment process (i.e. selection bias), a Heckman correction method is applied using the inverse Mill's ratio (Heckman, 1979; Hellmann & Puri, 2002). To derive the inverse Mill's ratio, this empirical contribution first computes a probit selection model that is equal to the selection equation of the IV regression. Based on the residuals of the predicted probabilities of each RBSO to receive VC, the inverse Mill's ratio is computed (see Bertoni et al. 2011 and Engel 2002 for a similar approach). This inverse Mill's ratio addresses the potential selection bias and generates more consistent estimation parameters in the regressions (Colombo & Grilli, 2010; Tucker, 2010). Thus, the inverse Mill's ratio is inserted in the growth equation of the IV approach in order to account for unobserved heterogeneity and hence, more consistent estimation parameters. As the IV approach first estimates the predicted probability of VC-backed and non-VC-backed firms to receive VC and uses these predicted probabilities in a second-stage linear regression, it is corrected for possible correlations of the endogenous explanatory variable (*VC-Equity*) and the error terms of the exogenous explanatory variables.

In order to verify the results from the IV regression, this dissertation also employs a control function (CF) as a third approach (see Colombo and Grilli 2010 and Vella and Verbeek 1999 for a similar approach). Within the control function, a control factor (i.e. the estimated value of the generalized residuals) is computed for both VC-backed and non-VC-backed RBSOs based on the receipt of VC using the probit regression. Hence, if a venture capitalist would act as a scout, all observed and unobserved factors that positively influence RBSO growth would have a likewise positive impact on the receipt of VC. Thus, a positive correlation of the error terms in the selection equation and the growth equation would exist resulting in a positive coefficient for the residual lambda (Colombo & Grilli, 2010). This residual (*Lambda (VC)*) is included in the set of covariates of the growth equation including the dummy variable *VC-Equity*. In this specification, the latter expresses the experimental average treatment effect. In case both IV regression and control function approach lead to similar results, the analyses are more robust (Colombo & Grilli, 2010; Vella & Verbeek, 1999).

3.5 Empirical Results and Discussion

Based on the introduction of the variables and methods used, this section summarizes and discusses the empirical results derived. For a better overview, the findings are presented in two sections, starting with the results concerning the RBSOs' growth rates and continuing with the results concerning the role of a VC involvement. In the third subsection, a discussion of the results is presented. Table 3 presents the results of the OLS regressions referring to RBSO employee growth as dependent variable. First, the control and independent variables are presented in separate specifications (models 1-5). Second, the full model is presented with all control and independent variables (model 6). Positive and significant values in the models indicate a positive association with RBSO employee growth. In table 4, the receipt of VC is included in the analysis by controlling for endogeneity using the IV and the CF approach (columns 3 and 4). For reasons of comparison, the analyses also contain a regular OLS approach including the dummy variable *VC-Equity* without any controls for endogeneity (table 4, column 2). Although the analyses might suffer from endogeneity, the results are nevertheless presented for reasons of comparison. Further, table 4 reports the results of the probit equation where the dichotomous variable *VC-Equity* is regressed on a set of covariates (i.e. the selection

equation) in order to compute the predicted values for each RBSO to receive VC (column 1). The results represent average marginal effects. Finally, tables 5 and 6 represent the results of the analyses using revenue growth as the dependent variable to test the robustness of the results. In order to verify whether or not the combination of variables suffers from multicollinearity, variance inflation factors (VIF) are used. Due to the fact that mean VIF values of the models lie below the suggested threshold level of five as suggested by Chatterjee and Hadi (2006) and the maximum VIF values below the threshold level of 10 as suggested by O'Brien (2007), this dissertation concludes that multicollinearity is not an issue.

3.5.1 Results Concerning Growth Factors of Research-based Spin-offs

When the employee growth of the RBSO is considered, the variable *Educational Homogeneity*, measuring whether or not the founding team has a homogeneous educational background, has a significantly positive effect at the 1 percent level (table 3, models 2 and 6). Second, the findings of the OLS regressions find that the proxy variables for social capital, *TrainingI* and *TrainingII*, significantly influence RBSO employee growth. Whilst *TrainingI* has a significantly negative effect at the 1 percent level, *TrainingII* has a significantly positive effect at the 5 percent level on RBSO employee growth in the same models (table 3, models 3 and 6). Third, when evaluating the role of an equity investment from the 'Fraunhofer Gesellschaft' (*PRO-Equity*), no statistical model in table 3 detects a significant effect on employee growth. Fourth, the analyses detect a statistically significant and positive effect at the 10 percent level of the variable *Noveltechnology* on employee growth (table 3, model 6).

In table 4, the receipt of VC is included in the scope of analysis. When regarding the OLS model without controls for endogeneity (table 4, column 2), the results show a positive and significant effect of the variable *Educational Homogeneity* at the 1 percent level on employee growth. When controlling for endogeneity, the IV approach leads to a similar result: The variable *Educational Homogeneity* has a highly significant positive effect at the 0.1 percent level on RBSO employee growth (table 4, column 3). When referring to the CF approach, the effect of the variable *Educational Homogeneity* remains positive and significant at the 1 percent level when regarding RBSO employee growth (table 4, column 4). Further, *TrainingI* has a highly significant negative effect at the 0.1

percent level on RBSO employee growth whereas *TrainingII* has a significant and positive impact at the 1 percent level on RBSO employee growth within the OLS and IV specification respectively (table 4, columns 2 and 3). Similarly, the direction of the effects remain unchanged when referring to the CF approach having a level of significance at the 1 percent level for the effect of the variables *TrainingI* and *TrainingII* on RBSO employee growth (table 4, column 4). When evaluating the role of an equity investment from the ‘Fraunhofer Gesellschaft’ (*PRO-Equity*), neither the analyses in table 3, nor the analyses incorporating the receipt of VC in the scope of analysis detect a significant effect on employee growth (table 4, columns 2, 3, and 4). The OLS regression without controls for endogeneity confirms the positive and significant influence of the commercialization of a novel technology on RBSO employee growth at the 10 percent level (table 4, column 2). This effect remains positive and significant at the 5 percent level when accounting for the endogenous nature of a VC investment using the IV method (table 4, column 3). Although the CF approach shows a positive effect of the variable *Noveltechnology* towards RBSO employee growth, the effect is not significant (table 4, column 4).

When considering RBSO revenue growth as dependent variable (tables 5 and 6), the findings are rather similar. The effect of a homogeneous educational background of the founders on RBSO revenue growth (table 5, models 2 and 6) has the same direction compared to the results derived from the analyses on employee growth and is slightly not significant. Based on the results regarding the effect of trainings on RBSO revenue growth, statistical significance in the same direction as for employee growth can only be detected for *TrainingII* at the 10 percent level (table 5, models 3 and 6). Again, for an equity investment from the parent research organization (*PRO-Equity*), no significant effect can be detected concerning revenue growth either (table 5, models 4 and 6). In a similar vein, the results neither show any statistical support for the positive effect of the variable *Noveltechnology* when evaluating the effect on revenue growth of the RBSOs (table 5, models 5 and 6). In table 6, this dissertation presents the results when including the receipt of VC in the scope of analysis regarding RBSO revenue growth. In line with the direction of the effect of the variable *Educational Homogeneity* on RBSO revenue growth derived in table 5, both the OLS approach without controls for endogeneity and the IV approach (table 6, columns 2 and 3) show a significantly positive influence at the 5 percent level. Further, the CF approach confirms the positive effect the

variable *Educational Homogeneity* has on RBSO revenue growth at the 10 percent level (table 6, column 4). Hence, this dissertation finds support for Hypothesis 1b given the positive effect of a homogeneous educational background on the RBSO's employee and revenue growth.

Considering the effect of trainings on RBSOs' revenue growth, the OLS approach without controls for endogeneity and the IV approach confirm the positive and significant effect of *TrainingII* at the 5 percent level (table 6, columns 2 and 3). Additionally, the CF approach confirms a positive and significant effect at the 10 percent level of *TrainingII* on revenue growth (table 6, column 4). The 'Fraunhofer Gesellschaft's' supporting scheme for academic entrepreneurs aimed at building and exploiting networks to outside professionals - which is the main content of *TrainingII* - seems to have a significant influence on growth. On the other hand, for a training dedicated to awaken the academic founders' awareness to processes of successful technology transfer (which is the content of *TrainingI*), the results do not detect a positive influence on growth. Based on that, this dissertation finds partial support for hypothesis 2, too. Further, no analyses of an equity investment from the 'Fraunhofer Gesellschaft' (*PRO-Equity*) on the revenue growth of the RBSO detects a significant effect (tables 5 and 6). These results are in line with the previous analyses on the effect of the variable *PRO-Equity* on RBSO employee growth tables (3 and 4). Hence, this dissertation infers from the results that a pure bridge-financing from the parent research organization does not serve as initial spark accelerating technology commercialization and thus firm growth. Therefore, no support for hypothesis 3 is found. In a similar vein, no statistical support for the positive effect of the variable *Noveltechnology* on revenue growth of the RBSOs (tables 5 and 6) is found. Hence, the commercialization of a novel technology seems to influence employment growth rather than revenue growth in the context of RBSOs. Thus, this dissertation finds only partial support for hypothesis 4b.

Table 3: Determinants of RBSO Growth (employees)

The table shows the empirical results when regressing on the dependent variable employee CAGR disregarding the involvement of VC.

Dependent variable Model	Employee CAGR 1		Employee CAGR 2		Employee CAGR 3		Employee CAGR 4		Employee CAGR 5		Employee CAGR 6	
	b	se										
Control variables												
1 Firm Age	-0.003	[0.005]	-0.005	[0.005]	0.000	[0.005]	-0.001	[0.005]	-0.005	[0.005]	-0.005	[0.006]
2 Founders	0.000	[0.014]	0.000	[0.014]	0.011	[0.016]	-0.013	[0.020]	0.000	[0.016]	0.008	[0.021]
3 GDP	5.576	[6.709]	3.434	[6.500]	4.017	[6.332]	5.600	[6.609]	5.560	[6.414]	0.903	[5.409]
4 B2B	0.166**	[0.063]	0.167***	[0.058]	0.173***	[0.060]	0.180**	[0.070]	0.204***	[0.076]	0.233***	[0.067]
5 Entrep. Experience	0.003	[0.017]	0.005	[0.016]	0.004	[0.016]	0.002	[0.016]	0.002	[0.017]	0.007	[0.016]
6 Patent	-0.007	[0.051]	0.007	[0.050]	-0.021	[0.045]	-0.009	[0.048]	-0.007	[0.051]	0.004	[0.045]
7 Product Business	0.052	[0.051]	0.044	[0.049]	0.029	[0.049]	0.045	[0.051]	0.068	[0.054]	0.047	[0.047]
8 High-Tech	0.058	[0.050]	0.059	[0.049]	0.051	[0.048]	0.054	[0.049]	0.061	[0.050]	0.054	[0.046]
Indep. variables												
9 Educ. Homogeneity-	-		0.132***	[0.049]	-	-	-	-	-	-	0.178***	[0.054]
10 Training I	-	-	-	-	-0.181***	[0.065]	-	-	-	-	-0.200***	[0.064]
11 Training II	-	-	-	-	0.201**	[0.079]	-	-	-	-	0.202**	[0.078]
12 PRO-Equity	-	-	-	-	-	-	0.078	[0.066]	-	-	0.027	[0.062]
13 Noveltechnology	-	-	-	-	-	-	-	-	0.080	[0.066]	0.123*	[0.069]
No. of observations	77		77		77		77		74		74	
R-sq	0.17		0.23		0.25		0.19		0.19		0.39	

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001. Robust standard errors are reported in brackets.

Table 4: Determinants of RBSO Growth (employees) incl. VC Equity Investments

The table shows the empirical results when regressing on the dependent variable employee CAGR including the involvement of VC.

Dependent variable Model	VC-Equity Probit		Employee CAGR OLS (w/o controls for endogeneity)		Employee CAGR IV (w/ controls for endogeneity)		Employee CAGR CF (w/ controls for endogeneity)	
	dy/dx	se	b	se	b	se	b	se
Control variables								
1 Firm Age	0.038***	[0.013]	-0.004	[0.006]	-0.003	[0.005]	-0.004	[0.006]
2 Founders	0.032	[0.027]	0.002	[0.021]	0.007	[0.022]	0.003	[0.023]
3 GDP	14.562*	[7.600]	0.277	[5.499]	0.724	[4.898]	0.333	[5.948]
4 B2B	0.077	[0.090]	0.216***	[0.068]	0.228****	[0.062]	0.217***	[0.077]
5 Entrep. Experience	-0.032	[0.021]	0.01	[0.015]	0.007	[0.015]	0.01	[0.017]
6 Patent	0.234****	[0.054]	-0.029	[0.054]	0.000	[0.059]	-0.025	[0.063]
7 Product Business	0.258****	[0.067]	0.012	[0.048]	0.040	[0.057]	0.015	[0.059]
8 High-Tech	0.096	[0.079]	0.036	[0.048]	0.046	[0.045]	0.037	[0.051]
9 Average IPO USA	-0.010****	[0.002]	-	-	-	-	-	-
10 Inverse Mill's Ratio	-	-	-0.006	[0.023]	-0.024	[0.026]	-0.008	[0.029]
Independent variables								
11 Educ. Homogeneity	-0.189**	[0.079]	0.188***	[0.057]	0.186****	[0.051]	0.188***	[0.064]
12 Training I	-0.067	[0.083]	-0.203****	[0.057]	-0.207****	[0.060]	-0.203***	[0.072]
13 Training II	-0.346***	[0.106]	0.247***	[0.076]	0.216***	[0.080]	0.243***	[0.094]
14 PRO-Equity	0.271****	[0.075]	-0.016	[0.068]	0.017	[0.064]	-0.012	[0.075]
15 Noveltechnology	-0.094	[0.092]	0.134*	[0.077]	0.141**	[0.069]	0.135	[0.084]
16 Lambda (VC)	-	-	-	-	-	-	0.017	[0.106]
17 VC-Equity	-	-	0.104	[0.082]	-	-	0.082	[0.137]
18 VC-Equity (predicted)	-	-	-	-	-0.061	[0.164]	-	-
No. of observations	74		74		74		74	
R-sq (pseudo R-sq)	0.61		0.42		0.36		0.43	
F-test of excl. instruments	-		-		11.96****		-	
Underidentification test	-		-		9.40***		-	

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001. Robust standard errors are reported in brackets. For column 4, standard errors are based on 10,000 bootstrap replications. Results for the probit regression in column 1 represent marginal effects. Test statistics are calculated via STATA command ivreg2 (column 3).

3.5.2 Results Concerning the Role of VC

In the second set of analyses, this dissertation aims to evaluate how a VC investment influences the growth of the RBSO. First, it is assessed whether venture capitalists act as scouts when investing in RBSOs. Second, this dissertation evaluates the role of VC investors as coaches by analyzing the experimental average treatment effect towards RBSO growth. This experimental average treatment effect is expressed by the variables *VC-Equity* as well as *VC-Equity (predicted)* in the respective econometric specifications. Before turning to the econometric evidence however, this dissertation uses a bivariate test and finds that RBSOs with VC grow significantly faster compared to RBSOs without VC. In more detail, the bivariate analysis finds that RBSOs with VC show an 11 percent higher average employee growth rate compared to RBSOs without such financing. In line with this finding, the analysis finds as well that VC-backed RBSOs outperform their non-VC-backed peers by about 20 percent on average when their revenue growth is considered. Hence, the results are similar to prior empirical studies showing that VC-backed firms outperform non-VC-backed firms (Alperovych & Hubner, 2013; Bertoni et al., 2011; Croce et al., 2013; Engel, 2002; Zacharakis & Meyer, 1998).

In order to evaluate if this superior performance is the result of a scouting function, the results of the probit estimates (tables 4 and 6, column 1), which give an indication of the likelihood of an RBSO to receive VC, have to be considered. When referring to the results of the probit regression, the analysis finds that *Firm Age* positively and significantly increases the RBSO's chances to receive VC at the 1 percent level. This finding is not surprising since each additional year the RBSO has been in existence represents market acceptance of the product or service. In a similar vein, the analysis finds a positive and significant effect at the 10 percent level for the variable *GDP* on the receipt of VC. Said differently, the more positive the GDP develops, the more favorable are general market conditions increasing the chances of firm growth and the receipt of VC. In addition, the results also provide evidence that VC investors rely on factors that decrease information asymmetries between the investor and the investee. These include for example the availability of a patent, which positively and highly significantly increases the RBSOs chances to receive VC at the 0.1 percent level (table 6, column 1). This finding is not surprising since a patent signals that a technology has reached a certain maturity and can be protected. Another factor that highly significantly increases the likelihood

to receive VC at the 0.1 percent level is a product-oriented business model (table 6, column 1). RBSO's that follow a product-oriented business model have a 26 percent higher likelihood to receive VC compared to RBSOs without a product-oriented business model. This finding is in line with latest research which shows that the development of a product-based business model is favored by venture capitalists over a service-oriented business model (Munari & Toschi, 2011). This aspect becomes particularly relevant in case the management team breaks up or if the venture capitalist decides to replace the management team, which is not uncommon in the early stages of a RBSO's development (Elitzur & Gavious, 2003; Hellmann & Puri, 2002).

In contrast, the average number of IPOs in the USA has a highly significantly negative effect at the 0.1 percent level on the RBSO's chances to receive VC. Additionally, the analysis finds significant relationships between RBSO resources and the likelihood to receive VC for the variables *Educational Homogeneity*, *TrainingII* and *PRO-Equity*. For example, the results show a significantly negative effect at the 5 percent level when regarding the effect of a homogeneous educational background concerning the likelihood to receive VC. Put differently, the RBSO's chances to receive VC decrease by about 19 percent in case the founding team consists of founders with an equal educational background (table 6, column 1). Further, this dissertation detects a significantly negative effect of *TrainingII* at the 1 percent level towards the receipt of VC (table 6, column 1). Based on these results, this dissertation concludes that the participation in a training intended to build managerial and entrepreneurial skills as well as networks to outside professionals (*TrainingII*) leads to a reduced probability of a VC investment. On the other hand, an equity involvement from the research organization has a highly significant and positive effect at the 0.1 percent level concerning the likelihood of an RBSO to receive VC (table 6, column 1). This implies that the 'Fraunhofer Gesellschaft' can signal quality of an RBSO by providing a first equity investment. In turn, this qualitative signal apparently reduces informational frictions given that it has already been assessed to be of sufficient quality so that follow-up VC financing becomes more likely.

Table 5: Determinants of RBSO Growth (revenues)

The table shows the empirical results when regressing on the dependent variable revenue CAGR disregarding the involvement of VC.

Dependent variable Model	Revenue CAGR 1		Revenue CAGR 2		Revenue CAGR 3		Revenue CAGR 4		Revenue CAGR 5		Revenue CAGR 6	
	b	se										
Control variables												
1 Firm Age	-0.015	[0.012]	-0.017	[0.011]	-0.007	[0.012]	-0.010	[0.011]	-0.016	[0.012]	-0.007	[0.010]
2 Founders	0.017	[0.021]	0.016	[0.020]	0.019	[0.021]	-0.014	[0.027]	0.009	[0.023]	-0.018	[0.033]
3 GDP	20.734	[12.683]	18.613	[12.302]	18.542	[12.178]	20.046*	[11.981]	19.188	[12.228]	12.654	[10.795]
4 B2B	0.105	[0.130]	0.108	[0.136]	0.138	[0.127]	0.127	[0.132]	0.149	[0.160]	0.221	[0.170]
5 Entrep. Experience	-0.029	[0.039]	-0.026	[0.038]	-0.033	[0.039]	-0.033	[0.040]	-0.022	[0.039]	-0.024	[0.039]
6 Patent	0.075	[0.136]	0.088	[0.138]	0.048	[0.126]	0.079	[0.137]	0.087	[0.143]	0.072	[0.153]
7 Product Business	0.126	[0.091]	0.111	[0.093]	0.076	[0.092]	0.109	[0.094]	0.164	[0.108]	0.072	[0.104]
8 High-Tech	-0.060	[0.100]	-0.062	[0.101]	-0.071	[0.103]	-0.063	[0.101]	-0.028	[0.098]	-0.038	[0.102]
Indep. variables												
9 Educ. Homogeneity	-	-	0.137	[0.106]	-	-	-	-	-	-	0.214	[0.130]
10 Training I	-	-	-	-	-0.169	[0.134]	-	-	-	-	-0.147	[0.136]
11 Training II	-	-	-	-	0.330*	[0.175]	-	-	-	-	0.353*	[0.191]
12 PRO-Equity	-	-	-	-	-	-	0.178	[0.140]	-	-	0.123	[0.148]
13 Noveltechnology	-	-	-	-	-	-	-	-	0.167	[0.176]	0.153	[0.185]
No. of observations	66		66		66		66		63		63	
R-sq	0.20		0.22		0.25		0.23		0.22		0.31	

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001. Robust standard errors are reported in brackets.

Table 6: Determinants of RBSO Growth (revenues) incl. VC Equity Investments

The table shows the empirical results when regressing on the dependent variable revenue CAGR including the involvement of VC.

Dependent variable Model	VC-Equity Probit	Revenue CAGR OLS (w/o controls for endogeneity)	Revenue CAGR IV (w/ controls for endogeneity)	Revenue CAGR CF (w/ controls for endogeneity)				
	dy/dx	se	b	se	b	se	b	se
Control variables								
1 Firm Age	0.038***	[0.013]	0.002	[0.011]	0.001	[0.011]	0.002	[0.015]
2 Founders	0.032	[0.027]	-0.038	[0.036]	-0.022	[0.036]	-0.032	[0.045]
3 GDP	14.562*	[7.600]	11.058	[11.392]	12.946	[10.548]	11.389	[13.217]
4 B2B	0.077	[0.090]	0.165	[0.178]	0.193	[0.155]	0.183	[0.208]
5 Entrep. Experience	-0.032	[0.021]	-0.011	[0.038]	-0.015	[0.033]	-0.015	[0.045]
6 Patent	0.234****	[0.054]	-0.027	[0.173]	0.028	[0.154]	0.005	[0.194]
7 Product Business	0.258****	[0.067]	-0.016	[0.128]	0.044	[0.126]	0.006	[0.150]
8 High-Tech	0.096	[0.079]	-0.090	[0.094]	-0.072	[0.094]	-0.079	[0.112]
9 Average IPO USA	-0.010****	[0.002]	-	-	-	-	-	-
10 Inverse Mill's Ratio	-	-	-0.094	[0.056]	-0.112*	[0.057]	-0.109	[0.076]
Independent variables								
11 Educ. Homogeneity	-0.189**	[0.079]	0.286**	[0.138]	0.281**	[0.123]	0.288*	[0.163]
12 Training I	-0.067	[0.083]	-0.176	[0.132]	-0.169	[0.133]	-0.187	[0.172]
13 Training II	-0.346***	[0.106]	0.508**	[0.215]	0.446**	[0.222]	0.489*	[0.264]
14 PRO-Equity	0.271****	[0.075]	0.009	[0.152]	0.032	[0.136]	0.035	[0.189]
15 Noveltechnology	-0.094	[0.092]	0.232	[0.213]	0.240	[0.182]	0.241	[0.238]
16 Lambda (VC)	-	-	-	-	-	-	0.105	[0.194]
17 VC-Equity	-	-	-0.012	[0.201]	-	-	-0.151	[0.316]
18 VC-Equity (predicted)	-	-	-	-	-0.242	[0.286]	-	-
Number of observations	74		63		63		63	
R-sq (pseudo R-sq)	0.61		0.34		0.31		0.35	
F-test of excl. instruments	-		-		12.44****		-	
Underidentification test	-		-		11.82****		-	

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001. Robust standard errors are reported in brackets. For column 4, standard errors are based on 10,000 bootstrap replications. Results for the probit regression in column 1 represent marginal effects. Test statistics are calculated via STATA command ivreg2 (column 3).

In order to assess if the scouting function of venture capitalists is prevalent to the coaching function, the variables influencing RBSOs' growth should also influence the likelihood of receiving VC. Hence, if resources are available that have a positive influence on growth, a venture capitalist should be attracted by them given the increased chances that the investment is increasing in value. However, the results provide no empirical evidence that RBSO specific resources in the categories of human, social, financial, and technological capital that have a positive effect on growth do also positively affect the likelihood of the RBSO to receive VC. Further, the IV specification shows a negative and significant effect at the 10 percent level for the inverse Mill's ratio concerning revenue growth (table 6, column 3). This finding indicates that unobservable factors that are positively associated with RBSO revenue growth are negatively associated with the receipt of VC. Hence, this dissertation finds no clear indication that the superior growth of VC-backed RBSOs over non-VC-backed RBSOs is rather the result of the selection capabilities of the expert investors.

When regarding the venture capitalists role as coach on RBSO growth, measured as the experimental average treatment effect, the analyses show mixed results. As aforementioned, the experimental average treatment effect is approximated with the variables *VC-Equity* and *VC-Equity (predicted)*. Whereas the binary variable *VC-Equity* measures the receipt of a VC investment, the variable *VC-Equity (predicted)* represents the RBSO's predicted probability to receive VC based on the resource configuration of the firm at foundation. Thus, the effect of a VC investment is assessed from the actual receipt of VC as well as the RBSO's calculated probability to receive VC. Based on the OLS specification without controls for endogeneity and the CF approach, the direction of the effect of the variable *VC-Equity* (table 4, columns 2 and 4) on RBSO employee growth is positive and slightly not significant. In contrast to the OLS and CF approach, the IV specification shows that the direction of the effect of the variable *VC-Equity (predicted)* on RBSO employee growth is negative but insignificant (table 4, column 3). Noteworthy is the interpretation of the coefficient *Lambda (VC)* which describes the correlation between the error terms of the VC selection and growth equation (table 4, column 4). The positive yet insignificant coefficient *Lambda (VC)* in the CF approach indicates that the correlation of the error terms of the growth and selection equation, if any, is positive (Engel, 2002; Colombo & Grilli, 2010). Said differently, this analysis shows that there exists a positive, yet insignificant, relationship between the unobservable factors that

affect RBSO growth and the likelihood to receive VC - indicating a “coaching” effect. However, given the fact the effect is insignificant, the relationship could also be spurious.

When referring to the experimental average treatment effect calculated for the revenue growth of the RBSOs (table 6, columns 2, 3 and 4), the direction of the effect is negative. Within the OLS specification without control for endogeneity (table 6, column 2), the direction of the effect found for the variable *VC Equity* on RBSO revenue growth is negative and insignificant. Likewise, the IV specification confirms the negative direction of the effect (table 6, column 3). Further, the CF approach also indicates a negative but insignificant effect (table 6, column 4). In line with the effect found for the variable *Lambda (VC)* regarding RBSO employee growth, the direction of the effect is again positive but insignificant when regarding RBSO revenue growth. Again, there exists a positive correlation between unobservable factors that drive RBSO revenue growth and the receipt of VC indicating a coaching effect. However, the contribution of the involvement of a venture capitalist to RBSO growth (i.e. scouting or coaching function) has to be interpreted with caution since the econometric specifications do not show consistent results throughout all specifications.

3.5.3 Discussion of the Empirical Results

RBSOs are considered one very important instrument towards fostering technology transfer. Given this fact, it is of particular interest how universities and research organizations can enhance the technology transfer process by analyzing the resource base that contributes positively to RBSO success. Although an increasing amount of studies concentrate on analyzing technology transfer processes (Czarnitzki et al., 2014; Festel, 2013; Fryges & Wright, 2014; Guerrero et al., 2014; Urbano & Guerrero, 2013; Wright, 2014), the success factors of transfer processes from research institutions have not been disentangled so far. This dissertation analyzes the technology transfer process of a research institution focusing on applied research by investigating the influence of the spin-offs’ resource base on their growth. An overview of the results for the different hypotheses derived can be found in table 7.

The findings offer important insights into aspects concerning the support of RBSOs. When addressing the human capital of the RBSO’s founding team, this dissertation finds

support for hypothesis 1b that homogeneity amongst academic founders in the RBSOs has a positive influence on their growth (see table 7). Interestingly however, this finding is contrary to other empirical studies that find a positive relationship between team heterogeneity and firm success (Knockaert et al., 2011; Unger et al., 2011; Visintin & Pittino, 2014). The authors for instance argue that a heterogeneous management team is more likely capable of dealing with the quickly changing environment young companies are confronted with and that they can better anticipate changes (Colombo et al., 2010; Knockaert et al., 2011; Shane & Venkataraman, 2000). However, given that homogeneity/heterogeneity can be expressed by multiple proxy variables, the findings derived may not necessarily show contradicting results since the issue of education has not yet been looked at from an empirical point of view. Important however, when arguing that heterogeneity per sé is advantageous, this dissertation clearly relativizes this finding.

Table 7: Overview of Hypotheses Regarding RBSO Growth

The table gives an overview of the supported and not supported hypotheses.

Hypothesis	RBSO Employee Growth	RBSO Revenue Growth	Overall Result
Human Capital			
H1a	Homogeneity amongst academic founders has a negative influence on the RBSO's growth.	Not supported	Not supported Not supported
H1b	Homogeneity amongst academic founders has a positive influence on the RBSO's growth.	Supported	Supported Supported
Social Capital			
H2	Supporting schemes offered by the parent research organization intended to develop a broader social capital for the RBSOs have a positive effect on the RBSO's growth.	Supported (partially)	Supported (partially) Supported (partially)
Financial Capital			
H3	A financial investment from the parent research organization has a positive effect on the RBSO's growth.	Not supported	Not supported Not supported
Technological Capital			

H4a	A higher degree of novelty of the technology commercialized has a negative effect on the RBSO's growth.	Not supported	Not supported	Not supported
H4b	A higher degree of novelty of the technology commercialized has a positive effect on the RBSO's growth.	Supported	Not supported	Supported (partially)

In addition and although these findings hold probably true when considering the general company development and team competencies, this effect seems to be weaker in the context of a high-technology research setting. In this circumstance, heterogeneity can lead to less common ground between the founding members translating into potential conflict (Amason, 1996; Kamm & Nurick, 1993; Miller, Burke, & Glick, 1998). In line with this assumption, Knockaert et al. (2011) and Tsui et al. (1992) argue that homogeneity among founding members might strengthen the relationship between the founding team - which this dissertation can confirm with regard to the fact that a homogeneous educational background of the founding team members seems to matter when considering the complex environment RBSOs operate in. The findings derived indicate that a homogeneous educational background of academic entrepreneurs is not per se a barrier to firm growth since the benefits regarding the mutual understanding about the core technology seem to outweigh the costs of a knowledge-gap concerning other areas of the business (i.e. accounting, marketing), at least in the context of RBSOs. RBSOs often develop radically new technologies which are not suited to the various customer needs at the stage of invention (Clarysse et al., 2005; Colombo et al., 2014). Thus, the academic founding team needs to 1) identify potential customers that could benefit from the new technology and 2) develop and adjust the technology so that it can be used by them. In other words, during the early stages of product development, a homogeneous founding team providing a knowledge base for deepened discussions seems to be beneficial for the commercialization of a customer-suited product or service (Beckman et al., 2007; Ruef et al., 2003). This collective knowledge allows the founding team to anticipate where the technology might be of greatest use by developing applicable use-cases, which then seem to translate into sustainable firm growth (Amason & Sapienza, 1997).

Concerning the RBSOs' social capital, this dissertation finds mixed results for hypothesis 2. Whereas *TrainingI* provided by the 'Fraunhofer Gesellschaft' imposes a significantly negative impact on growth, a significantly positive effect is detected for *TrainingII*. The negative influence of *TrainingI* on growth might be explained by the fact that a training intended to shaping the awareness how scientific endeavors can successfully be commercialized (which is the content of this training) does not necessarily focus on growth intentions. With *Training I*, the 'Fraunhofer Gesellschaft' intends to awaken the entrepreneurial spirit of its scientists. Hence, the training might lead to a rising attention of its researchers to consider being an entrepreneur and thus increase the number of spin-offs. However, a lasting effect on RBSOs' growth cannot be inferred from the results derived. Nevertheless, as several studies suggest, effective entrepreneurial trainings foster the expansion of innovative industries, enhance entrepreneurial intention and action in terms of specific steps towards business creation, and ultimately new venture performance through increased knowledge, skills, and capabilities acquired during trainings (Bergmann, 2017; Keuschnigg & Nielsen, 2001; Martin, McNally, & Kay, 2013; Sanchez, 2011; Zhang, Duysters, & Cloodt, 2014). Therefore - although being beyond the scope of this dissertation - further analysis of specific components of entrepreneurial trainings and the effect on the creation of new spin-offs is strongly encouraged.

On the other hand, the empirical results find support that a training intended to develop entrepreneurial and managerial skills as well as a network to outside professionals (i.e. *TrainingII*) has a positive effect on the RBSO's development. This finding is in line with prior studies showing that a more diversified network has a positive impact on firm development since external knowledge can be accessed and exploited (Stam et al., 2014; Yli-Renko et al., 2001). Thus, the initial homogeneity of academic entrepreneurs, as afore-mentioned, can be addressed by offering supporting schemes that allow the academic founding team to acquire the relevant knowledge, skills, capabilities, and a network of outside business professionals in order to widen their competence fields (Agarwal & Shah, 2014; Colombo et al., 2014; Lockett et al., 2003; Murray, 2004; Wright et al., 2006). Scholten et al. (2015) find as well that access to a broad range of knowledge outside the firm positively influences employee growth of academic spin-offs. Likewise, Martin et al. (2013) state in their meta-analytic study that entrepreneurship education and trainings positively influence new venture performance. Referring to the results derived, the researcher can obviously learn how to act more managerial

and entrepreneurial and thus exploit the knowledge provided by the network (Scholten et al., 2015; Walter et al., 2006). This finding is also in line with Coleman (1988) regarding his assumption that the creation of social capital can contribute to human capital by acquiring skills and capabilities necessary for a new venture's successful development.

Within the analyses, this dissertation does not detect a significant impact of an equity participation of the research institution towards the growth of the RBSO. Given the fact that an increasing number of universities and research institutions initiate own funds for supporting their spin-offs (Jensen & Thursby, 2001; Moray & Clarysse, 2005; Nightingale et al., 2009; Shane, 2002) this finding is surprising given that the results suggest that these initiatives are not relevant for the growth of RBSOs. However, the finding has to be interpreted in a broader context. Jensen and Thursby (2001) for example show theoretically that equity participations by universities are pareto-superior to e.g. technology transfer incentives in the form of royalty payments or patenting. This finding is empirically confirmed by Di Gregorio and Shane (2003) who detect that equity investments lead to increased firm creation rates compared to patenting and licensing as equity investments are adequate to align the interests of the individual researchers, the industry, as well as the universities and lead to the highest returns for universities (Bray & Lee, 2000; Feldman et al., 2002). It may thus be the case that the university funds are important to support the commercialization of business ideas in the seed stage of the spin-off's development, a life cycle stage most venture capital investors would not invest in (Moray & Clarysse, 2005). Therefore, in line with the findings of Di Gregorio and Shane (2003), Fraunhofer's equity funds may be relevant for a higher number of spin-offs created whereas a direct effect for later spin-off growth cannot be detected in this research setting. Further, when considering European universities in comparison, the available amounts that can be invested are limited. In order to finance academic spin-offs during their growth phase, this dissertation could recommend to structure these funds in a way that they can invest higher amounts along with venture capitalists in later financing rounds. Further studies are encouraged to find out whether a direct investment of public funds may be effective when co-invested with venture capitalists by leveraging the financing provided with the coaching function of a professional VC investor.

Finally, the empirical results provide support for hypothesis 4b as the analyses find that RBSOs that invent and commercialize a novel technology are more likely to face growth compared to RBSOs that do not. This finding supports the view that the introduction of innovations of a more radical type have a positive effect on firm performance (DeCarolis & Deeds, 1999; Guo, Lev, & Zhou, 2005; Li & Atuahene-Gima, 2001), particularly in the context of young firms (Rosenbusch et al., 2011). In this regard, Aspelund et al. (2005) find for example that radical compared to incremental innovations increase the probability of survival. The authors further explain this by arguing that incremental innovations in comparison to radical innovations offer only a minor competitive advantage to the firm since they are more likely to find imitators. On the other hand, radical innovations raise the entry barriers for potential competitors and leave the RBSO more time to exploit the value of the product or service, especially in niche markets in which small firms such as RBSOs often operate (Porter, 2008; Rosenbusch et al., 2011). Further, Clarysse et al. (2011) argue that radical innovations offer a greater applicability and unprecedented use-cases of the technology invented leading to an increased growth potential. This finding is supported regarding the results for RBSO employee growth showing that the commercialization of a novel technology increases growth. On the contrary however, the findings are not supported when referring to the analyses concerning revenue growth. This circumstance might however be explained as follows. The development of a (radically) new technology normally requires additional expert-employees (e.g. programmers, developers) who translate the business opportunity into a marketable product or service (Bower, 2003). In addition, marketing efforts directed towards identifying early technology adopters might also explain the increase in employees (i.e. business development, sales). However, the technology implementation and testing requires time so that generating revenues on the basis of the technology commercialization requires more time. Thus, revenues are deferred into the future.

When considering the results of the second set of analyses for the influence of a VC investment on the RBSOs' growth, this dissertation finds for example that an equity investment from the 'Fraunhofer Gesellschaft' has a significantly positive impact on receiving VC. This finding supports the assumption that new ventures that have undergone an investment process signal firm quality (Bertoni et al., 2011; Davila et al., 2003; Gubitta et al., 2016). In the case of RBSOs, the equity investment from the 'Fraunhofer Gesellschaft' (*PRO-Equity*) serves as such a signal and obviously attracts VC investments.

However, although an investment from the 'Fraunhofer Gesellschaft' serves as a positive signal for VC investors, the results do not show that the same influences RBSO growth. Neither do the analyses show that other factors which drive company growth to have a significant influence on the likelihood to receive VC. This finding is of particular interest as logic implies that factors influencing RBSO growth would also influence the receipt of VC. Thus, receiving VC equity would indicate that venture capitalists are able to select those RBSOs with the highest growth prospects. In other words, since this dissertation does not find such a congruence, it can be inferred that venture capitalists do not necessarily select RBSOs based on factors that are positively associated with growth. Hence, no clear indication of a selection effect of venture capitalists concerning investments in RBSOs is found when referring to the different empirical methods applied within this dissertation. Instead however, the empirical results rather point to a coaching function which is mainly prevalent concerning employee growth when elucidating whether venture capitalists exert a selection or a coaching function for the RBSOs' development. This finding might be explained as follows. First, a VC investment is likely to trigger recruiting efforts of the RBSO leading to an increase in employees in various areas (programmers, business development and sales experts, accountants, etc.) in order to reach agreed objectives relating to growth. Given the innovative nature of these firms however, generating first revenues based on (radically) new technologies takes a longer period of time so that the effect does not yet manifest in revenue growth (Aspelund et al., 2005). Hence, based on the fact that the analyses find no strong support that venture capitalists act as scouts when investing in RBSOs, the superior performance is more likely attributable to a venture capitalist acting as a coach rather than a scout.

To this end, the findings indicate that encouraging technology transfer is a beneficial strategy for universities and research institutions as several spin-offs from the 'Fraunhofer-Gesellschaft' are effective and show substantial growth rates. But the results detect as well that academic institutions need to evaluate diligently which support measures prove efficient given the financial limitations these institutions typically face and hence, the measures initiated should be evaluated constantly. In addition, it can be inferred from the analyses that individual researchers involved in a spin-off process should provide detailed feedback to their technology transfer office and should demand offers they specifically need in order to smoothen the growth of their firms.

3.6 Limitations and Further Research Concerning Research-based Spin-offs

Although the analyses find robust relationships between RBSO resources and firm growth, the results are not devoid of limitations. Due to the fact that the analyses investigate RBSOs that have spun out from one research institution, it would be interesting to verify whether the empirical results derived can be found for other research institutions which have implemented similar or different spin-out processes and dispose of another resource provision or a different culture and strategy, too. However, given the fact that the ‘Fraunhofer Gesellschaft’ is large and has different industry focuses with different centers and also varying cultural facets, it can be well argued that the 98 firms are a representative sample for the large variety of RBSOs. Simultaneously, it has to be acknowledged that this dissertation does not presume this sample to be representative for all RBSOs. For one thing, the definition of RBSOs is not as straightforward and does not follow one clear definition. For another, the absence of reliable and comprehensive statistics on RBSOs on a German or European level makes it very difficult to define the total population of these firms and draw universal conclusions for them (Colombo & Grilli, 2010).

In addition, one could comment that the study is subject to further sample selection biases. The primary reason is that the analyses suffer from survivorship bias given that it refers to surveyed firms which were still existing at the time the data was collected. This limitation is however common to the majority of survey-based studies (Bertoni et al., 2011). Since the effects on firm growth and not firm survival are studied, it is reasonable to analyze surviving companies. Another limitation that has to be acknowledged is related to a potential single respondent bias. This is however difficult to circumvent since part of the data is gathered by surveying the academic founders. Thus, it is difficult if not even impossible to assure that the founders have actually filled out the survey accurately and to the best of their knowledge. This dissertation was however able to complement and verify the reliability of the founders’ answers by secondary data gathered by the research institution based on objective facts. In addition, the collected data is more reliable for another reason as well. First, the number of spin-offs from research organizations is per se not large and second, the dissertation managed to collect data on quite a substantive share of the spin-offs that were created from the largest research organizations in Germany. According to a study from Acatech (2010) on academic entrepreneurship in Germany, the total number of academic spin-offs created

within the largest public research institutes in Germany amounted to 687 in July 2010, of which 432 spun-out from the ‘Fraunhofer Gesellschaft’. Thus, the sample analyzed is representative for the population of spin-offs from the largest German research organizations to a substantial degree.

The analyses and findings may serve as a basis for further investigations on RBSOs which have spun-off from research organizations. A fruitful avenue for future research might be to consider analyzing the RBSO’s resource base of different research organizations in combination and try to analyze to what extent the resource provision differs among the varying public and private organizations and how the differences translate in the RBSOs’ development. In future research, it would also be interesting to gather information on more mature RBSOs with or without public listings and analyze their resource base. Further, as the findings suggest that the content and design of various entrepreneurial trainings and professional support is important for the spin-offs’ development, this dissertation also encourages both qualitative and quantitative research on this type of support offered by the various research institutions and universities. When considering the diverse landscape of these institutions, it is likely that the large array of supporting schemes differs depending on the ecosystem the institution is located in. However, not all supporting schemes may be suited to the context of RBSOs and their specific circumstances. In order to streamline and support the institutions in their development of training programs and to ensure that public funding is spent in accordance with the overall objective (i.e. foster growth), this dissertation encourages detailed research on training programs and professional supporting schemes and the consequences for RBSO development and growth.

3.7 Conclusion and Contribution Concerning Research-based Spin-offs

This empirical contribution investigates RBSO’s resource endowments and aims to identify important resources that affect growth. The analyses are built upon a consistent set of hypotheses based on the resource-based view of the firm. The empirical findings are deducted from 98 German-based RBSOs that have spun-out from the ‘Fraunhofer Gesellschaft’ in the period 1997 through 2012. With this study, this dissertation complements the current literature on RBSOs and entrepreneurial finance towards understanding growth factors of RBSOs involving the role of VC investments. Hence, the contribution is twofold. First, the findings complement the resource-based view of the firm by

providing novel insights about growth factors that are decisive for RBSOs. Second, the findings complement prior studies in the area of academic entrepreneurship by addressing the growth of RBSOs while simultaneously focusing on VC. This extended viewpoint is particularly relevant for policy makers, TTOs, and academic entrepreneurs alike.

When referring to the literature addressing academic entrepreneurship, RBSOs are often characterized to be homogeneous and to lack valuable networks to business professionals outside academia (Agarwal & Shah, 2014; Colombo et al., 2014; Lockett et al., 2003; Murray, 2004; Wright et al., 2006). At the same time however, particularly heterogeneity in both the management team and networks are found to be valuable for firm growth (Cleyn, Braet, & Klofsten, 2015; Stam et al., 2014; Visintin & Pittino, 2014). The empirical results derived find evidence that homogeneity within the academic founding team is not a disadvantage to the growth of their firms *per se*. Instead, this dissertation finds that a homogeneous founding team with an equal academic background is positively associated with employment and revenue growth. Additionally, this dissertation finds that the lack of entrepreneurial and managerial skills as well as networks to outside partners can be successfully addressed with training programs. Further, the empirical results confirm that trainings provided by the ‘Fraunhofer Gesellschaft’ intended to coach an entrepreneurial mindset as well as providing a platform to network with external business professionals positively affects RBSO growth. Lastly, this dissertation also finds that the commercialization of a novel technology has a positive impact on RBSO growth. On the contrary, an investment from the parent research organization has no effect on RBSO growth based on the analyses.

Beyond the internal resources of the academic founding team, the analyses also confirm that VC-backed RBSOs show a higher performance in terms of employment and revenue growth rates compared to non-VC-backed RBSOs. Hence, this dissertation disentangles the value-adding effect of a VC investment by evaluating the venture capitalist’s role as a scout or coach. Many academic scholars argue that the superior growth of VC-backed firms over non-VC-backed firms may be the result of venture capitalists scouting promising firms that would also grow well in the absence of VC. Another view is that venture capitalists coach the investee which may lead to superior performance. This dissertation finds no such support that venture capitalists scout RBSOs based on factors that determine their growth. In contrast, the empirical results suggest that venture capitalists

prefer signals ('hard facts') of firm quality such as patents or prior investments from the parent research organization, which they obviously interpret as signals reducing informational frictions. Despite the fact that these factors signal firm quality to a venture capitalist, this dissertation does not find that these factors contribute to RBSO growth. Further, the empirical analyses show inconclusive results of a positive effect based on the venture capitalist's role as coach. However, this dissertation infers from the results that the superior performance of VC-backed compared to non-VC-backed RBSOs is likely the result of a venture capitalist coaching the RBSO rather than scouting it. Overall, the findings derived support the importance of research on academic entrepreneurship and hence, more empirical work towards understanding growth factors of RBSOs and the role of VC is encouraged in order to design suitable policy measures and trainings that support the development of these important firms.

4 The Signaling Value of Crowdfunding in a VC Context

Given the increasing popularity of crowdfunding as a new means to finance new ventures, this dissertation assesses whether and how crowdfunding campaign-specific signals that affect campaign success influence venture capitalists' selection decisions in a new venture's follow-up funding process. Further, the empirical analyses also focus on how the presence of a crowdfunding campaign influences the syndication behavior of venture capitalists against the background of other new venture-related characteristics. The analyses to follow rely on cross-referencing a dataset of 66,000 crowdfunding campaigns that ran on Kickstarter between 2009 and 2016 with 100,000 investments in the same period from the Crunchbase dataset. Drawing on signaling theory and the micro-finance literature, the empirical findings reveal that a successful crowdfunding campaign leads to a higher likelihood to receive follow-up venture capital financing, and that there exists an inverted U-shaped relationship between the funding received compared to the funding desired and the probability to receive VC funding. Further, the analyses find statistical evidence that a special endorsement of campaigns by the crowdfunding platform provider as well as word-of-mouth volume on social media platforms has a likewise positive impact on the probability to receive VC.⁴

In addition to the campaign related signals, this dissertation also focuses on the role of a crowdfunding campaign itself while simultaneously controlling for other new venture-specific circumstances, too. The data used are also extracted from cross referencing the Kickstarter and Crunchbase dataset. The final sample includes a total of 504 new ventures of which 193 had a crowdfunding campaign before receiving venture capital. Drawing on signaling theory and the syndication literature, the overarching empirical finding is that crowdfunding influences the syndication behavior of venture capitalists. First, crowdfunded new ventures have a lower likelihood of a syndicated investment as

⁴ This empirical contribution has been presented at various conferences and is currently under revision for publication at the **Journal of Small Business Management**. The conference contributions are as follows: Thies, F., Huber, A., Bock, C., & Benlian, A. (2017) - Do venture capitalists follow the crowd? – The relevance of crowdfunding campaigns for venture capitalists' investment decisions. **European Academy of Management**, Glasgow – Scotland. Thies, F., Huber, A., Bock, C., & Benlian, A. (2017) - Do venture capitalists follow the crowd? – The relevance of crowdfunding campaigns for venture capitalists' investment decisions. **Interdisziplinäre Jahreskonferenz Entrepreneurship, Innovation und Mittelstand („G-Forum“)**, Leipzig – Germany.

well as a smaller number of syndicate partners. Second, the findings reveal that crowd-funded new ventures facilitate the formation of international syndicates. More broadly, the results support the assumption that a crowdfunding campaign can mitigate information asymmetries between the investor and the investee and is hence factored into the investment decision of venture capitalists reducing their need to form syndicates.⁵

The remainder of this empirical contribution is structured as follows. Section 4.1 provides a literature review to develop an understanding of crowdfunding and its role in the context of VC financing. Further, this section identifies gaps in the current micro-finance and VC literature dedicated to syndication and derives a coherent set of hypotheses. In section 4.2, the sample is introduced and the methods used for the empirical analyses are outlined. Thereafter, section 4.3 presents and discusses the empirical results. The limitations of the empirical contribution are outlined in section 4.4, followed by a subject-specific conclusion in section 4.5.

4.1 Literature Review on Crowdfunding and VC

4.1.1 Signaling Theory and Classical Signals in VC Investing

Signaling theory deals with understanding why certain signals such as a product warranty might be a reliable signal for consumers and could thus be relevant to them in buying decisions (Spence, 1973). Extensive research has been conducted on what is collectively referred to as signaling theory, to understand which signals might be reliable and could thus be relevant for the consumer in buying situations (Spence, 1973; Spence, 2002). Transferred to the context of entrepreneurship and new venture creation, signaling theory describes efforts of the capital-seeking party (i.e. the entrepreneur) to reduce information asymmetries by providing information about the inherent quality of the new venture to the capital providing party (i.e. the venture capitalist). In other words, signaling theory circumscribes that entrepreneurs signal the quality and viability of their new venture to a venture capitalist in order to stand out and suggest superior quality and ability compared to other capital-seeking ventures (Arthurs et al., 2009; Busenitz et al., 2005; Connelly et al., 2011). In its basic form, signals share the characteristic of being 1) observable and 2) costly. Hence, a signal must be noticeable

⁵ This empirical contribution is currently under revision for publication in **Research Policy**.

by outsiders and the costs of producing the signal must not outweigh its benefits (Connelly et al., 2011; Moss et al., 2015).

As mentioned before, empirical evidence concerning the value of different signals in the context of VC investing is versatile. Most importantly, Petty and Gruber (2011) conclude that a good management team with sufficient business experience pursuing a promising business idea might already be valued as a good signal from a venture capitalist's perspective so that a deal proposal is not rejected. Thus, human capital characteristics play an important role in VC decision-making since human capital is also associated with firm growth (Baeyens et al., 2006; Knockaert et al., 2010; Zacharakis & Meyer, 2000). Further, venture capitalists clearly favor a product-oriented business model over a service business given that the latter is fully dependent on their founding team (Munari & Toschi, 2011). As mentioned in the introductory section, the latter aspect is particularly relevant if the management team breaks up, or if the venture capitalist decides to replace the management team (Elitzur & Gavious, 2003; Hellmann & Puri, 2002). Furthermore, patents are commonly referred to have a strong signaling value to outside investors since they allow to buffer a firm from competitors (Conti et al., 2013; Haeussler et al., 2014). Lastly, venture capitalists can reduce information asymmetries concerning a new venture by mainly investing in new ventures that have already been evaluated (i.e. undergone a due diligence) by a preceding investor, such as business angels or other VC funds from prior investment rounds (Bertoni et al., 2011; Davila et al., 2003). This practice implies that prior investors have already assessed the new venture to be of high-quality what may reduce the perceived investment risk from a venture capitalist's perspective (Bonardo et al., 2010; Lerner, 1999, 2002). Still, crowdfunding campaigns usually represent new ventures including their products and services that are in their infancy, i.e. their seed and start-up stage of development. Hence, the above-named signals such as a patented technology or a history of investment rounds are unlikely available. Thus, a new venture without the above-mentioned signals can nevertheless show superior quality over other capital seeking new ventures by providing crowdfunding campaign-related signals that could in turn serve as a substitute or complement to the traditional signals relevant in VC decision making.

4.1.2 Signaling in Crowdfunding and Hypotheses

Signaling in crowdfunding is an important concept since campaign initiators are often first-time entrepreneurs (Vismara, 2016), and the commercialization and financing of new products and services via crowdfunding is also subject to information asymmetries between backers (e.g. investors) and campaign owners (e.g. entrepreneurs) (Belleflamme, Lambert, & Schwienbacher, 2014). Crowdfunding in its present form comprises various forms, yet reward-based (e.g. Colombo et al. 2015; Mollick 2014; Wessel et al. 2015; and Wessel et al. 2016), lending-based (Dushnitsky et al., 2016), and equity-based (e.g. Ahlers et al. 2015; Lukkarinen et al. 2016; Roma et al. 2017; and Vismara 2016) crowdfunding campaigns have been subject to increased attention lately. However, and given that lending- and equity-based crowdfunding is still in its infancy and hardly available to a broad range of investors as mentioned before, particularly in Germany, the most popular and by far largest venues in terms of funding volume are reward-based platforms (Cholakova & Clarysse, 2015; Roma et al., 2017). These platforms allow individuals to donate (i.e. pledge) graduated amounts to a project in exchange for a product prototype or other similar token-items gifts (Antonenko et al., 2014; Xu et al., 2016). In this regard, relevant scholarly work finds that campaign success is negatively related to a campaign's funding goals (Colombo et al., 2015; Mollick, 2014). Put differently, the higher the desired funding the entrepreneurs seeks to collect through the crowd, the less likely the chances that the full funds are provided. Further, Colombo et al. (2015) find that the more capital is acquired in the early phase of the campaign, the more likely its success. Concerning social capital, measured as the number of campaigns supported by the campaign initiator, the authors find a positive influence of social capital in reward-based campaigns on both the number of early backers and the amount of pledges received (Colombo et al., 2015). In a similar vein, Mollick (2014) confirms that the number of friends on Facebook (i.e. a proxy of network size) is positively related to campaign success. Further, Mollick (2014) also finds that both a video that explains the project in more detail as well as updates that demonstrate the project's progress are positively related to campaign success. Lastly, an interesting finding provided is that geographic distance still plays a role in crowdfunding campaigns. Although the availability of online services should relax the accessibility of campaigns by backers as suggested by Agrawal, Catalini, and Goldfarb (2011), the location of the campaign initiators still plays a role for campaign success (Mollick, 2014).

Whilst the above-named signals lead to success in reward- and equity-based crowdfunding campaigns collectively or individually, the success of a campaign per se can be considered one of the strongest signals a crowdfunding campaign can create. In other words, a successful crowdfunding campaign demonstrates a positive assessment of the new product or service and allows the entrepreneur to better assess the market potential. In turn, the demonstrated market demand could translate into a positive assessment by the venture capital investor since it is one key indicator when screening deals (Petty & Gruber, 2011). This circumstance is clearly demonstrated in the introductory example of Lifx. Once the entrepreneurial team behind Lifx completed their crowdfunding campaign with a record amount of pledges worth USD 1.3m, the new venture quickly raised another USD 12m through a series A venture capital funding round led by Sequoia Capital (Dingman, 2013), a leading and reputable Silicon Valley VC investor. On the other hand, entrepreneurs with unsuccessful campaigns may not necessarily be deprived from venture capital. For example, the entrepreneur could, given the reasons that caused the campaign to be unsuccessful, adjust the product or service and apply for VC funding with an improved business concept and still receive funding. Hence, the crowdfunding campaign may not only signal quality to a third party such as a venture capitalist, it also provides valuable feedback to the entrepreneur and its product or service. However, in the reward-based example mentioned above, the crowd served as an initial catalyst by assessing the idea via their investments. Thereafter, Lifx was able to collect substantial amounts of VC. Thus, the signaling value in regard to a post campaign follow-up investor is clearly in the spotlight.

Given this noteworthy example, the novelty of crowdfunding and its importance in the financing process of new ventures, the analysis of success drivers of crowdfunding campaigns are gaining momentum (e.g. Agrawal, Catalini, and Goldfarb 2015; Colombo et al. 2015; and Mollick 2014). However, little is known about the impact of crowdfunding campaigns on the post-campaign funding events for entrepreneurial initiatives and the signaling value of campaign-characteristics to expert investors. Despite the fact that both crowdfunding and venture capital have been subject to increased academic attention (Xu et al., 2016), research on a combined view of these two forms of entrepreneurial finance is still very scarce. An exception are Mollick and Kuppuswamy (2014), who present a working paper and survey-based article on 286 reward-based crowdfunding projects, both successful and unsuccessful, and the post-campaign development of the

new ventures. They find for example that 90 percent of the firms remain in operation after their campaign at survey date in 2013. Further, their preliminary results show that about 59 percent of respondents used the campaign to secure seed-funding to start a business. An additional study is provided by Roma et al. (2017) who focus on technology new ventures and state that crowdfunding can ignite professional investor's interest if accompanied by rather traditional signals of quality such as the availability of patents or a large network of social ties. Further, Drover, Busenitz, Matusik, Townsend, Anglin, and Dushnitsky (2017) also find that a crowdfunding campaign can serve as a certification mechanism that is factored into the venture capitalist's investment decision. Based on this preliminary argumentation and given that peer opinions receive increased attention in financial markets (Chen, De, Hu, & Hwang, 2014), this dissertation firstly focuses on the value of the success or failure of the crowdfunding campaign itself, the role of platform endorsements, as well as brand exposure on social media platforms and how these campaign-related characteristics affect venture capitalist decision-making. Thereafter, the role of a crowdfunding campaign is assessed when considering the syndication behavior of a venture capitalist.

The role of campaign success in VC financing

In order to reduce the risk involved when investing in a new venture, venture capitalists use a variety of mechanisms through which new ventures are evaluated. As noted before, venture capitalists assess the potential of business models (Munari & Toschi, 2011), the availability of a patented technology (Conti et al., 2013; Haeussler et al., 2014; Hoenen, Kolympiris, Schoenmakers, & Kalaitzandonakes, 2014; Munari & Toschi, 2011), as well as preceding investments by other professionals (Bertoni et al., 2011; Davila et al., 2003) amongst a variety of other tangible and intangible factors during their screening process. When considering the early stages of crowdfunding projects in the life cycle of a firm, however, these signals are hardly available when evaluating investment proposals. Based on that, the human capital of the founding team as well as an indication of market acceptance are likely the only signals that can be considered by a venture capitalist when assessing the prospects of the entrepreneurial initiative. Nevertheless, when assessing a new venture, both backers (amateurs) and venture capitalists (experts) share a common interest by looking for information that signal quality and thus reduce information asymmetries (Mollick, 2013).

Against this background, it can be argued that crowdfunding does not only give the campaign initiators the option to seek funding for their idea, it also allows them to pre-test the market acceptance for their product or service (i.e. assess potential demand). According to Petty and Gruber (2011), the potential of the target market is one key indicator for a venture capitalist when screening deals. In that regard, entrepreneurs can signal the market potential of their idea through their campaign supporters. In other words, a large collective of individuals that support a crowdfunding initiative assesses the idea to be superior to others and also attests demand which can reduce informational frictions concerning market acceptance (Burtch, Ghose, & Wattal, 2012; Mollick & Nanda, 2016). Hence, a successful crowdfunding campaign may serve as positive signal for outside investors since the funded project received positive feedback from a large group of individuals that could turn into future customers (Ahlers et al., 2015; Mollick & Kuppuswamy, 2014; Vismara, 2016). As a result, a venture capitalist may rely on the decision of the crowd in order to evaluate the future potential of the entrepreneurial initiative and to infer whether the new venture and its product or service is worth investing (Agrawal et al., 2016; Mollick & Nanda, 2016). Given that a successful campaign signals market acceptance and superior quality, the following is hypothesized:

H1: A successful reward-based crowdfunding campaign has a positive influence on receiving VC funding.

Despite the fact that the success of a campaign per se is one major signal of market acceptance that is produced by the backers, the level of campaign funding is another important signal a campaign initiator can create. Put differently, attractiveness of an entrepreneurial initiative is also expressed by the degree of funding the new venture received compared to the funding it initially demanded from the crowd. As previously noted, the new venture *Lifxs* raised a record amount of pledges worth USD 1.3m, 13-times the initial funding goal (Dingman, 2013). Thus, the degree of overfunding can be considered another distinct signal of attractiveness being considered in the evaluation process of venture capitalists. Although the funding goal is negatively related to campaign success (Colombo et al., 2015; Mollick, 2014), a supply of finance from the backers that exceeds the demand from the campaign initiators can nevertheless be interpreted as a signal of above-average acceptance. However, from the entrepreneurs view,

the degree of (over-)funding might also affect the need for additional finance. New ventures having collected a high amount of funding through the crowd are a) attractive for a venture capitalist as outlined before, but also b) less in urge of additional funding given that their financial need is saturated. Hence, given the fact that the amount received relative to the amount required (i.e. *funding ratio*) is another signal of market acceptance and quality, the following hypothesized:

H2: The receipt of VC funding has a curvilinear (an inverted U-shaped) relationship with the funding ratio of the campaign.

The role of campaign endorsement in VC financing

Beyond the signal of market potential of the product or service, third-party endorsements play a crucial role in reducing information asymmetries between two parties (Mollick, 2013). Endorsements are signals of reputation provided by a third party, which are based on objective factors. In the context of venture capital for example, endorsements represent investments from prior investors that have already evaluated the potential investee (Bertoni et al., 2011; Davila et al., 2003; Kim & Wagman, 2016). In that regard, a venture capitalist can infer from a positive assessment by another investor that the potential investee is of superior quality and can incorporate this signal in the decision-making process in order to reduce information asymmetries ex-ante (Bonardo et al., 2010; Lerner, 1999, 2002). Again, when considering the early stages of development of firms using reward-based crowdfunding, endorsements by prior investors are rather unlikely since these entrepreneurial initiatives usually did not acquire other investments prior to crowdfunding.

However, reward-based crowdfunding campaigns may also be subject to an endorsement process in which platform-staff assesses a campaign's quality (Mollick, 2014; Wessel et al., 2015). These so called 'staff picks' represent campaigns that are of exceptional quality in terms of the degree of innovation, campaign description, and the use of multimedia technology (Kickstarter, 2016b). Objectivity is ensured by the fact that 'staff picks' cannot be altered by the campaign creators themselves but are rather based on their effort in comparison to competing campaign owners. In that case, a 'staff pick' gives some sort of credit and special attention to a campaign as well as its creators and also helps potential backers to a) gain awareness of the project and b), to assess the

quality and seriousness of the campaign. In other words, a ‘staff pick’ can help a potential investor to distinguish good campaigns from bad ones. Mollick (2014) and Wessel et al. (2015) provide empirical evidence that a ‘staff pick’ has a positive influence on campaign success and the number of backers respectively. Given the large universe of potential projects to support, individual investors can rely on this qualitative signal when selecting campaigns which they prefer to support. By relying on a ‘staff pick’, backers can assume that the campaign is more likely to reach its funding goal and provide the promised reward in exchange. Likewise, in the process of screening potential investments, a professional investor can also rely on the judgement provided by the platform owner in selecting high-quality campaigns that are superior to others. In other words, platform endorsements pre-select a certain amount of campaigns outperforming others in various aspects. This superiority can ultimately translate into an increased level of seriousness pursued by the entrepreneurs and signal trust to outside parties, such as venture capitalists. Based on these arguments, the following is proposed:

H3: The endorsement of a reward-based crowdfunding campaign by the platform provider has a positive influence on receiving VC funding.

The role of brand exposure on social media platforms in VC financing

Given that reward-based crowdfunding campaigns enjoy increased popularity, project creators are urged to increase appearance and demonstrate superior quality in order to stand out compared to competing campaigns. However, individuals are restricted by few available informational cues which can be used in the individuals’ assessment of a new venture’s or project’s quality in the context of crowdfunding (Dellarocas, 2003; Godes et al., 2005). Amongst them, the primary source of information about a project (i.e. project description, videos, updates, etc.) largely stems from a single source - the project creator. Hence, backers are confronted with potentially biased information, which they have to assess upon plausibility. As a result, other sources of trust and quality become more valuable for potential backers when assessing projects (Thies, Wessel, & Benlian, 2016). Besides platform-relevant cues such as ‘staff picks’, the use of word-of-mouth (WoM), or more suitable for the context of crowdfunding platforms, electronic word-of-mouth (eWoM), is an additional signal which individuals can rely on in a crowdfunding context (Dellarocas, 2003). The latter circumscribes a comment about

a product and/or company from potential, actual, or former customers (Hennig-Thurau, Gwinner, Walsh, & Gremler, 2004).

These comments, both positive and negative, inherit the power to influence the reliability, credibility, and trustworthiness of the product or company under scrutiny and can support an individuals' decision-making process (Arndt, 1967; Brown, Broderick, & Lee, 2007). According to Thies et al. (2016), "spreading the word in social media raises awareness for the respective crowdfunding campaign without requiring financial investments and can be central in persuading prospective backers to invest" (Thies et al., 2016, p. 848). Hence, eWoM can lead to more backers being aware of a campaign and increase credibility and trustworthiness if backers hear from interesting projects from their personal network. Thies et al. (2016) test this hypothesis in their study on 23,340 reward-based crowdfunding campaigns and find empirical evidence that eWoM in the form of comments on the campaign website and Facebook-shares today indeed influence the number of backers tomorrow. They conclude that consumers are positively influenced by recommendations and feedback from their network. Further, eWoM may also help ambitious campaigns to raise awareness from venture capitalists. Following this argumentation, the following is proposed:

H4: The volume of electronic-Word-of-Mouth in a reward-based crowdfunding campaign has positive influence towards receiving VC.

In addition to the value of campaign-related signals towards their importance in the post-campaign allocation of funding through venture capitalists, this dissertation also evaluates how the presence of a campaign itself influences the syndication behavior of venture capitalists against the background of other new venture-related characteristics. In essence, a syndicate is formed if at least two investors jointly invest in a portfolio company by acknowledging both risk and reward involved in the transaction (Hopp & Lukas, 2014; Terjesen et al., 2013; Wright & Lockett, 2003). Syndicates have been formed as a means for investors to gain access to deals that would otherwise be impossible for small and less-reputable VC firms (Hopp & Lukas, 2014; Manigart et al., 2006). Further, while being part of an investment syndicate, less experienced investors learn from more experienced investors and gain reputation which poses an additional advantage (Chou, Cheng, & Chien, 2013). Lastly, when joining a syndicate, the syndicate partners can define a process through which the investee's potential is evaluated from

multiple perspectives given the larger amount of experience that is available in the syndicate. Hence, joining a syndicate might lead to improved project selection (Altintig et al., 2013; Brander, Amit, & Antweiler, 2002; Bygrave, 1987), and an increase in portfolio diversification given that a larger amount of investments can be made (Hopp, 2010; Kogut, Urso, & Walker, 2007).

On the contrary and despite the advantages that come along with the syndicate network, joining a syndicate comes at a cost. For one thing, the experience of the syndicate partners has a lasting impact on the syndicate as well as the investee's performance. In that regard, less experienced venture capitalists are more likely motivated to join a syndicate in comparison to more experienced venture capitalists in order to benefit from the knowledge spillover and experience of the more senior syndicate members (Casamatta & Haritchabalet, 2007; Cestone, Lerner, & White, 2006). Moreover, suboptimal syndicate contracts among participants allow syndicate members to exploit the benefits of the syndicate, while providing insufficient resources, translating into syndicate costs outweighing the benefits (Chou et al., 2013; Cumming, 2007). In these situations, syndicate members are subject to a loss in reputation, limited access to future deal flow, and exclusion from further investment rounds (Wright & Lockett, 2003). Obviously, the reduced risk also comes at the cost of reduced reward, since a syndicate that shares the risk collectively has to share the expected profits, too (Brander et al., 2002; Hopp & Lukas, 2014). To conclude, although a VC syndicate may entail several advantages to the individual investor, a syndicate also has its downsides (Barringer, 2000; Dimov & Milanov, 2010).

In order to avoid the detriments that come along with syndication while simultaneously exploiting the advantages of risk diversification, venture capitalists can rely on the assessment of an even larger collective - the crowd. Thus, a successful crowdfunding campaign may truly serve as signal of quality by representing the opinion of market acceptance through the 'wisdom of the crowd' (Agrawal et al., 2016; Bruton et al., 2015; Mollick, 2014; Mollick & Nanda, 2016). Therefore, the support of a campaign can be interpreted as a signal of firm quality and thus reduce information asymmetries between the investor and the investee. Based on this overarching assumption and the fact that peer opinions receive increased attention in financial markets (Chen et al., 2014), this dissertation draws its attention on how crowdfunding affects the venture capitalist's

decision to syndicate. Manigart et al. (2006) give a comprehensive overview of motivations that can influence VC syndication, highlighting the financing, the value adding, the deal flow, and the deal selection motive. This dissertation focuses on the deal flow and deal selection motives in theorizing the link between crowdfunded ventures and venture capitalists' syndication behavior for two main reasons: First, the latter two suit the intended research context of this empirical contribution with the focus on crowdfunding and its presumed positive signaling value to reduce information asymmetries. That is, the argumentation outlined above highlights that crowdfunding can have a certification effect for a new venture that can ignite professional investors' interest based on the objectified feedback towards a product or service a crowdfunding campaign provides (Drover et al., 2017; Roma et al., 2017). Second, the motives outlined by Manigart et al. (2006) offer the right degree of precision while being mutually exclusive. The first two motives - the finance and the value adding motive - are of lesser importance for this empirical contribution and the theoretical framework drawing on signaling theory as these motives are more related to the context of the resource based view of the firm (Barney, 1991; Barney et al., 2001; Penrose, 1996; Wernerfelt, 1984). That is, these motives draw on the resources of the VC funds in terms of financial means, skills, and capabilities in regard to value adding activities. Hence, the financing and value adding motive would go beyond the scope of signaling theory and are thus not considered.

In line with that, the deal selection motive - according to Brander et al. (2002) and Manigart et al. (2006) - states that venture capitalists syndicate in order to reduce company-specific risk. As such, when a potential portfolio company is assessed from more than one investor, the risk of adverse selection is reduced given the increased capacity of the syndicate in assessing the available information (Lehmann, 2006; Lerner, 1994; Plummer et al., 2016; Sah & Stiglitz, 1984). This aspect is particularly relevant for venture capitalists investing in new ventures in their early stages of development, since uncertainty about the new ventures' potential is large and thus the need for syndication is higher compared to VC firms investing in ventures in later development stages (Manigart et al., 2006). In addition to the human capital of the founding team, new ventures in this life cycle stage often have no other tangible- (e.g. patents) and intangible assets (e.g. a brand) that could serve as a signal that reduces the unsystematic investment risk from a venture capitalist's perspective. In line with that, Bygrave (1988) finds a positive relation between uncertainty about the investment object and willingness to syndicate.

Further, Lerner (1994) provides evidence that established VC firms tend to syndicate more with similar established peer investors in first round investments that are characterized by high information asymmetries. In later rounds, he finds, syndicates also comprise a joint investment of established and less-established VC firms.

When screening potential investments, the potential of the target market is amongst the most important indicators being scrutinized by investors (Petty & Gruber, 2011). Before the occurrence of crowdfunding, the assessment of the target market's potential in terms of product or service acceptance and demand was largely the product of an investors' individual assessment and experience. With crowdfunding however, entrepreneurs can attest market demand which can reduce informational frictions in a VC screening process (Burtch et al., 2012; Mollick & Nanda, 2016). Hence, the opinion of a large collective assessed in a crowdfunding campaign reduces uncertainties about market acceptance and thus the risk of failure may be decreased, a factor of utmost importance in the screening of portfolio firms (Petty & Gruber, 2011). As a result, uncertainty is reduced and likewise the need to syndicate is affected when arguing against the background of the deal selection motive (Bygrave, 1988; Manigart et al., 2006). As such, and given the fact that crowdfunding is likely to decrease information asymmetries between the new venture and the investor, the following is hypothesized:

Hypothesis 5: Venture capitalists are less likely to syndicate when investing in crowdfunded ventures compared to investing in non-crowdfunded ventures.

Beyond the selection motive, venture capitalists also syndicate in order to have access to many investment opportunities (Manigart et al., 2006; Sørenson & Stuart, 2001). Deal flow circumscribes a venture capitalist's access to a large number of potential investments that fit to the VC fund's overall portfolio strategy (Manigart et al., 2006). In that regard, Lerner (1994) and Manigart et al. (2006) argue that the probability to have access to investments of high quality increases with the size of the individual investor's syndicate network due to increased status and visibility. For instance, an investor might be invited to join a syndicate even though he was not involved in sourcing the deal (Bovaird, 1990).

Before being considered a valuable syndication partner however, venture capitalists with a smaller network and fewer resources might actively invest in a large number of

syndicated investments and thus increase their deal flow in order to increase the awareness from the potential partners' perspective (Hopp & Lukas, 2014). Hence, less experienced venture capitalists are more likely motivated to join a syndicate as non-lead investors compared to more experienced ones in order to profit from the knowledge and experience of the syndicate's lead investors (Casamatta & Haritchabalet, 2007; Cestone et al., 2006). In addition, inexperienced VC funds may find it more difficult to diversify their portfolios based on the scarcity of their available resources (Huntsman & Hoban, 1980; Murray, 1999). Hence, access to a larger array of deals does not only increase an inexperienced VC fund's visibility, but also allows the fund to access knowledge and gain experience from investment opportunities it would otherwise be withheld from. As a result of this resource constraint, there exists an inverse relationship between fund size and syndication necessity - the smaller the fund, the higher the need to seek syndicate partners.

When considering that crowdfunding can raise awareness about an entrepreneurial venture on a global level, also small venture capital funds can uncover these ventures. Since many investment opportunities are often captured by well-connected and experienced funds with diverse social capital before other funds outside that network could make investment offers, easy access to potentially new portfolio firms via crowdfunding allows less experienced venture capitalists to learn about investment opportunities they would not have heard of before. Thus, less experienced VC funds profit from the increase in potential deals to source from in order to improve their track record by gaining deal exposure. Nevertheless, less experienced VC funds are still confronted with large information asymmetries concerning the new venture that can better be addressed in a syndicate. Put differently, given their resource scarcity, less experienced funds may rely more heavily on the 'wisdom of the crowd' compared to more experienced funds when building their own investment track record. Hence, crowdfunding allows less experienced VC funds to access a larger number of investments and simultaneously reduces the risk of adverse selection given that the investment object is assessed from both, the crowd as well the syndicate members (Lehmann, 2006; Lerner, 1994; Plummer et al., 2016; Sah & Stiglitz, 1984). Taken together, this dissertation argues that crowdfunding opens a new channel to discover attractive investment opportunities for less experienced VC funds in order to gain investment exposure. Given this assumption, the following is hypothesized:

Hypothesis 6: VC syndicates of crowdfunded ventures are less experienced than VC syndicates of non-crowdfunded ventures.

Another argument that supports the assumption that crowdfunding influences the deal-flow of investment syndicates is the degree of internationality. Traditionally, investors often invest in firms which are located nearby in order to interact (i.e. monitor) and exchange information with the portfolio company (French & Poterba, 1991; Seasholes & Zhu, 2010; van Nieuwerburgh & Veldkamp, 2009). Thus, spatial proximity enables the VC investor to monitor the new venture and thus reduces costs resulting from information asymmetries during the investment phase. Therefore, new ventures being close to the VC investor have increased chances of receiving an investment (Agrawal et al., 2016). However, Sørenson and Stuart (2001) show that a VC firm is more likely to invest in a more distant venture if a syndicate partner exists that the VC has a) previously worked with and b), is located near the portfolio firm. In other words, international syndicates require at least one local firm to deal with the portfolio firm directly, whereas co-investors could be located far away. In line with Manigart et al. (2006), for a fund with a broad investment scope, this fact is particularly relevant as it increases possibilities to invest in ventures that are located far away but fit the portfolio strategy. However, without the local partner, the likelihood that such funds invest in interesting investment opportunities that are not close by are rather small (Manigart et al., 2006). As crowdfunding platforms are accessible worldwide and offer information about the entrepreneurial ventures, these platforms provide investors with a new and globally available channel to source deals. For example, investors with a broad investment scope have access to a large number of investment opportunities by getting to know about them via crowdfunding platforms. Hence, their deal flow is positively influenced from a quantitative perspective. Thus, crowdfunding provides an unprecedented opportunity for remote investors to locate deals and then syndicate with a partner who is located close to the targeted new venture. Hence, crowdfunding as a new deal channel does not only create opportunities to syndicate over remote distances, but the syndicates are likely to become more heterogeneous in terms of internationality at the same time. Based on this argumentation, the following is hypothesized:

Hypothesis 7: VC syndicates of crowdfunded ventures are more international than VC syndicates of non-crowdfunded ventures.

4.2 Data and Research Methodology

4.2.1 Dataset and Descriptive Statistics

The primary source of information consists of campaign-level data from Kickstarter, which is currently the worldwide leading reward-based crowdfunding platform. Since its launch in 2009, Kickstarter raised over USD 2.8 billion with more than 12 million pledges funding over 110,000 successful projects (Kickstarter, 2016c).

The data was gathered automatically using a self-developed web-crawler to retrieve the available information of every campaign. The data includes all projects that ran on Kickstarter, starting in 2009 until June 2016, resulting in nearly 300,000 campaigns, both successful and unsuccessful, that sought funding from the crowd. Following previous studies focusing on entrepreneurial initiatives on crowdfunding platforms (Kuppuswamy & Bayus, 2015; Mollick & Kuppuswamy, 2014; Mollick & Robb, 2016; Yang & Hahn, 2015), this dissertation limits the dataset for the main analysis. Even though Kickstarter offers 15 distinct categories for projects, this empirical contribution focusses on three major categories: “*Games*”, “*Design*”, and “*Technology*”. Unlike the remaining categories, nearly all projects in these three categories are related to entrepreneurial activities that are not just one-off projects (Yang & Hahn, 2015). Campaigns that received follow-up external funding were identified using the Crunchbase database that is commonly used in other studies investigating the funding behavior of investors (e.g. Alexy, Block, Sandner, and Ter Wal 2012; Ter Wal, Alexy, Block, and Sandner 2016). As of October 2016, the Crunchbase database consists of 115,481 legal entities that were established and legally registered. Further, the database contains information on a total of 146,847 investment rounds comprising 48,337 investors and is hence considered more accurate, concerning small and medium-sized enterprises as well as large multinationals, compared to other sources (Alexy et al., 2012). Given that the investment process requires time after a campaign took place, only campaigns in the period 2010 through 2015 are considered so that new ventures having performed crowdfunding had sufficient time to seek funding and thus be included in Crunchbase.

In order to answer research question two and three and to match the data retrieved from Crunchbase with the initial dataset from Kickstarter, the sources had to be combined. Therefore, a string matching method was applied that provides a similarity score

between two different text strings by performing different string-based matching techniques. It returns a new numeric variable containing the similarity score, which ranges from zero to one. A score of one implies a perfect similarity according to the string matching technique and decreases when the match is less similar (Raffo & Lhuillery, 2009). The method was applied to two pairs of variables from each dataset. First, the names of the creator of the campaign were matched, which is usually a person or a company on Kickstarter, with the company name provided by Crunchbase. The second relevant pair of variables was the website from the campaign (Kickstarter) and the company (Crunchbase). Following this procedure, the resulting matches were sorted by their similarity score and the first 5000 matches were checked manually to guarantee the validity of the process. The process of manually correcting the false positives is a desirable action, since the purpose of the string matching is to identify a dataset with a minimum of false positives. The manual check was extremely important as only 684 corresponding investments made into crowdfunding campaigns were correctly matched. On the other hand, the possible elimination of false negatives induced by the matching algorithm should not introduce any systematic bias due to an assumed random distribution (Raffo & Lhuillery, 2009). Given the focus on the period 2010 through 2015, 610 out of the 684 campaigns identified represent the final sample. Table 8 provides an overview of the categorical distribution of crowdfunding campaigns in the period 2010 through 2015.

Table 8: Category Overview of Crowdfunding Campaigns 2010 through 2015
The table shows an overview of the absolute number of firms without (column 1) and with (column 2) follow-up VC financing in the respective categories provided by Kickstarter (N=610).

Category	Campaigns w/o follow-up VC		Campaigns w/ follow-up VC	
	N. of firms (abs.)	N. of firms (in %)	N. of firms (abs.)	N. of firms (in %)
Art	19,770	7.6%	6	1.0%
Comics	6,428	2.5%	-	-
Crafts	5,168	2.0%	2	0.3%
Dance	2,923	1.1%	-	-
Design	17,295	6.6%	133	21.8%
Fashion	13,663	5.2%	31	5.1%
Film/Video	50,326	19.3%	19	3.1%
Food	16,928	6.5%	20	3.3%
Games	20,321	7.8%	75	12.3%

Journalism	3,141	1.2%	4	0.7%
Music	42,035	16.1%	3	0.5%
Photography	8,115	3.1%	3	0.5%
Publishing	28,075	10.8%	11	1.8%
Technology	18,346	7.0%	302	49.5%
Theatre	8,721	3.3%	1	0.2%
Total	261,255	100%	610	100%

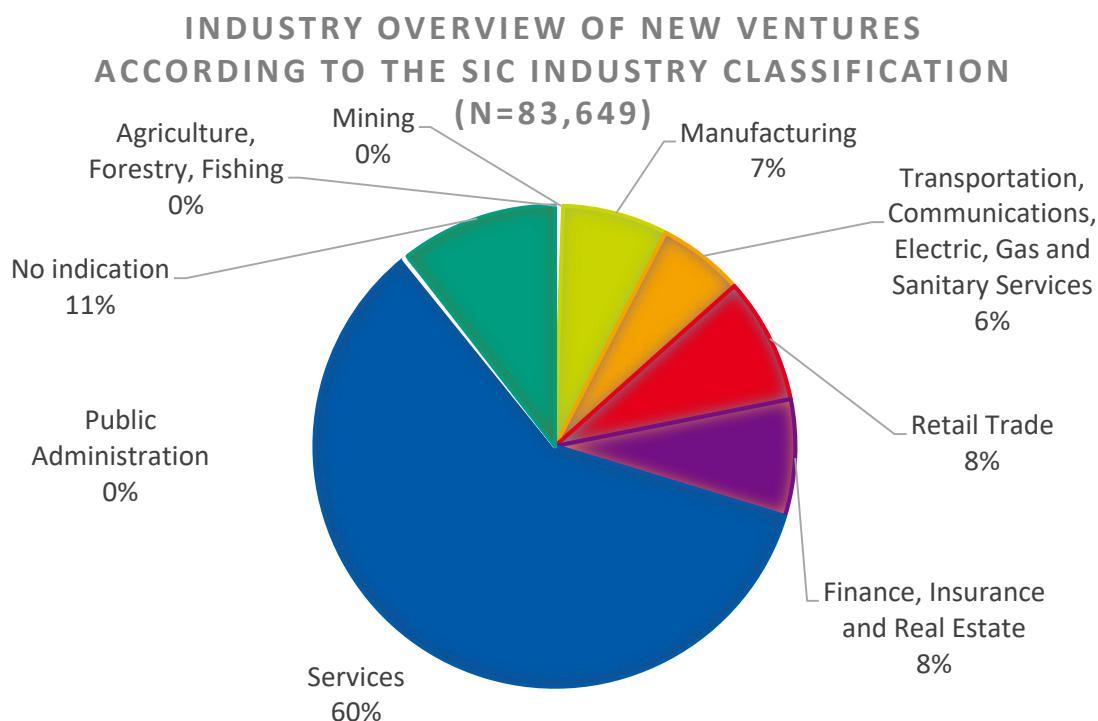
The majority of crowdfunding campaigns without follow-up VC concentrate in the areas of *Film/Video* (19 percent), *Music* (16 percent), and *Publishing* (11 percent). This distribution is in accordance with the fact that the majority of reward-based crowdfunding campaigns are initiated against the background of cultural events (Schwienbacher & Larralde, 2010). When considering campaigns that received follow-up financing identified by the matching technique, the distribution changes. Here, investments mainly concentrate in the categories of *Technology* (50 percent), *Design* (22 percent), and *Games* (12 percent) since new ventures' need for external investors is typically higher in these categories. This distribution further strengthens the argument to limit the dataset for the analysis to these categories. Hence, the final sample used in the analyses concerning research question two comprises 510 crowdfunding campaigns initiated in the period 2010 through 2015 in the categories of “*Games*”, “*Design*”, and “*Technology*”.

The analyses concerning research question three relies on the data description elaborated on so far, applies an additional approach, however. As research question three focusses on the presence of a crowdfunding campaign itself as a signal of new venture quality rather than the campaign-related signals themselves, the analyses also consider other firm-relevant information. Hence, the perspective shifts from campaign-related informational cues to new venture related informational cues. Hence, the 510 identified campaigns need to be matched to legal entities, representing 267 new ventures. Based on this final sample that comprises firms having completed at least one crowdfunding campaign before their first round of VC, a matched sample of VC-backed firms without a crowdfunding campaign was constructed according to a set of predefined characteristics (Bertoni, Croce, & Guerini, 2015; Chemmanur et al., 2011; Croce et al., 2013; Engel & Keilbach, 2007; Tian, 2012). A reason for this approach is that the allocation of VC is non-random and subject to a certain selection bias. First, firms with or without crowdfunding are subject to choose whether to apply for VC funding. Second, venture

capitalists can choose from a large universe of firms having similar characteristics. In order to address the selection bias, a matching estimator is chosen by selecting control group firms based on a propensity score matching algorithm (e.g. Bertoni et al. 2015; Croce et al. 2013). Thus, the entire Crunchbase database was used in order to sample the most similar peers for each of the 267 new ventures identified that have completed at least one reward-based crowdfunding campaign in their history.

Figure 7 provides an overview of the industry allocation of the entire population of potential firms included in Crunchbase with and without crowdfunding. Following the standard industry classification codes (SIC), one can conclude the Crunchbase database primarily includes new ventures that can be allocated to the *Services* industry (60 percent). This industry allocation is not surprising given the fact that many new ventures provide (digital) platform-based solutions and are thus allocated to the service industry. Beyond a relatively large proportion of new ventures that did not indicate any industry classification (11 percent), the categories of *Finance, Insurance and Real Estate* and *Retail Trade* show the third highest proportion with 8 percent respectively. Only 7 percent of new ventures can be allocated to the *Manufacturing* industry.

Figure 7: Industry Overview According to the SIC Industry Classification
The figure shows an overview of industry affiliation separated by the total sample and the respective percentage allocation.



When comparing the 267 identified new ventures with the total number of potential new ventures that could serve as a control group member, some differences should be pointed out, however. As such, table 9 provides an overview of industry allocations of new ventures with crowdfunding (column 1) and without a prior crowdfunding campaign (column 2). When referring to new ventures with a crowdfunding campaign, the majority (56 percent) of new ventures can be allocated to the services industry again (table 9, column 1). This allocation is not different compared to new ventures without crowdfunding (table 9, column 2). Nevertheless, the second largest industry represented with new ventures having used crowdfunding is *Manufacturing* with 19 percent (table 9, column 1). This allocation is not surprising since many initiatives on Kickstarter develop a physical and product-like prototype which is, according to the SIC definition, an act of manufacturing and thus belongs to this respective category. Note-worthy is also the difference of new firms belonging to the *Retail Trade* category. Whilst new ventures with crowdfunding are represented with 13 percent in this category (table 9, column 1), only 8 percent of the total Crunchbase database of new ventures without crowdfunding belong to this category (table 9, column 2). On the contrary, the SIC category *Finance, Insurance and Real Estate* is underrepresented for new ventures having used crowdfunding (5 percent) compared to new ventures without (8 percent) (table 9, columns 1 and 2).

Table 9: Industry Overview of New Ventures

The table shows an overview of industry affiliation separated by new ventures with crowdfunding (column 1) and new ventures without crowdfunding (column 2).

SIC Industry Classification	New Ventures w/ Crowdfunding		New Ventures w/o Crowdfunding	
	N. of firms (abs.)	N. of firms (in %)	N. of firms (abs.)	N. of firms (in %)
Agriculture, Forestry, Fishing	3	1%	217	0%
Mining	0	0%	235	0%
Manufacturing	52	19%	5,858	7%
Transportation, Communications, Electric, and other Services	12	4%	4,827	6%
Retail Trade	36	13%	7,049	8%
Finance, Insurance and Real Estate	14	5%	6,547	8%
Services	149	56%	49,605	59%

Public Administration	1	0%	258	0%
No indication	0	0%	8,786	11%
Total	267	100%	83,382	100%

To derive a suitable control group from the vast amount of potential new ventures available, a probit-model is used in which the dependent variable is the probability of performing a crowdfunding campaign. The independent firm-specific variables include the firm-age, the number of founders and employees, and industry dummies.⁶ By applying this matching algorithm, this dissertation aims to find for each VC-backed firm with a preceding crowdfunding campaign the three most similar peers (i.e. nearest neighbors) of VC-backed firms without a preceding crowdfunding campaign. Given that no optimal ratio of treated and control groups exist and that larger matches do not lead to gains in efficacy (Sørensen & Stuart, 2000; Sørenson & Stuart, 2008), larger control groups are used only to test the robustness of the results. The final sample derived contains 504 unique new ventures, of which 193 had completed at least one reward-based crowdfunding campaign on Kickstarter before they received funding from venture capitalists. The remaining 311 new ventures comprise similar peers without a crowdfunding campaign in their history.

4.2.2 Variables and Methods Concerning VC Investing

For the econometric model, the occurrence of follow-up funding from a venture capitalist after a crowdfunding campaign was used as a binary dependent variable. Logit models are well established and used for binary outcomes. The probability of an outcome is modeled as a function of one or more regressors (Cameron & Trivedi, 2005). In this case, the probability of a crowdfunding project receiving VC as a follow-up investment was modeled depending on a set of control variables and the hypothesized effects regarding market demand, endorsement, and brand exposure. The applied method is thus formalized as follows:

⁶ The control group was constructed using nearest-neighbor matching with Mahalanobis distance (see e.g. Croce, Marti, and Murtinu 2013) using STATA command psmatch2). Further, the sampling of the control group with replacement was performed. This approach allowed that each potential control group firm has the chance to be selected more than once.

$$p_i = \text{PR}[y_i = 1 | x_i] = \Phi(\beta_1 + \beta_2 x_i) \quad (1)$$

Here y_i is the occurrence of external VC funding (0/1) depending on crowdfunding campaign characteristics x_i . As the event of external funding is extremely rare (i.e. 510 investments out of 56,000 campaigns), a penalized maximum likelihood logistic regression is applied with the Stata function *firthlogit*. This technique is suitable for dealing with such rare events in a sense that the binary dependent variable of an external follow-up investment (1) occurs approximately a hundred times fewer than a non-event (0) (Firth, 1993; Hilbe, 2009).

In order to assess the proposed influence of campaign success, endorsement, and brand exposure, several proxy variables are used in the regression analysis. Concerning the role of market demand, success (*Success*) is considered in the data as whether or not the campaign reached its funding goal (see hypothesis 1). Kickstarter uses an all-or-nothing funding mechanism, meaning that funds are only paid out if the funding goal is reached. This measurement of success is well established in the crowdfunding literature (Mollick 2014). Further, the ratio of the actual funding received in relation to the funding required is used as an alternative measure (*Funding Ratio*) (see hypothesis 2). Again, for campaign endorsement this analysis follows Mollick (2014) and Wessel et al. (2015), as this dissertation uses a binary variable (*Staff Pick*) that was coded with the value of one in case the campaign was a so-called ‘staff pick’ and zero otherwise (see hypothesis 3). As mentioned before, being endorsed by the platform provider entails several advantages (e.g. exposure on a separate list of campaigns recommended by Kickstarter) and is reserved for campaigns that are selected by Kickstarter staff because they are particularly compelling (Kickstarter, 2016b). Lastly, brand exposure was measured by a variable reflecting the accumulated volume of eWOM by the campaign in the form of the logarithmic shares on the social network Facebook (*Facebook Shares (LN)*) (see hypothesis 4) (Thies et al., 2016).

In addition, several other control variables that were used in recent reward-based-crowdfunding studies identifying success factors, other quality signals, and creator experience in crowdfunding are employed. One key control variable is whether the campaign includes a video (*Video*) (Mollick, 2014). Uploading a video is strongly recommended by Kickstarter, claiming that it highly improves the success rate (Kickstarter, 2016a). The binary variable was coded with the value of one in case the campaign had

a video and zero otherwise. Additional controls are the campaign's funding goal in logarithmic terms (*Funding Goal (LN)*) and the number of offered rewards (*No. of Rewards*) (Agrawal et al., 2011; Kuppuswamy & Bayus, 2015). Further, the description length of the campaign (*Description Length (LN)*) is controlled for, assuming that a longer and more detailed description can reduce information asymmetries (Wessel et al., 2016). Additionally, the analyses controls for the category (*Games, Design, and Technology*) and the year (2010-2015) in which the campaign ran on Kickstarter. In addition to these controls, a variable counting the number of campaigns (*No of Campaigns*) a creator has launched on Kickstarter previously is included to assess his experience with the platform (Zhang, 2006). Finally, the number of backers that supported the campaign (*Project Backers*) is accounted for.

However, given that campaign success (*Success*), the funding ratio (*Funding Ratio*), an endorsement (*Staff Pick*), and brand exposure (*Facebook Shares (LN)*) are partly a result of the campaigns' intrinsic quality, the analyses are able to test if these signals are of additional value to a venture capitalist beyond the campaign itself. In case the methods applied detect that the campaign success, the funding ratio, a project endorsement, and increased brand exposure have an additional signaling value to a VC investor, an increase in the goodness of fit of the model could be expected. Further, a typical two-step Heckman correction method (i.e. the inverse Mill's ratio) is used to account for the unobserved heterogeneity in the VC investment process, referred to as selection bias (Heckman, 1979; Hellmann & Puri, 2002). To derive the inverse Mill's ratio, a selection equation is computed with campaign success as binary dependent variable. Using a probit estimator, the analyses regress the campaign's success on a set of independent and control variables that have empirically proven to influence campaign success. The variables used represent the independent and control variables as outlined above.

In addition, both the number of project updates and project comments are used in logarithmic terms in the selection equation. This procedure follows the assumption that the number of project updates and comments are related to campaign success (Arndt, 1967; Brown et al., 2007; Thies et al., 2016), but do not influence the receipt of VC. Based on the calculated residuals of the predicted probabilities of each campaign to be successful, the inverse Mill's ratio is computed (see for example Bertoni et al. 2011 and Engel 2002 for a similar approach). This inverse Mill's ratio addresses the potential

selection bias and generates more consistent estimation parameters in the regressions (Colombo & Grilli, 2010; Tucker, 2010). In a second step, the inverse Mill's ratio is inserted in combination with the previously introduced independent and control variables in the second-stage regression in order to account for unobserved heterogeneity. To test the robustness of the results, calculations are repeated using standard logit regressions and secondly use the full dataset including all categories. In order to avoid using potential outliers distorting the results, the 99 percentile is used for the analyses. Finally, the analyses also consider whether multicollinearity between the covariates is an issue for the analyses by considering variance inflation factors (VIF). Due to the fact that mean VIF values of the models lie below the suggested threshold level of five as suggested by Chatterjee and Hadi (2006) and the maximum VIF values below the threshold level of 10 as suggested by O'Brien (2007), multicollinearity is not an issue.

4.2.3 Variables and Methods Concerning VC Syndication

In order to test whether crowdfunding influences the syndication behavior of venture capitalists (i.e. hypothesis 5), two different dependent variables are used. First, a binary variable *Syndicate* is employed that is coded with the value of one in case the new venture received funding from a syndicate and zero otherwise (e.g. Dimov and Milanov 2010). Second, a count variable named *Syndicate Size* is used representing the number of investors in the syndicate (Jolink & Niesten, 2016; Ferrary, 2010; Wang, Wuebker, Han, & Ensley, 2012; Wang & Wang, 2012). Concerning the experience level of the syndicate investors (i.e. hypothesis 6), three different dependent variables are used. First, the average (i.e. *Average Investments*) and total number of investments (i.e. *Total Investments*) are used as a proxy for the syndicates' experience based on their number of deals in the past (e.g. Chemmanur, Hull, and Krishnan 2016). Further, this dissertation also accounts for the average age of the syndicate partners as a proxy for the syndicate's experience with the dependent variable *Average Age*. Lastly, it is also tested how crowdfunding influences cross-border syndication (i.e. hypothesis 7) with the binary dependent variable *International Syndicate* that is coded with the value of one in case the syndicate comprises at least two investors from different countries of origin and zero otherwise. Furthermore, this dissertation also tests for the number of investor countries of origin with the dependent variable *# of investor countries* as another proxy for the internationality of the syndicate. The independent variable in all analyses is the

binary variable *Crowdfunding* that is coded with the value of one in case the new venture completed a crowdfunding campaign before their first funding round with one or more VC investors and zero otherwise.

In addition, several control variables are employed, too. First, the new ventures' age is accounted for as well as the number of founding team members by the variables *Venture Age* and *Number of Founders* (e.g. Alexy et al. 2012; Criaco et al. 2014; Scholten et al. 2015; Wang et al. 2012; and Wang and Zhou 2004). Second, the new venture's respective SIC industry is included with the variable *Industry Dummy* (see e.g. Jolink and Niesten 2016). Third, following studies in a similar context, this dissertation also accounts whether or not the new venture is a US-based firm with the binary variable *US Firm* that takes the value of one in case the new venture is based in the US and zero otherwise (e.g. Chahine, Arthurs, Filatotchev, and Hoskisson 2012). Lastly, this dissertation also accounts for the number of employees the new venture has with the categorical variable *Number of Employees*. Using the variables outlined above, the empirical analyses rest upon three different methodological approaches.

As the hypotheses concerning the syndication behavior of venture capitalists deals with different types of outcomes (i.e. dependent variables), the econometric analysis has to be adjusted accordingly. For the dichotomous dependent variables whether or not a syndicated VC investment followed a crowdfunding campaign (*hypothesis 5, Syndication (0/1)*) and whether or not this syndicated investment is international (i.e. *hypothesis 7, International Syndicate (0/1)*), a logit model is applicable. Here, the model specifies the probability of an outcome as a function of one or more independent variables (Cameron & Trivedi, 2005) and can be formalized as follows:

$$\Pr(y = 1|x) = F(x\beta) \quad (2)$$

where F is the cumulative distribution function of the logistic distribution for the logit model (Long, 1998). The probability of observing an event given x is the cumulative density evaluated at $x\beta$.

For the dependent variables *Syndicate Size* and *# of investor countries* (*hypothesis 5 and 7*), a Poisson regression is used as these dependent variables are count variables (Cameron & Trivedi, 2013). The model is formalized as follows:

$$E[y_i|x_i, \varepsilon_i] = \exp(\alpha + x_i\beta + \varepsilon_i) \quad (3)$$

where y_i denotes the dependent count variable, x_i represents the investment specific independent variable (*Crowdfunding*) and all controls, while ε_i acts as the error term. All three remaining dependent variables are count variables (hypothesis 6, *Average Investment*, *Total Investments*, and *Average Age*) as well. Still, as these variables are all significantly over dispersed, using a negative binomial regression instead of a Poisson regression is advised (Cameron & Trivedi, 2013; Long, 1998). All results are robust to the Poisson specification. The formalization is concurrent with (3). The baseline models include the before-mentioned control variables. In the full model, the indicator *Crowdfunding* (0/1) is included respectively.

4.3 Empirical Results and Discussion

4.3.1 Results Concerning Crowdfunding and VC Investing

Before turning to the econometric evidence, this dissertation provides descriptive statistics for all variables that are used in the econometric models concerning the analyses of campaign-specific signals in table 10. The descriptive statistics are divided in the full dataset, including all crowdfunding campaigns without follow-up VC from the entrepreneurial focused categories “*Games*”, “*Design*”, and “*Technology*”, and the identified campaigns that received follow-up VC investments. Here, some differences should be pointed out. Surprisingly, no significant differences in the aspired funding goal of the campaigns and funding ratios can be identified. To be more precise, 32 percent of campaigns that received follow-up VC were not successful on Kickstarter in the first place measured with the variable *Success*. Still, compared to all campaigns from the entrepreneurial focused categories, their success rate is much higher. The same applies to all other campaign characteristics that have empirically shown to have an influence on campaign success (e.g. Agrawal et al. 2015; Mollick 2014, or Thies et al. 2016). Further, table 10 also shows that crowdfunded campaigns that received follow-up VC received significantly more support from backers (*No. of Backers*), had a significantly higher funding goal (*Funding Goal*), and were also significantly more trending (*Facebook Shares (LN)*) on social media platforms.

Table 10: Summary Statistics of Crowdfunding Campaigns

The table shows an overview of the crowdfunding campaign-specific characteristics of new ventures without VC follow-up financing and new ventures with follow-up VC financing.

Summary Statistics	All Campaigns w/o follow-up VC		Campaigns w/ follow-up VC		Mean Diff.
	Mean	SD	Mean	SD	
Number of Campaigns	2.50	7.37	1.94	1.89	1.87*
No. of Backers	86.95	779.27	1,391	3,128	-40.59***
Funding Goal	42,516	1,092	72,720	130,839	-0.68
No. of Updates	2.48	4.45	7.04	6.45	-25.18***
No. of Rewards	7.68	4.76	10.56	4.52	-14.95***
Video (0/1)	0.71	0.45	0.95	0.22	-12.96***
Description Length (LN)	7.65	1.00	8.75	0.81	-27.22***
Success (0/1)	0.37	0.48	0.68	0.47	-15.98**
Funding Ratio	3.71	178.44	3.62	7.17	0.01
Staff Pick (0/1)	0.10	0.29	0.39	0.49	-14.83**
Facebook Shares (LN)	1.57	2.36	4.35	3.20	-28.97***

* p<0.05, ** p<0.01, *** p<0.001.

Further, table 11 and table 12 present the results of the penalized maximum likelihood logistic regressions referring to the receipt of VC as dependent variable using the full data set including all categories available on Kickstarter (table 11) as well as the reduced dataset referring to the categories Games, Design, and Technology (table 12). Further, to test the robustness of the results, table 13 and table 14 repeat the analyses using a standard logit method and the receipt of VC as dependent variable. Hereby, the dependent variable is regressed on campaign-specific signals of all campaigns available on Kickstarter (table 13) as well as the reduced categories (table 14). In each analysis, the independent variables are presented in separate specifications (models 1-6). Positive and significant values in the models indicate an increased likelihood of receiving post-campaign follow-up VC funding.

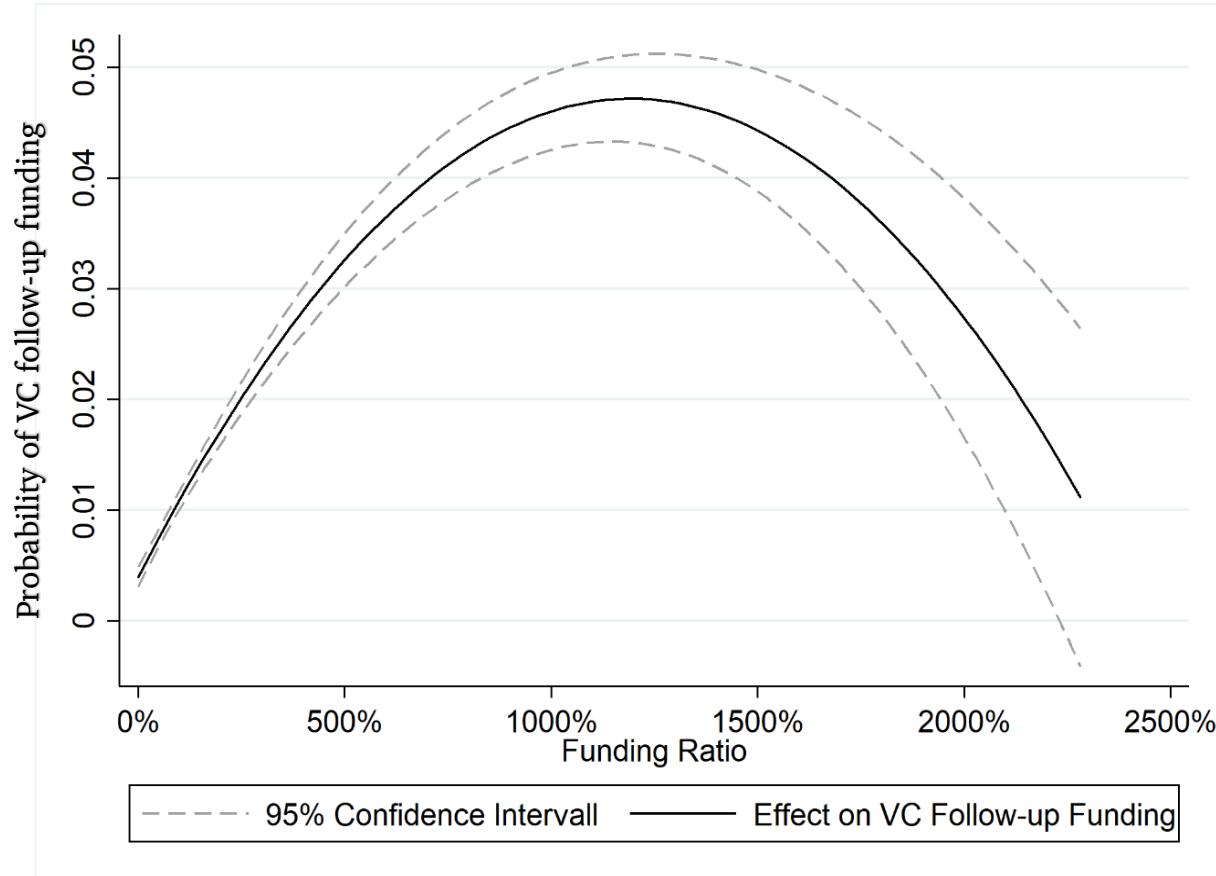
Considering the focal variable *Success*, indicating whether the reward-based crowdfunding campaign reached its funding goal, reveals that the variable has a positive and highly significant effect at the 0.1 percent level on the likelihood for the campaign owners to receive follow-up VC funding (tables 11 and 12, model 2). This effect remains positive and significant at the 0.1 percent level when referring to the results concerning the logit estimates (tables 13 and 14, model 2). In other words, the results imply - in

line with hypothesis 1 - that a successful crowdfunding campaign increases the entrepreneur's chance to receive follow-up VC significantly. Based on these results, the analyses find that crowdfunding allows entrepreneurs to pre-test the market acceptance of their business idea, where a positive outcome becomes a valuable signal concerning the likelihood to receive VC (Petty & Gruber, 2011). Hence, this dissertation infers from the results that the decision of a large collective of individuals to support a crowdfunding initiative strengthens the notion that the supported project is superior to others. Further, a successful campaign attests demand which can further reduce informational frictions about future uncertainties (Burtch et al. 2012; Mollick & Nanda, 2016). Hence, the success of a crowdfunding campaign is a positive signal for venture capitalists since the funded project received positive feedback from a large group of individuals (Ahlers et al., 2015; Mollick & Kuppuswamy, 2014; Vismara, 2016). Given this finding, one can state that venture capitalists apparently rely on the wisdom of the crowd in order to evaluate the potential of the entrepreneurial initiative and whether the new venture and its product or service is worth investing.

Further, the empirical findings also detect a positive and highly significant effect at the 0.1 percent level of the variable *Funding Ratio* towards the receipt of follow-up VC funding (tables 11 and 12, model 3). Again, this finding is positive and significant at the 0.1 percent level when referring to the results of the logit analysis (tables 13 and 14, model 3). Put differently, the higher the campaign's ratio of the amount collected in relation to the campaign's initial funding goal, the more likely a funding. Nevertheless, as outlined before, the penalized maximum likelihood logistic regressions confirms that this relationship turns negative at a certain point and remains highly significant at the 0.1 percent level (table 11 and 12, model 4). Regarding the results of the logit analysis, this effect is confirmed both for the direction of the effect as well as the level of significance (tables 13 and 14, model 4). In other words, the empirical findings confirm - in line with hypothesis 2 - an inverted u-shaped relationship between the funding ratio of a crowdfunding campaign and the likelihood of post-campaign follow-up VC financing. Figure 7 illustrates this effect by showing that the probability of receiving VC follow-up financing increases until a crowdfunding campaign is about 14x overfunded. For campaigns having collected about 14 times or more of their initial funding goal, the likelihood of a VC follow-up funding decreases.

Figure 8: Curvilinear Effect on VC Follow-up Funding

The figure shows that there exists a curvilinear relationship between the funding received compared to the funding desired (i.e. funding ratio in percent) and the probability to receive follow-up VC funding.



In line with the previous findings so far, the campaign endorsement through Kickstarter, measured by the variable *Staff Pick* has a positive and highly significant effect at the 0.1 percent level on the likelihood to receive VC when referring to the analyses concerning all categories available on Kickstarter (table 11, model 5). Regarding the analysis considering only the categories Game, Design, and Technology, the effect remains positive and is significant at the 1 percent level (table 12, model 5). This finding finds support when referring to the logit analysis. While the direction of the effect is similarly positive when regarding the analysis using both, the full as well as the reduced categories (tables 13 and 14, model 5), the level of significance differs. When regarding the logit estimates including all categories, the variable *Staff Pick* is highly significant at the 0.1 percent level (table 13, model 5). The analyses focusing on the reduced categories show a level of significance at the 1 percent level, however, (table 14, model 5). Hence, campaigns endorsed by Kickstarter have a higher chance of receiving venture capital compared to non-endorsed campaigns. The results hint at evidence that third-party endorsements

play a crucial role in reducing information asymmetries between two parties (Mollick, 2013). Given that other endorsements such as prior investment rounds are likely unavailable in the early stages of development of new ventures using crowdfunding, a ‘staff pick’ gives a degree of reputation to a campaign as well as its creators. In other words, this endorsement supports the campaign to a) gain awareness from the viewpoint of potential investors, both backers and venture capitalists and b), supports both in assessing the quality and seriousness of the campaign in order to distinguish good campaigns from those of lower quality. Given these findings, one can conclude that third-party endorsements on crowdfunding platforms reduce informational frictions and thus positively influence the decision-making behavior of both amateur and expert investors alike. Hence, the analyses find empirical evidence for hypothesis 3.

Lastly, the results regarding the role of social media interaction, measured by the variable *Facebook Shares (LN)* finds a positive and significant relationship of the campaign-related signals for the receipt of post-campaign VC follow-up funding at the 1 percent level when considering all Kickstarter categories (table 11, model 6). The effect remains positive and significant at the 5 percent level when regarding the findings derived based on the analysis using only Games, Design, and Technology as available categories (table 12, model 6). Likewise, the logit estimates show that the variable has a positive and significant effect at the 1 percent level when regarding the analysis including all categories (table 13, model 6) and is positive and significant at the 5 percent level when referring to the results focusing on the reduced categories (table 14, model 6). Given these results, the findings show empirical evidence that social media interaction amongst crowdfunding backers influences VC decision-making. Hence, similar to amateur investors such as backers, venture capitalists seem to rely on the signaling value of social-media awareness demonstrating reliability, credibility, and trustworthiness of the product or company under scrutiny (Arndt, 1967; Brown et al., 2007; Thies et al., 2016). In that regard, expert investors such as venture capitalists are likely to be influenced by trending ‘hot’ products and companies that are being currently ‘en vogue’ on the market. Based on that, the findings support hypothesis 4.

Concerning the control variables, the campaign’s *Funding Goal* has a positive and significant effect at the 0.1 percent level for receiving VC (tables 11 through 14). Second,

the *Description Length* has a likewise positive and significant effect considering the likelihood of VC follow-up funding throughout all specifications (tables 11 through 14). Third, the campaigns' number of updates has a negative and significant effect at the 5 percent level, the 1 percent level as well as the 0.1 percent level towards receiving follow-up VC (tables 12 through 14). Fourth, the inverse Mills ratio is negative and highly significant at the 0.1 percent level in all specifications (tables 11 through 14). This implies that the use of the two-step Heckman procedure is adequate (Heughebaert & Manigart, 2012; Knockaert, Foo, Erikson, & Cools, 2015).

Given the bayesian information criterion (BIC) indicator of goodness-of-fit, the analyses can verify that campaign success, endorsement, and brand exposure increase the model fit beyond the baseline model (i.e. model 1 in tables 11 through 14 respectively), pointing towards additional value for expert investors.

Table 11: Determinants of VC Funding - All Categories (Firthlogit)

The table shows the empirical results when regressing on the dependent variable receipt of VC while focusing on all categories.

Dependent variable	Receipt of VC											
Model	1		2		3		4		5		6	
	β	t										
Control variables												
1 Category (control)	Yes	-										
2 Year (control)	Yes	-										
3 Number of Campaigns	-0.004	[-0.372]	-0.005	[-0.493]	-0.010	[-0.793]	-0.013	[-1.016]	-0.003	[-0.295]	-0.003	[-0.325]
4 No. of Backers	0.000**	[2.668]	0.000	[1.670]	0.000	[-0.112]	0.000	[-0.688]	0.000*	[2.385]	0.000*	[2.183]
5 Funding Goal (LN)	0.650***	[17.810]	0.681***	[18.422]	0.710***	[18.596]	0.721***	[18.963]	0.626***	[16.799]	0.608***	[15.310]
6 No. of Updates	-0.021*	[-2.429]	-0.028**	[-3.145]	-0.031***	[-3.501]	-0.034***	[-3.831]	-0.019*	[-2.193]	-0.018*	[-2.156]
7 No. of Rewards	-0.007	[-0.667]	-0.008	[-0.769]	-0.003	[-0.272]	0.000	[0.006]	-0.008	[-0.831]	-0.008	[-0.749]
8 Video	0.178	[0.892]	0.250	[1.244]	0.210	[1.046]	0.263	[1.304]	0.186	[0.926]	0.192	[0.963]
9 Description Length (LN)	0.232***	[3.376]	0.261***	[3.769]	0.200**	[2.887]	0.206**	[2.974]	0.236***	[3.426]	0.238***	[3.465]
10 Inverse Mills Ratio	-0.949***	[-17.278]	-0.696***	[-10.981]	-0.842***	[-15.337]	-0.723***	[-12.574]	-0.884***	[-15.211]	-0.847***	[-12.723]
Independent variables												
11 Success			0.866***	[6.854]								
12 Funding Ratio					0.116***	[9.555]	0.328***	[8.577]				
Funding Ratio#Funding Ratio							-0.013***	[-5.448]				
13 Staff Pick									0.327***	[3.351]		
14 Facebook Shares (LN)											0.070**	[2.675]
pseudo R-sq	-	-	-	-	-	-	-	-	-	-	-	-
BIC	6,249.9		6,207.6		6,065.6		6,030.9		6,246.7		6,247.9	
ll	-2,950.4		-2,922.9		-2,852.1		-2,828.4		-2,942.5		-2,943.1	
chi2	1,939.2		1,963.2		1,967.9		2,006.6		1,955.3		1,941.2	
N	261,158		261,158		259,566		259,566		261,158		261,158	

* p<0.05, ** p<0.01, *** p<0.001. T-values in brackets. Test statistics are calculated via STATA command Firthlogit. Year controls cover the periods 2010 through 2015. Category controls include all categories outlined in table 8 (column 1).

Table 12: Determinants of VC Funding - Reduced Categories (Firthlogit)

The table shows the empirical results when regressing on the dependent variable receipt of VC while focusing on Games, Design and Technology.

Dependent variable	Receipt of VC											
Model	1		2		3		4		5		6	
	β	t										
Control variables												
1 Category (control)	Yes	-										
2 Year (control)	Yes	-										
3 Number of Campaigns	-0.004	[-0.347]	-0.004	[-0.410]	-0.007	[-0.638]	-0.010	[-0.792]	-0.003	[-0.261]	-0.003	[-0.276]
4 No. of Backers	0.000	[1.135]	0.000	[0.651]	0.000	[-0.839]	0.000	[-1.181]	0.000	[0.970]	0.000	[0.878]
5 Funding Goal (LN)	0.722***	[17.029]	0.731***	[17.165]	0.780***	[17.632]	0.781***	[17.690]	0.695***	[15.992]	0.671***	[14.138]
6 No. of Updates	-0.025**	[-2.649]	-0.029**	[-3.092]	-0.034***	[-3.520]	-0.036***	[-3.697]	-0.022*	[-2.406]	-0.022*	[-2.345]
7 No. of Rewards	-0.014	[-1.230]	-0.014	[-1.233]	-0.010	[-0.840]	-0.007	[-0.601]	-0.016	[-1.361]	-0.015	[-1.298]
8 Video	0.283	[1.205]	0.349	[1.476]	0.302	[1.280]	0.346	[1.459]	0.286	[1.214]	0.285	[1.213]
9 Description Length (LN)	0.293***	[3.818]	0.310***	[4.019]	0.253**	[3.258]	0.253**	[3.270]	0.294***	[3.822]	0.294***	[3.836]
10 Inverse Mills Ratio	-0.904***	[-16.328]	-0.683***	[-10.365]	-0.804***	[-14.518]	-0.707***	[-12.071]	-0.847***	[-14.419]	-0.807***	[-11.791]
Independent variables												
11 Success			0.776***	[5.429]								
12 Funding Ratio					0.107***	[8.107]	0.276***	[6.763]				
Funding Ratio#Funding Ratio							-0.010***	[-4.146]				
13 Staff Pick									0.308**	[2.877]		
14 Facebook Shares (LN)											0.070*	[2.337]
pseudo R-sq	-	-	-	-	-	-	-	-	-	-	-	-
BIC	4,618.1		4,593.8		4,463.6		4,442.9		4,616.4		4,616.5	
ll	-2,221.6		-2,203.9		-2,138.9		-2,123.1		-2,215.3		-2,215.3	
chi2	1,016.0		1,054.8		1,036.1		1,060.7		1,031.3		1,017.2	
N	56,220		56,220		55,656		55,656		56,220		56,220	

* p<0.05, ** p<0.01, *** p<0.001. T-values in brackets. Test statistics are calculated via STATA command Firthlogit. Year controls cover the periods 2010 through 2015. Category controls include Games, Design, and Technology.

Table 13: Determinants of VC Funding - All Categories (Logit)

The table shows the empirical results when regressing on the dependent variable receipt of VC while focusing on all categories.

Dependent variable	Receipt of VC											
Model	1		2		3		4		5		6	
	β	t										
Control variables												
1 Category (control)	Yes	-										
2 Year (control)	Yes	-										
3 Number of Campaigns	-0.007	[-0.632]	-0.009	[-0.744]	-0.013	[-1.035]	-0.016	[-1.250]	-0.006	[-0.560]	-0.007	[-0.587]
4 No. of Backers	0.000*	[2.262]	0.000	[1.421]	0.000	[-0.257]	0.000	[-0.806]	0.000*	[2.013]	0.000	[1.825]
5 Funding Goal (LN)	0.651***	[17.805]	0.682***	[18.473]	0.711***	[18.597]	0.723***	[18.963]	0.627***	[16.807]	0.609***	[15.325]
6 No. of Updates	-0.021*	[-2.476]	-0.028**	[-3.188]	-0.031***	[-3.550]	-0.035***	[-3.877]	-0.019*	[-2.240]	-0.019*	[-2.205]
7 No. of Rewards	-0.007	[-0.693]	-0.008	[-0.795]	-0.003	[-0.308]	0.000	[-0.029]	-0.009	[-0.856]	-0.008	[-0.774]
8 Video	0.191	[0.949]	0.263	[1.299]	0.224	[1.105]	0.277	[1.364]	0.198	[0.982]	0.205	[1.019]
9 Description Length (LN)	0.233***	[3.398]	0.262***	[3.791]	0.202**	[2.911]	0.207**	[2.999]	0.237***	[3.447]	0.239***	[3.487]
10 Inverse Mills Ratio	-0.954***	[-17.331]	-0.700***	[-11.033]	-0.847***	[-15.394]	-0.727***	[-12.611]	-0.889***	[-15.266]	-0.852***	[-12.782]
Independent variables												
11 Success			0.869***	[6.876]								
12 Funding Ratio					0.117***	[9.518]	0.331***	[8.614]				
Funding Ratio#Funding Ratio							-0.013***	[-5.496]				
13 Staff Pick									0.326***	[3.342]		
14 Facebook Shares (LN)											0.070**	[2.676]
pseudo R-sq	0.297		0.303		0.301		0.305		0.298		0.298	
BIC	6,346.2		6,307.9		6,169.3		6,146.3		6,347.6		6,351.4	
ll	-3,011.4		-2,986.1		-2,916.8		-2,899.1		-3,005.9		-3,007.8	
chi2	2,543.8		2,594.6		2,508.5		2,543.9		2,554.8		2,551.0	
N	251,834		251,834		250,300		250,300		251,834		251,834	

* p<0.05, ** p<0.01, *** p<0.001. T-values in brackets. Test statistics are calculated via STATA command Logit. Year controls cover the periods 2010 through 2015. Category controls include all categories outlined in table 8 (column 1).

Table 14: Determinants of VC Funding - Reduced Categories (Logit)

The table shows the empirical results when regressing on the dependent variable receipt of VC while focusing on Games, Design and Technology.

Dependent variable	Receipt of VC											
Model	1		2		3		4		5		6	
	β	t										
Control variables												
1 Category (control)	Yes	-										
2 Year (control)	Yes	-										
3 Number of Campaigns	-0.007	[-0.612]	-0.008	[-0.669]	-0.011	[-0.890]	-0.013	[-1.037]	-0.006	[-0.531]	-0.006	[-0.544]
4 No. of Backers	0.000	[0.945]	0.000	[0.485]	0.000	[-0.981]	0.000	[-1.303]	0.000	[0.788]	0.000	[0.685]
5 Funding Goal (LN)	0.724***	[17.126]	0.733***	[17.252]	0.782***	[17.642]	0.783***	[17.697]	0.697***	[16.083]	0.674***	[14.214]
6 No. of Updates	-0.025**	[-2.700]	-0.030**	[-3.140]	-0.034***	[-3.572]	-0.036***	[-3.747]	-0.023*	[-2.458]	-0.022*	[-2.398]
7 No. of Rewards	-0.015	[-1.252]	-0.015	[-1.257]	-0.010	[-0.871]	-0.007	[-0.632]	-0.016	[-1.382]	-0.015	[-1.320]
8 Video	0.303	[1.276]	0.369	[1.546]	0.323	[1.353]	0.366	[1.532]	0.305	[1.284]	0.304	[1.283]
9 Description Length (LN)	0.295***	[3.844]	0.312***	[4.045]	0.255**	[3.285]	0.255***	[3.298]	0.296***	[3.847]	0.296***	[3.861]
10 Inverse Mills Ratio	-0.909***	[-16.413]	-0.687***	[-10.424]	-0.810***	[-14.583]	-0.711***	[-12.116]	-0.852***	[-14.496]	-0.813***	[-11.867]
Independent variables												
11 Success			0.779***	[5.446]								
12 Funding Ratio					0.107***	[8.077]	0.279***	[6.799]				
Funding Ratio#Funding Ratio							-0.010***	[-4.193]				
13 Staff Pick									0.308**	[2.867]		
14 Facebook Shares (LN)											0.069*	[2.332]
pseudo R-sq	0.218		0.223		0.222		0.225		0.219		0.219	
BIC	4,722.3		4,701.8		4,575.2		4,566.4		4,725.1		4,727.7	
ll	-2,273.6		-2,257.9		-2,194.7		-2,184.9		-2,269.6		-2,270.9	
chi2	1,264.7		1,296.2		1,252.4		1,272.2		1,272.9		1,270.2	
N	56,220		56,220		55,656		55,656		56,220		56,220	

* p<0.05, ** p<0.01, *** p<0.001. T-values in brackets. Test statistics are calculated via STATA command Logit. Year controls cover the periods 2010 through 2015. Category controls include Games, Design, and Technology.

4.3.2 Results Concerning Crowdfunding and VC Syndication

The key descriptive statistics for the analyses regarding the effect of a crowdfunding campaign towards the syndication behavior of venture capitalists are presented in table 15. As mentioned before, the sample includes a total of 504 investments with an average of 1.9 founding members and an average age of 4.2 years. Regarding the correlation matrix (table 15), one can see that correlation levels are low, both from a numeric and significance-level perspective. In addition, the presence of multicollinearity is controlled for between the covariates by considering variance inflation factors. Given that the mean VIF values do not exceed the suggested threshold level of five (Chatterjee & Hadi, 2006), and the maximum VIF values are below the threshold level of 10 as suggested by O'Brien (2007), multicollinearity is not an issue.

Table 15: Correlation Table of Independent and Control Variables

The table shows an overview of the correlation between independent and control variables.

	Mean	S.D.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)
Number of Founders (1)	1.857	1.272	1	18	1.000					
Venture Age (2)	4.151	4.205	1	34	-0.166*	1.000				
Industry Dummy (3)	5.601	1.710	1	8	0.079*	0.127*	1.000			
Number of Employees (4)	1.589	0.685	1	5	0.024	0.160*	0.055	1.000		
US Firm (5)	0.637	0.481	0	1	-0.082*	0.023	0.005	0.017	1.000	
Crowd- funding (6)	0.383	0.487	0	1	-0.021	-0.075*	0.093*	-0.088*	0.272*	1.000

* p<0.1, ** p<0.05, *** p<0.01.

The descriptive statistics are divided into new ventures with and without crowdfunding (table 16). When regarding the sample distribution, some differences should be pointed

out. First, entrepreneurial ventures without and with crowdfunding show a significant mean difference concerning the receipt of syndicated VC as well as syndicate size. Second, syndicates investing in entrepreneurial ventures without crowdfunding show on average less investments measured by the variable *Average Investments*. When regarding the number of total investments as well as the average age of the syndicate members, the relationship changes. Investment syndicates investing in new ventures without crowdfunding show on average a higher number of total investments (*Total Investments*) and tend to be older (*Average Age*) compared to syndicates investing in entrepreneurial ventures that used crowdfunding. Lastly, international syndicates are on average more represented with entrepreneurial ventures having not used crowdfunding compared to those who have. Likewise, the number of syndicate countries is higher for new ventures without a crowdfunding campaign compared to firms with a crowdfunding campaign. Given the fact that this empirical contribution aims at finding the most similar peers to each crowdfunded venture, the firm-specific characteristics are not significantly different thus showing that the ventures analyzed are as similar as possible (results not tabulated).

Table 16: Summary Statistics of Crowdfunding Campaigns 2010 through 2015
The table shows the summary statistics regarding the syndication behavior of venture capitalists and new venture-specific information of new ventures without and with crowdfunding.

Summary Statistics	New Ventures w/o crowdfunding		New Ventures w/ crowdfunding		Mean Diff.
	Mean	SD	Mean	SD	
Syndicate	.4758842	.500223	.2849741	.4525761	4.3174 ***
Syndicate Size	2.086817	1.576701	1.756477	1.629088	2.2574 *
Average Investments	149.455	241.5224	202.7253	286.1809	-2.0250 *
Total Investments	268.6688	386.6001	243.3523	406.7999	0.7004
Average Age	15.49766	13.66055	13.56009	12.90934	1.3373
Int. Syndicate	.1672026	.373758	.1295337	.336663	1.1418
# of VC countries	1.176849	.5366362	.8497409	.7240025	5.8037 ***

* p<0.05, ** p<0.01, *** p<0.001.

Now, the focus shifts to the econometric modelling, which is based on the sample of 504 new ventures of which 193 had a crowdfunding campaign before they have received VC. Table 17 presents the results of the logistic and poisson regressions referring

to *Syndication* as well as *Syndicate Size* as dependent variables. In the first set of analyses, this dissertation focuses on the influence of crowdfunding on the syndication behavior of venture capitalists. When regressing on the dependent dummy variable *Syndicate*, the negative and highly significant coefficient for the variable *Crowdfunding* in the analyses indicate a negative influence towards receiving syndicated VC (table 17, column 2). This effect is also found for the size of the syndicate as dependent variable. Here, the variable *Crowdfunding* is significant and negative at the 5 percent level when referring to the variable *Syndicate Size* as dependent variable (table 17, column 4). Hence, support for hypothesis 5 is found in that crowdfunding negatively influences syndication. When turning to the empirical results concerning the influence of crowdfunding concerning the experience of the syndicate and its members, the dependent variables include the average (*Average Investments*) and total number of investments (*Total Investments*) of the syndicate members (table 18, columns 1-4), as well as the average age (*Average Age*) of the syndicate members (table 19, columns 1 and 2). However, the results do not reveal a strong level of significance how crowdfunding influences the collective experience of the syndicate. The empirical results show that crowdfunding has a positive effect on the average and total number of investments at the 10 percent level of significance (table 18, columns 2 and 4), whereas the effect on the average age of the syndicate members is negative but insignificant (table 19, column 6). Hence, one can infer from the results that crowdfunding has only a marginal effect on the experience of the syndicate that provides funds. Thus, hypotheses 6 has to be rejected. In the third set of analyses, it is evaluated how crowdfunding influences the internationalization of syndicated VC investments following crowdfunding campaigns. Thus, the dependent variables are whether or not the syndicate is international (i.e. contains at least two different countries of origin of the venture capitalists) (table 20, columns 1 and 2), and the absolute number of the venture capitalists' countries of origin (table 20, columns 3 and 4). The results reveal that crowdfunding has a positive and significant effect at the 5 percent level towards receiving funding from an international syndicate (table 20, column 2). This effect is similarly positive and significant at the 5 percent level when the number of investor countries is considered (table 20, column 4). Hence, from the results one can infer that having realized a crowdfunding campaign prior to receiving VC increases international syndication, which supports hypothesis 7. This dissertation also repeated the calculations using different numbers of matching

neighbors and also completed the analyses against the background of the entire database available in Crunchbase. The results confirmed the main effects and thus support the robustness of the findings (results not tabulated).

Table 17: Determinants of the Syndication Behavior of Venture Capitalists

The table shows the empirical results when regressing on the dependent variables Syndicate (columns 1 and 2) and the variable Syndicate Size (column 3 and 4).

Model Dependent Variable Method	Baseline Model Syndicate Logit		Full Model Syndicate Logit		Baseline Model Syndicate Size Poisson		Full Model Syndicate Size Poisson	
	b	t	b	t	b	t	b	t
1. Number of Founders	0.043	[0.489]	0.035	[0.470]	0.011	[0.381]	0.010	[0.348]
2. Venture Age	-0.007	[-0.271]	-0.017	[-0.673]	-0.015*	[-2.098]	-0.017*	[-2.409]
3. Industry Dummy	Yes		Yes		Yes		Yes	
4. Number of Employees								
Number of Employees: 1	0.000	[0.000]	0.000	[0.000]	0.000	[0.000]	0.000	[0.000]
Number of Employees: 2	0.515*	[2.543]	0.469*	[2.268]	0.112	[1.439]	0.097	[1.239]
Number of Employees: 3	0.943*	[2.351]	0.864*	[2.075]	0.361*	[2.272]	0.333*	[2.105]
Number of Employees: 5	0.923	[0.881]	0.696	[0.685]	0.109	[0.325]	0.052	[0.157]
5. US Firm	0.206	[1.049]	0.455*	[2.200]	0.097	[1.278]	0.151*	[2.053]
6. Crowdfunding			-0.901***	[-4.240]			-0.204**	[-2.649]
7. Constant	-1.251	[-1.540]	-1.162	[-1.505]	0.193	[1.429]	0.219	[1.749]
pseudo R-sq	0.032		0.060		0.011		0.016	
BIC	738.9		726.1		1776.3		1773.9	
ll	-329.0		-319.5		-847.7		-843.4	
chi2	20.8		38.2		35.7		46.6	
N	504		504		504		504	

* p<0.1, ** p<0.05, *** p<0.01. T-values in brackets. Test statistics are calculated via STATA command Logit (column 1 and 2) and Poisson (columns 3 and 4). Industry dummies include the industries outlined in table 9 (column 1).

Table 18: Determinants of a VC Syndicate's Level of Experience (1/2)

The table shows the empirical results when regressing on the dependent variables Average Investments (columns 1 and 2) and Total Investments (column 3 and 4).

Model Dependent Variable Method	Baseline Model		Full Model		Baseline Model		Full Model	
	Average Investments		Average Investments		Total Investments		Total Investments	
	Neg. Bin. Reg.	Neg. Bin. Reg.	Neg. Bin. Reg.	Neg. Bin. Reg.	Neg. Bin. Reg.	Neg. Bin. Reg.	Neg. Bin. Reg.	Neg. Bin. Reg.
	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>
1. Number of Founders	0.124	[1.564]	0.126	[1.649]	0.100	[1.471]	0.106	[1.584]
2. Venture Age	0.003	[0.098]	0.004	[0.130]	-0.018	[-0.637]	-0.017	[-0.626]
3. Industry Dummy	Yes		Yes		Yes		Yes	
4. Number of Employees								
Number of Employees: 1	0.000	[0.000]	0.000	[0.000]	0.000	[0.000]	0.000	[0.000]
Number of Employees: 2	0.186	[1.011]	0.235	[1.308]	0.223	[1.343]	0.246	[1.489]
Number of Employees: 3	0.339	[1.152]	0.412	[1.366]	0.782*	[2.306]	0.832*	[2.414]
Number of Employees: 5	-0.494	[-0.756]	-0.395	[-0.612]	-0.252	[-0.361]	-0.174	[-0.251]
5. US Firm	0.627**	[3.172]	0.559**	[2.889]	0.635***	[3.344]	0.571**	[3.028]
6. Crowdfunding			0.328*	[1.845]			0.293*	[1.771]
7. Constant	3.310***	[7.246]	3.373***	[7.457]	4.072***	[9.303]	4.125***	[9.503]
pseudo R-sq	0.008		0.009		0.008		0.009	
BIC	2416.7		2419.2		2866.40		2869.4	
ll	-1173.8		-1172.4		-1398.7		-1397.5	
chi2	-		-		-		-	
N	203		203		203		203	

* p<0.1, ** p<0.05, *** p<0.01. T-values in brackets. Test statistics are calculated via STATA command Nbreg. Industry dummies include the industries outlined in table 9 (column 1).

Table 19: Determinants of a VC Syndicate's Level of Experience (2/2)

The table shows the empirical results when regressing on the dependent variable Average Age (column 1 and 2).

Model Dependent Variable Method	Baseline Model		Full Model	
	Average Age	Neg. Bin. Reg.	Average Age	Neg. Bin. Reg.
	b	t	b	t
1. Number of Founders	-0.039	[-0.850]	-0.041	[-0.879]
2. Venture Age	0.023	[1.843]	0.022	[1.727]
3. Industry Dummy	Yes		Yes	
4. Number of Employees				
Number of Employees: 1	0.000	[0.000]	0.000	[0.000]
Number of Employees: 2	0.336**	[3.006]	0.332**	[2.972]
Number of Employees: 3	0.504**	[3.200]	0.494**	[3.175]
Number of Employees: 5	-0.271	[-0.660]	-0.307	[-0.734]
5. US Firm	-0.083	[-0.721]	-0.069	[-0.597]
6. Crowdfunding			-0.103	[-0.887]
7. Constant	2.245***	[12.957]	2.237***	[13.062]
pseudo R-sq	0.033		0.034	
BIC	1428.0		1432.2	
ll	-679.9		-679.3	
chi2	-		-	
N	191		191	

* p<0.1, ** p<0.05, *** p<0.01. T-values in brackets. Test statistics are calculated via STATA command Nbreg. Industry dummies include the industries outlined in table 9 (column 1).

Table 20: Determinants of International Syndication of Venture Capitalists

The table shows the empirical results when regressing on the dependent variables International Syndicate (columns 1 and 2) and the Number of VC countries (column 3 and 4).

Model Dependent Variable Method	Baseline Model Int. Syndicate Logit		Full Model Int. Syndicate Logit		Baseline Model # of VC countries Poisson		Full Model # of VC countries Poisson	
	b	t	b	t	b	t	b	t
1. Number of Founders	-0.058	[-0.368]	-0.051	[-0.296]	-0.034	[-1.162]	-0.033	[-1.072]
2. Venture Age	0.070	[1.818]	0.082*	[1.969]	0.011	[1.884]	0.013*	[2.121]
3. Industry Dummy	Yes		Yes		Yes		Yes	
4. Number of Employees								
Number of Employees: 1	0.000	[0.000]	0.000	[0.000]	0.000	[0.000]	0.000	[0.000]
Number of Employees: 2	0.272	[0.807]	0.305	[0.882]	0.057	[0.806]	0.061	[0.885]
Number of Employees: 3	0.329	[0.596]	0.428	[0.728]	0.145	[1.267]	0.157	[1.338]
Number of Employees: 5	0.526	[0.437]	0.874	[0.738]	0.007	[0.042]	0.072	[0.462]
5. US Firm	-0.976**	[-2.999]	-1.180***	[-3.360]	-0.242***	[-3.632]	-0.278***	[-4.180]
6. Crowdfunding			0.860**	[2.233]			0.175**	[2.394]
7. Constant	-0.190	[-0.339]	-0.480	[-0.797]	0.266**	[2.943]	0.293**	[3.190]
pseudo R-sq	0.067		0.088		0.013		0.017	
BIC	306.9		306.7		579.1		582.8	
ll	-124.3		-121.5		-254.9		-254.2	
chi2	15.5		17.6		169.4		177.6	
N	200		200		203		203	

* p<0.1, ** p<0.05, *** p<0.01. T-values in brackets. Test statistics are calculated via STATA command Logit (column 1 and 2) and Poisson (columns 3 and 4). Industry dummies include the industries outlined in table 9 (column 1).

4.4 Limitations and Further Research Concerning Crowdfunding and VC

Although the analyses find robust relations between crowdfunding and post-campaign follow-up VC financing, this empirical contribution is however also subject to limitations. First, although all crowdfunding platforms rely on the same principle (Agrawal et al., 2013; Bruton et al., 2015; Cholakova & Clarysse, 2015; Mollick, 2014), many forms of different crowdfunding platforms exist today. Despite the fact that they share the common objective of capital sourcing, the availability of informational cues that reduce information asymmetries may differ. Further, the research mainly concentrates on the categories “*Games*”, “*Design*”, and “*Technology*” of the Kickstarter platform given the assumption that campaigns in these categories are unlikely to be one-off projects but rather serious entrepreneurial initiatives with a more likely need for external investors (Yang & Hahn, 2015). Hence, caution should be exercised when referring from the conclusion to other forms of crowdfunding platforms and categories.

Second, the research data includes a possible elimination of false negatives induced by the matching algorithm applied. Thus, this method cannot make any reliable inference about how many crowdfunding campaigns truly received follow-up investments. But the method chosen should not introduce any systematic bias (Raffo & Lhuillery, 2009). Furthermore, due to data availability, this empirical analysis was not able to consider other firm-specific characteristics of the crowdfunded projects, which might have served as additional signals for the VC investment. These include for example the human- and social capital of the founders or the availability of patents. Third, it has to be acknowledged that this study may be subject to an identification problem. That is, the intrinsic quality of a crowdfunding project may cause that a) the campaign itself is successful and b), that follow-up VC can be acquired. Hence, a positive investment decision by a venture capitalist may also be triggered by the inherent project quality rather than the campaign success itself. However, when considering that the intrinsic quality is largely unobservable in crowdfunding, the methods chosen nevertheless controlled for a project’s quality using proxies that have empirically proven to influence campaign success. In addition, the inclusion of the two-step Heckman correction method (i.e. the inverse Mill’s ratio) to account for the unobserved heterogeneity adds to the quality of the analyses by addressing a potential selection bias. Further, the findings show that

the variables representing campaign success, a project endorsement, and brand exposure increase model fit beyond the quality of the project itself. Based on these findings, this dissertation shows that expert investors rely on factors that go beyond the project's observable quality. At the same time, this dissertation also recommends to refrain from over-interpreting the findings since the methods chosen cannot fully isolate the effect of campaign success, a project endorsement, and brand exposure.

A fruitful avenue for future research would be to investigate crowdfunding campaigns on other platforms and their post-campaign financing in more detail. For example, given the large variety of crowdfunding forms, this dissertation encourages to investigate lending- or equity-based crowdfunding platforms and to assess whether the campaign-related signals prevalent in these forms of crowdfunding influence the receipt of VC. In particular, the latter is of interest since equity crowdfunding has gained increased attention both from entrepreneurs as well as researchers (e.g. Ahlers et al. 2015 and Colombo et al. 2015) and is considered a potential alternative to traditional financing provided by business angels or venture capitalists. Hence, it would be interesting to see whether equity crowdfunding has the potential to substitute traditional forms of risk-capital for new ventures or if it complements the traditional forms as reward-based crowdfunding does.

4.5 Conclusion and Contribution Concerning Crowdfunding and VC

With these two empirical contribution, this dissertation focuses on the question whether successful crowdfunding campaigns are more likely to receive VC than unsuccessful campaigns, and if the existence of a crowdfunding campaign influences the syndication behavior of venture capitalists. Based on the research question two and three derived in the literature review, this dissertation firstly directs the focus to reward-based crowdfunding campaigns and their signaling value for post-campaign follow-up VC investments. Given the increased popularity amongst commercially-oriented entrepreneurs to use crowdfunding as a new means of entrepreneurial finance (Schwienbacher & Larralde, 2010), this dissertation investigates if and how crowdfunding campaign-related factors influence the decision-making process of venture capitalists in post-campaign follow-up financing rounds. The analysis builds upon a consistent set of hypotheses and the empirical findings are deducted using a dataset comprising data from Kickstarter and Crunchbase.

Within the context of reward-based crowdfunding, amateur investors such as backers share similar objectives compared to experts such as venture capitalists when selecting investment objects (Mollick, 2013). In other words, both individuals face informational asymmetries and share an equal interest by searching for clues that signal quality and thus reduce the investment risk (Mollick, 2013). Hence, this dissertation investigates if informational cues that may influence a large collective of individuals similarly influence the investment decision of professional investors such as venture capitalists. Given this research question, the study contributes to advancing signaling theory against the background of the microfinance literature by showing that the effectiveness of quality signals is similar for expert and amateur investors in some aspects regarding the campaign while it differs in others. For instance, the analyses find that a campaign endorsement provided by Kickstarter does not only positively influence the campaign's chances of success (Wessel et al., 2015), but also increases the likelihood of post-campaign follow-up investments from a venture capitalist. Further, the analyses conclude that electronic-word-of-mouth also positively influences the receipt of VC after a crowdfunding campaign. This finding is in line with prior research showing that the success of a campaign is positively linked to the number of Facebook-shares and comments on the campaign website (Thies et al., 2016). One reason for this effect might be the herding behavior of amateur investors that can be explained by short decision times given the duration of the campaign or the emotional bonding between the amateur investor and his social-media network (Baddeley, 2010; Kuan, Zhong, & Chau, 2014). Apparently, VC investors are also subject to a certain degree of herding behavior given that they are apparently influenced by the fact how successful campaigns are on social media channels. Finally and most importantly, the results find empirical evidence that a successful campaign has a positive impact for the campaign initiator's chances to receive post-campaign follow-up VC financing. This finding is clearly in line with the expectation that a positive assessment of the potential of a campaign works as a signal for outside investors (Ahlers et al., 2015; Mollick & Kuppuswamy, 2014; Vismara, 2016). In other words, a large group of individuals assessed a project to be worth investing and likely to succeed in the market, an assessment which venture capitalists obviously value. Further, this dissertation finds an inverted u-shaped relationship between a campaign's funding received compared to the funding desired and the probability of a follow-up VC investment. Hence, if a campaign achieved a low level of funding success, the need

for capital remains intact, whereas campaigns with a high level of funding success have a reduced need and thus reduced likelihood of acquiring VC funding.

In order to provide novel insights if and how crowdfunding influences the investment behavior of venture capitalists in terms of their need to form syndicates, this dissertation takes the perspective of the venture capitalist in selecting portfolio firms. Following Manigart et al. (2006) and relying on two major motives why venture capitalists form syndicates - deal selection and deal flow - this dissertation shows that crowdfunding does in fact influence both motives. Roma et al. (2017) already pointed out that crowdfunding has a positive and lasting value for technology entrepreneurs in their follow-up financing round after the campaign. This positive effect of a crowdfunding campaign is largely due to the fact that crowdfunding offers entrepreneurs a platform through which they can show a potential investor that there exists a certain degree of demand (Roma et al., 2017). Hence, if the crowd supports a campaign, it simultaneously attests demand which can reduce informational frictions concerning potential market acceptance (Burtch et al., 2012; Mollick & Nanda, 2016). As such, a successful crowdfunding campaign may serve as a valuable signal for outside investors since the funded project received feedback from a large group of individuals that could turn into future customers (Ahlers et al., 2015; Moen, Sørheim, & Erikson, 2008; Mollick & Kuppuswamy, 2014; Vismara, 2016; West & Noel, 2009). Beyond the signaling value the campaign inherits, the entrepreneur additionally collects valuable feedback about the products' or services' use from the campaign backers which he can use in the iterative process of product/service improvement. As such, information asymmetries may be reduced given that the business opportunity received validation from a market perspective (Roma et al., 2017). As one main motive for venture capitalists to syndicate is to assess company-specific risk prior to investing (Brander et al., 2002; Manigart et al., 2006). This dissertation finds that crowdfunding apparently reduces perceived informational frictions and thus also the need to form syndicates. In addition, the findings provide empirical evidence that a previous crowdfunding campaign also alters the composition of syndicates. This dissertation argues that crowdfunding, given its global availability, offers remotely located investors a channel through which they can increase their deal flow, by forming more internationally oriented syndicates. Contrary to the expectations however, the assumed effect of a crowdfunding campaign to attract smaller and thus likely less-experienced VC funds could not be confirmed as the analyses do not find strong support for

this hypothesis. Overall, the findings indeed show that crowdfunding does not only influence whether or not expert investors form syndicates, they also show how the composition of syndicates changes if an investee used crowdfunding before.

Based on these results, the contribution of this work is twofold. First, this dissertation contributes to advancing signaling theory against the background of the microfinance and VC literature. It does so by assessing if signals relevant for amateur investors such as the crowd have an equal value to experts such as venture capitalists. Based on the results derived, the findings show that collective investment decisions from amateur investors indeed influence the decision-making process of expert investors such as venture capitalists. Hence, it can be inferred from the results that the decision of a large crowd to support a product or service supported on Kickstarter may give sufficient evidence about the potential of the entrepreneurial initiative. In addition, the suggested potential apparently reduces information asymmetries between the campaign initiator and the investor increasing the chances of a post-campaign follow-up VC investment.

In addition to the theoretical contribution this empirical contribution provides, the practical implications for the entrepreneur and venture capitalists are also noteworthy. Given the increasing popularity of crowdfunding amongst entrepreneurs, this source of entrepreneurial finance turned into an important form of funding for commercially-oriented new ventures (Schwienbacher & Larralde, 2010). For instance, 45 out of the 50 largest crowdfunding campaigns in 2012 turned into new firms after they had collected their first funds through individual investors (Mollick, 2014). Hence, for those successful crowdfunding entrepreneurs who still need funding in order to expand business operations further, the findings show that entrepreneurs can use their campaigns as signaling instrument to a) shape awareness in the competitive environment of new ventures seeking VC funding and b), show superiority over other ideas or projects, which increases their chances to finance their growth. In addition, the findings show that syndicated investments are less likely. This implies that the entrepreneur is not necessarily obliged to deal with multiple investors simultaneously and satisfy individual requirements. Furthermore, as his campaign proved to be a valuable signal, the entrepreneur's bargaining position is greatly enhanced. Another important practical contribution is that entrepreneurs seeking expansion can profit from the more internationally oriented syndicates that the results show. In other words, the increased internationality

also increases access to have local expert investors in the network even though they might be remotely located.

5 Overall Conclusion and Contribution

The growth and survival of new ventures is probably the most important aspect regarding the effect entrepreneurs have on economic integration and growth (Alhor et al., 2008). The societal well-being in the form of innovation (Acs & Audretsch, 1988; Kuratko, 2005), job creation (Blanchflower, 2000; Parker, 2009), and productivity increases (van Praag & Versloot, 2007) are all subject to flourishing new ventures that have the resources and capabilities in order to exploit newly identified opportunities and thus strive from being small incumbents to well-established corporations. Yet, and although the concept of entrepreneurship is gaining an ever-increasing attention from both research and policy makers, the outcomes of all means that are intended to increase the number of new ventures created is all but satisfactory when considering the case of for example Germany. Despite the fact that public research institutions and universities have tremendously increased their focus on entrepreneurship (Munari et al., 2015), the number of founders as well as the ratio of founders in comparison to the total population reached its lowest level in 2016 since the burst of the new economy at the beginning of the new century (KfW, 2017a; KfW, 2017b). As a consequence of these unsatisfactory conditions, this dissertation is motivated to develop new insights about growth drivers of new ventures with a particular focus on academic entrepreneurship. Further, this dissertation also elaborates how crowdfunding as a new means of entrepreneurial financing influences the selection and syndication behavior of venture capitalists. The latter aspect is particularly relevant when considering that the survival and growth of new firms strongly depends on the availability of financial capital (Binks & Ennew, 1996; Cassar, 2004; Ebben & Johnson, 2006). Further, the focus towards the financing of new ventures is insofar important that the financing decision made at the beginning has a lasting imprint on the development of the new venture (Berger & Udell, 1998; Cassar, 2004).

5.1 Theoretical Contribution

Overall, the empirical findings derived from the three research questions are intended to enhance the ever increasing number of dedicated entrepreneurship research in general, as well as the number of research contributions focusing on academic entrepreneurship (e.g. Cleyn et al. 2015; Goel et al. 2015; Guerrero et al. 2014; McAdam and McAdam 2008; and Stam et al. 2014) and new venture financing such as crowdfunding

and VC (e.g. Mollick 2014; Roma et al. 2017) in particular. Hence, the results concerning the role of venture capital towards the growth of RBSOs complements literature towards understanding growth factors of RBSOs against the background of the resource-based view of the firm (Barney, 1991; Barney et al., 2001; Penrose, 1996; Wernerfelt, 1984). The results derived provide novel insights about the growth of RBSOs by widening the focus, i.e. incorporating venture capital into the analysis. Although research argues that academic founding teams in RBSOs are often homogeneous and lack valuable networks to business professionals outside academia (Agarwal & Shah, 2014; Colombo et al., 2014; Lockett et al., 2003; Murray, 2004; Wright et al., 2006), this dissertation finds evidence that homogeneity is not a disadvantage to new venture growth per se. Second, the results provide empirical evidence that the lack of entrepreneurial and managerial skills as well as networks to outside partners, another shortcoming of academic founders (Cleyn et al., 2015; Stam et al., 2014; Visintin & Pittino, 2014), can be alleviated provided that the research institution offers trainings that coach an entrepreneurial mindset as well as provides a platform to network with external business professionals. Third, the empirical results find that VC-backed RBSOs show a higher performance in terms of employment and revenue growth compared to non-VC-backed RBSOs. Although VC positively contributes to the RBSO's employment growth, the empirical results do not verify that effect for revenue growth. However, the empirical results provide sufficient evidence that the superior performance of VC-backed compared to non-VC-backed RBSOs is likely the result of a venture capitalist coaching the RBSO rather than scouting it.

When regarding the signaling value of crowdfunding in a venture capital context, this dissertation aims to develop new empirical insights regarding signaling theory (Busemitz et al., 2005; Spence, 1973, 2002) against the background of the microfinance and VC literature. For one thing, the empirical findings confirm that venture capitalists apparently rely on the wisdom of the crowd when scouting new ventures (Agrawal et al., 2016; Bruton et al., 2015; Mollick, 2014; Mollick & Nanda, 2016). Said differently, the empirical findings confirm that a crowdfunding project that has convinced a large collective of individual supporters (i.e. reached its funding goal) is more likely to receive post-campaign VC funding. However, the analyses also discovered that there exists an inverted u-shaped relationship between the funding received versus the funding demanded and the probability of follow-up VC funding. In other words, new ventures that

have received only a fraction of their required funding are more likely to be in need of additional post-campaign financing. On the contrary, new ventures with a high funding ratio are less likely to be in need of additional post-campaign VC funding given that their financial demand is satisfied with crowdfunding already. Furthermore, the findings also provide empirical evidence that endorsements of crowdfunding campaigns and increased social media attention signal campaign quality and thus increase the new venture's probability to receive post-campaign VC funding.

Beyond the value of crowdfunding-campaign related signals, this dissertation also provides new insights about the syndication behavior of venture capitalists. Given the fact that venture capitalists syndicate in order to reduce company specific risk and thus the risk of adverse selection (Brander et al., 2002; Lehmann, 2006; Lerner, 1994; Plummer et al., 2016; Sah & Stiglitz, 1984), particularly when investing in early-stage firms (Manigart et al., 2006), this dissertation finds that crowdfunding reduces the perceived company specific risk and thus decreases the need to syndicate as well as the absolute syndicate size. In addition, the empirical evidence suggests that crowdfunding also offers a new channel of deal sourcing for venture capitalists in order scout new ventures to invest in. Said differently, the findings confirm that new ventures using crowdfunding are more likely funded by international syndicates compared to new ventures without. This finding is particularly surprising given the fact that local proximity enables the investor to reduce costs associated with information asymmetries and translates into an increased chance of early stages investments (Agrawal et al., 2016). Hence, crowdfunding serves as a catalyst reducing the perceived risk of new ventures and thus advances signaling theory and provides important implications for the microfinance and VC literature.

5.2 Practical Contribution

Beyond the theoretical contributions, this dissertation provides a number of practical recommendations deducted from the research questions addressed in the literature section of this dissertation.

Considering the fact that RBSOs often comprise a founding team as well as a technology that is in the early stages of development (i.e. and thus not yet market ready) (Clarysse et al., 2005; Colombo et al., 2014), it is exclusively subject to the founding team to a)

find market participants that could use the new technology invented and b), to transform the invented technology to a product or service that serves an array of different customer requirements. Hence, in the early stages of product creation, homogeneous founding members are to the benefit of technology commercialization given that a management team that shares a similar educational background seems to work better together and shares an advanced understanding of the new technology (Beckman et al., 2007; Ruef et al., 2003). Hence, initiatives undertaken by research organizations intended to create heterogeneous teams with a large degree of heterogeneity are not a prerequisite of growth in the long run. More importantly however, well-developed supporting schemes that develop or strengthen a heterogeneous skills set that goes beyond the skills and capabilities already possessed by the academic entrepreneur leaves a lasting imprint on the RBSO's development. Given the fact that the empirical findings do not find a positive influence of pure equity investments from the research organization on growth, the RBSO might be better off receiving, for example, further trainings or access to business professionals such as accountants, lawyers, consultants free of charge.

Further, this dissertation also provides practical insights how crowdfunding affects the post-campaign financing of new ventures. First, entrepreneurs can use crowdfunding as a new means to introduce a new product or service and acquire new customers (Ahlers et al., 2015; Mollick & Kuppuswamy, 2014; Vismara, 2016), while simultaneously reducing informational frictions by signaling an investor that there exists market demand, a critical factor in the evaluation of new ventures (Burtch et al. 2012; Mollick & Nanda, 2016). Second, striving for an endorsement by the platform provider may not only support the entrepreneur's campaign to be successful (Mollick, 2014; Wessel et al., 2015), it also reduces informational asymmetries ex-ante and thus increases the probability of VC funding (Bonardo et al., 2010; Lerner, 1999, 2002). Third, from the perspective of the VC investor, a crowdfunding campaign can also serve as a means to reduce adverse selection and thus reduce the need to syndicate.

In conclusion, this dissertation develops new empirical insights towards understanding the dynamic nature of financing choices of new ventures and how they affect the post-funding development of the newly created entrepreneurial entity. In a nutshell, venture

capitalists act rather as coaches than scouts in the context of new ventures in an academic setting. Further, crowdfunding as a new means of entrepreneurial finance affects both the selection and syndication behavior of venture capitalist, a novel finding in the entrepreneurial finance discipline. This dissertation including its empirical findings derived shall provide impetus for further analysis on the financing of new ventures in order to generate new insights to better understand the survival and growth of these important firms. The latter aspect is of utmost importance when considering the negative trend of newly created entrepreneurial activities on a European level in general, and Germany in particular, as new knowledge can support to reverse this trend in order for both the economy and the society to be prepared for the new challenges to come within this century.

6 References

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