Exploring Recent Phenomena in Entrepreneurial Finance

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Abstract

This dissertation consists of three essays that address important and very recent issues in the field of entrepreneurial finance. In the first essay, I examine the reasons that drive recently emerging multibillion-dollar valuation levels of so-called 'unicorns'. In the second essay, I investigate the current status of collaborations between incumbent firms and ventures in order to cope with the ongoing digital transformation. Based on empirical findings, I develop a collaboration model between incumbents and ventures depending on the venture's development stage. In the third essay, I draw from Initial Coin Offering (ICO) data to explore how early stage investors influence the outcomes of ICOs and the overall survival rate of blockchain technology-based firms.

This dissertation contributes to the research on entrepreneurial finance and entrepreneurship and more specifically to the understanding on recent phenomena concerning the influence of investors' characteristics on finance decisions and collaborations and subsequently their influence on ventures' success.

First, I present that being founded within a cluster region and in particular within the Silicon Valley area, increases significantly the chances for ventures to achieve ultra-high valuation levels. Furthermore, I show empirically that a considerable share of ultra-high valuation levels is devoted to aggressive and inorganic growth strategies in order to gain large market shares rapidly and achieve a market-dominating role. Thereby, I find that corporate investors play a decisive role for ventures to become successful.

Second, I provide evidence from the German market that corporate investments are mainly driven by the ambition of incumbents to gain momentum within the digital transformation of existing business models. However, based on my empirical findings, I identify the trend that incumbents collaborate increasingly with more nascent ventures and apply non-equity-based approaches.

Third, I demonstrate that the beneficial influences of venture capital investors hold also in the context of the blockchain technology. Particularly, I deliver evidence that the specialization and the reputation of investors has a positive influence on the success probability of blockchain technology-based firms. Thereby, I show again the dispositive role of corporate investors. In each essay, I discuss the theoretical and practical contributions of my work and provide novel insights on recent phenomena in the area of entrepreneurial finance.

Zusammenfassung

Die vorliegende Dissertation besteht aus drei Forschungsprojekten, die wichtige und aktuelle Fragestellungen im Bereich Gründungs- und Wachstumsfinanzierung adressieren. Im Rahmen des ersten Forschungsprojekts untersuche ich die Hintergründe, die zu den derzeit vermehrt auftretenden Multimilliarden-Dollar Bewertungen von sog. ‚Unicorns' führen. Im zweiten Beitrag erforsche ich den aktuellen Stand von Kooperationen zwischen etablierten Unternehmen und Start-ups mit dem Ziel die anhaltende digitale Transformation zu bewältigen. Basierend auf empirischen Ergebnissen, entwickle ich im Zuge des Beitrags ein Modell für die Zusammenarbeit zwischen etablierten Firmen und Start-ups, abhängig von deren Reifegrad. Im dritten und letzten Beitrag der Dissertation gehe ich ausgehend von „Initial Coin Offering (ICO)" Daten der Frage nach in wie weit Frühphaseninvestoren das Ergebnis von ICOs als auch die grundsätzliche Überlebenswahrscheinlichkeit von Blockchain-basierten Unternehmen beeinflussen. Die Dissertation trägt somit zur Forschung im Bereich Gründungs- und Wachstumsfinanzierung als auch im Bereich Unternehmertum bei. Insbesondere, beleuchtet sie die Charakteristika von Investoren, deren Finanzierungsverhalten sowie deren Kooperationsverhalten und den daraus resultierenden Einfluss auf den Erfolg von Portfoliounternehmen.

Als Ergebnis des ersten Forschungsprojektes zeige ich auf, dass die Gründung innerhalb einer Clusterregion und insbesondere innerhalb des Silicon Valleys die Chance signifikant erhöht ein überdurchschnittlich hohes Bewertungsniveau zu erreichen. Weiterhin, zeige ich in diesem Rahmen und basierend auf empirischen Ergebnissen, dass ein Großteil der extrem hohen Bewertungen durch aggressives und anorganisches Wachstum getrieben wird, da Investoren den schnellen Gewinn großer Marktanteile und das Ziel einer marktbeherrschenden Stellung honorieren. Darüber hinaus zeigen die Ergebnisse, dass Corporate Venture Capital (CVC)-Investoren einen entscheidenden Einfluss haben, wenn es um den Erfolg von Start-ups und die Erreichung von extrem hohen Bewertungen geht.

Als Resultat des zweiten Forschungsprojekts, demonstriere ich, basierend auf dem deutschen Markt, dass die derzeitigen Investitionsbemühungen etablierter Firmen hauptsächlich auf der Motivation beruhen die digitale Transformation bestehender Geschäftsmodelle zu beschleunigen. Interessanterweise zeigen die empirischen Ergebnisse dabei einen Trend, dass etablierte Unternehmen zunehmend mit sehr jungen Start-ups kooperieren und zunehmend auf Kooperationsformen ohne Kapitalbeteiligung setzen.

Als Teil des dritten Forschungsprojektes erbringe ich den Nachweis, dass der günstige Einfluss von Frühphaseninvestoren auch im Kontext der Blockchain Technologie bestand hat. Besonders hervorzuheben ist dabei, dass die Spezialisierung und die Reputation von Investoren einen signifikant positiven Einfluss auf die Erfolgswahrscheinlichkeit von Blockchain-basierten Portfoliounternehmen haben. Weiterhin zeigt sich im Rahmen des dritten Forschungsprojektes erneut die maßgebliche Rolle von CVC-Investoren.

Innerhalb jedes einzelnen Forschungsbetrages diskutiere ich dabei die theoretischen und praktischen Implikationen meiner Arbeit und liefere weitergehende Erkenntnisse zu den jüngsten Entwicklungen im Bereich Gründungs- und Wachstumsfinanzierung.

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List of abbreviations

%	Percent
abs	Absolute
AIC	Akaike Information Criterion
AME	Average marginal effects
approx.	Approximately
AR	Augmented Reality
bn	Billion
B2B	Business to Business
B2C	Business to Consumer
BTBF	Blockchain Technology-based Firm
BTC	Bitcoin
BIC	Bayesian Information Criterion
CF	Control Function
CVC	Corporate Venture Capital
DAX	Deutscher Aktienindex
DLT	Distributed Ledger Technology
e-mobility	Electric mobility
e.g.	For example
ERC 20	Ethereum Request for Comments 20
etc.	et cetera
GDP	Gross Domestic Product
GP	General Partners
HHI	Herfindahl Index
HY	Half-year
i.e.	Id Est
IP	Intellectual Property
IL	Log Likelihood
ICO	Initial Coin Offering
IMF	International Monetary Fund

IoT	Internet of Things
IPO	Initial Public Offering
IT	Information Technology
IVC	Individual Venture Capital
Ln	Logarithmus naturalis
LP	Limited Partners
No.	Number
m	Million
M&A	Merger & Acquisition
Obs.	Observations
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
p	Significance Level
PE	Private Equity
RBV	Resource-based View
Reg.	Regression
R-sq.	R-squared
R&D	Research & Development
Std. Dev.	Standard Deviation
UK	United Kingdom
US	United States of America
USD	United States Dollar
VC	Venture Capital
VIF	Variance Inflation Factor
VR	Virtual Reality
w/	With
w/o	Without

1 Introduction

1.1 Background

In the 21th century, the speed of technological development has reached unprecedented levels. This development continuously drives the number of innovations that disrupt existing business models and industries. Starting with the widespread introduction of the personal computer in the 1990s, the stage had been set for an ongoing trend that leads to the emergence of new business models, products, and services. Today, the main drivers of this development are subsequent innovations and technologies such as the internet of things (IoT), blockchain,[1] and internet platform-based business models. A considerable number of these innovations is forged by entrepreneurs or their ventures. Ventures, or more precisely entrepreneurial entities, are tools for entrepreneurs to exploit new business opportunities once they have discovered, evaluated, and decided to pursue them (Lumpkin and Dess 1996). The founding process itself of a new venture is a highly complex process that relies on several factors.[2] In particular, Katz and Gartner (1988, p. 429) have explained, "emerging organizations are organizations-in-creation, that is, organizations at the stage in which all properties necessary to be an organization come together". This dissertation refers to ventures as legal entities that have been founded recently by an individual entrepreneur or a group of entrepreneurs with a focus on exploiting business opportunities by offering new products or services. Applying this frequently used definition, ensures comparability with previous studies in the field of entrepreneurial finance (Gompers and Lerner 2001; Breuer and Pinkwart 2018).

With the introduction of widely accepted internet platform-based business models like Airbnb or distributed technologies like blockchain, ventures have gained growing importance and have continued to disrupt existing business models. Since the 2000s, ventures have increasingly been recognized as an important factor for technological progress and economic growth due to their contribution to market economies (Bertoni et al. 2011; Audretsch 1995). In par-

[1] Blockchain was invented by Satoshi Nakamoto in 2008 to serve as the public transaction ledger of the cryptocurrency bitcoin. The technology relies on a growing list of records that are linked using cryptography and which are resistant to data modification.

[2] The founding process of ventures represents a completely separate research topic, which is not considered in detail within this dissertation.

ticular, ventures have considerably contributed to the distribution of newly emerging technologies, such as artificial intelligence and the IoT, as well as to ongoing digitalization. Further, they play a key role at the forefront of technological disruption. By offering faster and more market-focused innovations, ventures have actively contributed to the increasing speed of technological development. For example, Facebook and Instagram have within a decade transformed the communication behavior of large sections of consumers, including the acquisition of billions of users within this time. Instagram reached an audience of 1 billion active users in 2018, eight years after being founded (Tech Crunch 2018), whereas the telephone reached 50 million users 75 years after being introduced.

Furthermore, the effects and implications that are evolving from new ventures are not limited to consumers, but also have an influence on incumbent competitors and established market structures. In particular, new ventures and start-ups stimulate remaining market participants to adapt and reconsider their business models as only those firms survive which innovate constantly (Schumpeter 1943; Arrow 1962). According to Schumpeter's argument, ventures add to overall welfare by introducing and fostering innovative technologies and business models. Besides generating and stimulating innovations directly, ventures also add to economic and societal welfare by creating jobs and increasing production efficiency. Thus, entrepreneurial activities (i.e., ventures' activities) gain increasing importance for general economic development. The rise of ventures and start-ups can also be observed in the US where the percentage of new entrepreneurs among all adults has increased from 0.28% in 2013 to 0.31% in 2019 (Fairlie and Desai 2020).

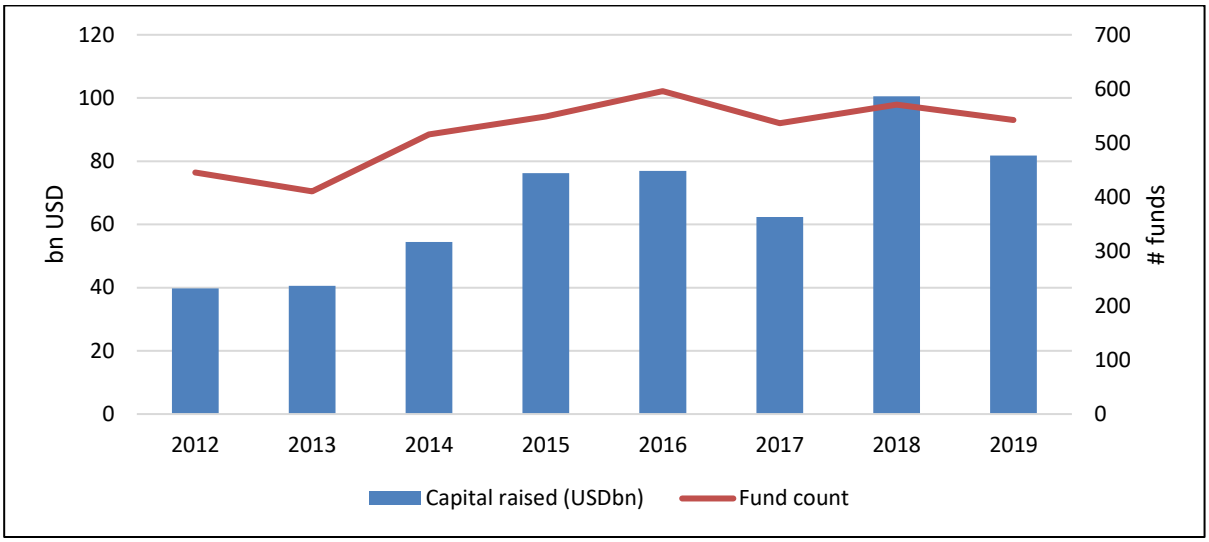
However, ventures and in particular those ventures with strong growth ambitions are regularly impacted by financial constraints that impede the exploitation of identified business opportunities, that is, starting their business operations (Bruno and Tyebjee 1985; Bertoni et al. 2015). Sufficient financing is thus a central issue and a challenge for entrepreneurs when founding and growing new ventures (Carter et al. 2006; Neeley and van Auken 2011; Breuer and Pinkwart 2018; Gompers and Lerner 2001). For technology-based ventures in particular, financial capital needs can be enormous. Therefore, ventures often need to access external funding sources to meet their capital requirements. From a venture's perspective, the financing decision is crucial due to the lasting influence of investors and the resulting implications for the future development of the venture. In other words, the initial financing decision can

be decisive for a venture's success in terms of growth, valuation levels, and survival probability in the mid- to long-term. Consequently, the financing of ventures is a central research topic in the area of entrepreneurial finance. Current research lacks comprehensive answers to several questions regarding the implications of investor-investee relationships, success-determining factors for investors as well as the influence of investment staging on the performance of ventures (Tian 2011; Colombo and Murtinu 2017).

Regarding early stage investors, venture capital (VC) and corporate venture capital (CVC) are the most relevant in terms of financing volume as well as against the background of their influence on portfolio companies. The importance of VC is also illustrated by the fact that 15% of all German start-ups receive a VC investment (Kollmann et al. 2019), which represents a substantial amount of the overall funding. Often VC investors acquire minority stakes in ventures, aiming to achieve financial returns in an exit scenario within a comparably short period of time (Achleitner 2001). Although such investments have a high return potential, VC is generally perceived as a high-risk asset class due to the nascent development stage of ventures at the time of investment (Gompers and Lerner 2004). Historically, VC has represented a niche investment class with a limited number of investors. Although the ancestors of VC developed in the late 19th and early 20th centuries in the US, VC is a rather young asset class, since the first modern VC firm was formed in 1946 by MIT President Karl Compton. Starting in the 1970s and 1980s, the asset class of VC began to emerge. Whereas the US has a comparably long-standing tradition of VC investment, it took until the 1990s before the concept was established internationally (Gompers 1994). Now VC represents a globally acknowledged asset class (Weitnauer 2019).

Figure 1: Global venture fundraising

The figure presents the amount of global VC fundraising and the number of new established funds from 2012 to 2019. Source: (KPMG 2020)



Fostered by major success stories during the post-dotcom era[3] and the realization of high financial returns, the VC market has exhibited tremendous growth in recent years. While becoming more mature, the VC market has changed and has become more scattered. Figure 1 illustrates that the number of funds as well as respective fund sizes have increased. Because of continuously high capital inflows to the VC market and an increase in competition, ventures' valuation levels have gained momentum. Overall, this is one of the driving forces behind the emergence of ultra-high funding rounds as well as multibillion-dollar valuation levels in the case of so-called 'unicorns'. The availability of high VC levels as well as the opportunity to conduct numerous funding rounds enable today's ventures to remain private for a longer period.

At the same time, the intensified competition for finding promising investment opportunities and high-quality ventures among early stage investors leads to a stronger specialization of investors, regarding their preferred industry sectors and development stages of ventures. Investor specialization on specific development stages or in certain industries (Norton and Tenenbaum 1993) represents the fact that the contribution of VC is not limited to financial capital but also comprises guidance, governance services, and the provision of complementary

[3] The post-dotcom era denotes the time after 2002 when the stock market bubble, which had been caused by excessive speculations on internet-related companies in the late 1990s, burst.

assets. In particular, VC investors as well as CVC investors provide their portfolio companies strategic advice, managerial resources, and operational support, for example, by implementing accounting procedures and systems (Davila et al. 2003; Hellmann 2002; Arqué-Castells 2012; Balboa et al. 2011). The increasing importance of CVC is illustrated by the fact that CVC investors have participated in almost 30% of all venture financing rounds in the first quarter of 2020 globally (KPMG 2020). The rise of CVC is nevertheless also the result of the fact that the growth of innovative ventures also represents a threat to established firms that need to adapt to new requirements. Ongoing digitalization adds to these challenges by shortening market response times and product development times. This increases the need for incumbent firms to collaborate with or to acquire ventures to access the most innovative technologies and services. Due to (potentially) conflicting interests, goals, and corporate cultures, establishing mutually beneficial collaborations between incumbents and ventures can be rather difficult (Dushnitsky and Shaver 2009). Generally, corporate investors compete with more traditional players in the VC market; these corporate investors are specifically considered in this dissertation. In addition, completely new means of financing such as crowdfunding and initial coin offerings[4] (ICOs) have evolved more recently. Crowdfunding and ICOs also have to be taken into consideration when discussing the financing options of ventures due to their amount of capital contribution. Since the financial crises in 2007–2008, the share of ventures that receives funding through crowdfunding campaigns has increased drastically (Gray and Zhang 2017). Apart from crowdfunding, ICOs as a means of financing have manifested impressively since the mid-2010s. Within this comparably short period, the increasing interest in ICOs has translated into an ICO financing volume of more than 20 billion USD in 2018 and more than 900 ICO events (Malinova and Park 2018). The application of ICOs is currently a widespread financing paradigm in the blockchain industry which might gain additional importance in other industries and hence disrupt industries that so far rely on traditional funding systems (Chanson et al. 2018). To summarize, the early stage investor landscape has become more

[4] Initial coin offerings are a recently emerging source of funding which is based on cryptocurrencies. In an ICO, ventures sell new cryptocurrencies in the form of tokens to investors usually in exchange for more established cryptocurrencies such as Bitcoin or Ethereum. The tokens represent functional units of the new cryptocurrency and can be used in the future to pay for products or services which are offered by the respective venture. Currently, ICOs are not subject to regulation or enforcement of securities laws in most countries.

diverse in recent years, and investors differ in terms of non-financial support and their underlying strategic goals.

Given the general research topic, the motivation of this dissertation is to provide a better understanding of the relationship between investors and portfolio companies against the background of CVC and VC financing. The central research focus addresses the question of which investor-related factors influence the growth of ventures and how they act in concert with other investors as well as the question of how corporate investors should design their collaboration models to follow strategic goals while supporting portfolio companies. By following these research questions, this dissertation examines recently emerging phenomena. Overall, the results of this dissertation give theoretical and practical recommendations to investors and funding-seeking ventures. Furthermore, the results help to improve investment decision processes and to secure future economic and societal welfare effects that arise from entrepreneurial activities.

1.2 Structure of the dissertation

This dissertation consists of three essays on recent phenomena in the area of entrepreneurial finance. The essays emerged from independent research projects, including individual research objectives and methodologies. Table 1 presents an overview of the essays and their key contributions. However, due the fact that the essays have been developed independently, some of the key concepts of entrepreneurial finance as well as definitions might occur repeatedly.

Chapter 2 provides the theoretical foundation of this dissertation by offering a brief introduction to the environment of entrepreneurial finance as well as by explaining ventures' lifecycles, including their sources of financing.

Chapter 3 examines and identifies factors that drive extremely high valuation levels. The first contribution of this dissertation reviews the influence of investors in the setting of ultra-high valued ventures, that is, 'unicorns'. While building on the resource-based view (Penrose 1959; Barney 1991) and signaling theory (Spence 1973, 2002), the contribution investigates the drivers of multi-billion-dollars valuation levels and examines if these drivers are identical to the drivers that influence the valuation of 'non-unicorns'.

Chapter 4 sheds light on the critical success factors of collaborations between corporate investors and ventures. Drawing on the dynamic capabilities approach (Teece 1999, 2014, 2017), the chapter specifically develops a conceptual framework model which considers various types of collaborations depending on the venture's level of maturity and that aims at aligning interests and enabling a maximization of positive effects.

Chapter 5 investigates the interrelation of VC and CVC investors and ICOs by considering their characteristics. This third contribution adds to the understanding of ICO dynamics by examining the interplay of ICOs with other sources of funding (i.e. investors) and identifies factors that influence ventures' short and mid-term success.

Last, Chapter 6 summarizes the research findings, including their theoretical and practical implications.

Table 1: Dissertation overview

Research topic:	Exploring recent phenomena in entrepreneurial finance		
Essay	I	II	III
Research question	What drives multibillion-dollar valuation levels for an increasing number of ventures?	How can incumbents make use of CVC and start-up collaborations to drive their digitalization?	How do investor characteristics and in particular VC influence the outcome of ICOs and the midterm development of blockchain technology-based firms?
Unit of analysis	Individual ventures that have exceeded valuation levels of 1 billion USD	Dyadic investment relationships between a CVC unit and a start-up company	Individual blockchain-based ventures that have conducted an ICO
Research approach	Deductive reasoning; quantitative	Conceptual model framework; quantitative	Deductive reasoning; quantitative
Main theory	Signaling theory and resource-based view	Dynamic capabilities view	Signaling theory
Methodology	Ordinary least squares regression	Descriptive sample analysis	Heckman twostep regression; bivariate probit regression with sample selection
Main contribution	Identification of general factors that drive the likelihood for ventures to achieve a multibillion-dollar valuation	Enhanced understanding of the collaboration models between start-ups and incumbents with regard to digital transformation; evidence from the German market on the increasing importance of collaborations with nascent ventures	New insights into the interrelation of funding sources (i.e., VC investors, CVC investors and ICOs) and ventures' mid-term performance

2 Theoretical background

This chapter outlines the joint theoretical foundation for all three essays. Moreover, a literature review of the field of entrepreneurial finance is given, followed by an analysis of the financing sources of entrepreneurial ventures throughout their lifecycle. Both components help to understand the context and contributions of the individual essays. The analysis of the financing sources is thereby conducted against the background of the resource-based view as well as against the background of signaling theory.

Originating from the theoretical basis, the last section of this chapter presents the detailed development of the research questions. First, the last section works out the influencing factors that lead to the occurrence of unicorns. Second, the last section elaborates on the relationship between incumbents and new ventures with regard to ongoing digitalization. Third, the role of VC investors in ICOs as well as their influence on the mid-term development of blockchain technology-based firms (BTBFs) is examined.

2.1 Literature review on entrepreneurial finance

Historically, entrepreneurship and the sub-discipline of entrepreneurial finance were predominantly considered as a field of applied trade rather than an academic field of research (Landström 2005). This was mainly because entrepreneurship has consistently been regarded as a practical field of interest based on the assumption that founding a business is a necessity for individuals with a lower level of education, against the backdrop of missing alternative opportunities (Kuratko 2016). Given the widely accepted economic and societal importance of entrepreneurial activities and ventures, public and academic interest has increased significantly in the related academic discipline of “entrepreneurial finance” which is “a field at the intersection between entrepreneurship and corporate financial theory” (Landström 2017, p. 5; Amit et al. 1993).

According to Bonnet and Wirtz (2012, p. 93), “entrepreneurial finance has a longstanding interest in a firm’s capacity to access financial capital to fuel growth.” To address this research topic, agency theory has evolved as one of the main avenues of research in entrepreneurial finance. Originally introduced by Jensen and Meckling (1976), agency theory represents the theoretical framework of several studies. For example, Kaplan and Strömberg (2004) contribute to the discussion by providing insights into the risks that VC investors face when investing

in new ventures and how such risks can be reduced by introducing contractual agreements which subsequently facilitate access to capital for ventures. Based on agency theory, Bitler et al. (2002) find explanations for entrepreneurs' large average ownership of shares. According to agency theory, selling equity shares to external investors (i.e. raising financial capital for the further development of the venture) generates economic incentives for entrepreneurs to generate personal benefits at the expense of outside shareholders. These outside shareholders will anticipate the potential loss of wealth and price this risk when acquiring stock. Hence, agency costs result in high costs for capital and subsequently comparably low share prices. Agency theory is based on the assumption that information is distributed asymmetrically between investors and investees. While entrepreneurs have information that might be helpful for investors in the investment decision process, the availability of such information for investors is quite limited (Moss et al. 2015).

Thus, as Bonnet and Wirtz (2012, p. 93) explain, "the capacity of an entrepreneurial firm to raise financial resources at a reasonable cost to bring it on an 'expansion path' crucially hinges on the formal structuring of the relationship between the entrepreneur and the outside investors, not on his or her identity". In other words, by applying various governance mechanisms (monitoring, financial incentives, due diligence processes, etc.), the level of potential agency conflicts, and thus the level of uncertainty for the investor, can be reduced while share prices would better reflect the real value. From a practical perspective, this implies that VC investors conduct several stages of venture screening to obtain as much information as possible about the respective venture to safeguard their investment decision and to reduce risks ex ante (Rosenbusch et al. 2013). Apart from the fundamental question in entrepreneurial finance (what sources of financing new ventures use), the remaining research themes in the field of entrepreneurial finance relate to the topics of investment selection, the reduction of uncertainties, the role of signals, and the influence of investors.

Existing research investigates whether early stage investors are able to select superior investment opportunities per se or if their treatment makes them more successful on average. The respective results remain ambiguous while particularly agreeing that "VC-backed ventures survive at a much higher rate than those ventures backed by other sources" (Zacharakis and Meyer 2000, p. 323). Colombo and Grilli (2010, 2005) as well as Bertoni et al. (2011) find no clear evidence that VC investors are able to select superior ventures, but they confirm that

their support and treatment (managerial guidance, monitoring, etc.) substantially add to a venture's development. Rosenbusch et al. (2013), Baum and Silverman (2004) as well as Chemmanur et al. (2011) suggest that VC investors are able to select ventures that exhibit higher efficiencies and have larger growth and success potential. Bertoni et al. (2011) provide evidence that the treatment of VC investors has a clear positive effect on a venture's future development with regard to sales and employee growth in the mid- and long-term. These findings are further underpinned by Puri and Zarutskie (2012) who confirm the treatment effect of VC investors based on a longitudinal data set of 10,349 VC-backed firms based in the US. Furthermore, Bock et al. (2018) find a positive impact on employment and revenue growth in the case of research-based spin-offs if they are backed by VC investors. Generally, the positive effect of VC treatment is larger in early stages of venture development which requires resources that can be provided by the respective investors (Rosenbusch et al. 2013; Baum and Silverman 2004; Grilli and Murtinu 2015). Furthermore, Lee et al. (2011) conclude that the longer the involvement of valuable investors lasts, the more ventures can benefit.

Moreover, a superior investment selection of VC investors is tantamount to the reduction of investment risks and the collecting of more complete information on ventures. Venture capital investors usually receive up to several hundred business plans and proposals from new ventures seeking financing. Only the most promising ones which pass an initial screening proceed to the next stage, and VC investors consider them in detail by exercising due diligence, as time is a scarce resource for VC investors (Zacharakis and Meyer 2000; Yung 2009). In the course of due diligence, investors examine almost every assumption on which a business is founded, including an in-depth investigation of market players, potential growth of the venture's target market, and financial representations, among others (Fried and Hisrich 1994; Wiltbank 2005). The goal of this due diligence process is to retain a risk evaluation in comparison to alternative investment opportunities (Petty and Gruber 2011) and thus to broaden the investment decision basis.

Early stage investors and particularly VC investors frequently make use of staged financing processes to reduce information asymmetries and investment risks. Staged financing describes the process in which ventures receive agreed capital and resources once they have reached certain agreed milestones instead of receiving the entire investment amount upfront. By applying this procedure, investors can withdraw from investments if stipulated milestones

(i.e. stages) are not met. Subsequently, investors do not put their complete investment at risk in the beginning, but they can reevaluate the opportunity to invest additional capital (or withdraw from the investment) once more reliable information is available (Hopp and Lukas 2014; Wang and Zhou 2004; Neher 1999).

Surprisingly, the results of Zacharakis and Meyer (1998) indicate that the availability of a larger amount of information on a respective venture does not necessarily lead to a better decision-making process. They conclude that the plethora of information leads to the effect that investors overestimate the accuracy of the information which they believe in. Zacharakis and Shepherd (2001) confirm this and present evidence that VC investors' decisions are often biased by overconfidence, as they make investment decisions more by intuition than by relying on the full array of available information.

Nevertheless, investors use the information obtained during extensive due diligence processes, including received signals to make their investment decision. Generally, VC investors are assumed to be better positioned to cope with information asymmetry or the lack of perfect information compared to other financial firms based on their knowledge and experience (Croce et al. 2013). Early stage investors need to rely on (informal) signals due to the absence of complete and perfect information when they make investment decisions (Busenitz et al. 2005). Based on these theoretical foundations, this dissertation examines whether the assumed positive selection and treatment effect of CVC and VC investors holds to be true in different settings. More specifically, the dissertation reviews the influence of this effect in the setting of ultra-highly valued ventures, in the case of ongoing digitalization as well as in ICOs. Moreover, the dissertation elaborates on the question of whether the quality of these effects differ based on the characteristics and reputation of investors. Particularly, the provision of non-financial support is considered as a key quality of investors throughout all three core-chapters.

Another important research stream in the field of entrepreneurial finance emerges from the question of what signals ventures need to send to attract investors and to reduce information asymmetries ex ante (Vismara 2016). Originally introduced by Spence (1973), signaling theory is concerned with ventures' means to reduce information asymmetries in investor-investee relationships. Imminent information on the anticipated venture's future development allows

the investor to increase his or her decision-making reliability and thus to reduce the investment risk (Spence 2002; Busenitz et al. 2005). Subsequently, signals produced by ventures should emphasize their future growth prospects and quality compared to other competing investment opportunities (i.e. major capital-seeking ventures). However, producing and receiving a signal must outweigh the cost of its production (Connelly et al. 2010). Certo et al. (2017, p. 36) emphasize that signals have two key criteria: "[they need to be] observable / known in advance [i.e. prior to the investment]; and costly / difficult to imitate."

From an empirical perspective, the value of several types of signals have been examined in recent studies regarding their influence on investors' decisions. While Fisch (2019) identified the signaling of technical capabilities as a relevant investment criteria in a blockchain context, this is confirmed more broadly by several studies that find patents owned by a venture as a strong signal for investors (Häussler et al.; Hoenig and Henkel 2015; Johnson and Robinson 2014). Patents are thus a decisive signal, as they allow ventures to maintain a competitive advantage by exclusively exploiting new technologies (Hsu and Ziedonis 2013). Furthermore, existing research finds that a founder's team's characteristics and their commitment to the venture are a strong signal (An et al. 2019; Vismara 2016; Fisch 2019).

Previous research has also identified signaling technical capabilities (Fisch 2019), founder team characteristics, and the commitment of founders to invest in ICOs (Vismara 2016; Fisch 2019) as success critical. More specifically, Petty and Gruber (2011) demonstrate that an experienced and well-performing management team that possesses a strong track record can be regarded as a positive signal. This is driven by the assumption that human capital plays a crucial role for the future development of most ventures (Zacharakis and Meyer 2000; Knockaert et al. 2010). However, an investor's funding in a venture also sends a signal to other investors about the venture's quality (Davila et al. 2003; Baum and Silverman 2004). Following Thies et al. (2018), this holds to be true in the case of crowdfunding, as the successful completion of a crowdfunding campaign significantly increases the chance of receiving follow-up funding from VC investors. The positive value of this signal stems from the assumption that previous investors have already spent effort and resources to evaluate the venture, and thus they confirm with their investment a sufficient venture quality and appropriate level of investment risk (Davila et al. 2003; Bertoni et al. 2011). For very early-stage ventures, the signals which are produced by third parties might be highly beneficial due to the general lack of other relevant

information which can be assessed by potential investors (Plummer et al. 2016). However, the signaling effect that stems from the investment of an early stage investor is not limited to other investors; rather, it can also be received by other stakeholders of the venture (such as customers, suppliers, etc.) and thus be beneficial for further development (Bertoni et al. 2011). Given the scarcity and highly individual evaluation of signals, the correct interpretation of signals in the context of financing nascent ventures can be regarded as a highly complex process. Particularly, investments in new or nascent ventures suffer from a larger information asymmetry compared to investments in more mature firms, and thus, have a higher investment risk (Plummer et al. 2016). Signaling theory represents the academic framework for the fifth chapter of this dissertation. This chapter examines whether investors that have invested previous to or during an ICO event influence the ultimate success outcome of the respective ventures. The investment of VC and CVC investors previous to or during an ICO event sends signals to the remaining investors and influences their investment decision. The study investigates whether investor characteristics, such as reputation or specialization, influence the strength of signals in parallel for potential selection and treatment effects.

2.2 Financing sources along a venture's lifecycle

Finance is assumed to be of central importance for ventures as liquidity constraints during the start-up phase or respective implications have been identified as increasing the likelihood of failure (Cassar 2004). Furthermore, ventures with sufficient levels of early-stage financing exhibit higher probabilities for growth (Landström 2017). Although a large variety of financing options exists, securing capital sources for new ventures remains one of the main challenges for entrepreneurs (Carter et al. 2006). The definition of entrepreneurial finance remains overall rather blurry and comprises several sources of capital, such as angel investors, VC, private equity (PE), hedge funds, microfinance, and project finance. They all aim at financing young ventures with growth ambitions. However, entrepreneurial finance also comprises various subtopics that emerge from various sources of capital such as financial contracting, capital availability, public policy, and international differences stemming from discrepancies between institutions and cultures (Cumming 2012). Given the diversity and complexity of these research topics, studies in the field of entrepreneurial finance usually focus on one of these topics at a time (Cumming 2012). Based on the academic consensus that the financing of new ventures remains one of the greatest challenges for entrepreneurs and founders, the different

sources of capital remain a prevalent research interest. Table 2 provides an overview of major financing stages and sources of financing for new ventures.

Table 2: Sources of financing along a ventures' lifecycle
The table illustrates the availability of different sources of financing along the lifecycle of new ventures, following Leach and Melicher (2012), Fisher et al. (2016) and Picken (2017).

Venture Lifecycle stage	Financing stage	Available financing sources
Development stage	Pre-seed financing	Entrepreneur's assets
		Bootstrapping
		Family & friends
		Incubators & accelerators
Seed stage	Seed financing	Entrepreneur's assets
		Family & friends
		Initial coin offerings
		Business angels
		Corporate venture capital
		Early stage venture capital
		Crowdfunding
		Government assistance programs
Start-up stage	A-round financing	Business operations
		Initial coin offerings
		Corporate venture capital
		Venture capital
		Government assistance programs
		Commercial banks
Expansion stage	Follow-on rounds	Business operations
		Commercial banks
		IPO
		Venture Capital
		Private equity

Following Achleitner and Braun (2018) as well as Leach and Melicher (2012), this chapter elaborates and discusses the different financing stages and major financing sources along a venture's lifecycle. It aims at providing a comprehensive picture of the entrepreneurial finance landscape along a venture's lifecycle stages. This helps to place the main contribution of this

dissertation in a larger context and to understand the focus on corporate venture capitalists, venture capitalists, and IOCs. Furthermore, this approach allows one to highlight the altering needs of ventures when they become more mature. Moreover, this chapter describes the key characteristics of the external financing sources following a venture's development stages (i.e., when they become available for a venture for the first time).

2.2.1 Development stage

The development stage of a venture is characterized by the entrepreneur's conceptual development of how to exploit an opportunity by transforming an idea into a business. In the majority of cases, ventures in the development stage have not yet been legally founded, making the entrepreneur's own assets the most likely source of financing (Lins 2016). Existing research concludes that the "funding gap" cannot be filled completely by the entrepreneur's assets without adapted spending behavior regarding personal expenses (Carter and van Auken 2005; Freear et al. 1995). Hence, bootstrapping, which is closely linked to the use of an entrepreneur's assets, occurs regularly as a supplementary means to secure the financing of nascent ventures. Winborg and Landström (2001) provide a rather broad definition of bootstrapping and describe it as a method to not rely on long-term external capital while one is simultaneously securing access to resources. In contrast, Harrison et al. (2004) define bootstrapping in a more nuanced way. They see financial bootstrapping as a combination of two dimensions that are both of equal importance for this strategy's success. The first dimension of bootstrapping is defined as a venture's efforts to develop creative ways of gaining access to financial sources, without using finance from established capital providers such as banks or traditional equity investors. The second dimension encompasses ventures' aim to minimize their capital needs while securing access to necessary resources to develop their venture. The first dimension typically means that entrepreneurs sell valuable private assets to increase the liquidity of the venture (Leach and Melicher 2012; Lins 2016). The second dimension comprises an entrepreneur's willingness to reduce his or her living standard by reducing private expenditures to impact the venture's financing needs positively. Achleitner and Braun (2018) argue that bootstrapping is a rather seldomly used means of financing, as internally generated funds regularly fall short of a venture's capital needs. This is true in particular when considering ventures with strong growth ambitions or in capital-intensive high-tech sectors.

Family and friends represent the second major source of financing in the development stage (Achleitner and Braun 2018; Leach and Melicher 2012), especially when assuming that entrepreneurs are subjected to the pecking order theory. This means that entrepreneurs draw on closely related or internal sources of financing first (i.e. their own funds, funds from family and friends, etc.). The benefits of relying on family and friends as a source of capital are supported by several studies that find that family and friends might have an information advantage compared to completely external investors, thus enabling them to provide cheaper finance due to fewer contractual issues (Lam 2010; Lee and Persson 2016). This behavior is fostered by social norms to support the visions and goals of family members or individuals with close relations (Kotha and George 2012). Nevertheless, the use of family and friends as a source of financing comes at the risk of harming personal relationships if the venture does not develop as initially intended and funds owed to family and friends are irrecoverable, leading to the moral indebtedness of the entrepreneur (Grichnik et al. 2017).

This dissertation assumes an additional capital source: incubator and accelerator programs. Incubator and accelerator programs are usually the vehicles of incumbent corporations or research institutions that seek to engage with nascent ventures in a meaningful way by providing them guidance and resources to develop marketable products and services (Albort-Morant and Oghazi 2016; Bruneel et al. 2012; Becker and Gassmann 2006). What is paramount to these programs is the provision not of financial capital but of operational support and resources (e.g. office space, production facilities, networks, etc.). This lowers, in general, the hurdle for entrepreneurs to engage with such programs as they commonly do not lose control or ownership. The focus of incubator and accelerator programs is highly individual and can hardly be conflated (Grimaldi and Grandi 2005; Kruft and Kock 2019). Such programs seek to, for example, discover new technologies, attract qualified employees, conduct market screening for CVC activities, generate financial returns, and other goals. Although this dissertation identifies the increasing importance of such programs, driven by ongoing digitalization and the overall trend of non-equity-based collaboration models, relevant findings from the research literature are still limited.

2.2.2 Seed stage

Once a venture develops a concrete product idea and exhibits at least a conceptual revenue model, it enters the seed phase which coincides with the reception of the respective financing.

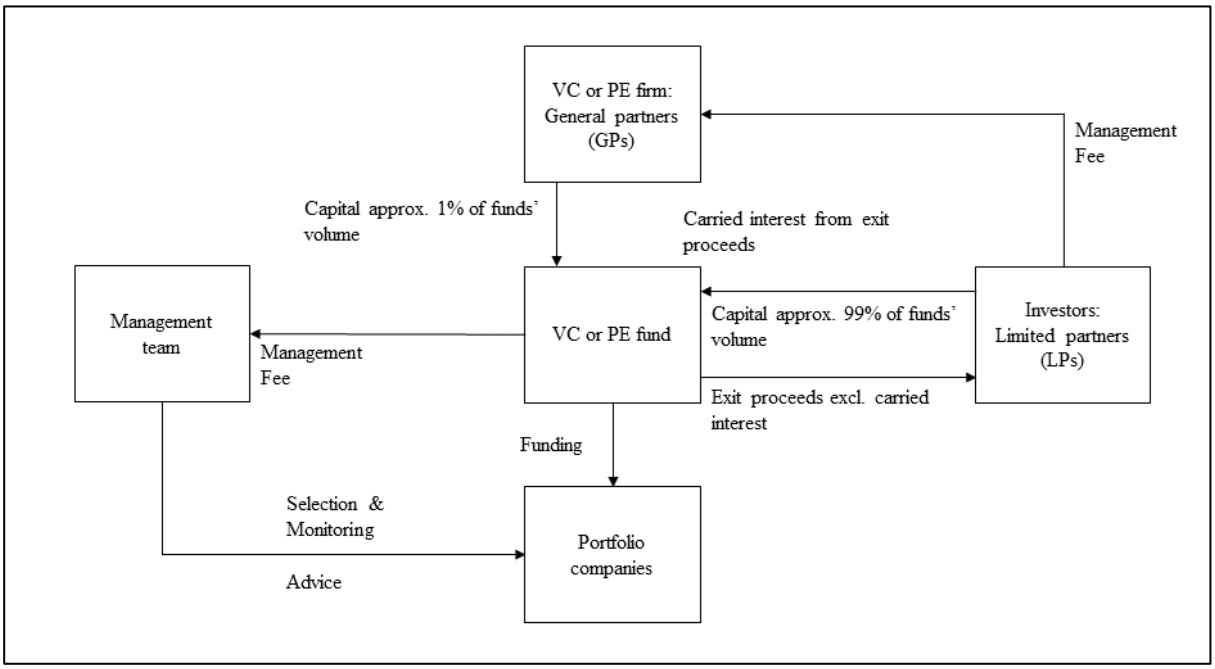
Although an entrepreneur's assets as well as those of family and friends remain relevant sources of finance during this development stage, ventures increasingly try to attract external sources of capital to cover necessary resources for growth. In the past, external financing in the development stage was mainly provided by two sources: business angels and early stage venture capitalists.

Business angels are primarily defined as "high-net-worth individuals with considerable business experience, who invest a portion of their wealth in high-risk, high-return start-ups" (Croce et al. 2016, p. 1; Coveney and Moore 1998; Lindsay 2004). Usually they obtain a minority equity stake in the venture. Besides providing financial capital which is on average considerably less than in the case of venture capitalists, business angels often use their extensive networks and work experience to support their investments (Mason and Harrison 2000). Given their experience, business angels usually invest in the seed and more seldomly in the start-up stage of ventures, as their knowledge has the greatest leverage at the beginning of a venture's lifecycle when prices are rather low (Maxwell et al. 2011; Elitzur and Gavious 2003). By providing lower amounts of capital per investment and thus maintaining different target search criteria than venture capitalists do, business angels are essential for the survival of a large group of ventures (Lindsay 2004). This is reflected by the fact that business angel markets have been recently estimated to be approximately the same size as the VC market (OECD 2011).

The second traditional and probably most prominent as well as most relevant source of financing for ventures in the seed and start-up phase is VC. In particular, a subgroup of VC investors, so-called early-stage VC investors, are specialized in providing funding in the seed phase, which usually comprises comparably low financial contributions at a higher risk. From a structural perspective, they hardly differ from the larger group of later-stage venture capitalists. Hence, this dissertation considers both groups as VC. Venture capitalists are financial intermediaries who invest in high-risk ventures that exhibit high growth potential. Venture capital is defined as an institutional (Bessler and Kurth 2007), formal (Bruton et al. 2009; Gompers and Lerner 2001), and professional type of investment that includes the provision of managerial input (Davila et al. 2003), monitoring (Gulati and Higgins 2003), and access to networks (Cumming and Johan 2007), along with the provision of financial capital (Lee and Wahal 2004; Gompers and Lerner 2004). Venture capitalists invest in a variety of ventures to reduce the overall risk of total loss of the invested capital (Black and Gilson 1998).

Figure 2: VC / PE fund structure

The figure illustrates the commonly applied structure for VC and PE funds following Tykvová (2018) and Schefczyk (2006)



In most cases, VC is provided by VC funds which are also known as investment vehicles. A VC fund is typically structured as a limited partnership between investors (i.e. the limited partners) and a general partner (i.e. the fund). The specific legal implementation is subject to country-specific corporate law regulations and considers liability risks as well as tax optimization. Within this structure, the general partner is responsible, during the inception phase of a new fund, to collect capital commitments from investors such as high-net-worth individuals, pension funds, corporate investors, and institutional investors, among others, in a process called fundraising (Schefczyk 2006).

Once the general partner has achieved a certain threshold of committed capital, which is referred to as the "first closing," the fund's operations start. Often the general partners and the management team invests their own money into the fund to demonstrate confidence and a strong commitment to the project. The fundraising usually continues until the total planned fund size is reached, that is, until the "final closing" threshold is reached. Nevertheless, the appointed management team starts to screen the market and selects potential portfolio investments once the first closing has been reached. At this point, the general partner is confident that the level of capital commitment is sufficient to successfully pursue the investment

strategy. The selection of portfolio investments follows criteria, for example, focusing on certain industries, distinct geographical regions, and specific venture development stages that have been defined and disclosed to the limited partners during the fundraising process. As soon as a VC fund has started to invest, its management team begins to monitor the development of the portfolio investments and to provide management support to the portfolio companies while the funds usually remain invested for a period of 3–14 years. The majority of VC funds possess a contractually fixed lifetime which is defined within the fundraising process and which impels the general partners to sell the fund's portfolio companies within this period. This implies that within or at least at the end of the fund's lifetime, all investments need to be exited. During the holding period for portfolio companies, limited partners regularly do not receive any financial proceeds from the VC fund in contrast to the general partners who receive a management fee from the limited partners to cover their administrative expenses and for their supervisory services. Once parts of or the entire portfolio of the fund is sold, potential profits are distributed among the limited and the general partners following distribution schemes which were agreed upon during the fund's initiation. Figure 2 presents the most common VC fund structure and illustrates services as well as capital flows in detail. Due to the strong operational influence of VC investors and their importance for financing young ventures in general, the role of VC investors is considered as a key success factor throughout this dissertation.

The start-up stage is usually the earliest stage of a venture's lifecycle, when CVC becomes available. Corporate venture capital significantly differs from VC as "CVC investments are minority equity investments by established firms in entrepreneurial ventures" (Dushnitsky and Shaver 2009, p. 1046). The development of CVC markets has been subject to several waves and follows the global capital markets (Gompers and Lerner 2000b). In contrast to VC investors, CVC investors usually pursue a different set of goals, that is, a broader set of goals including strategic targets such as knowledge transfers, innovations, and attraction of key employees, amongst others, to create benefits for the incumbent investing firm in addition to the pure realization of financial returns (Chesbrough 2002). By following these strategic goals, CVC investors are regularly associated with stronger operational support of their ventures compared to independent VC investors. Existing research remains ambiguous whether the strategic goals of investors are beneficial for a venture's development or not. Dushnitsky and Shaver (2009, p. 1047) see certain threats arising from the fact that CVC investors might "pursue

[their] own interests and undertake actions that adversely affect the entrepreneurial venture" to avoid competitive situations or to privilege existing businesses. Conversely, Park and Steensma (2012) find significantly higher innovation rates for ventures that have received an investment from CVC investors. The overall importance of CVC investments as a financing source becomes more obvious when considering that CVC accounts for 15% of the VC industry as of 2011 (Chemmanur et al. 2014). Due to the amount of contributed capital, CVC is considered a central research object in this dissertation. In particular, the widely acknowledged provision of strategic (i.e. non-financial) support by CVC investors is assumed in this dissertation to be a key success factor for ventures.

Another source of capital for start-up financing is (equity) crowdfunding. Although several subcategories of crowdfunding campaigns exist, including reward-based crowdfunding (Colombo et al. 2015) and lending-based crowdfunding (Dushnitsky et al. 2016), equity crowdfunding remains the most serious financing option (Ahlers et al. 2015). From a practical perspective, crowdfunding campaigns collect small investment amounts from a large group of individuals by using online platforms which act as an intermediary to finance projects or ventures (Ahlers et al. 2015; Agrawal et al. 2014). The notable rise of crowdfunding and its establishment as a means of financing is also observable in the growing number of online platforms, the increasing average funding amounts and the rising number of funded projects (Dushnitsky et al. 2016). According to Chang (2020), the volume of global crowdfunding financing topped 30 billion USD in 2015 and is expected to grow further and potentially to outpace VC investment volume in the mid-term. As the influence of individual investors in crowdfunding campaigns on venture development is rather limited due to the individual investment size and structure, crowdfunding is not considered in detail in this dissertation. Though it remains notable, crowdfunding can be seen as a way for small and private investors to participate in risky investment opportunities that offer the potential for high returns.

More recently, ICOs have emerged as an additional source of financing for ventures in the start-up and development stages beyond. Because of the introduction of blockchain technology and cryptocurrencies, a considerable number of technology-based ventures have started to sell products or service-related tokens in exchange for legal tender or cryptocurrencies. By doing this, they raise capital while avoiding compliance and intermediary costs to a large ex-

tent with ICOs, which share several similarities to Initial Public Offerings (IPOs) and crowdfunding events (Kaal and Dell'Erba 2017; Benedetti and Kostovetsky 2018). More specifically, with ICOs, new coins are issued on a blockchain and transferred to investors in return for capital transmitted as cryptocurrency (Dell'Erba 2017). In contrast to IPOs and equity crowdfunding, the coins that are received by investors as exchange for their capital contribution can usually be used in a later development stage of the venture (once the venture has started its regular business operations) to buy the products or services offered by the venture. Hence, investors' interest in ICOs can be regarded as a direct indicator for the market's interest in the venture's products (i.e. to test market interest). Although the ICO process duration may vary depending on the success of the venture's initiatives, the most successful ICOs have been concluded within a few minutes, highlighting the extremely efficient and rapid access to funding that results from using ICOs as a financing source (Dell'Erba 2017; Kaal and Dell'Erba 2017; Catalini and Gans 2018). Due to low entry hurdles, ICOs offer the opportunity for small and private investors to participate in the financing of high-risk, high-return venture projects and thus democratize entrepreneurial finance (Ackermann et al. 2020; An et al. 2019). Subsequently, ICOs have the potential to disrupt established financing processes for ventures particularly in the very early development stages. As ICOs have emerged very recently as a new finance means for ventures, this dissertation examines the interplay of ICOs with other sources of funding (i.e. other investors) as these sources influence ICO outcomes as well as a venture's mid-term success probability.

Given the overall societal and economic benefits generated by the prosperous and dynamic development of the venture landscape, governments also provide financing during this development stage through assistance programs (Cumming and Johan 2007; Koski and Pajarinen 2013). By providing additional sources of financing, governments try to mitigate shortfalls that arise from a lack of private capital markets. Generally, equity financing by public subsidies can be grouped into two categories: non-repayable subsidy grants and public VC. Besides those equity financing means provided directly by governments, venture support is complemented by several means such as tax advantages, subsidy loans, and incubator programs. Often governmental venture support (equity or non-equity-based) is also provided indirectly via research institutions or universities. In summary, public subsidies represent a very heterogenous group of financing sources, differing in selection criteria and funding volume.

2.2.3 Start-up stage

Within the start-up stage, ventures have established their first substantial business operations, and ideally their revenues have begun to grow but in the majority of cases not sufficiently to cover all expenses. This is true particularly if ventures try to gain market shares rapidly and foster growth that leads to a cash deficit (Min and Wolfinbarger 2005). Hence, the need for additional capital gains urgency as ventures in the start-up stage need to cover operating costs and to conduct strategically important investments to maintain their growth momentum and to maximize the venture's future value. From the perspective of the source of capital, the start-up stage is quite similar to the seed stage, with only minor differences. Typically, VC and CVC investors that are already invested provide additional capital during this stage in follow-on funding rounds and lead additional new funding rounds to broaden the investor base. In contrast, some early stage investors such as business angels often sell their stakes at this development stage of the venture. Previously involved external investors contribute usually additional capital to avoid a dilution of their stake in the growing venture when new investors join the venture's investor universe (Megginson 2004; Broughman and Fried 2012).

Another external source of financing (at least in a later phase of the start-up stage) is commercial bank loans. Although information asymmetries and a missing long-standing track record of successful business operations hamper the provision of debt, commercial banks offer selectively specialized financing solutions if ventures fit their lending strategy and exhibit an acceptable risk profile (Ueda 2001; Colombo and Grilli 2007; Ibrahim 2010).

2.2.4 Expansion stage

Ventures that have succeeded in the previous development stages and that have established a running operational business enter the expansion stage (Leach and Melicher 2012). At this stage, the capital needs can be enormous mainly for two reasons. First, as a condition for increasing revenue streams, a simultaneous increase of working capital (i.e. inventories and accounts receivable) is for the majority of all business models indispensable (Baum and Silverman 2004). Second, as ventures in the expansion stage often focus on aggressive and inorganic growth strategies (Kenney and Zysman 2019a; Stayton and Mangematin 2018), capital needs are further increased to enable the venture to conduct relevant acquisitions. At the beginning

of the expansion stage, VC investments remain the most important source of financing. Two additional sources of external capital become available in the later course of the expansion stage.

Private equity funds can be regarded as elder brother of VC funds (Wallmeroth et al. 2018; Achleitner 2001). They usually follow similar structures as VC funds do (Figure 2) and consist of limited and general partners. However, they differ in terms of their risk profile, their amount of contributed capital, their investment focus as well as in their limited partners' investment horizon. The dynamics and size of PE markets can be observed when considering that PE funds raised 385 billion USD through new funds globally in 2019 (McKinsey 2019). While sharing numerous similarities with VC investors, PE investors differ in several aspects when investing in ventures that are in their expansion stage. Usually, PE investors target more mature and established entities (Tykvová 2018) than VC investors do and acquire larger shares. This implies that PE investments tend to be less risky than VC investments are regarding the potential loss of the complete invested capital. Furthermore, PE investors usually make extensive use of leverage when acquiring a company's stake while VC investors focus on equity and equity-like investments. However, the line between VC investors and PE investors has become blurry, and PE investors have started increasingly to acquire minority stakes, driven by return expectations and fiercer competition for attractive investment targets, whereas historically they have focused on majorities and buy-out investments (Brown and Wiles 2015). For example, Postmates[5] received a 225 million USD investment from GPI Capital, a PE investor, while also being backed by several VC investors (Kunthara 2019). Of course, this development is also driven by the fact that several ventures have achieved multibillion-dollar valuation levels, and thus, the size of investment tickets match the criteria of PE investors rather than those of VC investors (Bamberg 2016).

Finally, once a venture has a proven track record and an established business operation, an IPO can be considered as a source of financing. Going public by conducting an IPO, which

[5] Postmates is a US-based company which provides local delivery services of restaurant-prepared meals. Postmates was founded in 2011 by Bastian Lehmann, Sean Plaice, and Sam Street. The company received funding from VC firms such as Spark Capital and Founders Fund as well as from PE investors such as GPI Capital and asset managers such as BlackRock at the same time.

means issuing shares and selling them to a broad investor universe via stock exchanges, represents the most favorable exit option for previously involved investors. Hence, IPOs are often considered as a measurement of success in entrepreneurial finance research (Nahata 2008; Jackson et al. 2012; Bottazzi et al. 2008). In particular, an IPO offers the opportunity for a venture's investors to cash in as the venture's equity will be offered publicly for the first time (Venkataraman et al. 2008). Investment banks play an important role during this development stage as they support and guide ventures with regard to their financing decisions (Lins 2016) and have a significant influence on the successful outcome of IPOs (Bessler and Kurth 2007). Yet going public remains a rarely used source of financing. Hellmann et al. (2005) present evidence that IPOs account only for 25% of all venture exits by number in North America. One reason for this finding might be that IPOs cause large regulatory and organizational efforts such as disclosing a prospectus and stricter governance and disclosure requirements. Gao et al. (2013) present conclusive evidence that the leverage of synergies enables ventures to create a greater value in a sale to a strategic acquirer in the same or related industry than does going public.

2.3 Development of the research questions

2.3.1 Unicorns-what drives multibillion-dollar valuations?

The term 'unicorns' refers to ventures that have always been private, have received at least one funding round of institutional capital, are not a divisional buyout of a public company, and have an estimated market value of 1 billion USD or more (Brown and Wiles 2015). Although public and media interest in this particular subgroup of VC-backed companies has increased since the 2010s, academic research on this topic remains rather limited. In particular, companies such as SpaceX, Airbnb and Stripe or former unicorns such as Facebook and Uber (previous to their IPOs) have gained increasing interest, driven by their innovative technologies, rapid user growth, and high diffusion rates (Koetsier 2016; Waters 2015).

While research in the area of VC and entrepreneurial finance has identified several factors that drive the success probability of ventures in a more general context, existing research largely fails to provide evidence about whether the existing findings can be transferred to unicorns as a very special group of ventures. The success or respectively the valuation levels of ventures are influenced by factors that can be attributed to three categories. First, investors themselves

influence the value of a venture not only by agreeing to a certain share price level but predominantly by contributing to the venture's value creation (Bonini et al. 2012; Jackson et al. 2012). Existing research has not answered the question of whether this positive influence pertains to the case of multibillion-dollar valuation levels.

Second, existing research results have identified economic and environmental factors that influence valuation levels (Dias and Macedo 2016; Romain and van Pottelsberghe de Potterie 2004; Gompers and Lerner 2000b). This includes the question of whether being founded within an innovation cluster impacts the success probability and later valuation levels of unicorns. Finally, venture-intrinsic factors have proven to influence success probability as well as valuation levels. Besides more clear factors such as the quality of the management team (Maschke and Knyphausen-Aufseß 2012), innovativeness and strategy play a decisive role (Häussler et al.; Simon 2016; Stayton and Mangematin 2018). Nevertheless, a second question needs to be addressed by investigating whether the probability of becoming a unicorn is influenced by the same factors that also drive valuation levels.

The empirical contribution of Chapter 3 is twofold by adding insights to both questions and considering different analyses. From a theoretical perspective, Chapter 3 contributes to the literature on investors' influence, which evolves from the resource-based view of firms (Penrose 1959; Barney 1991) by examining investors' characteristics. Further, Chapter 3 adds insight to the literature on spatial distribution of economic success and links these findings to the literature on valuation (Festel et al. 2013; Meglio et al. 2017).

Given the intended research scope that addresses the factors influencing the emergence of ventures with extremely high valuation levels, the first research question is formulated as follows:

Research Question 1: What drives multibillion-dollar valuation levels for an increasing number of ventures

2.3.2 Digital transformation of large corporates: Corporate venture capital and start-up collaborations of German DAX 30 corporates

The speed of technological development and the emergence of disruptive business models have increased considerably during the last decade. This forces incumbents to respond to

these developments to maintain their competitive position. In particular, the ongoing digitalization has recently gained enormous momentum, querying consumers as well as B2B-based businesses (Islam et al. 2017; Jacobi and Brenner 2018; Karimi and Walter 2015). However, incumbents are often hindered by their inertia and their path dependencies which impede them from anticipating new developments in a timely manner (Salomo et al. 2007). It has been widely acknowledged that relevant capabilities and respective knowledge mainly develop outside incumbents' sphere of control at an ever-increasing pace (Ranft and Lord 2000; Sears 2017). As a result, recent research confirms that incumbents need to establish new ways of collaboration and research to exploit respective technologies and knowledge while remaining attractive as partners for ventures by preserving their development and growth opportunities (Cefis and Marsili 2015; Ferrary 2011; Zhao 2009; Ransbotham and Mitra 2010). Particularly, existing research states that future innovations in the digital field will be developed based on co-creation and network processes (Schreieck and Wiesche 2017)

Nevertheless, existing studies mainly focus on the application of CVC as a means of accessing relevant knowledge and capabilities (Gompers and Lerner 2000b; Chesbrough 2000, 2002; Dushnitsky and Lenox 2005), ignoring the rising number of alternative collaboration forms which are often non-equity-based, such as incubator programs and hackathon events (Briscoe and Mulligan 2014; Albort-Morant and Oghazi 2016). Several findings merit being closely examined in regard to their transferability from a wider context to the more specific context of incumbent venture relationship. To investigate whether existing findings from the research on entrepreneurial finance can be transferred to this special incumbent-venture setting remains one of Chapter 4's main research motives, in particular against the background of ongoing digitalization. For example, maintaining networks and being used to conduct research and development collaborations are identified as decisive factors when trying to access external knowledge away from the field of digitalization (Gallego et al. 2013; Cohen and Levinthal 1990). Furthermore, the technological as well as the industry-sectoral proximity between incumbents and start-ups influences the success of these relationships (Cassiman et al. 2005; Colombo and Rabbiosi 2014). Yet it remains unclear if this holds true in the digitalization context. Recent literature provides evidence that very young ventures possess relevant knowledge and that the most appropriate way of accessing this knowledge consists of non-equity-based collaboration forms instead of following traditional paths (Sabidussi et al. 2014; Müller and Hopf 2017; DeMan and Duysters 2005).

Furthermore, when addressing the lacking capabilities and knowledge of incumbents, with regard to the ongoing digitalization, the majority of research has drawn on the resource-based view which circumscribes firms as a bundle of resources that generates rents for the firm. The resource-based view does not consider dynamic relationships between resources or the influence of individuals (Penrose 1959). Chapter 4 draws on the dynamic capabilities approach which has emerged from the resource-based view (Eisenhardt and Martin 2000; Teece et al. 1997). The dynamic capabilities approach primarily considers the dynamic processes by which organizations change not only their resources and routines but also their products and services to adapt to changing environments (Teece 2014). The contribution of Chapter 4 is manifold. First, the empirical contribution provides evidence from the German market on the increasing dissemination of collaborations between incumbents and very young ventures. Second, Chapter 4 establishes a conceptual framework by categorizing different collaboration types between incumbents and ventures depending on the maturity level of the venture. Third, Chapter 4 identifies success-influencing propositions by transferring findings from different contexts to the area of considered relationships. Chapter 4 contributes to the literature on dynamic capabilities by identifying the most relevant processes for establishing seminal relationships between incumbents and ventures that drive innovations and digital transformation. In particular, Chapter 4 investigates the importance of absorptive capacity as an integral component of the dynamic capabilities framework (Cohen and Levinthal 1990). Summarizing the outlined research setting, the second research question is formulated as follows:

Research Question 2: How can incumbents make use of CVC and start-up collaborations to drive their digitalization?

2.3.3 Which investors' characteristics are beneficial for ICOs? Evidence from blockchain technology-based firms

While VC, business angels and crowdfunding are rather established means of financing young ventures, the recent occurrence of ICOs represents a disruptive change for capital sourcing in terms of volume as well as with regard to the underlying processes (Malinova and Park 2018; Ante et al. 2018; Fisch 2019; Fisch and Momtaz 2019). As ICO characteristics

do not match with existing means of financing, ICOs can be regarded as a completely new player in venture financing, particularly for blockchain-related ventures (Block et al. 2018).

However, the few existing empirical contributions show that a considerable number of BTBFs do not rely solely on ICOs but also consider additional capital providers, such as VC, in parallel (Kharif and Russo 2018; Russell 2018; Kastelein 2017). This development is further reinforced by the fact that VC investors traditionally aim to invest in new emerging technologies which offer the opportunity for strong future growth (Rosenbusch et al. 2013; Zacharakis et al. 2007). Hence, the blockchain industry and BTBFs are becoming increasingly attractive as targets for VC investors (Huang et al. 2019).

The research interest in the field of ICOs has increased considerably since the mid-2010s, mainly driven by the high amounts of provided capital (Xu et al. 2019; Bakos and Halaburda 2019, 2018). Studies have mainly elaborated success determinants of ICOs. Adhami et al. (2018), for example, examine the influences of disclosing a whitepaper[6] and the role of token presales. Furthermore, Ante et al. (2018) present findings on the influence of social media, business model quality, and human capital on the amount of funds raised in ICOs, while Fisch (2019) discusses the role of technical capabilities.

Apart from these ICO-focused findings, the question remains if the interplay between different capital providers has an influence on the success of BTBFs that conduct an ICO. This means it is currently unclear whether the existence of early stage investors that are invested prior to or during an ICO event has an impact on an ICO's success as well as whether this potential impact lasts during the mid-term development of BTBFs. This leads also to the question of which investor conditions and characteristics influence an ICO's success and if they maintain their relevance in the BTBF's midterm development.

Existing research in the field supports a positive effect of VC investors on the outcome of ICOs (Fisch and Momtaz 2019). In particular, Fisch and Momtaz (2019) present empirical evidence that VC investors are not per se able to select BTBFs of superior quality, which results in higher amounts of raised funding in ICOs, but that VC investors add value by their

[6] A whitepaper is a detailed description of a project for which an ICO is hosted. Usually, the whitepaper outlines the existing problem and a clear solution. Furthermore, a whitepaper discloses key technical information and the details on the team behind the project. The respective document is published in advance to an intended ICO.

treatment. Although existing research has identified the beneficial influence of VC investors on an ICO's outcome, a more nuanced view on the influencing characteristics of VC investors is lacking. Furthermore, existing research has not considered so far whether the execution of an ICO itself is influenced by unobservable factors and if the funding amount in an ICO, as a success measure, may be biased by a selection effect.

Therefore, the third contribution of this dissertation enriches the discussion by examining different characteristics of VC investors (that are invested prior to or during the ICO) and their influence on the ICO outcome as well as whether these influences hold in the mid-term development. From a theoretical perspective, Chapter 5 draws on the signaling theory of Spence (1973), as VC investment is enabled by signals that are sent by the respective BTBF but represents also a signal to other potential investors. Hence, this dissertation deduces the third research question as follows:

Research Question 3: How do investor characteristics and in particular VC influence the outcome of ICOs and the midterm development of BTBFs?

3 Unicorns-what drives multibillion-dollar valuations?[7]

3.1 Introduction

During the last decade a comparably new development began to evolve in the field of venture capital (VC) with the increasing occurrence of so called 'unicorns'. Originally introduced by Aileen Lee (Brown and Wiles 2015) the term 'unicorns' describes companies that have always been private, have received at least one funding round of institutional capital, are not a divisional buyout of a public company and have an estimated market value of 1 billion USD or more (Brown and Wiles 2015). In fact, it could be observed that an increasing number of ventures refuse to go public but remain privately owned instead. In order to cover their capital requirements, extended sources of private financing are necessary. So in contrast to previous periods, the median amount of total capital raised by unicorn firms in private financing rounds exceeds the median of technology-based IPOs in the meantime (Brown and Wiles 2015). That is why several studies refer to these financing events as "private IPOs" (Milanesi 2012; Kensinger et al. 2000; Brown and Wiles 2015). Although the public and media interest in this particular subgroup of VC-backed companies increased since the 2010s, academic research on this topic remained rather limited.

To a certain extent, this lack of studies might be given due to the general scarceness of data in the area of VC (Kaplan and Lerner 2016) which also persists in the case of unicorns. Especially as some studies see the possibility to retain sensitive financial and operational data private for a prolonged time period as an advantage of private ownership (Fenwick and Vermeulen 2015) compared to IPOs and related disclosure procedures. Furthermore, unicorns are still quite rare compared to the remaining universe of ventures. However, the lack of research is quite striking as today's unicorns are expected to disrupt large industry sectors (Divan 2016) which will bring major changes to everybody's daily life. Due to this, politics and governmental institutions recognized the importance of this disruptive potential and started to examine the

[7] This empirical contribution has been published at the **Business Research** as follows: Bock, Carolin; Hackober, Christian (2020): Unicorns—what drives multibillion-dollar valuations?. In: Business Research (Bus Res) 13, pp.949-984. Prior conference contributions are as follows: Bock, Carolin & Hackober, Christian (2020): Unicorns-what drives multibillion-dollar valuations?. Accepted for presentation at 2020 **Babson College Entrepreneurship Research Conference**, Knoxville, TN. Conference canceled due to Coronavirus.

evolution and location behavior of unicorns (Simon 2016). However, as the current research on unicorns is still rather nascent, one needs to focus on the more general literature and research that discusses high valuation levels in the area of VC. This is in particular the case as existing research that examines unicorns specifically is mainly limited to descriptive studies which report the rise of this phenomenon but do not identify factors that drive the probability for ventures to achieve multibillion-dollar valuations.

Previous research has identified that a start-up's valuation is based on numerous factors including factors that can be observed (e.g. industry, VC investor's quality) as well as on factors that are not publicly known (e.g. company's sales and assets) (Gompers et al. 2006). Due to the better availability of data and more meaningful results, existing research was conducted mainly considering observable factors. For example, Nahata (2008), Ebbers and Wijnberg (2012), Phalippou (2010) and Cumming and Dai (2011) found that the characteristics of investors and their respective quality have a strong impact on the valuation levels of portfolio companies, whereas other studies see the degree of innovation of companies as dominant factor for ventures to become successful (Da Rin et al. 2011). Furthermore, Miloud et al. (2012) find sales growth to be a decisive criterion when assessing high valuation levels especially in the high technology industry. Interestingly, Bergemann et al. (2008) show that high valuations in the venture's starting days do not necessarily lead to high valuation levels in later funding rounds which gives some indication that stakeholders along the venture's lifecycle have a material influence on the success probability and ultimately on the valuation levels. In contrast to this finding, Rungi et al. (2016) find that the valuation for ventures, which exceed the 10 billion USD threshold in later funding rounds, is already significantly higher in the second funding round which points to the special nature of unicorns.

However, given the extremely high valuation levels and the meteoric rise of unicorns as well as their unique and strong impact on all stakeholders, we presume that unicorns do not follow entirely common valuation patterns as they remain a very special phenomenon. Taking this into consideration, we conclude that the valuation and success factors of unicorns differ from factors that influence typical and common ventures, making unicorns a very special phenomenon which requires research on the question which factors drive the likelihood of becoming a unicorn.

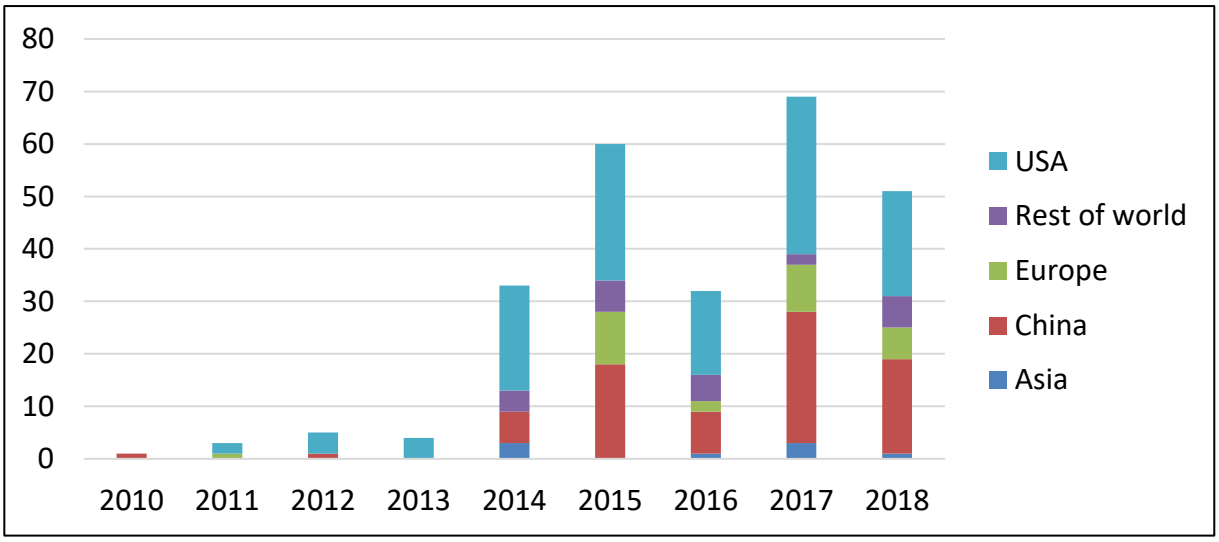
In order to establish a better understanding of unicorns and their valuation levels, we shed light on the question what drives the probability for young ventures to become a unicorn by identifying differentiating characteristics of ventures. Further, we answer in a second analysis the question what factors are decisive that some unicorns outperform "common" valuation levels. By providing answers to these questions, the contribution of our work is twofold. First, we contribute to the growing literature regarding the growth and emergence of ventures and more specifically on determinants for venture valuation (Grilli and Murtinu 2014; Lerner 2010; Mason and Brown 2014). We provide novel insights how investors' characteristics and economic conditions impact the likelihood for ventures to become a unicorn and hence identify critical influences for venture success. Thereby, our findings can be generalized to a certain extent and transferred to the more general question which conditions influence the success probability of young ventures and how they can be supported on their growth path. Further, our results are relevant to the valuation literature, as we confirm the hypothesis that the growth strategy has an impact on valuation levels (Gompers et al. 2016; Salamzadeh and Hiroko 2015; Meglio et al. 2017) but show simultaneously that other factors might be overestimated in prior research.

3.2 Theoretical considerations and hypotheses development

Reviewing the list of unicorns, the often-cited concentration of unicorns in certain geographical areas becomes obvious. More than three-quarter of the current unicorns are based in the US and China. The number of China-based unicorns increased continuously since 2014, whereas the number of unicorns founded in the US remains rather stable (Figure 3).

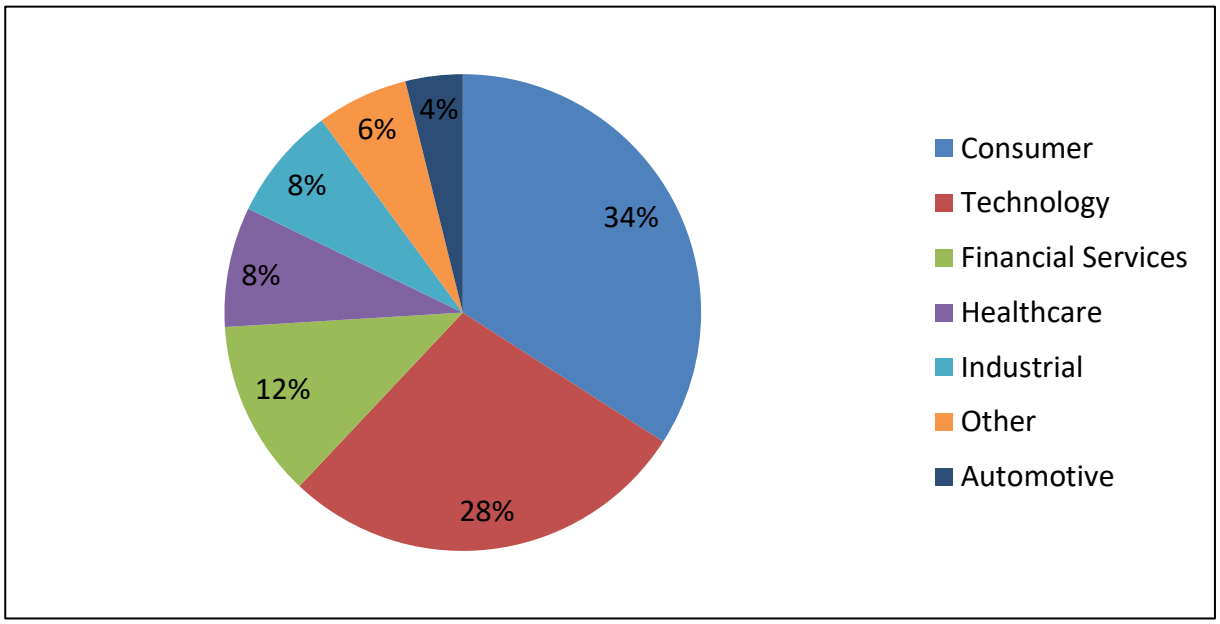
Further, by reviewing US- and China-based unicorns in detail, a clear domination of certain local areas becomes obvious. Whereas in the US a clear domination of the Silicon Valley, followed by the New York area is observable, most unicorns are based in Beijing and Shanghai in China.

Figure 3: Number of 'unicorn births'
The figure presents the number of ventures that achieve a 'unicorn-status' i.e. achieve a valuation level of more than 1 billion USD per region and year.



However, the speed of the rise of unicorns seems to decrease after reaching its peak in 2017. Figure 3 shows the slowdown as the number of ventures which became a unicorn in 2018 was 26% below that of 2017.

Figure 4: Unicorn sectors in 2018
The figure presents the sector allocation of all unicorns that are considered in our analysis as per end of 2018. N=235



The majority of all unicorns operate in the consumer and technology sector followed by unicorns that are active in the field of financial services (Figure 4). Similar to the origin of unicorns,

the majority of unicorns' initial lead investors are based in the US, however, we see an increase of investors based outside the US over time.

Although, we find an increasing public awareness for unicorns, this special form of VC-backed companies has received only limited attention in the current academic discussion so far. Therefore, it seems reasonable to review the more general literature on VC and start-up valuation first and subsequently to deduce relevant aspects for unicorns. By doing this, we identify three potential general areas of influence that might impact the success as well as the valuation of ventures and which can serve as a basis for deducting hypotheses.

First, we find investor-related factors in existing literature as an influencing category for the success probability of ventures. Experience and investor's skills have a direct influence on the performance of a VC-backed company (Bengtsson and Wang 2010; Gompers et al. 2006; Achleitner et al. 2013; Bottazzi et al. 2008). Especially in the case of venture financing, this aspect seems to be important as VC investors provide usually additional advice in comparison to pure financial backing (Bonini et al. 2012; Jackson et al. 2012).

Second, we identify economic and environmental factors as influencing category for the success probability of ventures in existing research. Innovation clusters represent a special type of economic environment. Further, past research has identified a relationship between overall economic conditions and valuation levels of ventures (e.g. GDP growth, interest rates, number of IPOs) (Dias and Macedo 2016; Romain and van Pottelsberghe de Potterie 2004). This factor is relevant as funds increase the implied valuation of their investments in times of higher capital inflows (Gompers and Lerner 2000a).

Last, company-intrinsic factors, i.e. the quality of the venture and its management team, seem to play a role for the success probability (Maschke and Knyphausen-Aufseß 2012). Although it is quite difficult to measure the quality of a venture, the innovativeness seems to have a positive influence on the potential success of a venture (Block et al. 2015; Häussler et al.).

3.2.1 Hypotheses development

Based on the review of existing literature, we develop four hypotheses which we consider as most relevant when assessing whether ventures will achieve a unicorn status and the level of their respective valuation.

3.2.1.1 Investor reputation

A firm's reputation can be described as an intangible asset that is based on public recognition of the quality of a firm's activities and outputs (Shapiro 1983; Lee et al. 2011; Rindova et al. 2005). In particular, reputation, which results from a VC firm's prior experience and performance, is economically important (Achleitner et al. 2018) as it can generate future rents by reducing information asymmetries among different actors (Hsu 2004). In the case of ventures and their respective investors that means that entrepreneurs are able to select superior investors based on their reputation although they did not previously interact with them. For investors, the reputation construct comprises their experience, their network capabilities and the level of direct assistance which they provide to portfolio firms (Hsu 2004). Thereby, highly reputed investors can generate superior performance through two general levers (Haagen 2008; Tykvová 2018). First, it is presumed that they invest in superior ventures (selection effect) and second, their strong operational support for their portfolio companies (e.g. mentoring, financial assistance (MacMillan et al. 1989)) facilitates the successful development of the venture (treatment effect). Given the current levels of capital inflow and the availability of financial capital, reputation gains increasing institutional and investors' awareness for certain venture capitalists as financial capital per se is not a differentiating factor among the VC investor universe (Hsu 2004). As a consequence, investors that possess a higher reputation create a higher visibility for themselves (Krishnan et al. 2011; Megginson and Weiss 1991) and attract ventures of superior quality which in turn have a higher probability to achieve a unicorn status.

Furthermore, investors and especially VC firms with high reputation attract fund managers and decision makers with high qualification (Cumming and Dai 2011). Given that, VC firms with higher qualified employees can make better investment decisions and hence invest with a higher likelihood in later unicorns. In addition, more reputable VC firms tend to operate a larger network within their industry (Alexy et al. 2012), which enables them to obtain an information advantage with regard to lucrative investment opportunities. On the other hand, a high reputation together with a proven track record increases the likelihood for a VC firm to receive higher investments (Groh and Liechtenstein 2011). This aspect is relevant as high capital inflows are the basis for the ability to invest in ventures on their unicorn track in consecutive investment rounds, especially to avoid a potential dilution of earlier acquired stakes. Interestingly, Hsu (2004) found that entrepreneurs are even willing to accept a discount on the valuation of their ventures in the first funding rounds in order to access the capital of investors

with a high reputation which might be beneficial in the long run. Bygrave and Timmons (1992, p. 208) state “It is far more important whose money you get than how much you get or how much you pay for it”.

Nonetheless, beside the superior investment selection made by more reputable investors, which should increase the probability for those ventures to become a unicorn, those VC investors also provide support and advice during their investment period and thus influence ventures’ operations directly by interacting with management teams (Alperovych and Hübner 2011). In addition, close relationships between investors and their portfolio companies enable investors to establish a better monitoring which conclusively increases success probabilities of their ventures (Bernstein et al. 2016). Furthermore, investors’ support include business referrals, extensive mentoring, and financial assistance (MacMillan et al. 1989; Breuer and Pinkwart 2018) as well as recruiting executive managers (Hellmann and Puri 2002).

In particular, business referrals should help ventures to increase their speed of growth, especially if these referrals are based on the investor’s network. Lindsey (2002) provides empirical evidence for the so called “keiretsu” phenomenon which describes that investors and in particular VC investors act as information brokers in imperfect information markets between different ventures, customers and future investors. More reputable investors have a larger number of portfolio companies making it easier for them to broker strategically important information among them (Hsu 2004). Hence, more reputable investors facilitate the establishment of collaborations between ventures and provide easier market access for them by giving referrals to other market participants. Thus, Lee et al. (2011) conclude that the longer the involvement of reputable investors lasts, the more likely they will add substantive value to the respective ventures.

Finally, a reputable investor group bears also a signaling effect for other investors in subsequent funding rounds. Future investors are more open to commit higher amounts of capital if they find highly-reputable existing investors among the venture’s group of investors. The reputation thereby takes on the role of a certification of the venture (Megginson and Weiss 1991). Of course, this effect leads to a rather increasing valuation and therefore increases the probability for ventures to achieve a unicorn status.

Taking these aspects into consideration, we derive the following hypothesis:

Hypothesis 1: *A high investor reputation increases a venture's probability to achieve unicorn status.*

3.2.1.2 Economic clusters

Past research has identified several factors that foster the establishment of new ventures in certain geographical areas, leading to clusters of innovation. Originally, three players were identified that facilitate the creation of clusters: universities and research institutions, large companies and the government (Leydesdorff and Etzkowitz 1996). However, recent research demonstrates that the establishment of clusters is way more complex and applies complex network theory to shed some light on the operating principles of innovation clusters (Ferrary and Granovetter 2009). Generally, clusters provide unique conditions for new ventures and consist of a network of companies that are geographically concentrated (Khan and Ghani 2004) which can be described as an ecosystem that promotes the creation of companies and enhances competitiveness (Yamawaki 2002; Sternberg and Litzenberger 2004; Carlsson 2002; Lemarié et al. 2001). Clusters show higher growth rates than other regions and past research found that the performance of young firms benefits from being founded within such clusters (Gilbert et al. 2008; Delgado et al. 2010). Subsequently, we assume that being founded within one of these ecosystems influences also the occurrence of unicorns.

First of all, the availability of human capital is thereby a differentiating factor. In particular, the availability of highly educated people seems to be essential for the establishment of innovative venture firms. Hence, Calcagnini et al. (2016) showed that the distance to universities is positively correlated with the creation of innovative ventures. Beside of the availability of human capital, they identified also other spillover mechanisms like patents, collaboration agreements and university spin-offs as favorable for the establishment of new ventures (Ubeda et al. 2019). Further, being founded within a cluster provides new ventures the opportunity to access marketplaces early, as potential customers of new innovative products are also part of the cluster, and give faster feedback on the functionality of the products (Gilbert et al. 2008). As a result, cluster participants should be able to adapt their products faster to customer needs and ultimately offer superior services or products. This goes in line with the argument that clusters force new ventures to be more competitive as competition is higher in these regions (Gilbert et al. 2008) but facilitates also differentiation behavior as entrepreneurs can

recognize gaps in existing products or services and fill them by providing new products or services (Gilbert et al. 2008).

In addition to these rather venture specific influences, clusters offer usually better financing conditions for new ventures based on the high availability of private capital in these regions. In fact, technology and innovation clusters typically show a high density of VC investors which provide the required funding for new ventures on their growth paths (Castilla 2003). Clusters facilitate the access to this funding and hence increase the speed of development of the respective ventures (Inderst and Müller 2004; Gaba and Meyer 2008).

In the US, past research has predominantly identified three relevant clusters when examining influencing factors and ecosystems for innovative ventures. First of all, the Silicon Valley serves as quasi role model for an innovation and technology cluster which is at the same time the origin of some of the most renowned and reputable VC investors (Saxenian 1994; Feldman 2001). Rosenthal and Strange (2003, p. 377) assume Silicon Valley to be "one of the most productive economies on the planet" in the area of software and computer-related industries. Further, the greater Boston area (Route 128) has been identified as a successful case for an innovation ecosystem in the biopharma area by Panetti et al. (2019) and was also included in the research of others (Feldman 2001).

However, beside Silicon Valley and Route 128, New York is the third area that has been identified as a regional area that produces a considerable number of new ventures majorly in the fintech area due to its strong financial sector (Romanelli and Khessina 2005; Zhang 2009).

Though, during the last years, new clusters evolved predominantly in China. Accompanied by the general economic rise, the Beijing area as well as the Shanghai area became clusters for the foundation of new innovative ventures including the provision of university and knowledge infrastructure as well as sources of funding (Long and Zhang 2011; Zhou and Xin 2003). Both regions are among the most innovative provinces in China (Wang et al. 2015). Although, these clusters are younger than established ones like the Silicon Valley, we assume that the venture development within these clusters follows basically the same patterns. In particular, we assume that unicorns, as unquestionable the most successful representatives of VC-backed companies, benefit from the conditions within clusters. Hence, we derive the following hypothesis:

Hypothesis 2: *Ventures that are founded within a technological innovation cluster possess a higher likelihood to become a unicorn.*

3.2.1.3 Corporate venture capital

During the last years, a couple of new investor types for financing new business ventures entered the market (Block et al. 2018). In particular, the activity level of corporate venture capital (CVC) investors rebound after it had collapsed following the bursting of the dotcom bubble. However, objectives and investment conditions set by CVC investors are different from independent VC investors. Goals and objectives for CVCs can be generalized only to a certain degree due to the fact that CVC programs are as unique as their parent corporations, although, they have one thing in common. Instead of being just a financial activity, CVC investors can be regarded as a combination of strategic and financial operations (Rossi et al. 2017; Block et al. 2018).

In most cases, CVCs try to obtain access to new technologies, markets and high qualified employees when investing in ventures. Usually these attempts include to leverage innovations of the venture (Galloway et al. 2017). This might be beneficial for the ventures as CVCs offer access to non-financial assets of the parent corporation. These services include expertise and infrastructure for product development, manufacturing, legal, sales, distribution and customer service activities among others (Park and Steensma 2012). Offering this non-financial support may facilitate the development of the venture and help to avoid failures compared to ventures backed by independent investors only, as they often lack relevant industry experience. Following this argument, Rossi et al. (2017) found that corporate investors engage with ventures in a more meaningful way by connecting them with the broader entrepreneurial ecosystem.

Indeed, providing ventures with support to access complementary assets differentiates corporate investors from pure financial investors and can help ventures to commercialize their products or services (Paik and Woo 2017; Röhm et al. 2018). In particular, there seems to be certain evidence that the level of innovativeness and the research intensity increases when corporate investors grant access to those complementary assets (Alvarez-Garrido and Dushnitsky 2016) which is in line with Kelly and Kim (2018) who find a positive relationship between general VC-backing and the growth in R&D expenditures and Park and Steensma (2013) who find that rates of innovation enhance in particular for ventures funded by corporate investors.

As we consider unicorns as highly innovative, the more general findings regarding the innovativeness and corporate-backing are transferable without any limitations to unicorns as a special subset of ventures. Furthermore, established corporate investors can reduce the widespread uncertainty for new technologies that are introduced by innovative ventures. By backing these ventures, incumbents generate a technology endorsement effect as they signal markets that they are convinced by a technology which is a strong argument for other market participants to apply these products (Paik and Woo 2017). Thus, receiving funding from a CVC investor can be regarded as a certification for the venture's products or services. As many unicorns have developed disruptive and innovative products and services, we assume that the technology endorsement effect should hold especially for this subgroup of ventures. In particular, the endorsement as well as the certification effect is supposed to have a positive influence on the development of ventures by lowering market entry barriers for them and enabling stronger sales growth.

Further, Chesbrough (2002) found that CVC investors are more patient when it comes to returns and exits. In fact corporate investors have less time constraints in their investment horizon (Paik and Woo 2017) which enables ventures and subsequently later unicorns to spend more time to develop products and services which could lead to a superior quality of the latter which should also be beneficial for the development of unicorns. Furthermore, more patient CVC investors are willing to remain invested for a longer time than independent VC funds with a finite lifetime and hence enable high follow-on funding rounds instead of promoting an exit through an IPO which gives unicorns the possibility to grow (Wadhwa and Phelps 2009; Guo et al. 2015).

Past research has found some evidence that CVC can outperform independent VC investors at least if there is a strategic fit between the venture and the investor (Morck 2000). Taking the different influences and effects into consideration we derive the following hypothesis:

Hypothesis 3: *CVC-backing increases a venture's probability to achieve unicorn status.*

3.2.1.4 Growth strategy

In general, it is difficult to answer why, e.g. Airbnb, achieves a post-money valuation of 30 billion USD without having any relevant assets and even more interesting for what they spend

almost 4 billion USD of funding without having a research-intensive or high-tech business model (Filloux 2014). But having a closer look at unicorns and prospective candidates, it becomes obvious that a lot of their valuation is based on market shares and strong growth rates.

One of the reasons for this development is that investors often accept growth metrics as proxies for value and hence are primarily interested in increasing users, engagement, customer acquisition, retention rates and revenues. Thereby, investors are comfortable to absorb high losses if they see a chance to lock-in "a position to generate quasi-monopolistic profits and, by extension, enormous capital gains" (Kenney and Zysman 2019b, p. 46).

A second reason for this strong focus on growth is that unicorns and their respective investors aim for a market dominating position especially when operating a platform business model and thus try to drive incumbents and other new entrants out of their market by acquiring them (Kenney and Zysman 2019b). VC investor Solomon (2015) reasons also that most of the valuation is about market shares and the ability to overwhelm competitors which is in line with the findings of Kaplan and Strömberg (2000) who find that it is decisive in investment decisions for investors that ventures offer high growth potentials in particular through acquisitions.

As a result, unicorns become often – as Ramadan et al. (2014) call them – "category king" as they define, develop and dominate new markets.

However, in order to gain market shares rapidly in a highly competitive environment with low market entry barriers, unicorns and prospective candidates are forced to make add-on acquisitions. This is in line with Stayton and Mangematin (2018, p. 28) who find "to be first to market in winner-takes-all-market niches" as key success factor for the creation of new ventures. The general application of "buy and build" or "inorganic growth" strategies in order to generate value is thereby already well known from the private equity domain (Hammer et al. 2017), however, in a less aggressive manner. In practice, the aggressive inorganic growth strategy can be observed for example in the case of Snapdeal, an Indian e-commerce company, which acquired 7 companies in 7 months in 2015 backed up by previous big ticket investments (Tiwari et al. 2019).

Thereby, inorganic growth strategies cannot only be beneficial from a market share and sales perspective but also from a cost perspective. Add-on acquisitions offer the opportunity for the acquirer to leverage synergies and hence to drive the value of the combined businesses (Hammer et al. 2016; Das and Kapil 2015). Furthermore, inorganic growth allows the acquirer to

access technologies (Zou et al. 2010) and assets which are possessed by the acquisition target and which can be used more efficiently or reallocated following the transaction (Borell and Heger 2013). Subsequently, a higher asset utilization rate or more favorable asset allocation generates certain value for the combined firm. Lastly, the conduction of add-on acquisitions enables the respective venture to overcome the "liabilities of smallness" faster as larger firms have easier access to capital and labor and are less vulnerable to external shocks, which is reflected in a valuation premium and favored by investors (Hammer et al. 2016).

While following aggressive growth strategies, this strategy enables some kind of self-enforcing development as ventures need capital to execute add-on acquisitions and become more likely funded due to their higher market share at the same time. At first glance, that seems to be a chicken or egg dilemma which it is not in fact as the venture or potential unicorn needs an initial funding to dispose of the capital needed for add-on acquisitions (Hammer et al. 2017). Rather, it seems reasonable to presume that investors are able to identify promising start-ups and support them on a rather aggressive strategy to gain market share (Kaplan and Strömberg 2000). This development is in line with Hammer et al. (2017) who presume that inorganic growth strategies are deterministic and planned components of the investment case rather than the result of opportunistic behavior during the holding period.

Though, ventures are required to achieve a "critical" size from a funding perspective in order to have sufficient financial resources and the capabilities to execute acquisitions. Hence, although inorganic growth strategies and potentials related to it might already exist in the very beginning of a venture, they become only obvious when being executed in a later funding round of a venture.

This leads to the following hypothesis:

Hypothesis 4: *Inorganic growth is driving post-money valuation of unicorns.*

3.3 Data

As our research addresses two different questions, we perform two independent analyses with different data samples. First, we conduct a hierarchical logistic regression analysis in order to examine which factors are driving the likelihood for ventures to achieve a unicorn sta-

tus, i.e. a post-money valuation of more than 1 billion USD. Second, we conduct a linear regression in order to assess our hypothesis that the post-money valuation of unicorns is primarily driven by their inorganic growth strategy. For both types of analysis, we construct a unique dataset as described in the following.

3.3.1 Dataset

Our sample comprises 258 VC-backed companies valued with 1 billion USD or more based on their post-money valuation. The list and post-money valuation of identified companies was retrieved from CB Insights global unicorn club list as per Nov 4th 2018 (CB Insights 2018). Due to missing data, we needed to reduce our sample size to 215 individual unicorns in our analysis. In particular, we face missing founding dates as well as latest funding dates which are required to control for the economic environment during this time and to construct our peer group. Furthermore, for ten unicorns, the initial investor was not disclosed and hence the assessment of reputation not possible.

To answer the question which factors drive the probability for ventures to become a unicorn, we make use of a peer group comparison. Subsequently, we have identified a direct peer for 113 unicorns which results in a total dataset of 226 companies (113 unicorns and 113 peers i.e. non-unicorns). For the exact matching procedure, we applied a similar procedure as Puri and Zarutskie (2012) as exact matching is the simplest and the most robust way to match two observations (Kelly and Kim 2018). Exact matching thereby describes a procedure which identifies peers based on the same numerical figures for given covariates. Usually that results in robust results but can be highly data-intensive for large datasets (Kelly and Kim 2018). Thus, the selection process conducted three steps in order to ensure a high similarity between unicorns and their peers and to limit external influences. First, we assumed for all peers that they are based in the same country. Second, we take only peers that are operating in the same industry as the unicorns based on the Crunchbase data and last, we request for peers that the founding dates are within a period of time of less than 12 months. Further, we needed to reduce the sample size for our second analysis (linear regression) from 258 unicorns to 235 due to missing data.

Remaining data on company and funding round details is also derived from Crunchbase, a free online database which was founded in 2005 and which provides information about technology companies, investors, and funding details majorly focused on the US market.

Though the Crunchbase database is comparably young, it becomes increasingly popular in VC research (Werth and Boeert 2013; Homburg et al. 2013; Croce et al. 2016; Schlichte et al. 2019). Further, the coverage of Crunchbase is on a comparable level to other more established data sources like Thomson One Private Equity (Werth and Boeert 2013) or data recorded by the National Venture Capital Association (Huang and Zhan 2015; Block and Sandner 2009). Potential biases, arising from the geographical focus of Crunchbase, have been considered and taken care of by cross-checking the completeness of the company list with other sources, e.g. CB Insights. Further, we conduct a web search to validate our data by comparing the unicorns' websites with the data in our sample. In particular, we check the unicorns' founding locations in order to reduce potential bias that might arise from any relocation developments. In addition, we compare the disclosed post-money valuation of each company in the sample in the Crunchbase and CB Insight database. Thus, we cannot detect any systematic bias but confirm the high data coverage of Crunchbase. Numbers for GDP growth in respective countries were taken from World Bank's World Development Indicators database.

3.3.2 Variables

3.3.2.1 Dependent variable

We apply two dependent variables for our research. For the analysis of factors that drive the likelihood to achieve a valuation above 1 billion USD we take a dummy variable which equals one if the respective company is a unicorn and zero otherwise (logit model). This modeling is particularly necessary as no reliable post-money valuation is available for most ventures and ventures that are valued below 1 billion USD.

Further, we take the post-money valuation to examine influences in the group of unicorns (linear regression model). We consider that the post-money valuation of unicorns as dependent variable fits best our research purpose although we are one of the first studies using this variable as success measure. Another advantage of our selection is that the post-money valuation is a continuous variable compared to previously used binary variables, thus providing an information gain. However, the post-money valuation of ventures is only available in a reliable

manner for unicorns. Hence, we apply this variable only for unicorns in the respective analysis but not for peers or analyses that include peers. Due to the high skewness of the post-money valuation in our sample, we apply the natural logarithm of the post-money valuation.

3.3.2.2 Independent and control variables

Historically, the age of an investor was argued to be a good proxy for the reputation of an investor. However, this does not consider any success-related components except the survival of an investor.

To overcome the shortcomings which arise from age as a reputation measure, recent studies apply new reputation indicators. Beside the total number of investments made by a VC firm, the share of investments exited via an IPO became a popular measure of investor reputation (Nahata 2008; Jackson et al. 2012; Bottazzi et al. 2008). This measure is based on the assumption that IPOs are the most favorable exit option for investors. Companies that undergo an IPO need to convince the public capital markets of their quality and offer on average abnormal high returns for their VC investors. Therefore, IPOs are typically the most profitable way to exit investments but the most complex way at the same time.

In order to test our hypothesis that more reputable investors increase the likelihood for ventures to achieve the unicorn status, we refer to the investor which acted as lead investor in the first (initial) funding round. Focusing on lead investors is in line with current research as the lead investors have the closest relationship with the portfolio company in investor syndicates and thus exert great influence (Li and Mahoney 2011; Wright et al. 2004; Krishnan et al. 2011). In addition, their equity stake usually exceeds that of the remaining investors. Further, focusing on the initial funding round is reasonable as early investors have a large influence on the venture's development due to their typically long investment history with the venture and due to their ability to shape the venture's strategy (Hsu 2004; Stayton and Mangematin 2018).

The reputation (*Inv_IPO Share*) was calculated following a similar approach like Nahata (2008) by taking the average of the yearly percentage share of IPOs backed by a specific investor compared to all IPOs in the same year. For calculating the reputation, we refer to a timespan from 1990 until 2018.

In addition, we include a dummy variable indicating whether the venture received funding by a CVC firm or not (*CVCinvestor*) in order to assess the influence of the latter and to test the

hypothesis whether ventures that receive funding from CVC investors exhibit a higher likelihood to become a unicorn.

To answer the question whether the foundation of ventures within innovation clusters influences the likelihood to become a unicorn, we incorporate dummy variables in our analysis. These dummy variables equal one if the venture is located within the respective region and zero otherwise (*SiliconValley_Target, Boston_Target, NewYork_Target, Beijingarea_Target, Shanghai_Target*).

To address the question whether strong and aggressive growth is driving the valuation of unicorns, we use the number of add-on acquisitions (*#Addon_acquisitions*) to account for non-organic growth as there is evidence for the existence of a "winner takes it all" premium (Simon 2016; Stayton and Mangematin 2018) for industry/market-dominating ventures.

To account for additional influences on the likelihood for new ventures to become a unicorn, we include the following control variables in our model. A lot of recently founded ventures operate in internet-related businesses in a business to customer (B2C) setting (Li and Mahoney 2011). Therefore, we include a dummy variable indicating if the respective unicorn's or peer's business model is related to the internet or mobile apps as well as a dummy variable that indicates if the unicorn or peer acts in the B2B sphere. The variable equals one if the company's business is app or internet related and zero otherwise (*Internetorapprelated*). The B2B variable (*B2B*) equals one if the company operates in the B2B sphere and zero if the company operates a B2C business model. Further, we include a dummy variable that equals one if the respective unicorn or peer operates a platform business model and zero otherwise (*Platform*). In addition, we control for the founding team size (*#founders*) following Bhawe et al. (2017) and Ratzinger et al. (2018) in order to account for the effects evolving from the diversity of founding teams (Eesley and Roberts 2012), particularly as founders' characteristics and team size have been identified as influencing factors in past research (Bernstein et al. 2017; Rungi et al. 2016).

We include the GDP growth in the year of founding (*GDP_growth_founding*) to control for general market effects on the respective founding behavior. Further, we control for the age at latest funding (*Age*). To control for the effect of overall economic conditions, we include the GDP growth during the latest funding round in the respective country (*GDP_growth_latestfunding*).

3.3.3 Descriptive statistics

Table 3 presents descriptive statistics of the variables used in the empirical analysis of all unicorns we have identified (Panel A). Further, Table 3 presents descriptive statistics for unicorns and identified peers (Panel B) and for the respective peers (Panel C) separately. T-tests for the comparison of means indicate that unicorns and respective peers differ to some extent, depending on the variables considered in our analysis.

Table 3: Descriptive statistics and comparison of means

The table presents descriptive statistics for all applied variables. Panel A presents statistics for all unicorns (irrespectively whether a peer was identified or not), Panel B presents statistics for unicorns with a matching peer and Panel C presents statistics for the corresponding peers. Panel D presents a comparison of means for Panel B and C.

	Panel A: All Unicorns			Panel B: Peer relevant unicorns			Panel C: Non-Unicorns (Peers)			Panel D: Comparison of means
Variable	Observations	Mean	Std. Dev.	Observations	Mean	Std. Dev.	Observations	Mean	Std. Dev.	t-Value
Dependent										
log_post-money val	235	0.63	0.81	113	0.67	0.81	-	-	-	-
Unicorn status	235	1.00	0.00	113	1.00	0.00	113	0.00	0.00	-
Control										
Age	235	3125.99	1959.37	113	2831.74	1521.10	113	2458.27	1337.39	-1.9601*
GDP_growth_founding	235	4.00	3.61	113	3.91	3.73	113	3.74	3.63	-0.354
GDP_growth_latest_funding	235	3.85	2.10	113	3.89	2.08	113	3.86	2.23	-0.120
Internetorapprelated	235	0.48	0.50	113	0.50	0.50	113	0.40	0.49	-1.472
B2B	235	0.46	0.50	113	0.45	0.50	113	0.50	0.50	0.664
Same_Origincountry_in_leadinvest	235	0.70	0.46	113	0.73	0.44	113	0.73	0.45	-0.149
Platform	235	0.46	0.50	113	0.45	0.50	113	0.33	0.47	-1.9169*
founders	235	2.19	1.25	113	2.18	0.99	113	1.87	0.98	-2.3629**
Independent										
Inv_IPO Share	235	0.00	0.00	113	0.00	0.00	113	0.00	0.00	-1.149
Silicon Valley_Target	235	0.28	0.45	113	0.28	0.45	113	0.19	0.39	-1.7308*
Route 128 _Target	235	0.02	0.14	113	0.04	0.19	113	0.04	0.19	0.000
New York _Target	235	0.09	0.28	113	0.09	0.29	113	0.08	0.27	-0.239
Beijing_Target	235	0.14	0.35	113	0.12	0.32	113	0.12	0.33	0.204
Shanghai_Target	235	0.06	0.24	113	0.04	0.21	113	0.07	0.26	0.855
CVCinvestor	235	0.51	0.50	113	0.56	0.50	113	0.27	0.45	-4.4888****
#Addon_acquistions	235	1.97	3.61	113	2.34	4.03	113	0.71	3.26	-3.3408****

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

Unicorns are more often backed by CVC investors compared to non-unicorns. In addition, the share of IPO exits is considerably higher for unicorn initial lead investors compared to non-unicorn lead investors. Comparing the entire unicorn sample of 235 cases with the relevant peers identified shows no significant difference.

3.4 Empirical analysis and results

As described, we conduct two types of analysis which are presented below, in order to examine our hypotheses. To test for multicollinearity of variables, we refer to the variance-inflation-factors (VIF). The mean VIF in all models is below an acceptable range of 10 VIF, indicating that multicollinearity is not a major issue (Gujarati 2003).

3.4.1 Logit model

To test our hypotheses and in order to examine the factors that separate non-unicorns from ventures with a valuation of more than 1 billion USD, we conduct a logistic regression analysis in line with Jain (2001). Hence, we model the probability of a venture to become a unicorn depending on a set of control variables and our hypothesized effects regarding investor reputation, being placed in a cluster and the existence of CVCs among the investor group. Our model is therefore formalized as follows:

$$\rho_i = PR[y_i = 1|x_i] = \Phi\,(\beta_1 + \beta_2 x_i)$$

Here, y_i is the occurrence of becoming a unicorn (0/1) depending on a ventures' characteristics x_i.

The results of the logistic regressions are presented in Table 4. Thereby, Panel A reports the results as marginal effects at the means, whereas Panel B reports the results as average marginal effects which is seen as superior when realistically interpreting the results. In model 1 to 5, we present the regressions for independent variables and controls separately, whereas model 6 contains the full model of all independent variables and controls. Since a valuation of more than 1 billion USD (unicorn) is indicated by a value of one, significantly positive coefficients denote an increase in the likelihood for ventures to become a unicorn. For all logit models, model fit was assessed by the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). Thereby, lower levels represent a better model fit (Akaike 1998). In

order to test our first hypothesis, we include investor reputation in our model. The logit estimates show that the likelihood to become a unicorn is positively impacted by the investor's reputation (*Inv_IPO Share*) when including our controls (model 2) as well as in the full model (model 6). Though, the effect remains statistically insignificant.

Reviewing the influence of being founded within a cluster presents ambiguous results. We find a significant (1% level) positive relationship for the likelihood to become a unicorn for Silicon Valley-based ventures (*SiliconValley_Target*) (model 3) which holds also in our full model (model 6). Significant effects from other clusters like Route 128 (*Route128_Target*) or Beijing (*Beijing_Target*) are not observable within our dataset. This result underlines to some extent the uniqueness of Silicon Valley when it comes to the foundation of innovative and successful ventures. In particular, it demonstrates that clusters exhibit different characteristics and finally different quality levels regarding the support of young ventures.

Furthermore, the logistic regression shows that the likelihood of becoming a unicorn is positively influenced by the existence of a CVC investor (*CVC Investor*). This effect is significant on a 0.1% level (model 4) and is line with hypothesis 3. Further, these findings persist in our full model (model 6) at the same significance level.

Finally, we cannot find any statistically significant effect that the number of add-on acquisitions *(#Addon_acquistions)* impacts the likelihood to become a unicorn, although the estimates show positive coefficients (model 5) which holds also in the full model (model 6).

Table 4: Determinants of achieving unicorn status

Panel A reports marginal effects at the means of logistic regression models explaining the likelihood of ventures to become a unicorn. Panel B reports the results of logistic regression models as average marginal effects [AME] (Bartus 2005). The usage of AMEs is more uncommon but seen as superior to the use of marginal effects at the mean when it comes to realistically interpreting the results (Greene 2000; Long 1997). While Model 1 explains the likelihood by considering the control variables, Models 2–5 separately test the different hypotheses. Model 6 displays our full model considering all the variables together. We report Huber–White heteroscedasticity-robust z-values in brackets.

Panel A: Determinants of achieving unicorn status [marginal effect at the means]

	Dependent variable: binary variable 1=unicorn; 0=non-unicorn					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Controls						
Age	0.0000453*	0.0000427	0.0000504*	0.0000643**	0.0000298	0.0000477*
	[1.66]	[1.58]	[1.83]	[2.16]	[1.14]	[1.69]
GDP_growth_founding	0.0129	0.0125	0.0191	0.00729	0.0234	0.0257
	[0.77]	[0.75]	[1.11]	[0.41]	[1.33]	[1.26]
GDP_growth_latestfunding	-0.000847	-0.00237	0.00923	0.00486	-0.0120	0.00607
	[-0.03]	[-0.08]	[0.30]	[0.16]	[-0.42]	[0.17]
Internetorapprelated	0.0272	0.0327	0.0341	0.0645	-0.00209	0.0461
	[0.30]	[0.37]	[0.38]	[0.66]	[-0.02]	[0.47]
B2B	0.00664	0.00835	0.00304	0.0300	0.0281	0.0533
	[0.08]	[0.10]	[0.04]	[0.32]	[0.33]	[0.58]

Platform	0.111	0.116	0.101	0.0782	0.0963	0.0610
	[1.39]	[1.44]	[1.24]	[0.92]	[1.10]	[0.64]
#founders	0.0947**	0.0922**	0.0858**	0.0918**	0.0911**	0.0759*
	[2.50]	[2.46]	[2.27]	[2.40]	[2.32]	[1.92]
Investor reputation						
Inv_IPO Share		18.42				15.57
		[0.88]				[0.65]
Economic cluster						
SiliconValley_Target			0.193**			0.183*
			[2.08]			[1.74]
Route128_Target			0.0896			0.175
			[0.50]			[0.96]
NewYork_Target			0.0847			0.0708
			[0.66]			[0.54]
Beijingarea_Target			-0.0253			-0.0904
			[-0.19]			[-0.64]
Shanghai_Target			-0.0849			-0.121
			[-0.46]			[-0.64]
Corporate venture capitalists						
CVCinvestor				0.327****		0.346****
				[4.36]		[4.52]
Addon acquisitions						
#Addon_acquistions					0.0373	0.0348
					[1.31]	[1.33]
No. Obs.	226	226	226	226	226	226
AIC	315.202	316.2112	320.3973	297.3502	308.0583	297.4769
BIC	342.5662	346.996	364.8642	328.135	338.8431	352.2054
Estimation method	Logit	Logit	Logit	Logit	Logit	Logit

Panel B: Determinants of achieving unicorn status [average marginal effects]

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Controls						
Age	0.0000426*	0.0000399	0.0000463*	0.0000551**	0.0000269	0.0000384*
	[1.71]	[1.61]	[1.89]	[2.24]	[1.15]	[1.69]
GDP_growth_founding	0.0121	0.0117	0.0176	0.00625	0.0212	0.0207
	[0.77]	[0.75]	[1.12]	[0.41]	[1.34]	[1.27]
GDP_growth_latestfunding	-0.000796	-0.00221	0.00848	0.00417	-0.0109	0.00489
	[-0.03]	[-0.08]	[0.30]	[0.16]	[-0.42]	[0.17]
Internetorapprelated	0.0255	0.0306	0.0313	0.0553	-0.00189	0.0371
	[0.30]	[0.37]	[0.38]	[0.66]	[-0.02]	[0.48]
B2B	0.00624	0.00781	0.00279	0.0257	0.0255	0.0429
	[0.08]	[0.10]	[0.04]	[0.32]	[0.33]	[0.58]
Platform	0.104	0.108	0.0924	0.0672	0.0871	0.0491
	[1.42]	[1.47]	[1.26]	[0.92]	[1.10]	[0.63]
#founders	0.0889***	0.0863***	0.0788**	0.0787**	0.0824**	0.0611*
	[2.63]	[2.58]	[2.36]	[2.49]	[2.39]	[1.95]
Investor reputation						
Inv_IPO Share		17.23				12.53
		[0.89]				[0.65]
Economic cluster						
SiliconValley_Target			0.178**			0.147*
			[2.15]			[1.76]
Route128_Target			0.0823			0.141
			[0.50]			[0.96]
NewYork_Target			0.0779			0.0570
			[0.67]			[0.54]
Beijingarea_Target			-0.0233			-0.0728
			[-0.19]			[-0.64]
Shanghai_Target			-0.0780			-0.0977

			[-0.46]			[-0.64]
Corporate venture capitalists						
CVCinvestor				0.281****		0.279****
				[5.19]		[5.28]
Addon acquisitions						
#Addon_acquistions					0.0338	0.0281
					[1.36]	[1.37]
No. Obs.	226	226	226	226	226	226
AIC	315.202	316.2112	320.3973	297.3502	308.0583	297.4769
BIC	342.5662	346.996	364.8642	328.135	338.8431	352.2054
Estimation method	Logit	Logit	Logit	Logit	Logit	Logit

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

In the full model of all independent and control variables taken together, the combination of effects becomes obvious. Although the average marginal effect does not consider the non-linear trend of the probability curve of logit regressions, the respective coefficients are more suitable to present a more vivid effect of the independent variables on the dependent variable than, for example, odds ratios (Hoetker 2007). Therefore, we present our results using average marginal effects in Table 4 panel B.

Within our full model, we see that the foundation of a venture in the Silicon Valley area (*SiliconValley_Target*) increases the predicted probability to become a unicorn, on average, by 14.7% (model 6). As already outlined, a statistically significant effect is only observable for Silicon Valley-based ventures (5% level). For ventures that are based in New York (*New York_Target*) or Route 128 area (*Route128_Target*) the model exhibits positive relationships but only on statistically insignificant levels. Surprisingly, we find negative coefficients for the predicted probably to become a unicorn (models 3 and 6) for ventures that have been founded in Beijing area (*Beijingarea_Target*) and Shanghai (*Shanghaiarea_Target*), though on statistically insignificant levels. Hence, the relevance of clusters seems to differ between different countries and the existing clusters possess different levels of development, whereas the Silicon Valley seems to be superior to others (Castilla 2003; Rosenthal and Strange 2003).

The predicted probability for ventures to become a unicorn is increased, on average by 28.1% (model 4) and 27.9% (model 6) if a corporate venture investor is part of the venture's investor group (*CVCinvestor*). This strong positive and highly significant (0.1% level) effect supports hypothesis 3 and gives a clear indication that corporate investors either select superior ventures or provide better support for their portfolio companies than pure financial investors do. Interestingly, the number of founders (*#founders*) shows a significant positive effect (5% level in

models 1 to 5 and 10% level in model 6) throughout all models. The positive impact of the number of founders on the predicted probability to become a unicorn hints on the widely stressed argument that a higher diversity within founding teams leads to higher performance (Beckman et al. 2007; Vogel et al. 2014).

3.4.2 Linear regression

In order to test our hypothesis that aggressive inorganic growth and subsequent add-on acquisitions drive the post-money valuation, we conduct a linear OLS regression analysis applying robust estimators to cope with heteroscedastic data. We incorporate this separate analysis to test hypothesis 4 as this hypothesis presents a slightly different perspective than the remaining hypotheses. Hypothesis 4 considers the question which type of strategy investors value once a venture has achieved a unicorn status which differs from the question what drives the likelihood of ventures to become a unicorn. In order to avoid potential bias that might arise from the timing dynamics, as ventures do not execute add-on acquisitions at the very beginning of their lifetime but rather once they have become more mature and especially once they achieved a unicorn status, we decided that the post-money valuation as a dependent variable as well as a linear regression model is most appropriate following Seppä and Laamanen (2001) and Heughebaert and Manigart (2012). In particular, we use a linear regression model instead of a truncated regression model as we consider only unicorns as relevant for our research question and hence other ventures with a post-money valuation below 1 billion USD are not part of the sample. Due to the skewness of the post-money valuation, we apply the natural logarithm of this variable in our model. Subsequently, we derive the following regression equation:

$$\log(post - money\ valuation)_i = \alpha_0 + \beta_1 investor\ reputation_i + \sum_{k=2}^{7} \beta_k\ cluster_i + \beta_8 corporate\ venture\ investor_i + \beta_9\ addons + \sum_{k=10}^{17} \beta_k controlvariables_{ki} + \varepsilon_i$$

The results of the linear regression are presented in Table 5. Basically, we consider the same variables as in our logit analysis but add the number of add-on acquisitions for the reasons

outlined above. Model fit was assessed by adjusted R-square, whereas higher values determine a better model fit. As we apply the natural logarithm of the post-money valuation of unicorns as dependent variable, positive coefficients indicate a supporting influence between variables and the respective post-money valuation. For the sake of completeness, we present the same model structure as in the logit analysis but focus on the results of models 5 and 6. Model 5 includes the number of add-on acquisitions while considering all control variables. Model 5 shows that the number of add-on acquisitions (*#Addon_acquisitions*) is positively linked to the post-money valuation at a high significance level (0.1% level). This effect also holds in the full model (model 6) and is in line with the often-cited assumption that the current venture and unicorn market is determined by a "winner-takes-it-all" approach and gives strong support for hypothesis 4 that aggressive and inorganic growth of unicorns is a value-determining factor. Although being outside of the focus of this analysis, we find no other significant effects that influence the post-money valuation of unicorns except for the foundation within the Silicon Valley area (*SiliconValley_Target*) which exhibits a positively significant effect (1% level) (model 6). Obviously, unicorns that are based in the Silicon Valley area are valued higher by their investors independently form their age or general economic conditions as we have controlled for both factors.

Table 5: Determinants of post-money valuation

The table displays ordinary least squares regression results with Huber–White heteroscedasticity-robust z-values. Number of observations differ from logit analysis in Table 4 as this analysis also include unicorns for which no respective peer could be identified based on our criteria.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Controls						
Age	0.0000150	0.0000150	0.0000266	0.0000135	0.00000428	0.0000163
	[0.55]	[0.55]	[0.94]	[0.49]	[0.17]	[0.61]
GDP_growth_founding	-0.0124	-0.0125	-0.000813	-0.0108	-0.000475	0.00301
	[-0.43]	[-0.43]	[-0.03]	[-0.36]	[-0.02]	[0.11]
GDP_growth_latestfunding	0.0280	0.0287	0.0264	0.0285	0.0284	0.0153
	[0.67]	[0.68]	[0.66]	[0.68]	[0.66]	[0.36]
Internetorapprelated	-0.129	-0.132	-0.138	-0.133	-0.205*	-0.237*
	[-1.05]	[-1.07]	[-1.08]	[-1.07]	[-1.75]	[-1.91]
B2B	-0.188	-0.186	-0.207*	-0.195	-0.144	-0.183
	[-1.57]	[-1.56]	[-1.67]	[-1.63]	[-1.29]	[-1.54]
Platform	0.181	0.179	0.171	0.190	0.136	0.129
	[1.44]	[1.43]	[1.35]	[1.52]	[1.18]	[1.12]
#founders	-0.0411	-0.0420	-0.0464	-0.0410	-0.0461	-0.0486
	[-0.93]	[-0.95]	[-1.08]	[-0.93]	[-1.13]	[-1.25]
Investor reputation						
Inv_IPO Share		-5.668				-11.39
		[-0.52]				[-1.03]
Economic cluster						
SiliconValley_Target			0.369***			0.281**
			[2.93]			[2.31]
Route128_Target			0.0769			0.116

			[0.40]			[0.57]
NewYork_Target			0.223			0.0625
			[1.22]			[0.42]
Beijingarea_Target			0.203			0.354
			[0.90]			[1.57]
Shanghai_Target			0.0251			0.182
			[0.11]			[0.83]
Corporate venture capitalists						
CVCinvestor				-0.0756		-0.113
				[-0.70]		[-1.09]
Addon acquisitions						
#Addon_acquistions					0.0753****	0.0749****
					[3.90]	[3.87]
No. Obs.	235	235	235	235	235	235
R-sq	0.029	0.030	0.064	0.031	0.133	0.164
p	0.427	0.457	0.172	0.385	0.00577	0.0225
Estimation method	OLS Reg.	OLS Reg.	OLS Reg.	OLS Reg.	OLS Reg.	OLS Reg.

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

3.5 Extended analysis and limitations

In order to check for extensions of our findings as well as to test the robustness of our results, we conduct additional analyses for the logit model as well as for the linear regression model which are not tabulated. In a first step, we include additional control variables in our model to test for unobserved effects. Following Zörgiebel (2016b), we include a dummy variable for unicorns which were founded during the financial crisis. In this context, the findings of Nanda and Nanda and Rhodes-Kropf (2013) are worth to be considered. Both found evidence that companies that are founded during "cold" markets are more likely to perform an IPO and face a lower risk of bankruptcy (Nanda and Rhodes-Kropf 2013). Hence, we would expect that unicorns have been founded predominantly during such "cold" times. This additional variable does not show any significant effect on our results, neither in the logit nor in the linear regression model.

Second to test the robustness of the investor reputation results, we replace the IPO share as proxy for the investor reputation by the age of the investor following Nahata (2008). Further, we consider relationships between CVC investors and the venture's business model. In order to examine whether CVC investors are primarily interested in ventures that could help them to adapt their own business models to a changing economic environment, we test for moderating effects between the existence of a CVC investor and a special type of business model (platform and internet or app related). However, based on our data sample we do not find any significant effects concerning these assumptions.

Further, we perform our analysis limited to certain geographic regions. Therefore, we create subsamples of our original dataset based on the origin of the ventures and respective unicorns. As we apply two different datasets for models 1 and 2, we rerun our analysis on four subsamples (two for China and two for the US). We focus on these two countries as most unicorns are domiciled in these countries whereas the socio-political conditions are completely different and hence diverging effects might be observed. As a result in the logit model, we find a stronger influence of the existence of a CVC investor on the likelihood to become a unicorn for China-based unicorns and a positive significant effect for the number of founders for US-based ones. Both effects are statistically significant at a 0.1% and 1% level respectively. The remaining results of the logit analysis are in line with the results of our full sample (Table 5). Running again our linear regression model (Table 5) in order to test hypothesis 4 on China and US-based subsamples separately, reveals that the number of add-on acquisitions as a value-determining effect loses its significance for China-based unicorns. However, the sign of the effect remains positive. For the US-based subsample, the significance of the add-on effect increases.

Finally, we conduct again our two types of analysis (logit and linear regression) for those unicorns with a post-money valuation of more than 2 billion USD as unicorns valued exactly or slightly above 1 billion USD threshold might provide a bias as their valuation could be primarily artificially increased due to publicity reasons. The linear regression model, limited to the subsample of unicorns that are valued above 2 billion USD, shows consistent results with the full sample. For the logit regression, we observe that the significance of the Silicon Valley effect diminishes but remains significant on a low level (10% level). We see two potential explanations for this effect. On the one hand, the Silicon Valley cluster support could primarily be important for less mature ventures or respective unicorns. On the other hand, one might argue that investors in the Silicon Valley area tend to provide ventures artificially high funding to enable them to pass the 1 billion USD threshold for publicity reasons which would increase the number of unicorns in Silicon Valley. However, we assume this explanation to be less relevant as the higher competition among VC investors within the Silicon Valley area should rather adjust such biased valuations.

Based on our analysis, we consider our results as robust in general. However, our robustness checks show that the degree of influence of considered factors varies depending on the origin and valuation level of the respective unicorn.

As every empirical study, our results are facing certain limitations. First, as unicorns are a very new phenomenon, the sample size is limited and there is currently no possibility to perform any long-term investigations. Closely linked to this limitation, scarcity of available data remains another limitation for our results which has also impacted previous studies (Homburg et al. 2013; Kaplan and Lerner 2016), due to the private ownership of unicorns. In particular, as the majority of all unicorns are headquartered in China or the US, there are no obligations for them to disclose annual reports or financials statements. Hence, our analysis is only able to measure the success of unicorns on a proxy level from an outside and third-person perspective.

Second, due to limited disclosure requirements, current research lacks detailed information on the ownership structure. To get deeper insights in the ownership and stock structure, it would be important to cope with the very common use of preferred liquidation rights in the field of unicorns. Especially unicorns with a valuation around 1 billion USD tend to sell stock with preferred liquidation rights to overcome the 1 billion USD valuation threshold for publicity reasons. But by selling stocks with preferred liquidation rights, the implicit and risk-adjusted valuation should be lower and probably in certain cases below 1 billion USD (Bartlett 2016).

Third, as the majority of unicorn investors are comparably young, they lack a proven track record. Hence, it is rather difficult to assess the performance of investors particularly in a long-term view.

Fourth, as per definition of unicorns, we include only VC-backed companies that are still operating. Following this approach, our results might face the risk of a survival bias. But by reviewing historical data on companies that achieved a unicorn status, it gets obvious that only very few of them dropped below a 1 billion USD valuation afterwards. Though, it is rather difficult how to deal with exited unicorns. However, most studies regard exited unicorns and VC-backed companies via IPO or an acquisition as the most favorable outcome for an investor (Bottazzi et al. 2008; Bengtsson and Wang 2010; Fitzgerald 2015). Taking both those arguments into consideration, effects from potential survival bias should be limited.

3.6 Conclusion and discussion

In this paper, we investigate the factors which drive the rising of VC-backed companies with a valuation of more than 1 billion USD, so called unicorns. Therefore, we follow a two-fold approach by examining factors that lead to a trespass of the 1 billion USD valuation threshold and the question which growth strategy is favored for unicorns by investors, separately. Based on the descriptive analyses, we observe that unicorns are a locally concentrated phenomenon with more than fifty percent based in the US. However, the share of China-based unicorns has been rapidly increasing during the last two years whereas activities in other countries remain on a comparably low level.

Based on our empirical results, we cannot find any significant influence of investor's reputation on the likelihood for ventures to become a unicorn. In particular, early investors have a higher influence as they are working in closer relationships with their portfolio companies and exhibit a stronger operational involvement (Hsu 2004; Stayton and Mangematin 2018). As we cannot find this effect to be significant in our analysis, we assume that this is due to the fact that the construct of investor reputation is hardly measurable. Hence, new measures of investor's reputation and quality should be considered in future research.

Besides that, we find limited support for hypothesis 2 that the foundation within a cluster increases the likelihood for ventures to become a unicorn as we find this effect to be significant only for the Silicon Valley area which indicates superior characteristics of this cluster in particular compared to other clusters in the US and China. Probably, this includes a self-reinforcing effect, as successful ventures and unicorns attract other ventures and investors, providing ultimately better infrastructure and leading to a highly innovative environment. The geographical proximity of VC investors might have an additional positive influence in this context on the likelihood of receiving further funding and allows investors to identify promising ventures earlier which results in locally concentrated unicorn births. Past research has identified that the political and regulatory environment has a direct effect on the likelihood of unicorn births (Safari 2013; Wright et al. 2005), however we see this effect as significant primarily on an inter-country level.

As we find further support for hypothesis 3 that CVC investors have a positive influence on the likelihood for ventures to become a unicorn, we are convinced that investors' strategic support and guidance might be one of the key differentiating factors besides financial support.

Especially, as CVC are not renowned for their investment selection but for their operational support by providing production resources, market access, etc. (Chemmanur et al. 2014; Narayanan et al. 2009; Chesbrough 2000).

Finally, our results indicate that aggressive and inorganic growth strategies measured by the number of add-on acquisitions are driving the level of valuation and hence are a favored strategy from an investor's perspective. This finding confirms the assumption that investors accept growth rates as a proxy for value. As an extension to existing research (Kenney and Zysman 2019b) this assumption does not hold only for platform-based business models but seems to be applicable to all unicorns. Furthermore, we find that inorganic growth is fostered by investors as we do not find any significant impact that add-on acquisitions increase the likelihood to become a unicorn per se but only that these drive post-money valuation levels. Of course, this implies that investors take the availability of potential add-on targets into consideration when investing in unicorns.

As profitability fades into the background and investors are willing to absorb high exceptional losses, we conclude that growth is one of the key drivers for valuation and return on investment based on the assumption that today's unicorns will turn in highly profitable companies some time in the future following role models like Facebook.

By comparing the results of both analyses (Logit and OLS regression) additional detailed conclusions can be drawn on the interconnection of the factors that drive the likelihood to become a unicorn and factors that influence the post-money valuation.

Our results show that the foundation in the Silicon Valley area has a positive impact on the likelihood to become a unicorn as well as on the post-money valuation. This underpins the exceptional position of the Silicon Valley cluster in today's unicorn ecosystem. However, whereas we assume that good entrepreneurial conditions for high quality ventures i.e. best-in-class research institutes, strong investor network, skilled labor force etc. have a positive impact on the likelihood to become a unicorn, the post-money valuation levels are probably also driven by the existence of large VC investors in the Silicon Valley area. With extremely high levels of committed capital, they are able to participate in or to drive multibillion funding rounds.

Second, as we cannot find any significant influence of CVC investors on the post-money valuation but a strong positive impact on the likelihood to become a unicorn, this finding indicates

that ventures benefit primarily from CVC support before they become a high-valued unicorn which is in line with the findings of Park and Steensma (2012). Furthermore, this finding indicates that CVC investors act as a signal to other market participants besides providing operational and financial support. However, we conclude that this effect decreases once the venture has achieved a unicorn valuation because unicorns have usually already established a strong footprint with regard to market and stakeholder awareness. In addition, the influence of an individual investor decreases usually during follow-on funding rounds due to larger investor universes and diluted shareholdings. This effect is in line with our result that the existence of a CVC investor does not directly impact the post-money valuation of unicorns.

Third, the number of add-on acquisitions, i.e. an inorganic growth strategy, only seems to influence the post-money valuation whereas we do not find any significant impact on the overall probability to become a unicorn. We assume that the major reason for this effect is that unicorns need to achieve a certain level of maturity in terms of organizational development and funding before acquisitions are executed on a large scale. That means investors value acquisitions and strong growth rates predominantly in later funding rounds and hence increase their funding and subsequently the post-money valuation. Furthermore, the larger funding rounds prepare the ground for additional large acquisitions which enable unicorns to gain considerable market shares and hence to boost their post-money valuation. Clearly, this effect comes only limited into play when assessing the likelihood of ventures to become a unicorn. To some extent this effect can be regarded as a self-enforcing process once the venture or unicorn has reached a certain threshold in terms of market share and received funding. At this point, investors seem to be willing to finance the further development of the unicorn toward an absolute market leader.

Our results contribute to the existing research in several ways. First, we add to the literature on investor quality and their subsequently assumed support for their portfolio companies. Whereas past research found majorly a strong relation between the reputation, i.e. quality of an investor, and the success probability of its ventures regardless of the ventures' state (Hsu 2004; Lee et al. 2011; Megginson and Weiss 1991), we add a more detailed view on this. By demystifying the role of the initial investor's reputation, we show that additional research is required to differentiate the relation between portfolio companies and investors depending on the ventures' lifecycle position.

Second, we contribute to the literature on spatial distribution of economic success. A common theme in this literature stream is that economic or innovation clusters support ventures and entrepreneurs (Nicotra et al. 2018; Romanelli and Khessina 2005; Sternberg and Litzenberger 2004). Based on our analysis, we add to this that large geographical differences exist between such clusters. Our results support the notion that a well-working ecosystem, like the Silicon Valley, fosters its own success by boosting unicorns and start-ups find enough established VC investors to collect enough money for reaching a unicorn status, hence creating a vicious cycle. Furthermore, the size of the start-up and the level of start-up's maturity seems to be decisive when assessing the support potential of a cluster.

Third, we add to the literature on CVC. The existing literature has already described the benefits of CVC extensively (Rossi et al. 2017; Park and Steensma 2012). However, our results highlight the interrelation between corporate investments and the success probability of ventures even for the most successful type of ventures, i.e. unicorns.

Lastly, we add to the valuation literature and more specific to the venture valuation literature. The venture's strategy has already been considered as important for the valuation in past research (Festel et al. 2013; Meglio et al. 2017; Salamzadeh and Hiroko 2015). Our results confirm thereby that growth is one of the most important and dominant factors concerning a start-up's valuation, an aspect which is accounted for by the valuation of investors.

Besides the theoretical contribution of our findings, we see also clear practical implications. Our results enable decision-makers and governments to adjust their policy in order to foster the emergence and growth of ventures. Further, our analyses have implications for founders and key executives of ventures as the results can be considered when conducting funding rounds and subsequently choosing new investors. In addition, our results help founders and entrepreneurs when it comes to the question of choosing the right location as well as finding the right strategy for their venture in order to maximize the likelihood to become a member in the club of unicorns if they wish so.

The main question that remains in current research is how the valuation of unicorns will develop in the future and if there will be any impairments necessary or if the rise of unicorns will remain as an ongoing development (Fenwick and Vermeulen 2015). In particular, the majority of all unicorns is still showing high cash-burn rates and negligible or only intangible assets (Zimmerman 2016). Further, some of the current unicorns even lack a business model and

generate only minor revenues but offer just great customer growth rates or growth potential. In fact, it will turn out if the current unicorn valuations are justified when the VC investors exit the unicorns via an IPO or private sale. However, there is certain consensus among venture capitalists that today's unicorns are overvalued (Gompers et al. 2016) especially as today's unicorns seem to be different from previous ones like Google or Facebook, which in fact were cash-generative and with a positive income in an early status (Cable 2017). Given that and taking into consideration that we were facing a slowdown of unicorn births in 2018, certain studies assume that we achieved already the peak of the unicorn trend (CB Insights 2016) or stand right in front of the bust of a unicorn bubble (Vardi 2016; Fitzgerald 2015).

However, the further development could rather be driven by the general VC inflow which is highly linked to general financial capital markets (Li and Mahoney 2011). Hence, high capital inflows to the VC market could enable further private initial public offerings (PIPO) which in some sectors exceed public IPOs in both frequency and dollar volume (Brown and Wiles 2015).

In the course of our study, we found an additional phenomenon which could be hardly assessed due to the available data. Currently, the role of preferred liquidity stock and its impact on valuation is rather unclear as only limited research has been conducted so far in this field. However, there is a clear indication that this special stock class has a strong influence especially for the unicorns with a valuation slightly above 1 billion USD and hence it could be worth to consider that phenomenon in future research purposes (Zörgiebel 2016a). This holds also for special term sheets that are used in venture financing rounds which are favorable for investors in particular in later funding rounds but which are usually detrimental to the interests of founders and early stage investors. However, research on those aspects is limited due to scarcity of data and particularly financials in the field of unicorn research. Overcoming this hurdle can open additional room for research purposes on a company level which should be linked with an investigation of the preferred liquidity stock phenomenon.

However, it remains unclear if growth and increasing market shares will remain key drivers for investor's valuation in the future. As we include only the initial investor, the question what drives the future valuation has to be left for future research. Nevertheless, despite of any potential valuation issues, there is a high probability that some of the unicorns will develop and offer very disruptive technologies (Fenwick and Vermeulen 2015) which will change traditional business models for ever.

4 Digital transformation of large corporates: Corporate venture capital and start-up collaborations of German DAX 30 corporates[8]

4.1 Introduction

Today's incumbent firms are increasingly exposed to rapidly changing economic environments and changes in technology. One of the most radical changes is thereby evolving from the ongoing digitalization of business models which disrupts entire sectors and forces incumbent firms to rethink their established business models. Because established companies are often blinded by the products, services and processes which made them successful, they recognize disruptive innovations for their business models too late (Salomo et al. 2007) or they are hindered by their inertia. However, coping with radical or disruptive innovations is a crucial competence for the long-run success of companies (Salomo et al. 2007) and hence it is essential for all established companies to deal with digital transformation and resulting business model changes if they intend to maintain their leading position.

Historically, firm's innovations were mostly driven by internal R&D and innovation activities based on company's internal and tacit knowledge. In contrast, in the area of digital business models, a lot of knowledge is based outside the firm's boundaries which requires new ways and models how to harness this knowledge. Subsequently, established companies started ways to examine how to access external knowledge and how to change business models in order to exploit this knowledge (Dremel et al. 2017). In particular, the acquisition of or the collaboration with small, young technology-based firms has recently become popular as a way to exit process and innovation rigidities (Cefis and Marsili 2015; Ferrary 2011; Zhao 2009). In addition, acquisitions and collaborations are a promising way to increase the speed of integrating innovations and to cope with rising time-to-market pressure (Ransbotham and Mitra 2010). As a consequence, the number of collaboration and acquisition programs tailored to the specific needs of start-ups and young firms and operated by incumbents raised tremen-

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dously during the last years. Therefore, our paper addresses the question which types of collaboration are appropriate for connecting incumbents and young start-up firms. We contribute an answer to this question by four different steps. First, we outline the basics of the dynamic capabilities approach as theoretical grounds for considering the topic of our paper. Second, we build a conceptual framework for collaboration activities of incumbents with start-ups according to the development stage of the latter. Third, in an empirical analysis, we analyze the recent developments of incumbents' collaborative activities with start-ups among the DAX 30 companies. Fourth, we derive propositions how the effectiveness of incumbents' innovation activities can be judged in further research.

Our paper contributes to research on dynamic capabilities as we demonstrate how this framework becomes effective in the context of disruptive technological changes and the reaction of incumbents toward this development. We demonstrate that incumbents are increasingly forced to access external knowledge to cope with the ongoing disruptive development of digitalization. Thereby, we provide evidence that the dynamic capabilities approach gains increasing importance as the development of digitalization is driven by young ventures and start-ups with respective tacit knowledge (Ranft and Lord 2000) outside incumbents' sphere of control at a much higher pace than ever (Sears 2017). This makes the development of digitalization quite special compared to earlier technological developments which were rather driven by incumbents themselves and hence a rethinking of the application of theoretical foundations is required. Subsequently, we assume that the application of dynamic capabilities is no longer only a beneficial option to develop the business but becomes an essential and obligatory part for incumbents' strategy. We enrich the discussion how incumbents can access this knowledge in order to transform their existing business model by presenting different strategies depending on the maturity of the target or collaboration partner. Subsequently, we demonstrate how the theoretical construct of dynamic capabilities proves its validity and how it is applied in the context of digitalization. Finally, we emphasize to regard the dynamic capabilities approach as a holistic framework by concentrating on the two highest order categories seizing and transforming dynamic capabilities whereas previous research has often focused on sensing dynamic capabilities, i.e. the identification and acquisition of external knowledge (Habtay and Holmén 2014; Hung and Tang 2008).

Based on our empirical research, we can demonstrate clearly that the collaboration and venturing activities of German DAX 30 corporates have increased strongly since 2012 and shifted into new areas. In particular collaboration efforts tailored to very young ventures (hackathons) and with a digital focus raised considerably since 2015 mainly driven by incumbents from non-digital sectors like utilities and automotive. However, based on these findings, we identify certain success determinants that should be considered when accessing external knowledge via collaboration or corporate venturing strategies. As a result, we see particular incumbents that are used to participate in R&D networks previous to the recent collaboration activities as best positioned to access external knowledge due to their existing knowledge spillover processes. Further, we see the collaboration with very young firms as more promising than the collaboration with more mature ones due to a higher flexibility, usually lower collaboration barriers like acquisition prices and more innovative knowledge.

4.2 Theoretical foundation of collaborations and acquisitions with the purpose of digitalizing business models

Historically, research on motives for firm collaborations and acquisitions was explained by a lack of resources (Ahuja and Katila 2001; Narayanan et al. 2009) and hence related to the resource-based view (RBV) which builds on the work of Penrose (1959) who regards firms as a bundle of resources that generates rents for the firm. However, as our paper examines the digitalization of business processes and hence a dynamic environment, we regard the dynamic capabilities approach, which was developed as an extension of the existing RBV (Lin and Wu 2014), as most suitable conceptual home for our research. Originally, the dynamic capabilities approach emerged from the RBV and considers processes by which organizations not only change their resources and routines but also their products and services so as to survive in changing environments (Eisenhardt and Martin 2000; Teece et al. 1997; Yeow et al. 2017). Teece et al. (1997, p. 516) first defined dynamic capabilities as “the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments”. Consequently, the dynamic capabilities approach represents a systematic shift from the resource-centered perspective toward a process-oriented perspective. The dynamic capabilities approach considers mediating processes (dynamic capabilities) (Lin and Wu 2014) between the resources and the dynamic market environments (Smart et al. 2007). Teece (2017) categorized dynamic capabilities based on his prior work (Teece et al. 1997; Teece 2014, 2016) into three distinct ”highest-order” categories that are all necessary to sustain a

successful business model by providing profitability over the long term including the ability to design and adjust business models:

1. *Sensing dynamic capabilities that are necessary to identify opportunities based on technological possibilities and technology developments which includes a holistic screening of internal and external knowledge resources. This aspect is decisive in our context as this capability enables incumbents to identify the best collaboration partners or acquisition targets to access external knowledge for digitalizing their own business model,*
2. *Seizing dynamic capabilities that are responsible for designing and refining business models as well as for committing the relevant resources. This capability is of key relevance for the development of digital business models by enabling incumbents to make use of acquired external knowledge, and*
3. *Transforming dynamic capabilities that are responsible for realigning the firm's structure and culture. This aspect is essential for firms in order to digitalize their business models as the process of digitalization will not only lead to additional business models but also replace and change existing ones.*

In fact, the dynamic capabilities approach proposes that incumbents should not only stick to their existing resources but rather try to invest into their capabilities that are much more agile (Cheng and Chen 2013). Thus, the dynamic capabilities approach considers firms' abilities to integrate, learn and reconfigure internal and external resources (Lin and Wu 2014) as more important for achieving a competitive advantage as just possessing them. This view helps to expand the understanding how collaboration and M&A activities can transform an existing business model into a digital one. The dynamic capabilities approach does not consider M&A as a general way to increase the knowledge base of the acquirer but rather as a selective possibility to apply and connect with external knowledge (Lin and Wu 2014). However, especially the aspect of sensing dynamic capabilities plays a key role for recognizing relevant developments (Grimaldi et al. 2013) in order to avoid effects of lock-in situations and ignoring disruptive developments. Incumbents need to scan permanently external developments, innovations and knowledge to ensure not to miss anything that might endanger their competitive advantage. This fact holds in particular as disruptive and groundbreaking innovations occur only rarely from internal resources. Coming back to our original research purpose on examining how established corporates can handle the digitalization of business models, the dynamic

capabilities approach provides a valuable framework for explaining the motivation of corporates to collaborate with young firms and their subsequent transformation by focusing on dynamic processes instead of static resources. In particular, the dynamic capabilities approach helps to establish an understanding of incumbent-internal processes that are success-critical for accessing external knowledge. However, for a successful collaboration between incumbents and ventures, additional dynamic capabilities of subordinated categories can be essential. In particular, the concept of absorptive capacity which was introduced by Cohen and Levinthal (1990) and which can be regarded as a kind of 'knowledge-related' dynamic capability (Lane et al. 2006; Zahra and George 2002), examines necessary preconditions of incumbents for successfully conducting collaborations and acquisitions. Absorptive capacity describes "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal 1990, p. 128) which includes an open corporate culture in order to avoid 'not-invented-here syndromes' that could potentially harm the performance of collaborations and M&A results (Szulanski 1996).

Prior research assumed that the R&D departments of incumbents or acquiring firms respectively are a particularly crucial component for applying the concept of absorptive capacity (Forés and Camisón 2016; Veugelers 1997). However, many firms in traditional industries seem to lack sufficient levels of absorptive capacity (Spithoven et al. 2009). Surprisingly, this issue occurs regardless of company size (Forés and Camisón 2016) and is hence also relevant for large corporates. Further, the concept of absorptive capacity should not be limited to R&D departments but expanded to other divisions given the fact that collaborations and acquisitions of innovative start-ups involve various resources and capabilities of the acquirer. Further, absorptive capacity is of particular importance in acquisition and collaboration situations as required knowledge for digitalization and transforming business models is embedded in tacit and socially complex knowledge of the acquired firm's individual and collective human capital (Ranft and Lord 2000).

Based on these theoretical grounds, it can be concluded that the currently ongoing collaboration approaches between incumbents and ventures or start-ups represent a practical application of dynamic capabilities. In particular, sensing dynamic capabilities (identification of collaboration partners or acquisition targets) as well as the subsequent seizing dynamic capabilities (to (re)develop a digital business model using the new available knowledge) are suitable

concepts to explain the ongoing changes concerning the digitalization of business models and incumbents' necessary reactions to them. However, for a successful application of these concepts, it remains absolutely essential for incumbents to create the corresponding internal setting by investing in absorptive capacity. This process encompasses the establishment of an open-minded internal research environment, the creation of an adaptive corporate culture as well as investing into transforming dynamic capabilities that enables incumbents to adapt their existing business models to the new customer needs.

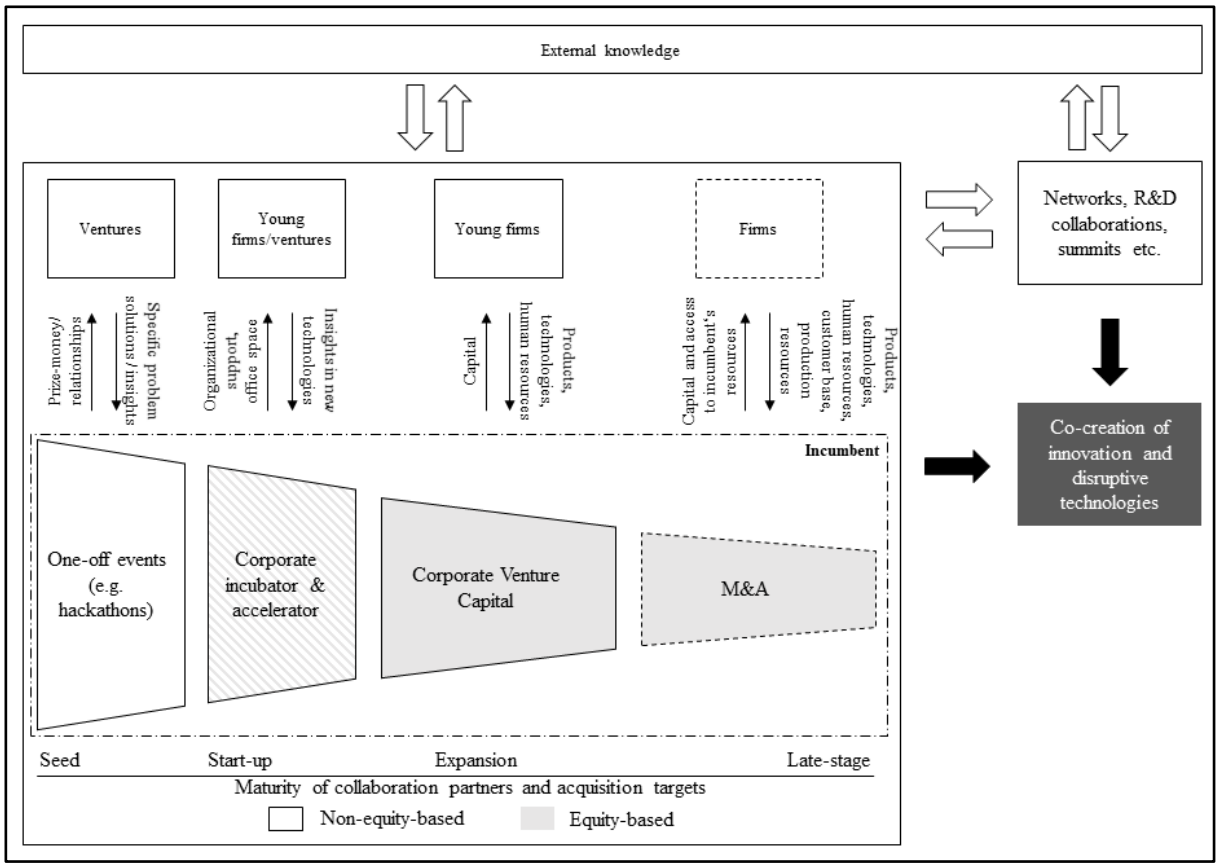
4.3 Proposed collaboration model for incumbents to access external knowledge

Based on our review of the theoretical basis and underlying concepts for coping with disruptive innovations, we develop a conceptual framework model how incumbents can respond to such developments by using collaborative activities and acquisitions. Figure 5 presents our conceptual framework including the different strategies for incumbents and their respective benefits as well as required resources. Prior research has already identified the collaboration between incumbents and young firms as beneficial for both parties as it enables incumbents to access new technologies and helps young firms to overcome organizational and capital restrictions (Colombo and Murtinu 2017). However, there are a couple of constraints for the adoption of collaboration and acquisition activities as ways to innovate which need to be considered. Besides the ability of incumbents to integrate new knowledge, the complementarity of resources, the price of the respective investment, the level of the target's demand for autonomy, the planned duration of the collaboration or investment and the maturity of the acquisition or collaboration target seem to be of importance for the success of the collaboration or acquisition.

The lifecycle of young firms is characterized by their development stages which determine the type of cooperation an incumbent firm may envision. Hence, the lifecycle of young firms is considered as key element for the development of our framework model concerning cooperation strategies of incumbents. Generally, young firms can be divided into four stages of maturity (seed, start-up, expansion and later-stage) (Fisher et al. 2016; Picken 2017). The seed-stage describes firms during their development of product concepts often without being an independent legal entity, followed by the start-up stage when firms start to market their products. After these early stages, firms usually enter the expansion stage when they start to increase their production and sales and finally enter the later stage. In the later stage, firms are

mature and face challenges like internationalization and developing successor products. These different stages lead to varying needs for support. At the same time, risks and investment need for incumbents differ according to the separate development stages of start-ups. In the following, we classify and discuss potential collaboration and acquisition strategies for incumbents based on the target maturity. Thereby, we consider different risk, capital and independence requirements.

Figure 5: Collaboration model for participation in digital innovations
The figure presents a conceptual framework how incumbents can access external knowledge in the context of digitalization by applying various approaches.



The most independent, and for all parties least risky, collaboration approach is thereby defined as non-equity partnerships which vary in planned duration and tightness of connection. Most of these non-equity-based collaborations between incumbents and young ventures can be characterized as 'one-off-events'. In particular, 'hackathons' became increasingly popular as an example for one-off-events (Briscoe and Mulligan 2014; Johnson and Robinson 2014). This concept comprises events in which incumbents invite entrepreneurs, young ventures or firms to solve specific (often technology-based) problems and offer prizes for the best solu-

tion. Typically, those hackathons last for one to two days (overnight) and possess a competitive character. 'One-off-events' enable incumbents to screen the landscape for promising innovative business ideas, young firms and ventures. Incumbents have the possibility to establish relationships with the business ideas and innovative entrepreneurs or ventures at limited risk that makes them suitable primarily for the collaboration with very young ventures.

Further, we incorporate three major types of equity-based investments for the collaboration between incumbents and young firms into our model (Kohler 2016). However, each of these types has several realizations in practice which are adapted to the individual needs of the participants, but which blur distinct borderlines between the program types at the same time. First corporate incubators and accelerators can be identified as a vehicle for incumbents to invest during the start-up phase (Albort-Morant and Oghazi 2016; Barbero et al. 2014; Becker and Gassmann 2006; Bruneel et al. 2012). The main focus of corporate incubators and accelerators is to support young firms by providing them guidance and resources (e.g. office space) to develop marketable products. Usually, corporate incubators or accelerators are linked only very loosely to the incumbent (Becker and Gassmann 2006). Further, incumbents usually do not exceed minority investments at this stage of young firms but offer follow-up investments by respective corporate venture capital (CVC) or M&A activities (van de Vrande and Vanhaverbeke 2013). However, many of these young firms are working on groundbreaking technologies and disruptive innovations that can be interesting for the incumbent's business model. Therefore, these very young firms could be a promising source for overcoming innovation shortcomings, but this implies certain efforts for coordinating the collaboration.

Second, CVC is an additional vehicle to invest in young firms in the late start-up and the expansion stage. Therefore, investments through the vehicle of CVC comprise higher amounts of equity. Simultaneously, an incumbent's support for target firms is more tailored to special needs and requirements of the target firms. These types of investment are closer linked to the incumbent's business activities. As a result, a considerable number of incumbents introduces formalized knowledge spillover processes for their CVC activities and tries to leverage developed technologies and products (Birkinshaw et al. 2002). However, investments in young firms in the late start-up or the expansion stage tend to be substantially more expensive than in the seed stage due to the lower risk of failure as they have already developed marketable products and their knowledge base can better be assessed. But these facts imply that the integration of

the ventures in these development stages into the incumbent's business might be associated with more difficulties as the start-ups have already developed certain own processes and structures (Gompers and Lerner 2000b).

The last type of investment we identified for the acquisition of targets within our model involving the tightest form of equity investments are M&A activities. The acquisition of complete firms, including their resources and capabilities, is the most traditional way to access external knowledge and is most suitable for established businesses. Although being applied for a long time, the complete acquisition of target companies raises several issues on how to integrate them and how to ensure that they keep the same level of innovativeness and development as prior to the acquisition (Angwin and Meadows 2015; Cloodt et al. 2006; Dushnitsky and Lenox 2005; Ranft and Lord 2002). For complete acquisitions, the target's level of autonomy post acquisition and the leveraging of synergies remains crucial in order to innovate the incumbent's own business model (Mahto et al. 2017).

However, our conceptual framework model of different collaboration and acquisition strategies does not cover success factors of the identified approaches on a firm-specific level but assigns the approaches according to the venture's development stages. Given that, the model is not meant to be exhaustive in terms of how firms can enter external knowledge but classifies cooperative strategies for incumbents with start-ups. We illustrate that by showing that external knowledge concerning the digitalization of an incumbent's business model is not bound to collaboration partners or acquisition targets but exists outside those boundaries. Collaborations and acquisitions should rather be regarded as a key to unlock the potential of external knowledge that can be used to create new value. Thereby, the external knowledge itself undergoes a continuous renewal process that can be applied to the digitalization of business models.

4.4 Current activities in Germany: evidence from German DAX 30 corporates

In order to elucidate the question on whether incumbents use collaboration and corporate venturing strategies to innovate their own business models, we examine the activities of the largest German corporates. We conduct a systematic analysis of German corporates that are publicly listed and part of the DAX 30 stock market segment. We decided to concentrate on the DAX 30 as the companies included in this index represent more than 80% of the overall market capitalization of German publicly listed companies and those companies substantially

influence the future German economic development. We focus our empirical analysis on three different collaboration approaches namely hackathons, as the most popular representative of one-off events, accelerators & incubators and CVC activities as we have previously identified them as most critical for incumbents. Further, these collaboration types show certain common characteristics across different industries so that they are comparable among the DAX 30 companies. We do not consider this list as being exhaustive as we are aware of the existence of additional collaboration programs like strategic alliances. However, these additional types of collaboration are often tailored to specific industries, difficult to identify and do not necessarily follow the goal of integrating digital business models developed by start-ups. Further, we do not consider usual M&A activities i.e. the acquisition of mature companies for two reasons. First, M&A activities of large corporates are usually used to follow overall strategic goals like increasing market shares or entering new geographical markets which is less relevant in our context. Second, available information for these activities is very limited due to a lack of disclosed data in order to protect business secrets.

4.4.1 Research method

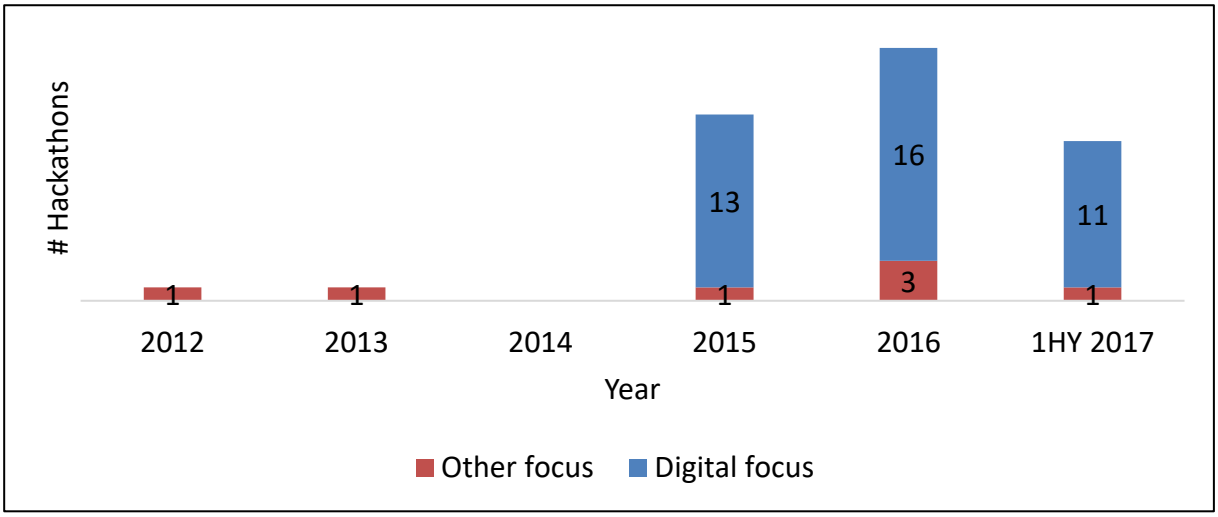
Based on a review of existing literature in the area of innovation and corporate venturing, we retrieved key words such as “corporate venturing”, “idea jam” or “start-up collaboration” for each of the three examined types of collaboration activities in order to detect which activities are used by the DAX 30 companies (for the complete list of key words please see Appendix A). To compile our hand-collected data sample and to assess whether an incumbent uses the respective type of collaboration, we perform a desktop research for each of the DAX 30 corporates by using the retrieved key words. In a second step, we reviewed relevant articles and websites and checked whether the activities can be classified as one of the three collaboration types (hackathons, incubator & accelerator or CVC). Furthermore, we checked annual reports for relevant information as well as newspapers using an internet-based press research platform. Moreover, the data gathering process was complemented by a cross check of the Crunchbase database in particular for any prior-existing incumbents’ initiatives. DAX 30 corporates for which we could not find any collaboration-related information were regarded as not active in the respective type of collaboration. Collaboration approaches that were additionally labeled as “digital focus” if keywords like “digitalization”, “IoT”, “AR/VR”, “e-mobility” could be found in respective press articles or on websites. In any other case, approaches were

labeled as “other focus”. In order to assign the incumbents to industry sectors, we follow the sector classification of Deutsche Börse AG (2017). However, due to the importance of the automotive sector, we separate it from the industrial sector. Furthermore, due to several industry-specific similarities we include the telecommunication sector in the information technology sector. The analysis was completed in June 2017.

4.4.2 Corporate hackathons

The use of hackathons as a collaboration approach between corporates and ventures or very young firms is a relatively new phenomenon. The number of hackathons increased significantly in the last few years due to the increased interest of corporates in this form of innovation cooperation (Briscoe and Mulligan 2014).

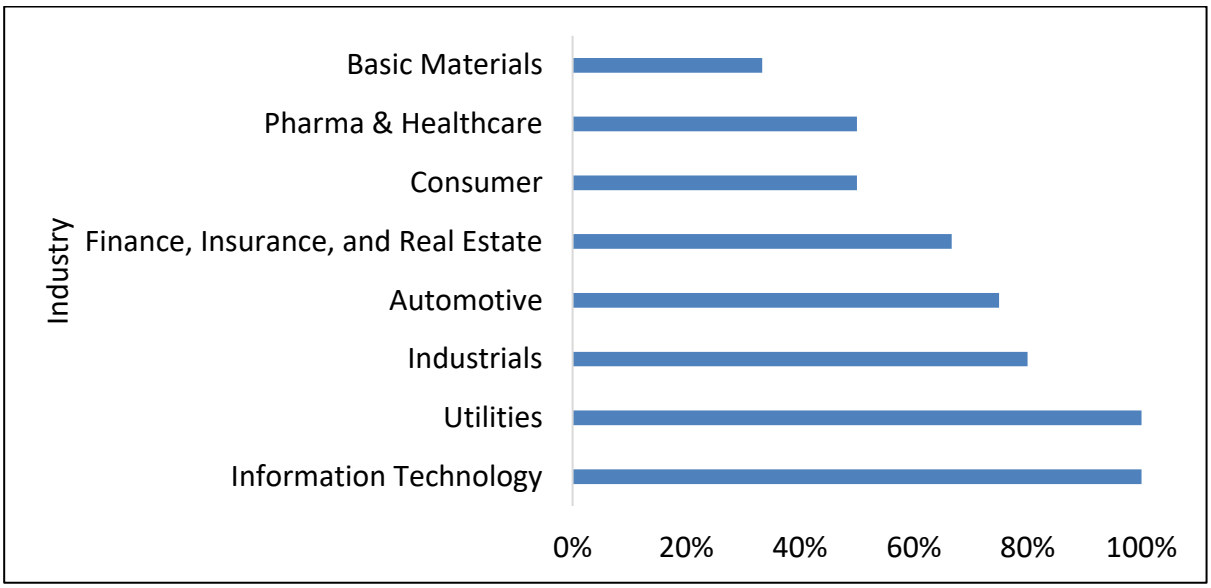
Figure 6: Number of hackathons organized by DAX 30 corporates
The figure presents the number hackathons conducted by German DAX 30 companies between 2012 and first half-year 2017, differentiating between digital and other focuses.



Hackathons are short, team-based, competition events and were originally established in the field of software or hardware development (Briscoe and Mulligan 2014; Byrne et al. 2017).

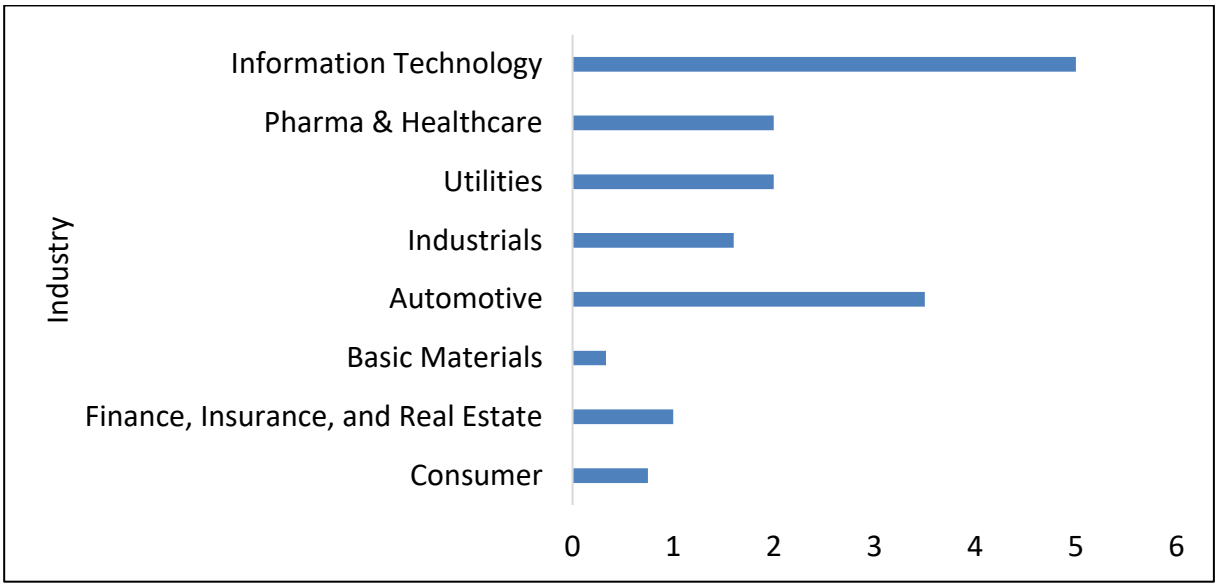
Figure 7: Percentage of DAX 30 corporates within an industry having organized at least one hackathon

The figure shows the percentage of DAX 30 corporates per industry that have conducted at least one hackathon as per first half-year 2017.



Recently, this collaboration type entered new fields like healthcare and banking aside the traditional programming area (Briscoe and Mulligan 2014; Parsi 2015). We identified 47 hackathons executed by German DAX 30 corporates between 2012 and 2017 (Figure 6). Some of them are organized jointly by several governmental institutions or corporates. We identified 7 hackathons conducted by at least two DAX 30 corporates. 40 out of 47 specifically focused on digitalization of business models and products. In five sectors, at least 50 % of the included corporates conducted hackathons (Figure 7). Not surprisingly, most hackathons were organized in the technology information sector on average (5 per company) followed by the automotive (3.5 per company) and utilities sector (2 per company) (Figure 8). We also identified an increasing popularity of hackathons within the finance (3 hackathons in 1HY 2017 compared to 2 hackathons in 2016 and 1 hackathon in 2015) and industrials sector (2 hackathons in 1HY2017 compared to 5 hackathons in 2016 and 1 hackathon in 2015). The majority of the observed hackathons were conducted in Berlin (13), followed by Munich (7) and Frankfurt am Main (4).

Figure 8: Average number of hackathon programs conducted by DAX 30 corporates
The figure presents the average number of hackathons per company in the respective industry sector as per first half-year 2017.



Hence, our analysis reveals that incumbents intensify their collaboration activities with young firms and ventures in one-off events. Although, hackathons became quite popular among DAX 30 companies, the question who owns the intellectual property (IP) that results from hackathon activities remains unclear, as it is still disputed and part of individual negotiations if it is owned by the incumbent or the hackathon participant. In course of our research, we found only three hackathons that disclose the IP handling in advance.

4.4.3 Corporate incubators and accelerators

The first incubators started as government and academic initiatives in the 1960s. During the internet era between 1998 and 2000, many private incubators were founded simultaneously to the rise of CVC investments due to the hope of corporates to participate in the economic upsurge and to explore new technological opportunities. Immediately after the burst of the dot-com bubble, the majority of incubators disappeared again (Becker and Gassmann 2006). Based on the past experience, a new generation of incubators developed that is no longer only a provider of financial and physical resources but also of knowledge-intensive services (Becker and Gassmann 2006; Grimaldi and Grandi 2005; Pauwels et al. 2016). Accelerators can be regarded as a type of this new incubator generation (Kohler 2016). Hence, we combine accelerators and incubators in our research by defining accelerators as a subtype of incubators. However, due to the fact that “no two business incubators are alike” (Allen and McCluskey 1990,

p. 64) and due to the firm-individual arrangement of those activities, it becomes sometimes hard to classify them as accelerator/incubator activities or as other activities like plain acquisitions. In order to assess if respective activities of incumbents qualify as accelerator or incubator for our study, we defined a set of 5 criteria where 4 need to be met as precondition for being included in the category incubator/accelerator.

1. *Access to physical resources (office space, laboratories, production machines, software) is given.*
2. *Office services (administrative services such as bookkeeping, reception services or legal advice) are granted.*
3. *Access to equity (own investments or access to venture capitalists and angel funds) is given.*
4. *Processual and entrepreneurial support (Sales and management support, mentoring, coaching) is given.*
5. *Network services (Establishing contact to potential customers and other companies, alumni network, access to experts, promotions at partner companies) are provided.*

Based on our research, we identified 19 incubator programs for German DAX 30 corporates. In total, 20 of the DAX 30 companies are involved in the 19 identified programs. 8 incubators are joint programs and are organized by at least two DAX 30 corporates. 17 out of 19 specifically focus on digitalization of business models and products in association with their core competencies or adjacent business fields. Looking at the number of newly founded incubators, we see that at least three incubators have been founded since 2014 per year (Figure 10).

Figure 9: Number of incubators and accelerators operated by DAX 30 corporates in Germany
The figure presents the number of incubator and accelerator programs conducted by German DAX 30 companies between 2012 and first half-year 2017, differentiating between digital and other focuses.

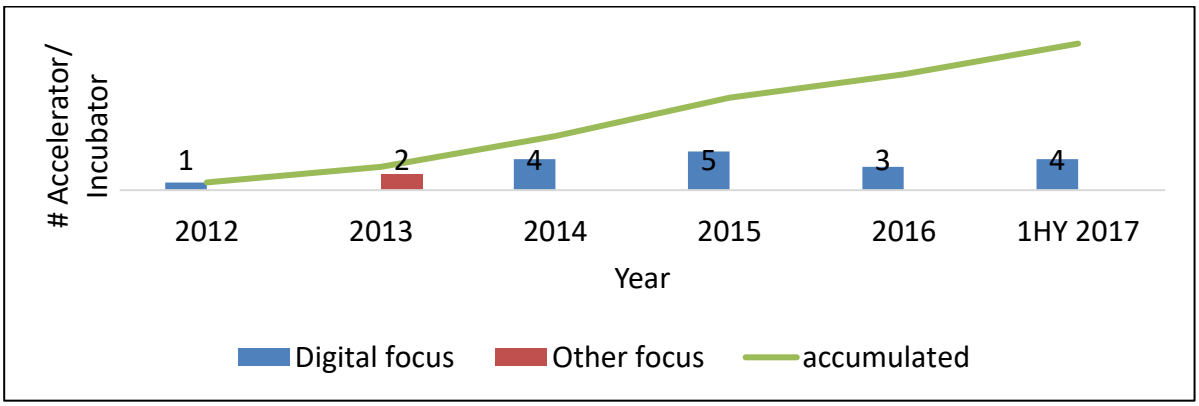
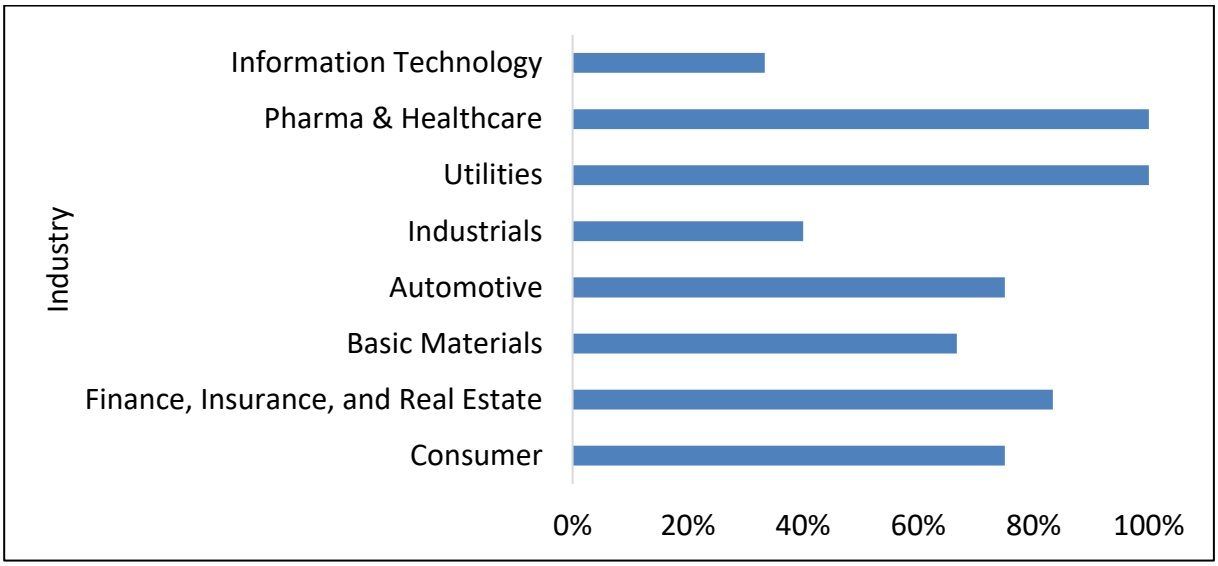
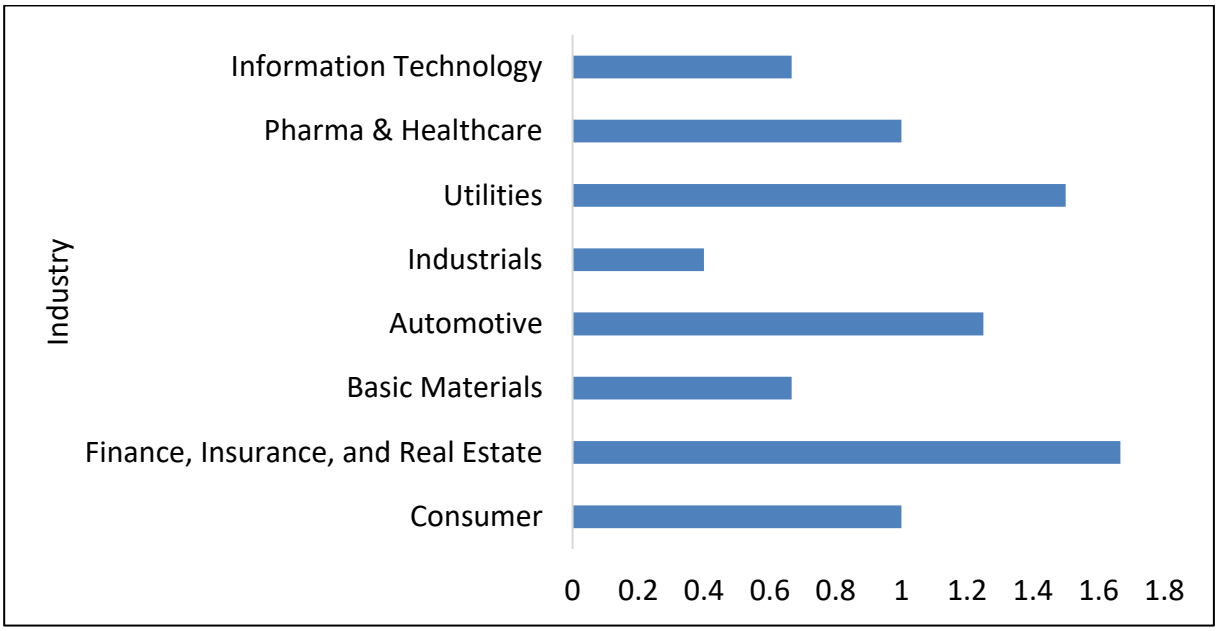


Figure 10: Percentage of DAX 30 corporates within an industry operating at least one incubator program
The figure shows the percentage of DAX 30 corporates that have conducted at least one incubator or accelerator program as per first half-year 2017.



Thereby, incubators are popular among all industries (Figure 10). Combining this fact with the analysis of our ratio of incubator programs per corporate (Figure 11), we see that incubators are especially established in the utilities, automotive and financial sector. Compared to that, the activity in the information technology and industrials sector is quite low (Figure 11). It seems that firms in the information technology and industrials sectors tend to focus more on early-stage ventures and therefore put their focus on hackathons rather than on incubator programs.

Figure 11: Average number of incubator programs conducted by DAX 30 corporates
The figure presents the average number of incubator programs per company in the respective industry sector as per first half-year 2017.



Based on our research we find for DAX 30 corporates that the number of organized hackathons is four times higher than the number of incubators and accelerator programs in the industrial sector and more than six times higher in the information technology sector respectively. However, we are aware that the number of hackathons can be higher due to the shorter program duration than in the cases of incubator and accelerator programs. Similar to the hackathon activities, most of the incubator programs are located in Berlin (9), Frankfurt am Main (6) and Munich (2).

4.4.4 CVC

After young firms have successfully managed the idea generation, prototyping development and market entry, scaling their product and penetrating the market are the next steps. For this to happen, young firms in the start-up-stage need follow-up investments which can e.g. be provided by CVC arms of big corporates. For the purpose of our study, we define CVC as corporate equity capital which is used to invest in legally independent start-ups by acquiring a minority stake (Benson and Ziedonis 2009; Chesbrough 2003; Dushnitsky and Lenox 2005; Schween 1996). Historically, the CVC market is characterized by cyclical fluctuations following closely the capital market development in most cases (Gompers and Lerner 2000b). The first German CVC unit was founded during the second wave in 1983 by Siemens (Schween 1996).

Currently, we see the fourth wave which has started in 2011 after the financial crisis but which is clearly focused on innovation and strategic fits (Battistini et al. 2015).

Figure 12: Number of legally independent CVC vehicles operated by DAX 30 corporates in Germany

The figure presents the number of German DAX 30 companies' CVC units between 1995 and first half-year 2017, differentiating between digital and other focuses.

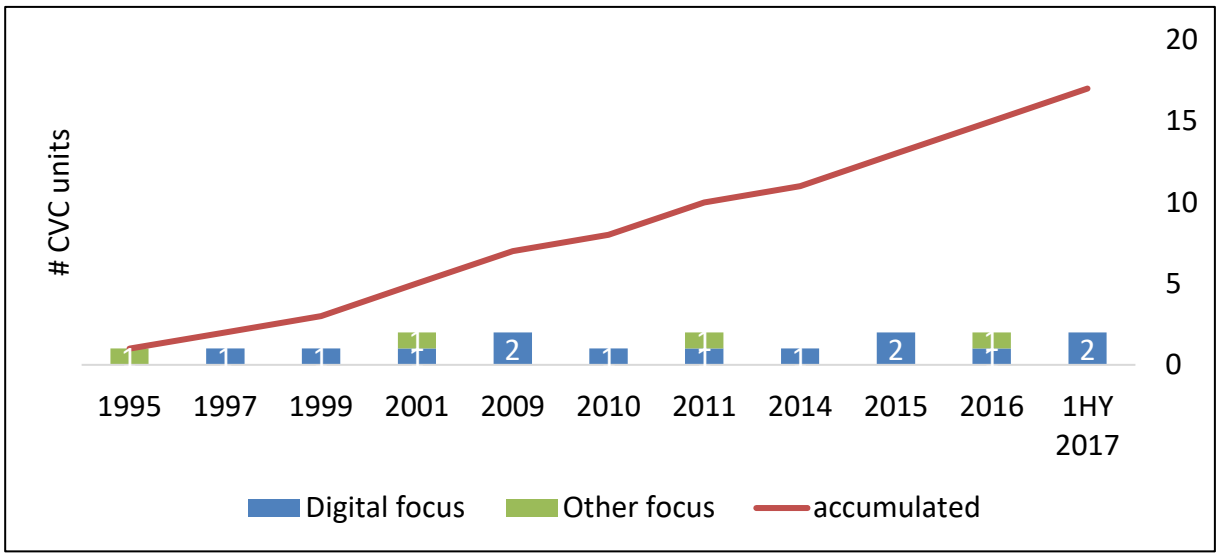
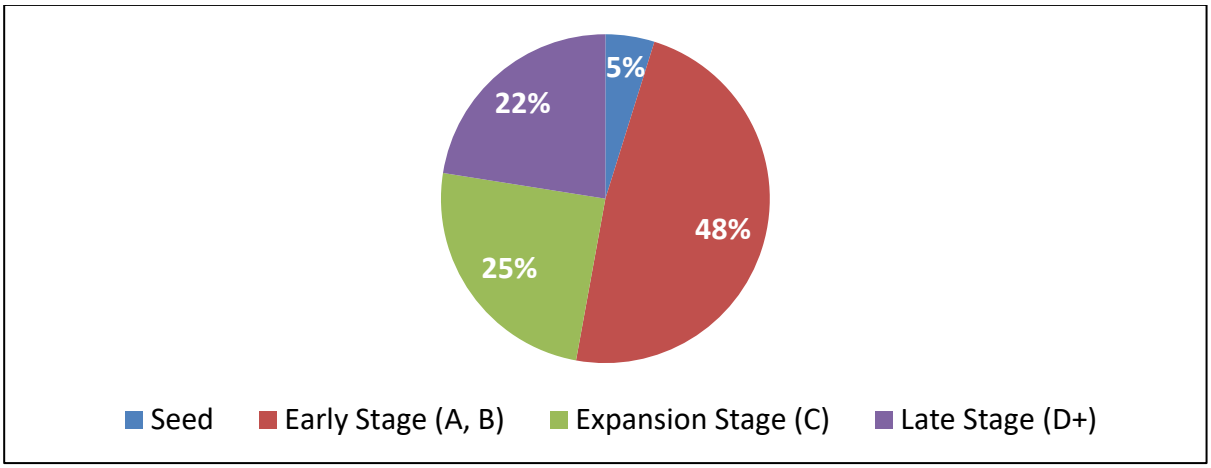


Figure 13: Investment timing of DAX 30 corporates

The figure illustrates the investment stages of todays' DAX 30 corporates between 1999 and first half-year 2017.



For the review of the German CVC market, we consider only incumbents that invest directly in young firms or via fully-owned subsidiaries that are still active. In course of our research, we identified 25 active CVC units for the DAX 30 corporates. Thereof, 17 corporates operate a separate and legally independent CVC unit and 8 DAX 30 corporates conduct investments directly via respective business units. Most legally independent CVC vehicles (12 of the 17) were founded since 2009 (Figure 12). Although, CVC investments usually invest minority stakes in

their target companies, three of those 17 CVC vehicles state that they consider majority stakes in specific circumstances, e. g., when a business is eminently important for a company´s strategy. Only for five DAX 30 companies, we cannot detect any CVC activities. An analysis of the development stages of the target companies in which the CVC units invest shows that a high share of CVC is invested in early stage companies (48%), 25% in expansion stage and 22% in later stage start-ups (Figure 13). Legally independent CVC vehicles were most common within the pharma & healthcare, information technology, utilities, automotive and financial sector (Figure 14 and Figure 15). The majority of all legally independent CVC vehicles (13 out of 17) focuses on digitalization of business model aspects whereas only 4 CVC units in our sample have a different focus.

Figure 14: Percentage of DAX 30 corporates within an industry operating at least one legally independent CVC unit

The figure shows the percentage of DAX 30 corporates per industry that operate at least one legally independent CVC unit as per first half-year 2017.

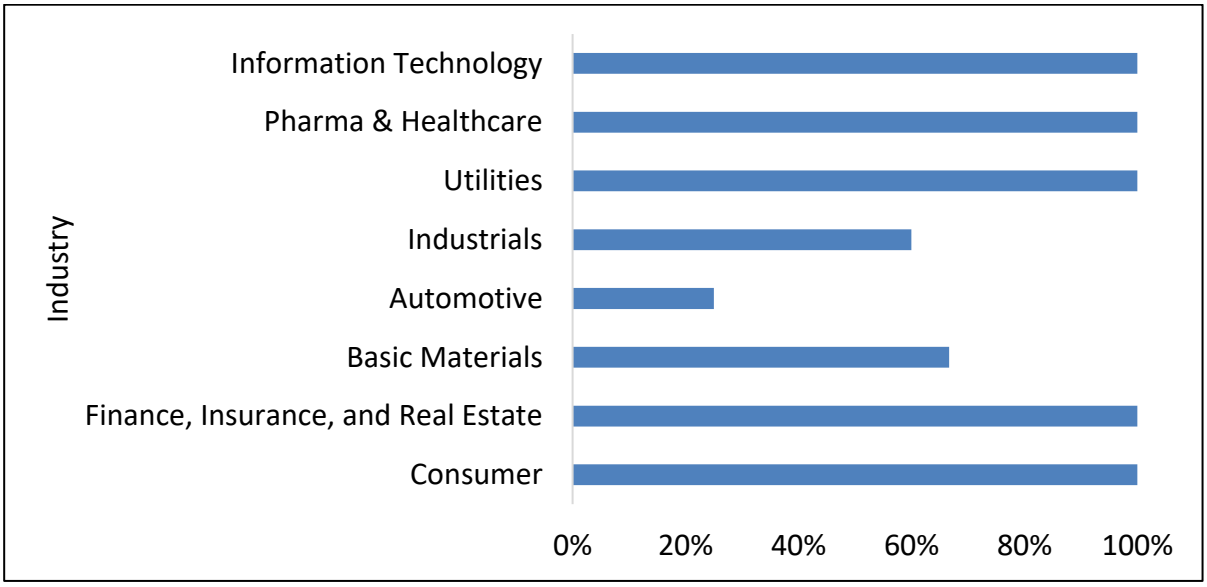
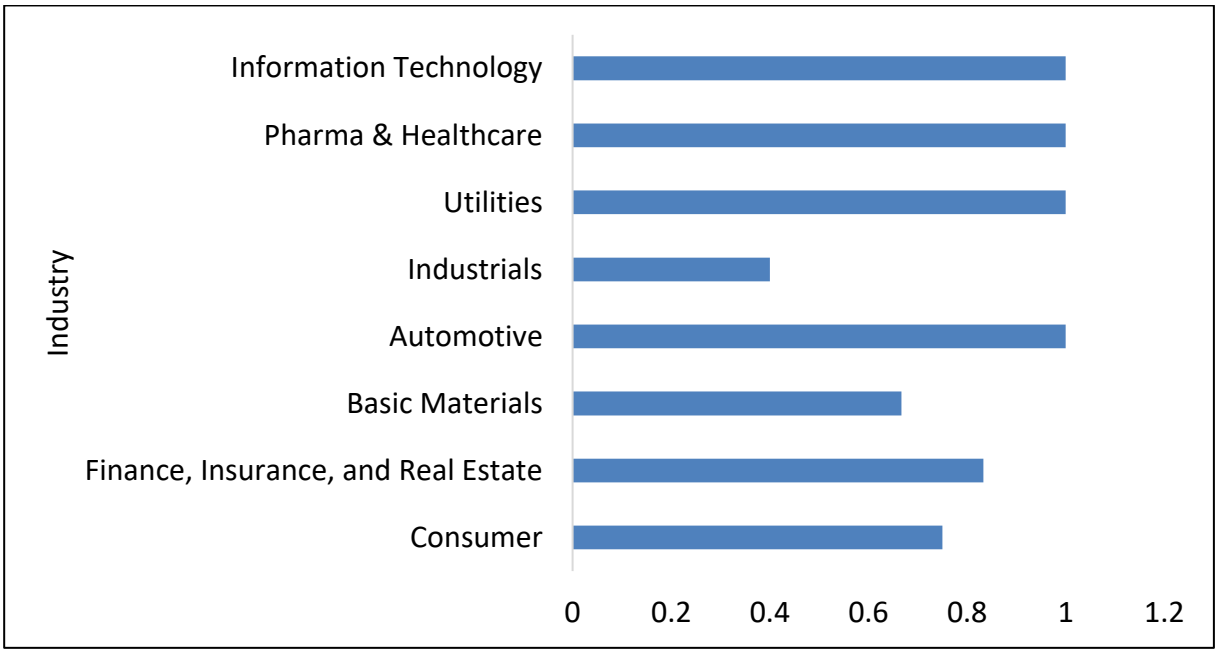


Figure 15: Average number of legally independent CVC units operated by DAX 30 corporates
The figure presents the average number of CVC units per company in the respective industry sector between as per first half-year 2017.



However, comparing CVC activities in the area of DAX 30 corporates with hackathons and incubator programs reveals that CVC activities often have a broader focus than the other two activities. Usually, CVC programs are not solely focused on digitalization of business models or products but also invest in business fields next to their corporate mother´s core competencies (Battistini et al. 2015). The analysis of the CVC activities further demonstrates that the investment focus is broader in comparison to the other two collaboration approaches (one-off-events and accelerator & incubator). One can conclude that CVC is rather used to invest in young firms in general, not limited to digitalization of business models and products. However, one potential limitation has to be considered when exploring the focus of CVC activities. We found some evidence that the focus of CVC programs could have changed over time in some cases as CVC programs typically last for several years. Hence, from today's point of view, it can be hardly assessed if CVC activities were originally founded with a digitalization focus or if the digitalization component was added later to the respective program.

4.4.5 Summary of descriptive research

In our study, we observe that large German corporates are increasingly trying to get access to external knowledge by collaborating with young start-ups. We found that most of the observed and analyzed collaboration approaches focus on digital transformation topics, e.g. 85

% of hackathons focus on digital topics, 89% of accelerators/incubators and 74% of CVC programs. Therefore, the intention to digitalize their business models seems to be the most important and prominent reason to conduct these programs for the DAX 30 corporates. Another insight is that the large German companies focus their innovation activities based on hackathons and incubator and accelerator programs mostly in start-up hubs such as Berlin and Munich. That fits to the fact that most German start-ups with digital business models have their headquarters in one of these cities (Berger et al. 2017). The DAX 30 corporate venturing activities have increased substantially since 2009.

15 out of 30 DAX companies offer all three analyzed collaboration approaches. In particular, almost all companies in the energy (100%), 75% in the automotive and 67% in the financial industry focus on all approaches (hackathons, incubators & accelerators and CVC). Obviously, these sectors seem to have the largest knowledge gaps and the highest pressure to digitalize their business models if we assume this factor as the main driver for collaboration activities. Further, 22 of 30 DAX corporates offer at least two of the three described collaboration approaches.

It can further be observed that in the last few years there is a trend toward collaboration with young ventures in earlier development stages, becoming apparent by the increasing number of hackathons and other non-equity-based collaboration approaches used. Concerning the timing of establishing the three collaboration approaches investigated in our empirical analysis, it seems that the DAX 30 corporates first started to establish new CVC programs from 2009 onwards, then started to establish incubator and accelerator programs since 2013 and at the last step implemented increasingly hackathons in their innovation portfolio since 2015.

4.5 Success determinants to be considered by incumbents for the purpose of digitalizing business models

Existing research agrees that most companies, especially in traditional industries, lack resources and capabilities that are essential to modernize their business models and make them sustainable in a digitalized world (Islam et al. 2017; Jacobi and Brenner 2018; Karimi and Walter 2015). However, in course of our research, we found two main reasons why incumbents can hardly overcome the hurdle to transform their business model on their own. On the one hand, as already mentioned, disruptive innovations are usually developed outside firm boundaries (Christensen et al. 2015). This holds in particular for the digitalization as most digital

business models are built upon networks or in young ventures. On the other hand, today's incumbents could rather be too late to start developing digital business models from scratch as the digitalization has already progressed in a couple of industries (e.g. Airbnb disrupted the hospitality industry or Uber and car sharing services changed the consumption of mobility). However, corporates that conducted networks and external knowledge sourcing strategies in the past might benefit from this experience in the current situation. Particularly, it should be noted that future innovations in the digital field will be the result of co-creation and network processes (Schreieck and Wiesche 2017) as the digitalization of business models and products is mainly about connecting formerly separated devices and resources. But this development implies that incumbents need to change their self-perception and their role in value chains to remain in the role of a leader as resources and capabilities will be less centralized and the role of the mediator in the network will evolve to the leading market position (Gallego et al., 2013). As future innovations in the field of digitalized business models will be the result of networks and cross-industry collaborations driven by the value of co-creation, we derive the following proposition:

> *Proposition 1: Incumbents that follow a network approach integrating young ventures to access external knowledge will be more successful than those not following this approach.*

By reviewing existing literature in the area of innovation research, we found that the collaboration with young innovative firms or the acquisition of them could be a promising way to close existing knowledge gaps (Cefis and Marsili 2015; Hussinger 2010). However, the success of such collaborations and acquisitions depends largely on the incumbent's dynamic capabilities and its absorptive capacity (Cohen and Levinthal 1990; Lin and Wu 2014). In particular, that means that an incumbent does not only need to be able to identify relevant collaboration partners and acquisition targets but also to interact with them appropriately. Incumbents especially need to avoid 'not-invented-here' situations by establishing an open-minded corporate culture (Cohen and Levinthal 1990). Subsequently, the ability to integrate, to interact and to collaborate with the target companies is an absolutely crucial success factor when accessing external knowledge. However, these abilities are not limited to the context of digitalization. Incumbents could acquire them by exchanging knowledge within networks and participating in collaborative R&D processes outside the digitalization area as well and integrate them into

their organizations. It seems to hold that incumbents that are used to adopt collaborative innovation processes and R&D networks and hence established a sufficient level of absorptive capacity will benefit from this experience when collaborating with or acquiring young firms. Further, we assume that absorptive capacity that was previously gained outside the area of digital business models can be transferred and reused in this context.

> *Proposition 2: Companies that are used to participate in R&D networks and collaborations will perform better when using acquisition and collaboration strategies for the purpose of digitalizing their business model.*

In the course of our research we found some evidence in the German market that especially corporates in traditional industries (engineering, energy, etc.) increase their efforts regarding the acquisition of external knowledge. Probably, this is due to the fact, that those companies show the most significant gaps regarding their existing resources and capabilities for establishing digitalized business models. These large gaps are usually accompanied by comparably low levels of absorptive capacity and internal 'digital' R&D resources, which might have a negative impact on the future innovation performance. Previous research has already shown that large differences in terms of technology and corporate culture lead to lower future innovation performance due to higher friction and communication needs (Kavusan et al. 2016), whereby large corporates might benefit from their past strong R&D activity (Chandy and Tellis 2000), as this activity is associated with a higher level of absorptive capacity.

On the other side, a high degree of technological similarity between incumbents and their collaboration or acquisition partners also has a negative impact on their future innovation performance (Colombo and Rabbiosi 2014). The reason for this effect is rather obvious and especially relevant in the context of digitalization of business models. Given the fact that the digitalization of business models is a radical innovation, the respective development often requires inputs from other technologies and industries in order to overcome existing barriers. Hence, incumbents and target companies with a high technological and organizational similarity tend to have a lower innovation performance (Cassiman et al. 2005). One reason for this effect could be that the level of disruptive potential is too low for those companies due to their high level of similarity and hence they cannot trigger a successful innovative development. Accordingly, these two contrary trends lead to the following proposition:

Proposition 3: Post-acquisition innovation performance follows an inverted U-shape based on technological and industrial similarity of incumbents and target companies.

Consequently, it is likely that the existing gaps between traditional industry players and young ventures will force them to pursue a strategy to acquire knowledge outside their boundaries in a particularly aggressive way. In order to reduce the required investment amount and to lower the risks which are associated with high initial investments for acquiring mature businesses, incumbents are increasingly interested in the collaboration with very young firms. We observe this development also for the German market where incumbents increase their activities by offering one-off events (e.g. hackathons) as well as incubator and accelerator programs in comparison to CVC activities. By offering those programs, incumbents get deep insights into the technology and capabilities of young firms without taking high investments (Sabidussi et al. 2014). Simultaneously, this approach gives incumbents the chance to intervene in the ongoing development of groundbreaking technologies and adapt them to a certain extent to their needs as well as to materialize unexplored growth options by "leveraging private synergistic values" which means that incumbents can realize strategic value gains by providing market access or offering better sourcing conditions by using economies of scale (Ransbotham and Mitra 2010). Further, in case of acquisitions, valuation uncertainties of very young target companies lead to considerably lower bids and selling prices than charged for established firms in similar industry areas. Additionally, the benefits of collaborating with very young target companies are supported by the fact that the digitalization of business models requires comparably new knowledge that is often bound in ventures and young start-ups (Müller and Hopf 2017). Subsequently, we derive the following proposition:

Proposition 4: The collaboration with or the acquisition of very young firms, is more promising than the acquisition of mature companies for the purpose of digitalizing business models.

Further, young firms which are developing new and disruptive business models gain an increasing self-confidence about their value for incumbents. Hence, founders and owners of start-ups are less willing to sell stakes in their businesses to incumbents as by doing this they lose influence and incumbents gain extensive rights on future strategic decisions. In particular as there is currently almost no restriction for gaining access to capital. Supported by low key interest rates and high capital inflows, business angels, venture capitalists, corporates and

other investors compete for promising targets giving young promising firms often the choice among different investors. As a consequence, corporate incubators and accelerators gain increasing attention as those programs represent looser forms of collaboration between incumbents and young firms than acquisitions. Further, this development is supported by the increasing number of one-off events like hackathons and summits as well as developing partnerships and licensing agreements. However, the increasing spread of non-equity-based collaborations might be beneficial for all participants as this can enable young firms to remain independent from incumbents' integration strategies. Moreover, this enables all parties involved in the cooperation to establish connections with several other parties which supports the network idea of digitalizing business models and facilitates innovation processes (DeMan and Duysters 2005; Sabidussi et al. 2014). At the same time, networks represent the cornerstone of recently hyped platform business models (Cenamor et al. 2017) so that the following proposition is put forth:

Proposition 5: Non-equity-based collaboration models will become more important and will help incumbents as well as young firms to develop and exploit new technologies.

4.6 Discussion and conclusion

This study investigates how incumbents react to changing environmental conditions by accessing external knowledge. Based on our research, we acknowledge that the digitalization of business models and products in all its manifestations and the resulting impact for incumbents has become one of the major research topics in the area of innovation, entrepreneurship and corporate venturing. The digitalization of business models or in other words the ongoing process of connecting the physical world with information technology is one of the most disruptive developments since the introduction of personal computers and is already disseminated in several exposed industries (e.g. consumer electronics, retail, etc.) but started to enter the remaining industries recently. Therefore, we analyzed the collaboration and venturing activities of all German DAX 30 corporates between 2012 and first half-year 2017 and provide clear evidence for a strong increase of these activities involving primarily very young target firms. Additionally, our study sheds new light on how these activities can be structured and organized by presenting our collaboration model which depends on the maturity of the collaboration or acquisition target as this is a decisive criterion for choosing the right approach. However, the sole maintenance of collaboration or venturing programs for identifying external

knowledge is not promising as the incumbent's capability to absorb respective knowledge is at least as important as the identification. Subsequently, incumbents are advised to invest in an open corporate cultural, sufficient R&D capabilities and their willingness to transform their existing business model.

4.6.1 Contribution

Overall, the contribution of our study is threefold. First, we provide clear evidence that German incumbents apply increasingly collaboration and corporate venturing approaches in order to access external knowledge in particular to cope with the ongoing digitalization. While previous literature focused mainly on incumbents outside Germany (Andersson and Xiao 2016; Colombo and Dawid 2016; Silveira and Wright 2016) and considered only CVC (Benson and Ziedonis 2009; Ernst et al. 2005; Gompers and Lerner 2000b) activities in the light of accessing external knowledge, we broaden the empirical base and include hackathons and incubators into our analysis. Furthermore, we can identify a trend toward these new collaboration types (hackathons, incubators) and can follow that increasingly very young ventures are targeted by incumbents. This sheds some light on the question how incumbents scan, search and explore new abilities. Hence, we contribute to the dynamic capabilities approach by providing previously missing detailed insights into the highest order category 'sensing dynamic capability'. While previous research has focused on setting the scene for dynamic capabilities in a more general context (Day 2014; Grimaldi et al. 2013; Teece 2016), it did not consider the application level of dynamic capabilities i.e. referred to it in an abstract and more general context and not specifically relating it to the new phenomenon of digital transformation. However, as digitalization is driven by young ventures and start-ups to a large extent, we believe that it is essential to establish an understanding how start-ups can be approached by incumbents and how the application of sensing dynamic capabilities looks like.

Second, building our research on the theory of dynamic capabilities enables us to elaborate on incumbents' internal processes that are required for operating collaboration or venturing activities in detail. Historically, several research was done how M&A activities impact the R&D activities of incumbents (Cassiman et al. 2005; Cefis and Marsili 2015) and which processes impact the selection of appropriate targets (Andersson and Xiao 2016; Hussinger 2010). However, only a few studies concentrate so far on the question which processes enable incumbents to implement external knowledge and how to transform their business based on the

knowledge they have acquired (Lin and Wu 2014). One potential reason for this development could be that past research considered usually the RBV as conceptual framework which implied to focus on potential knowledge gaps from a static perspective (Ahuja and Katila 2001; Narayanan et al. 2009). By building upon the dynamic capabilities approach, research becomes more process-focused. Subsequently, this development allows us to demonstrate that beside sensing dynamic capabilities, i.e. identifying external knowledge and opportunities, it is essential for incumbents to maintain sufficient levels of seizing and transforming dynamic capabilities, i.e. the ability to grow these opportunities and to transform their existing business model in order apply the strategy of accessing external knowledge successfully. Furthermore, by identifying these dynamic processes, we contribute to the question how incumbents react to changing socio-technological conditions as we develop a model how to access external knowledge depending on the maturity of the knowledge carrier. In addition, the model answers to some extent the question how technological changes are being adopted by incumbents and how incumbents as well as ventures or start-ups develop innovations and technological changes themselves.

Third, our study develops propositions based on our empirical findings as well as on the existing underlying theory. By doing this, we shed some light on the factors that impact the success probability of incumbents' collaboration and venturing approaches which helps to understand influences on the process of technological adaptation. As a result, our propositions allow to identify potential pitfalls for incumbents when deciding to access external knowledge by establishing collaborations or acquiring young companies.

4.6.2 Limitations & future research avenues

While providing insights into collaboration and venturing activities of incumbents in order to close knowledge gaps or to transform existing business models, our study has several theoretical and analytical limitations. First of all, a general scarcity of data can be observed when examining the collaboration and venturing activities of incumbents. In particular, financial data for these activities is not publicly available and hence a measurement of success is quite restricted. However, financial data supplemented by the incumbent's defined strategic goals would be absolutely essential to assess the success of collaboration and venturing activities in the long run. As a result, our study is limited to a descriptive analysis of German DAX 30 activities without considering the success of the activities. Further, available data is self-disclosed

by incumbents and hence might be biased by their self-reporting. This fact could be especially relevant in the case of digitalization as certain incumbents might be tempted to present themselves as more innovative than they really are by solely labeling their activities as “digital”. Nevertheless, we would like to encourage additional research on the success factors of corporate collaboration and venturing programs. In particular, this includes questions such as how to interact with collaboration partners and acquisition targets, which level of autonomy should be granted to acquisition targets or how they can be integrated into existing R&D processes. Further, we would suggest to enlarge the sample and include incumbents from different countries as well as to include smaller companies in order to examine if the observed activities disperse or if they are rather restricted to distinct groups of incumbents.

Second, our study focuses on three distinct collaboration and venturing activities (hackathons, incubators/accelerators and CVC). By doing this, we do not consider additional types of collaboration and knowledge exchange like pilot projects or pure research and development alliances. Although, there is certain evidence for the increasing use of non-equity-based collaborations with very young ventures. Hence, we recommend future research to conduct an in-depth analysis of new collaboration types that are less popular. However, we acknowledge that being acquired by a large incumbent might also bear certain risks for ventures and young start-ups. Ventures and start-ups might face a clash of a different corporate culture and need to accept that they need to relinquish their autonomy. Generally, they are in danger of being overrun with standardized and rigid processes and structures of the incumbent. As our paper is majorly focused on the challenges of incumbents, we do not examine impacts on ventures and start-ups in detail. However, we are aware of potential negative results for ventures and start-ups and recommend to include these effects in future research projects in detail.

Finally, our study faces certain limitations when analyzing the dynamic capabilities and their impact on the success of collaboration and venturing activities. From a theoretical perspective, we see clear evidence that a sufficient level of dynamic capabilities is necessary to identify relevant external knowledge as well as to access and potentially use this knowledge. However, as dynamic capabilities are usually tacit knowledge, they are hard to measure and it remains even more difficult to determine a sufficient level of these capabilities. To overcome this, future research would require to develop new measurements, in particular as we believe that currently used proxies like the R&D intensity of incumbents (Lee and Kang 2015) might fall too

short for assessing these tacit capabilities concerning the new forms of collaboration outlined in this paper.

5 Which investors' characteristics are beneficial for ICOs? Evidence from blockchain technology-based firms[9]

5.1 Introduction

The introduction of Bitcoin by Nakamoto (2008) paved the way for a completely new technology that has the potential to disrupt entire industries (Sultan et al. 2018; Friedlmaier et al. 2018). Acknowledged as one of the "Top 10 Emerging Technologies of 2016" by the World Economic Forum (2016), the blockchain technology, which is the underlying concept of Bitcoin, shows that the encrypted and distributed ledger technology (DLT) has the potential to exceed its original application in finance in the future. Driven by steep price increases for Bitcoins in 2017 and the evolution of new application areas for the DLT in logistics and health care services both, research and public interest increased considerably during the last years (Xu et al. 2019).

However, the rise of DLT was accompanied by another remarkable phenomenon. Instead of following typical financing patterns new ventures conduct increasingly Initial Coin Offerings (ICOs), a novel and unique form of blockchain-based funding (Chanson et al. 2018). Whereas the introduction of DLT marks a cutting-edge development from a technological perspective, ICOs mark the same from an entrepreneurial finance perspective. For the very first time, ventures are able to raise large amounts of funding with minimal effort while avoiding compliance and intermediary costs (Sameeh 2018; Kaal and Dell'Erba 2017). This has enabled that in 2018 over 900 early-stage entities have raised over 21.7 billion USD by conducting an ICO and hence surpassing most of other funding types (Malinova and Park 2018). Therefore, the funding of blockchain technology based firms (BTBFs) is an emerging topic in the area of entrepreneurial finance and receives increasing attention from theory and practice (Fisch 2019; Fisch and Momtaz 2019; Block et al. 2018; Boreiko and Sahdev 2018; Dusil and Cerny 2018)

However, ICOs do not substitute other funding mechanisms completely but compete and coexist with them. In particular, venture capital (VC) remains a viable source of funding for BTBFs as VC firms aim traditionally to invest in new emerging technologies, hoping for strong future

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growth (Rosenbusch et al. 2013; Zacharakis et al. 2007). The interest of VC investors in BTBFs is also confirmed by Huang et al. (2019) who show that VCs invest considerably in innovative finance markets. Further, the strong interest is also observable from various news and articles that report the investment of renowned VCs in BTBFs (Kharif and Russo 2018; Russell 2018; Kastelein 2017). As a result from the continued interest of VC, a considerable number of ventures receives funding from more than one source i.e. they combine several sources of funding like VC investments and ICO or see VC investors participate in their ICOs.

This enables ventures to combine advantages of different investor types at different stages of their development. For example, VC and CVC are usually stronger involved in the operational development of the venture, whereas crowdfunding rounds or ICOs provide larger funding amounts on average and enable ventures to gauge the market interest for their products or services. However, ICOs represent at the same time a new type of exit route for VCs as ICOs facilitate the sale of shares.

Due to the novelty of ICOs, little is known so far on the interplay of this type of funding and more established forms like the reception of VC. In particular, existing research in the domain of ICOs examines mainly BTBF-intrinsic factors against the background of ICO success and the level of returns for ICO investors. For example, Benedetti and Kostovetsky (2018) find that ICOs generate average buy-and-hold abnormal returns of 48% in the first 30 trading days for investors based on a dataset of 4,003 planned and executed ICOs. On the other hand, Momtaz (2018) present evidence that the loyalty of CEOs facilitates the attraction of investors and Rhue (2018) demonstrates that the code quality as well as website characteristics and the degree of social media presence influence the ICO success. Furthermore, Howell et al. (2018) find that ICO success is associated with disclosure and credible commitment of the founder team while An et al. (2019) conclude that the business and technical background of founders as well as the size of their social network influences the success of respective ICOs. Thus, Fisch and Momtaz (2019) are one of the very first who examine the influence of VC investors in the context of ICOs and demonstrate their beneficial impact. However, as they focus mainly on the question whether VCs are able to select superior BTBFs or if BTBFs benefit rather from the investors' treatment, they do not provide a detailed view on the characteristics and interrelation of investors which might impact the success of ICOs. Hence, this work is one of the first to shed light on the interplay of different investor types and their specific characteristics in the

context of blockchain and their subsequent impact on BTBFs' success. Thereby, we draw on the general research in the area of financing entrepreneurial ventures as well as on the signaling theory (Spence 1973) in order to provide additional insights to this question.

The remaining paper is structured as follows. First, we shed light on the general development and characteristics of ICOS. Second, we develop our research hypotheses, followed by the introduction of our data set and the used econometrical method. Third, we conclude by presenting our results and their implications and discuss potential limitations of our study.

5.2 Evolving of ICOs as financing instrument

Simultaneously to the introduction of cryptocurrencies, as a new means to clear payments, the idea arose to use cryptocurrencies and blockchain technology to conduct ICOs (Adhami et al. 2018). Economically, "ICOs can be defined as open calls for funding promoted by organizations, companies, and entrepreneurs to raise money through cryptocurrencies, in exchange for a "token" that can be sold on the internet or used in the future to obtain products or services and, at times, profits" (Adhami et al. 2018, p. 65) or in other words they are "an unregulated form of a crowdsale to raise funds through a blockchain by selling venture-related tokens or coins in exchange for legal tender or cryptocurrencies" (Amsden and Schweizer 2018, p. 7). That means, in an ICO, ventures offer a stock of specialized crypto tokens for sale with the promise that those tokens will operate as the only medium of exchange when accessing the venture's future product (Catalini and Gans 2018; Li and Mann 2018). From a technical perspective, there are several ways how to design an ICO (using an existing blockchain vs. creating a new blockchain) which are not addressed in this paper as we categorize all ICOs as a novel and unique form of blockchain enabled financing (Chanson et al. 2018). For a more technical detailed discussion of ICOs and blockchain please refer to Amsden and Schweizer (2018) or Chen (2018).

While ICOs have become the dominating form of financing mechanism in the blockchain area they are assumed to disrupt well-established industries that rely on traditional funding sources as well (Chanson et al. 2018; Gomber et al. 2017). The meteoric rise of ICOs is also observable when looking at numbers of ventures that have conducted an ICO as well as at the amount of money that has been raised in these. Although 2019 has represented a slowdown compared to 2018 when more than 14 billion USD were raised within more than 2,430 ICOs (Fromberger and Haffke 2019), the volume and value of ICOs has remained considerably high. Although

blockchain and ICO are rather nascent technologies, research interest increased considerably in recent times (Xu et al. 2019; Bakos and Halaburda 2018). Generally, research in this area can be classified into two separate streams.

First, the general application of blockchain and its impact on various industries has been examined by several researchers. Several analyses were conducted to explore the importance of blockchain for different industries and whether the blockchain technology can disrupt them (Varma 2019; Sultan et al. 2018). In particular, the importance of the blockchain development for the financial industry received extensive attention and has identified that its application may transform traditional trading methods and practice in the financial industry (Ashta and Biot-Paquerot 2018; Kim and Sarin 2018; Chen et al. 2017). Furthermore, Gomber et al. (2018) see that the introduction of blockchain will particularly impact four "financial" areas: operations management, payments, deposit services, and lending, whereas Dierksmeier and Seele (2018) discuss impacts on business ethics that may arise from the introduction of blockchain.

The second research stream in this area, which is even more relevant for our research setting, concerns ICOs, their application and impact. Howell et al. (2018) discuss in their paper if ICOs are an alternative to more traditional funding sources for new ventures, such as angel investors, VC investors, IPOs, or pre-sale crowdfunding platforms like Kickstarter. Catalini and Gans (2018) examine under which conditions entrepreneurs may prefer ICOs vs. competitive VC markets. Thereby, they derive respective conditions and characterize the optimal token supply schedule by relying on a game theory approach. Furthermore, there exist several studies that explore success determinants of ICOs (Adhami et al. 2018; Ante et al. 2018). For example Fisch (2019) examines the technical capabilities of ventures and how they impact the amount of funding in ICOs including the quality of their source code and the quality of their disclosed whitepaper. However, the sole use of ICOs as source of financing is rather seldom and, in most cases, ICOs are supplemented by angel investments or VC. Surprisingly, this issue has raised only limited attention in existing literature. Lin and Nestarcova (2019) discuss if blockchain businesses represent new investment opportunities for VC investors and which risks this brings on the table. To our knowledge, only Fisch and Momtaz (2019) examine the role of VC in ICOs. In particular, they explore the signaling role of VC in ICOs and whether VC-backed BTBFs outperform their peers. However, while examining the role of VC investors in ICOs, they do not consider individual characteristics of VC investors and their investment style in detail.

Thus, by investigating the influence of investors' characteristics like their reputation or their level of sector specialization which have proven to influence the success of respective portfolio companies (Shu et al. 2011; Lee et al. 2011; Bertoni et al. 2019; Gompers et al. 2009; Hochberg et al. 2015), we enhance the understanding on the interrelation between investors, ICOs and the mid-term success of BTBFs. More precisely, our research provides a more nuanced view on the beneficial influence of VC investors in ICOs and the development of BTBFs.

5.3 Background of ICOs and interplay with other funding sources

Securing of funding and liquidity represents one of the largest challenges for new ventures (Fisch and Momtaz 2019; Breuer and Pinkwart 2018; Achleitner et al. 2011). Traditionally, new ventures try to access external capital like angel, seed or VC in order to receive capital for their future growth and development. However, by doing this, entrepreneurs have often faced severe frictions (An et al. 2019). ICOs offer a way to reduce these kinds of frictions or even to overcome them completely. Existing literature has identified four primary reasons that make ICOs attractive and successful (Amsden and Schweizer 2018) in particular in comparison to traditional funding mechanisms.

First, ICOs help to overcome moral hazard and reduce information asymmetries (Momtaz 2019, 2018) by relying on immutable, non-negotiable governance terms when using blockchain technology (Howell et al. 2018). Respective governance terms are available to investors ex ante to their investment decision and cannot be changed ex post, signaling a strong commitment of the founding team on venture governance. Subsequently, the founding team has almost no possibility to benefit themselves on the expense of other investors and hence potential moral hazard is reduced considerably (An et al. 2019).

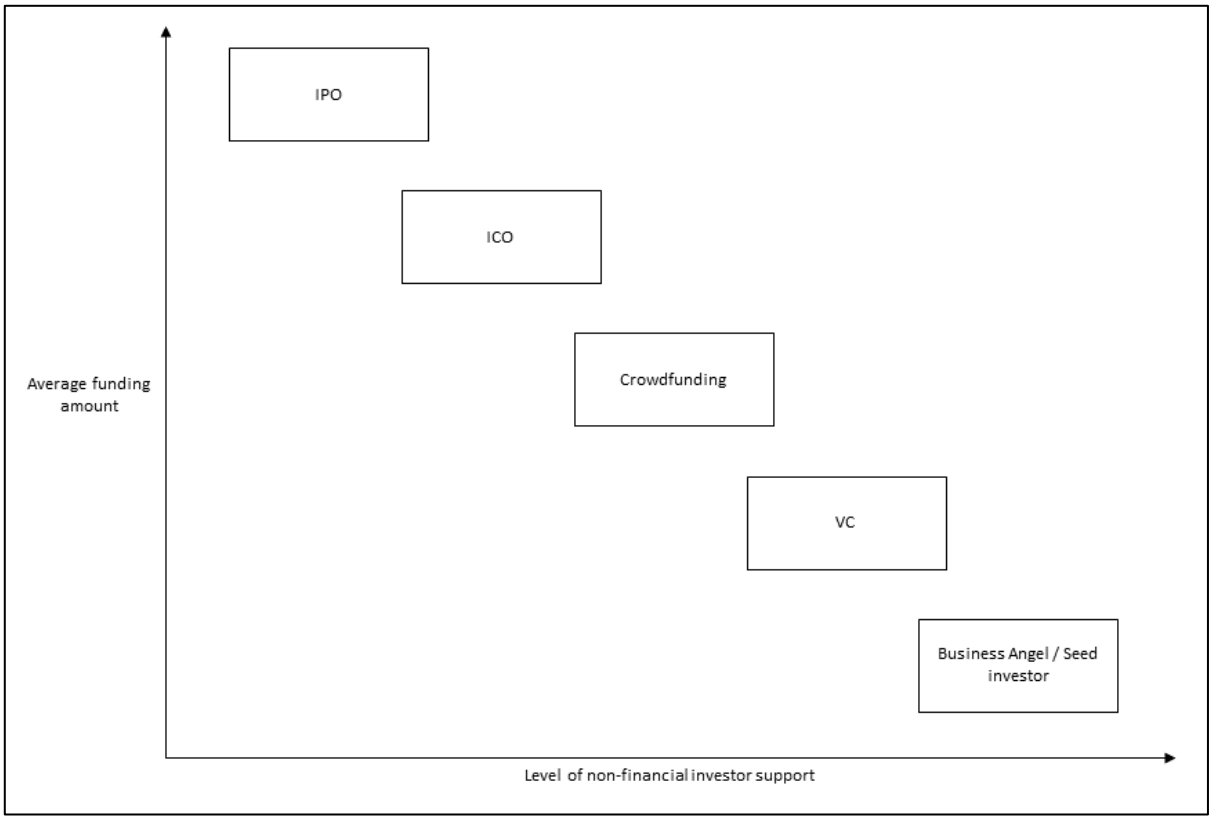
Second, by excluding most intermediary cost, ICOs possess a higher cost efficiency than other forms of financing (Amsden and Schweizer 2018). Basically, the entire generated value accrues to the token holders, i.e. investors, instead of to the intermediaries and sponsors in traditional networks.

Third, compared to other entrepreneurial financing options, ICOs offer the possibility to attract a wide range of investors. Whereas, traditional early stage financing options like VC are restricted to very few investors, ICOs "democratize" the investing process as they permit „a

broader range of individuals, who may be excluded from investing in traditional financing instruments, to invest in high-risk, high-return venture projects" (An et al. 2019, p. 34). In fact ICOs show a high degree of similarity with IPOs (Benedetti and Kostovetsky 2018) as IPOs sell a share of ownership from the company while an ICO sells a share from the project (Chohan 2017). Thus, permitting access to the investment process for a broad range of individuals can also be beneficial for the future venture's development as the investor universe can comprise future customers (An et al. 2019) leading to higher product awareness and enabling ventures to gauge future market demand (Chod and Lyandres 2018; Momtaz 2018).

Lastly, ventures and investors in ICOs benefit from rapid liquidity if the token gets listed on an exchange platform (Amsden and Schweizer 2018). In contrast to traditional shareholdings of investors in ventures which are of rather captive nature, tokens can be sold almost immediately by investors without harming the project itself after the ICO.

Figure 16: Degree of non-financial investor support
The figure presents the degree of financial support depending on the investor type.



Nevertheless, certain disadvantages can arise for BTBFs when using ICOs as their (solely) source of financing. As already mentioned, ICOs share a couple of similarities with IPOs or

crowdfunding campaigns (the average amount of capital raised within ICOs make a comparison with IPOs more suitable whereas given the usual development stage of the venture, a comparison with crowdfunding campaigns seems to be more appropriate). In general, ICOs do not offer any support for ventures beside contributing financial capital which represents a huge difference to other types of early stage investors (compare also Figure 16). Early stage investors provide usually non-financial support to their portfolio companies which comprises legal and management services among others as well as the provision of strategic advice. Existing research has identified non-financial support as a success-critical factor on the growth path of young ventures (Amornsiripanitch et al. 2015; Hellmann 2002; Sapienza 1992). Of course, this cannot be provided by ICOs or crowdfunding campaigns, as the larger investor universe limits the influence of individual investors and the anonymity of investors impede strong personal relationships. However, BTBFs receive also continued interest from more established early stage capital providers (Kharif and Russo 2018; Russell 2018; Kastelein 2017). As a consequence, these ventures are able to raise funding from several sources which enables them to combine different investor characteristics and advantages. Specifically, we observe that a considerable number of BTBFs receive angel or seed capital, followed by VC investments before finally conducting an ICO. This observation is in line with Kaplan and Lerner (2010) who estimate that roughly 60% of all IPOs are VC-backed which can be transferred to our context as IPOs share several similarities with ICOs. We assume that the non-financial support of VCs increases notably the success rate of ventures, whereas subsequent ICO events provide sufficient levels of capital for their mid- to long-term growth path. At the same time, ICO events represent additional attractive exit routes for VCs that have been invested prior to them.

5.4 Hypothesis development

Generally, the investment in young ventures is characterized by a high level of uncertainty and information asymmetries (Hellmann and Puri 2002). This holds also in the case of BTBFs and in particular when they conduct an ICO since the quality of a venture is often not directly observable by potential investors (Stuart et al. 1999). Especially, small and private investors who participate often in ICOs are facing large challenges when determining the true quality of a venture and subsequently deciding to invest (Ahlers et al. 2015). Hence, ventures need to send signals to attract potential investors and to convince them from their quality and future development perspective (Bocks et al. 2019). From a theoretical perspective, this draws on the

signaling theory which was initially introduced by the seminal work of Spence (1973) and which is concerned with the reduction of information asymmetries in investor-investee relationships. Past research has already identified the relevance of signaling technical capabilities (Fisch 2019), founder team characteristics (An et al. 2019) and commitment of founders to invest (Fisch 2019; Vismara 2016) in ICOs as success critical.

Furthermore, existing literature in the VC area has stressed which factors act as signal for VCs to invest. However, we argue that the VC investment itself represents a signal to future investors which is in line with Davila et al. (2003) and Baum and Silverman (2004) who find that the existence of VC investors represents an indicator for a certain level of quality of the venture.

Basically, we assume that the positive signal of existing VC investors is grounded on two distinct research streams that lead to superior performance and abnormal returns. First, VCs are supposed to select more promising ventures (selection effect) (Baum and Silverman 2004; Bertoni et al. 2011) and second to support them by providing complementary assets and services (treatment effect) (Fisch and Momtaz 2019; Jackson et al. 2012).

However, existing research in the VC domain remains ambiguous whether VCs are really able to select superior ventures (Baum and Silverman 2004). Several research concludes that VCs are not always able to select superior ventures or if they are able to identify them, VCs may not be able to invest in them (Bertoni et al. 2011; Colombo and Grilli 2010, 2005) as the ventures' superior nature enables them to self-select their sources of capital.

On the other side, several papers conclude that VCs are able to select superior ventures and to add substantial value during the holding period leading in combination to significant higher returns as VCs devote significant management resources to identify and understand promising ventures before investing in them (Davila et al. 2003). Subsequently, other research finds VCs are usually able to identify ventures that yield high future growth potentials and promise superior future returns (Rosenbusch et al. 2013; Bertoni et al. 2011; Chemmanur et al. 2011; Baum and Silverman 2004) by growing a mostly scalable business model.

Due to their investment model, VCs do not rely completely on public information when they make investment decisions but can fall back on valuable information which they obtain from their networks (Alexy et al. 2012). In particular, we argue that this leads to an information advantage and hence that the investment of respective VCs represents a positive signal to other investors during ICOs which is in line with Fisch and Momtaz (2019) who find that VC-

backed BTBFs outperform substantially their peers. Furthermore, given the superior performance of VC-backed ventures, the existence of a VC investor which is invested prior to the ICO can act under such circumstances as a signal to future investors by indicating a certain quality of the venture (Baum and Silverman 2004; Davila et al. 2003). This aspect is in particular important in the context of ICOs as publicly available information around ICOs is rather restricted and the fraud potential is considerably high (Fisch 2019).

However, besides making supposedly better investment decisions, VCs support their portfolio companies by providing a broad range of value-adding services and hence facilitate their growth during the holding period (Jackson et al. 2012; Tykvová 2018). This positive effect relies thereby majorly on the resource-based view, as VCs provide their portfolio firms resources they would otherwise lack (Fisch and Momtaz 2019; Rosenbusch et al. 2013; Baum and Silverman 2004). First, a VC investment is generally associated with an infusion of management expertise (Baum and Silverman 2004) which is crucial as ventures usually do not have an experienced management team due to their novelty. VCs increase the level of professionalization and provide multifold services to their venture through their influence. These services include among others HR, accounting and marketing services (Hellmann and Puri 2002). However, VCs help also to establish governance procedures and organizational set-ups of their portfolio companies by providing coaching and access to their network (Bertoni and Tykvová 2012; Hellmann and Puri 2002). Furthermore, VCs monitor their portfolio companies directly by taking board seats and incorporating respective legal clauses in formal contracts which reduces potential fraud risks and increases the feedback quality. Cumming and Johan (2007) argue thereby that both formal contracts and informal governance mechanisms are beneficial for the venture's development. Thus, the VC existence prior or during the ICO i.e. the respective signal reduces information asymmetry between investees and potential investors.

Hence, we derive the following hypothesis:

H1: VC backing increases ICO success.

Based on the assumption that VC backing is generally beneficial for ventures, the investment time, i.e. treatment time of the VC, should influence the ventures' performance. Existing research provides certain evidence that ventures that are younger when they receive their first round of investment have a significantly higher chance to become a high flyer than their older counterparts (Streletzki and Schulte 2013). In particular, we see three effects that might play

a role when assessing whether the investment timing of VCs influences the success probability of BTBFs.

First, existing research provides certain evidence that VCs are able to select superior ventures, i.e. picking winners (Stuart et al. 1999; Megginson and Weiss 1991). However, this superior selection is not only limited to investing in better ventures but includes that VCs are invested earlier in them. Subsequently, Baum and Silverman (2004) provide evidence that VCs are able to identify and preinvest in those ventures that are particularly likely to exhibit superior future performance.

Second, investing in very early stages extends the potential treatment period of VCs and hence the VCs' influence on the ventures' development which should raise the probability to close existing resource lacks and contribute to a successful development of the venture. This is in line with Grilli and Murtinu (2015) who present that very young ventures benefit more from the treatment effect provided by VCs than more mature ventures. In particular, they find that the treatment effect on sales growth is quite stronger for ventures that are younger at the time of the first VC investment. In addition to this, Cumming and Johan (2010) find that the value added, provided by VCs, is linked to the investment duration as longer investment durations result in higher value add.

Third, the lack of complementary resources is particularly large shortly after foundation and hence the potential for VCs is larger. Particularly, prior research has found that VC is able to contribute value by providing complementary resources particularly in very early stages of the venture's life (Bertoni et al. 2011; Sapienza et al. 1996). The reason for this effect is that very early stage ventures are on average in greater need of coaching (Fisch and Momtaz 2019) as they tend to exhibit a greater lack of resources. In addition to this, the VC investment implies of course also a certification for the respective venture which represents a positive signal to potential future investors.

These arguments result in the following hypothesis:

H2: Earlier VC backing increases the success probability of BTBFs.

Assuming that VC investors that are invested in a venture prior to a potential ICO represent a positive signal to follow-on investors during ICOs, the question remains whether investors' characteristics have a moderating role on the signal that is sent to other market participants.

However, relevant investor characteristics need to be observable by other market participants in order to have a signaling function. Among other characteristics, the reputation of an investor can have a signaling function as the reputation is rather public and can easily be obtained by the respective recipients. This is important as producing and receiving a signal must outweigh the cost of its production (Connelly et al. 2010).

Generally, the reputation of a firm is defined as an intangible asset that is based on public recognition of the quality of a firm's activities and outputs (Lee et al. 2011; Shapiro 1983; Rindova et al. 2005). In the case of VC investors, the reputation is based on VC firm's prior experience and performance which is seen to be economically important (Achleitner et al. 2018) as well as on VC's network capabilities (Alexy et al. 2012) and the level of direct assistance that is provided to portfolio firms (Hsu 2004). Furthermore, VCs with a higher reputation have usually been able to realize higher returns in the past which gives some indication that they will do so in the future as well (Phalippou 2010). Subsequently, a venture's partnership with a reputable VC signals both the present and future quality of the respective firm (Gulati and Higgins 2003). This is thereby in line with past research of Stuart et al. (1999) who have found that firms which have well-known equity partners and prominent alliance partners perform better.

Further, past research has shown in particular the beneficial impact of prestigious investors in the context of IPOs (Hamza and Kooli 2011; Shu et al. 2011; Megginson and Weiss 1991) as well as in the case of equity crowdfunding (Vismara 2016), which is highly relevant in our context as both funding events show remarkable similarities to ICOs. The superior performance of ventures that are backed by more reputable VC investors relies thereby on two separate levers. First, more reputable VCs seem to be able to select better ventures (selection effect) (Hamza and Kooli 2011; Krishnan et al. 2011; Nahata 2008) compared to other investors. Second, more reputable investors add substantive value to ventures during their holding period (Krishnan et al. 2011; Lee et al. 2011).

Particularly, we argue that the reputation of the VC investor enforces the signal to follow-on investors during subsequent ICOs based on the two previous identified levers. Thereby, we assume that more reputable VCs facilitate the ICO process and enable better outcomes. Interestingly, higher reputations itself initiate a self-enforcing mechanism as more reputable investors attract ventures of higher quality which seek funding and hence retain a higher probability

of superior future returns which increases again the VC's reputation. Thus, the backing of a venture by a highly reputable VC investor represents a certification (Megginson and Weiss 1991) and sends a quality signal to other market participants during the ICO, i.e. the signal indicates a lucrative investment opportunity. As a result, we hypothesize the following:

H3: BTBFs backed by more reputable VCs raise higher amounts of capital in ICOs.

While historically VC investors focused primarily on certain investment stages, recently the specialization on certain industries has become more popular (Siddiqui et al. 2016; Hagendorff et al. 2009). However, this aspect raises the question whether industry-specialized VC investors are able to outperform generalists and whether existing findings hold in the blockchain context. Existing research shows ambiguous results whether industry-specialized investors outperform generalists (Le Nadant et al. 2018). While Hagendorff et al. (2009) find no statistically significant relationship between industry specialization and portfolio company success as measured by the number of IPOs, Matusik and Fitza (2012) provide evidence that the relationship between portfolio company success and VC firm industry-specialization follow a U-shape with VCs having a moderate level of diversification showing the lowest performance. These findings are further supported by Gompers et al. (2009, p. 843) who find that "the performance of specialized firms appears to be better in general" after reviewing a global dataset of 11,297 portfolio companies. However, it is important to note that the knowledge i.e. the specialization of a VC firm relies majorly on past experience in the industry of the respective portfolio firm. Subsequently, Le Nadant et al. (2018) provide empirical evidence that investors with experience in the industry of their portfolio companies are more beneficial to their portfolio companies.

Generally, specialized (VC) investors are presumed to have a better performance due to two major effects. First, specialized VCs are able to select more promising ventures as their expert knowledge enables them to assess market potentials and business quality more reliably (Gompers et al. 2009). Second, specialized VCs are presumed to provide appropriate support due to their experience and market knowledge enabling a better development of the venture (Hagendorff et al. 2009). Summarizing both effects, generalist VC firms are assumed to be worse at allocating capital compared to specialized VC firms (Rajan et al. 2000; Scharfstein and Stein 2000).

As BTBFs represent a rather young industry which is highly complex due to the novelty of the technology and the strong usage of highly dispersed business models, we assume that a deep industry understanding of VCs is beneficial for respective portfolio companies and the findings from the more general VC research can be transferred to the blockchain context without any limitations. Furthermore, we assume that deep industry knowledge is represented by a stronger specialization of the respective VC. For BTBFs, we assume that the superior selection capabilities as well as the superior treatment of blockchain specialized investors should influence the ICO outcome of BTBFs.

H4: BTBFs backed by more blockchain-specialized investors are more successful.

Past research in the field of entrepreneurial finance has widely stressed the benefits of corporate venture capital (CVC) investors for portfolio firms (Galloway et al. 2017; Ivanov and Xie 2010). For example Park and Steensma (2012) show that CVC investors can contribute to the portfolio companies' development by providing valuable managerial resources. Furthermore, Chemmanur et al. (2014) find that CVCs can nurture innovation in portfolio firms and hence lead to a superior development. Unlike usual VC investors, which pursue predominantly financial objectives, most CVC investors combine strategic and financial goals (Block et al. 2018; Rossi et al. 2017) in order to contribute to the overall parent companies' strategy. In particular, they offer usually access to non-financial assets of the parent company including expertise, infrastructure for product development, manufacturing, legal, sales, distribution and customer service activities among others (Park and Steensma 2012) which can facilitate the ventures' development and which differentiates CVCs from pure financial investors. Especially in the very beginning of a venture's lifetime this support can help to commercialize its products or services (Paik and Woo 2017). Furthermore, renowned CVCs can reduce the widespread uncertainty for new technologies that are introduced by ventures. By backing these ventures, CVCs create a technology endorsement effect as they signal markets that they are convinced by a technology which is a strong argument for other market participants to apply these products (Paik and Woo 2017). CVC investments represent subsequently a certification for the ventures' products and services. Although, BTBFs are a rather new phenomenon, we see a considerable number of CVC investors that are invested in them. As BTBFs are often very nascent, in particular before they conduct potentially an ICO, we assume that the processes and influences that impact BTBFs are similar to the processes and influences that impact the more

general group of ventures and hence that BTBFs can benefit from CVC support and access to complementary assets. Subsequently, we presume that the support as well as the certification effect influence the ICO, if the CVC is invested previous to this funding event. Hence, we follow:

H5: The receipt of a CVC investment increases the amount of ICO funding.

5.5 Research design

5.5.1 Sample

We test our hypotheses using a comprehensive sample of BTBFs. We focus on BTBFs as these ventures are most probably conducting ICOs due to their technological proximity. In order to identify relevant ventures, we conducted the Blockchain Start-up Tracker provided by Outlier Ventures, a VC investor focused on BTBFs, which was founded in 2014 and which tracks developments around BTBFs since 2016. As per 18th April 2019, we were able to retrieve a list of 1,731 BTBFs from Outlier Ventures which serves as basis for our research. In order to ensure the comprehensiveness of our dataset, we crosschecked the number of identified ventures with other sources and research (Fisch and Momtaz 2019; Fisch 2019) but cannot find any substantial misses. We doublechecked the blockchain relatedness of each venture by accessing the venture's website and evaluating respective business descriptions as well as consulting third-party descriptions and, if available, disclosed whitepapers. In addition to this, we performed an extensive web research whether a venture was still active as per 18th April 2019 or not. In particular, we assumed that if a venture's website was no longer available at that date that the respective venture has stopped operating.

Furthermore, we merged the list of ventures with Crunchbase data for getting details on investors and funding rounds. Crunchbase is a free online database which was founded in 2005 and which provides information about technology companies, investors, and funding details majorly focused on the US market. Though the Crunchbase database is comparably young, it becomes increasingly popular in VC research (Schlichte et al. 2019; Croce et al. 2016; Homburg et al. 2013; Werth and Boeert 2013).

Unfortunately, the information on ICOs and BTBFs is not complete for all entries, which is a common issue in ICO and entrepreneurial finance research (Kaplan and Lerner 2016; Fisch 2019). In order to mitigate this issue, we hand-collected missing data to the extent possible

from various additional data sources, e.g. ICObench, CoinGecko, and ICO Rating. After excluding incomplete entries, our sample consists of 649 BTBFs that have conducted an ICO and out of which 182 received at least one round of VC financing.

Data for GDP growth in respective countries were taken from World Bank's World Development Indicators database. Furthermore, data on historic bitcoin prices was gathered from Coinmarketcap, which is one of the most established sources in ICO research (Fisch and Momtaz 2019; Fisch 2019; Lyandres et al. 2018). Finally, we retrieved the amount of annually raised VC from KPMG (2019).

5.5.2 Variables

5.5.2.1 Dependent variables

In order to investigate the hypotheses just outlined we use two different dependent variables. First, we follow existing research and incorporate the amount of funding raised during the ICO as success measurement (*Ln_amount_ICO*) for the respective venture (Fisch and Momtaz 2019; Momtaz 2018; Fisch 2019). Based on the assumption that ventures strive to achieve the highest possible amount of funding during their ICO, the received amount of funding represents a direct success indicator as it enables future growth options and indicates the venture's value for existing shareholders. Furthermore, as success-related data is rather scarce in the area of entrepreneurial finance, the amount of ICO funding represents one of very few opportunities to get an indicator on an objectively confirmed venture valuation similar to more general financing events like funding rounds, IPOs, or crowdfunding campaigns. The amount of funding during ICOs is thereby directly linked to the future development of the BTBF as the received proceeds enable BTBFs to grow their business and invest in required resources. As the amount of funding received during ICO events is highly skewed, we apply the natural logarithm of the respective amount.

Second, we apply a binary variable *Survived* which equals one if the respective BTBF is still operating as per 18th April 2019 and zero otherwise. Applying this second dependent variable as success measurement helps to shed light on BTBF's sustainability as well as on their mid-term development. Particularly, this approach allows us to differentiate between factors that impact the short-term success as well as the mid-term success of BTBFs. Further, the application of two variables measuring the success of the BTBF adds robustness to the results.

5.5.2.2 Independent and control variables

In addition to the dependent variables used, the independent and the control variables are summarized in Table 6. In order to answer the question whether financial investors, i.e. VC investors, increase the success of ICO events we incorporate a dummy variable *VC_investor* which equals one if a VC investor has been invested into the respective BTBF before or during the ICO event and zero otherwise.

Furthermore, we include a variable *Reputation_IPO* in order to address the point whether the investor's reputation has a moderating effect or influences the success of a respective venture. Therefore, we apply the share of investments exited via an IPO as investor reputation measurement following Bottazzi et al. (2008), Jackson et al. (2012) and Nahata (2008) which is based on the assumption that IPOs are the most favorable exit option for investors. By incorporating this measure, we refer to the lead investor which is in line with Krishnan et al. (2011) as lead investors maintain the closest relationship to the portfolio company in investor syndicates and thus exert great influence. The calculation of the variable is thereby based on a similar approach as applied by Nahata (2008) and takes the average of the yearly percentage share of IPOs backed by a specific investor compared to all IPOs in the same year. For calculating the reputation, we refer to a timespan from 1990 until 2018.

In order to assess whether an earlier VC backing influences the success of BTBFs we include the variable *lnDays1stVCinvtoICO*. This variable measures the number of days between the receipt of a first round of VC investment and the ICO. As the variable is highly skewed, we apply the natural logarithm. To examine our hypothesis that CVC investors are beneficial for the development of BTBFs we include a dummy variable *CVC_investor* that equals one if a venture has received CVC previous or during its ICO and zero otherwise. This approach is in line with Park and Steensma (2012) who find that particularly ventures that require specialized complementary assets benefit from CVC investors.

Furthermore, in order to elaborate on the question whether blockchain specialized investors impact the success of BTBFs, we incorporate a variable *HHI* which is the Herfindahl index for the first blockchain-specialized lead investor within the first three funding rounds prior to the ICO. This variable denotes the portfolio concentration of a specific investor. For calculating the

Herfindahl index, we refer to all investments conducted by a specific investor prior to the investment in the respective BTBF following a similar approach as Gompers et al. (2009). In particular, we rely on the same industry classification but add blockchain as a separate industry.

In addition to the independent variables used, this paper also controls for several effects that might influence the success of BTBFs. In order to analyze potential effects that may arise from the founding country, we incorporate country control variables which is in line with Fisch (2019). The dummy variable equals one if the venture's founding location is in the respective country and zero otherwise. The main reason for doing this is that a venture's location is decisive for attracting financial sources such as VC (Stuart and Sorenson 2003) or crowdfunding (Mollick 2014), although a stronger online exposure, like in the case of most crowdfunding rounds, seems to reduce potential geographic influences. Furthermore, cluster regions are supposed to support the foundation and development process of new ventures by providing resources and networks (Gilbert et al. 2008). Particularly, Switzerland has established a blockchain-friendly environment (Novak 2019) which might also be beneficial for the foundation of new ventures in this area. Furthermore, we control for the fact whether BTBF is built on the Ethereum blockchain or not (*Ethereum*). Therefore, we implement a dummy variable that equals one if the respective venture builds on Ethereum and zero otherwise. Most blockchain related ventures build on Ethereum and offer ERC20 tokens. Ethereum represents a de facto standard and offers certain advantages for ventures which might increase the success probability. By defining a set of rules that transactions need to follow, Ethereum enables a greater interoperability (Fisch 2019) and hence act as an indicator whether a venture is supposed to conduct an ICO (Chen 2018).

Based on the existing research findings that particularly new platform businesses are attractive investment cases for investors (Kenney and Zysman 2019a), we control for this in our models (*Platform*). Generally, asset-light business models are easier to scale and more flexible to adopt to changing environments. Subsequently, BTBFs that operate predominantly as platform provider could also demonstrate to be superior in terms of survival and success of ICO events.

In addition to these control variables, we control for the GDP growth during founding (*GDP_growth_fdg*). Therefore, we take the GDP growth rate of the country of foundation during the founding year from IMF database for each venture in our sample. We apply this control

variable as existing research provides certain evidence that the overall economic development has certain implications for the founding behavior as well as for the chance to receive sufficient funding levels. Nanda and Rhodes-Kropf (2013) provide evidence that promising and successful ventures are more often founded during economic "cold" times as times of strong economic growth induce that lower quality ventures also get funded as the overall market development conceals their potential quality issues at first. This effect seems to be additionally enforced by the fact that VC and private equity activity levels are closely related to the global economic development as VCs and private equity firms have higher levels of 'dry powder' at hand which fosters the likelihood for getting funded and achieving high valuation levels (Dias and Macedo 2016).

Besides these controls, we include further the number of founders in our models as a proxy for the diversification of the founding team (*#Founders*). Existing research assumes thereby that a more diversified founding team is beneficial for the development of the venture. More diverse founding teams can offset existing knowledge gaps or missing capabilities more easily what makes them more successful (Ratzinger et al. 2018; Bhawe et al. 2017).

Furthermore, we add a variable to our model that controls whether the venture has conducted a "pre-ICO" or not before it conducts the main ICO (*preICO*). The variable equals one if the venture has conducted a pre-ICO and zero otherwise. During pre-ICOs or "pre-sales" a small share of tokens is sold to early investors at a discount within a limited time span. To control for the existence of a pre-ICO is quite common in the blockchain research area (Fisch and Momtaz 2019; Amsden and Schweizer 2018; Fisch 2019) and is based on the assumption that word-of-mouth of early investors increases the attention for a venture and in turn increases the success probability of the main ICO. This phenomenon has been widely studied in the area of crowdfunding research (Amsden and Schweizer 2018; Colombo et al. 2015; Vismara 2015) and hence we control for it in our research context.

Most ventures that conduct an ICO prepare and provide prior to the funding event a so-called whitepaper. A whitepaper is usually published by the venture in order to disclose information about IT protocols, adopted public blockchain, token supply, pricing and the distribution mechanism, and details on the project to be developed (eventually a business plan, including a team description) to potential investors (Adhami et al. 2018), similar to a securities prospectus. However, the venture is not obligated to publish such a document but it evolved to a de

facto standard. In order to account for the existence of a whitepaper, we include a dummy variable equaling one if the venture has disclosed a whitepaper and zero otherwise (*Whitepaper*). We assume that disclosing a whitepaper forces ventures to act more self-disciplined and helps them to stay more focused. Nevertheless, producing a whitepaper comes with certain costs for the venture but allows potential investors to assess the success potential easier which makes the investors feel safer when investing besides raising additional attraction. A summary of variables used is outlined in Table 6.

Table 6: Definition of variables
The table describes the dependent, independent and control variables used.

Variable	**Description**
Control variables	
Country	Dummy variables indicating the BTBF's origin
Ethereum	A dummy variable indicating 1 if the BTBF's technology is based on Ethereum and 0 otherwise
Platform	A dummy variable indicating 1 if the BTBF operates a platform business model and 0 otherwise
GDP_growth_fdg	Variable indicating GDP growth (%) in the BTBF's founding year and country of origin
#Founders	Variable indicating the team size at BTBF foundation
Whitepaper	A dummy variable indicating 1 if the BTBF has disclosed a whitepaper and 0 otherwise
preICO	A dummy variable indicating 1 if the BTBF has conducted a pre ICO and 0 otherwise
BTCprice_fdg	Variable indicating the average Bitcoin price during the BTBF's founding quarter
Independent variables	
VC_investor	A dummy variable indicating 1 if the BTBF has received funding from a VC investor prior or during its ICO and 0 otherwise
lnDays1stVCinvtoICO	Variable indicating the natural logarithm of number of days between the BTBF's first funding event and BTBF's ICO (days)
Reputation_IPO	Variable indicating the average reputation of all lead investors prior and during BTBF's ICO measured as historical IPO Share
HHI	Herfindahl Index for blockchain specialized investors based on the lead investor within the first three funding rounds
CVC_investor	A dummy variable indicating 1 if the BTBF has received funding from a CVC prior or during its ICO and 0 otherwise

Dependent variables	
Ln_amount_ICO	Dependent variable indicating the natural logarithm of amount of raised money (USD) in ICO
Survived	Dependent binary variable indicating 1 if the BTBTF is operating as of 18th April 2019 and 0 otherwise

5.5.3 Method

In order to shed light on the collaboration between BTBFs and their investors as well as on respective success determining impacts, we apply the amount of received funding during ICOs as first success measurement. Since we study only BTBFs that have conducted an ICO, our analysis may suffer from a selection bias arising from the fact that unobservable factors might trigger the conduction of ICOs. To account for this potential selection bias and the resulting unobserved heterogeneity, we apply a two-step Heckman correction procedure in our models using the inverse Mill's ratio (Heckman 1976, 1979; Hellmann and Puri 2002). To compute the inverse Mill's ratio, a selection equation is used with *ICO* as binary dependent variable (equaling one if the respective BTBF has conducted an ICO and zero otherwise). Using a probit estimator, the analyses regress the ICO variable on a set of independent and control variables that have empirically proven to influence BTBFs' decision to conduct an ICO. Based on the residuals of the predicted probabilities of each BTBF to conduct an ICO, the inverse Mill's ratio is computed. Thus, the inverse Mill's ratio is applied in the BTBF outcome regression model in order to account for unobserved heterogeneity and hence, to retrieve more consistent estimation parameters (Colombo and Grilli 2010; Tucker 2010). We use the average Bitcoin price during the quarter of foundation of the respective BTBF as an excluded variable in the outcome equation in order to account for the unobserved heterogeneity. We conjecture that high Bitcoin price levels during the foundation increase the likelihood for BTBFs to conduct an ICO but that it will have no effect on the BTBFs chances to become successful as such. Besides the average Bitcoin price during the foundation quarter (*BTCprice_fdg*), we include all control variables in the selection equation. Subsequent to the selection model, a second-stage linear regression is conducted including the inverse Mill's ratio. For the second-stage linear regression, we regress the natural logarithm of the amount of ICO funding on all independent and control variables.

Furthermore, in order to apply our dependent success variable *Survived*, we follow a similar approach to control for a potential selection bias as in the case of the continuous dependent

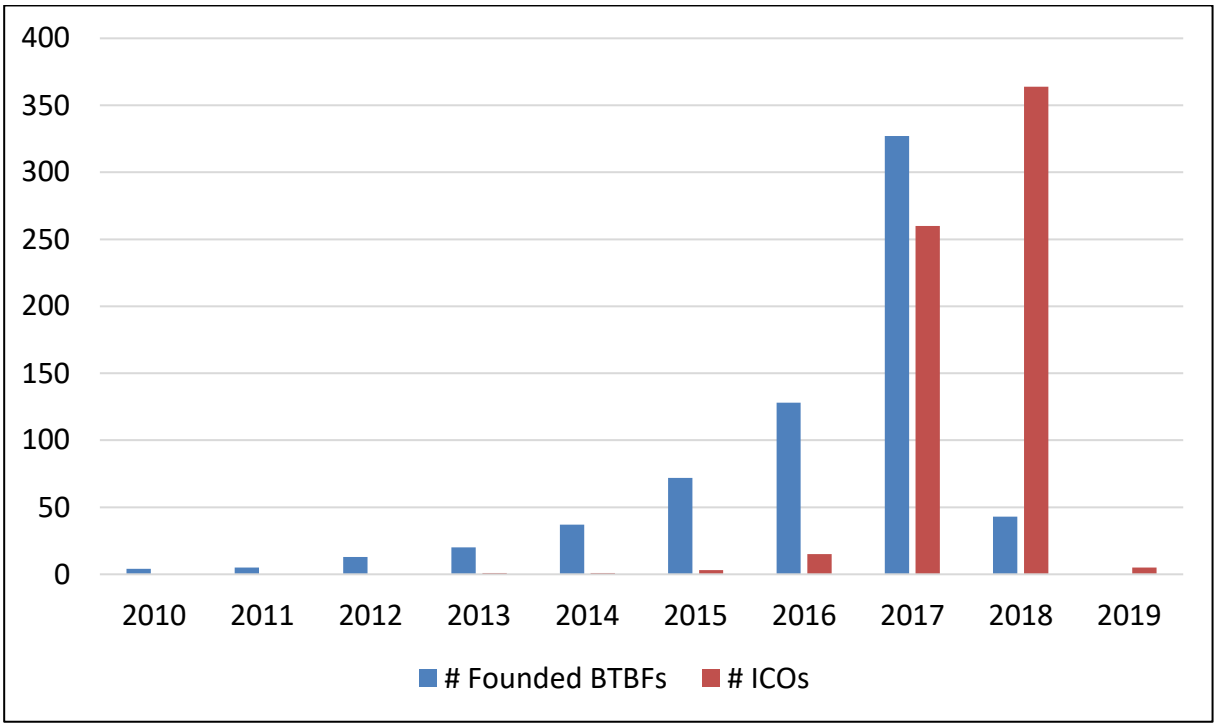
variable. For assessing the impact of our controls and independent variables on the dependent binary success variable *Survived* we estimate a bivariate probit model with sample selection (Heckprobit) (van de Ven and van Praag 1981). Similar to the approach in the continuous case we estimate a probit model by regressing the ICO variable on a set of independent and control variables that have empirically proven to influence BTBFs' decision to conduct an ICO (selection equation) and include the derived sample selection correction term in our success equation (Winston Smith and Robb 2011; Sandner et al. 2008). The success equation regresses thereby the binary variable *Survived* on the same set of independent variables and controls as in the continuous case. When $\rho \neq 0$, i.e. there is correlation between error terms of the outcome and selection equation, the standard probit model produces biased results. The Heckprobit procedure instead is intended to correct for selection bias, and to provide consistent, asymptotically efficient estimates for all the parameters in the model.

5.6 Empirical results

5.6.1 Descriptive statistics

As already outlined above, BTBFs and ICOs represent a rather new phenomenon. Figure 17 indicates that the number of foundations of BTBFs has peaked in 2017 and declined notably thereafter.

Figure 17: Number of founded BTBFs and corresponding ICOs
The figure presents the number of founded BTBFs per year as well as the number of executed ICOs.



Furthermore, Figure 17 shows that the number of conducted ICOs has risen particularly in 2017 and 2018 whereas a reduced level of activity can be observed in Q1 2019. Subsequently, it is observable that the number of ICOs follows the number of BTBFs foundations and hence, a strong preference of BTBFs to conduct ICOs as important funding resource. The strong increase of ICOs is thereby in line with the findings of Fisch (2019) who also present a peak of ICO activity in the first half of 2018 which indicates that the datasets of BTBFs that have completed an ICO are consistent to a certain degree.

Table 7: Industry overview of VC-backed and non-VC-backed BTBFs
The table shows an overview of industry affiliation separated by the total sample (column 1), BTBFs without VC (column 2) and BTBFs with VC (column 3).

	All BTBFs		**BTBFs w/o VC backing**		**BTBFs w/ VC backing**	
Industry	No. of firms	No. of firms	No. of firms	No. of firms	No. of firms	No. of firms
Consulting	31	4.78%	22	4.71%	9	4.95%
Energy	7	1.08%	6	1.28%	1	0.55%
Environmental	3	0.46%	3	0.64%	0	0.00%
Financial services	236	36.36%	178	38.12%	58	31.87%
Healthcare	14	2.16%	11	2.36%	3	1.65%
IT technology	159	24.50%	90	19.27%	69	37.91%
Media & Marketing	142	21.88%	114	24.41%	28	15.38%
Public administration	7	1.08%	6	1.28%	1	0.55%
Real estate	11	1.69%	7	1.50%	4	2.20%
Supply chain & Log.	22	3.39%	17	3.64%	5	2.75%
Others	17	2.62%	13	2.78%	4	2.20%
Total	**649**	**100%**	**467**	**100%**	**182**	**100%**

The BTBFs included in our sample operate in a variety of industries but predominantly in the financial services industry (36.36%), followed by the IT technology sector (24.50%). Overall, 182 BTBFs out of 649 BTBFs received funds from a financial investor prior or during their ICO but we do not find any material differences in the industry distribution when comparing BTBFs that have received VC proceeds and those that have not.

When regarding the geographical distribution of the BTBFs in our sample, 124 BTBFs are located in the US, followed by Singapore (70 BTBFs), and UK (57 BTBFs). Overall, the geographical distribution of BTBFs seems to be highly skewed and concentrated in certain regions.

Table 8: Summary statistics of BTBFs

The table shows all model variables for BTBFs that have conducted an ICO and BTBFs which have not conducted an ICO.

Summary statistics	**Panel A: BTBFs with ICO**			**Panel B: BTBFs without ICO**			**Panel C: Comparison of means**
	Observa-tions	Mean	Std. Dev.	Observa-tions	Mean	Std. Dev.	t-Value
Control							
Ethereum	649	0.703	0.458	82	0.488	0.503	-3.961****
Platform	649	0.182	0.386	82	0.378	0.488	4.201****
GDP_growth_fdg	649	2.722	1.685	82	2.762	1.613	0.205
#Founders	649	2.194	1.115	82	2.073	1.497	-0.887
Whitepaper	649	0.524	0.500	82	0.537	0.502	0.217
preICO	649	0.359	0.480	82	0	0	n/a
BTCprice_fdg	649	2214.544	3051.183	82	1816.583	3131.875	-1.110
Independent							
VC_investor	649	0.280	0.450	82	0.402	0.493	2.290**
lnDays1stVCinvtoICO	649	1.090	2.253	82	0	0	n/a
Reputation_IPO	649	0.0001	0.001	82	0.0003	0.002	2.666***
HHI	649	0.053	0.161	82	0.065	0.177	0.613
CVC_investor	649	0.026	0.160	82	0.122	0.329	4.383****
Dependent							
Survived	649	0.955	0.207	82	0.915	0.281	-1.605
Ln_amount_ICO	649	1.090	0.089	82	n/a	n/a	n/a

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

Table 8 presents the detailed descriptive statistics for all variables employed in our model. Further, we include in this table t-tests between the BTBFs that have conducted an ICO and those that have not conducted an ICO but which are included in the respective selection equations of our models. The t-tests indicate thereby that BTBFs that have conducted an ICO and those that have not differ to a certain extent regarding the variables considered in our models. In particular, we find significant differences for the investor-related variables e.g. *VC_investor, Reputation_IPO, CVC_investor*. Finally, Table 9 shows the correlation matrix for all variables and observations that are considered in our model.

Table 9: Correlation table of independent and control variables

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

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
(1) VC_investor	1.00											
(2) lnDays1stVCinvtoICO	0.70***	1.00										
(3) Reputation_IPO	0.16***	0.10**	1.00									
(4) HHI	0.52***	0.31***	0.21***	1.00								
(5) CVC_investor	0.30***	0.20***	0.12***	0.22***	1.00							
(6) Ethereum	-0.06*	0.04	-0.04	-0.05	-0.07*	1.00						
(7) Platform	0.10**	-0.03	0.07*	0.08**	0.04	-0.65***	1.00					
(8) GDP_growth_fdg	-0.04	-0.03	0.10**	0.02*	-0.03	0.05	-0.02	1.00				
(9) #Founders	0.07*	0.06*	0.08**	0.06*	0.04	0.05	-0.00	-0.00	1.00			
(10) Whitepaper	0.07*	0.05	-0.03	0.03	0.04	0.11***	-0.03	-0.08**	0.07*	1.00		
(11) preICO	-0.10**	-0.02	-0.05	-0.10**	-0.06	0.14***	-0.13***	0.06	-0.00	-0.16***	1.00	
(12) BTCprice_fdg	-0.17***	-0.16***	0.05	-0.04	-0.08**	-0.07*	-0.01	0.14***	-0.02	-0.24***	0.12***	1.00

* p<0.10, ** p<0.05, *** p<0.01

5.6.2 Main results

First of all, in order to verify whether or not the combination of variables suffers from multicollinearity, variance inflation factors (VIF) are derived for the probit as well as the OLS regression model. 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 does not seem to be an issue.

Table 10: Determinants of BTBF success (Heckman two step)

The table reports the results of the Heckman two step regression models. While Model 1 shows the selection equation based on a probit estimation, Models 2–7 present the outcome equation. Model 8 displays a linear regression without considering any endogeneity effects from a potential selection bias.

Dependent variable	**ICO Binary variable**	**Ln_amount_ICO (w/ controls for endogeneity)**	**Ln_amount_ICO (w/ controls for endogeneity)**	**Ln_amount_ICO (w/ controls for endogeneity)**	**Ln_amount_ICO (w/ controls for endogeneity)**	**Ln_amount_ICO (w/ controls for endogeneity)**	**Ln_amount_ICO (w/ controls for endogeneity)**	**Ln_amount_ICO (w/o controls for endogeneity)**
Model	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Controls								
Ethereum	0.233	0.117	0.102	0.109	0.134	0.133	0.118	0.076
	[0.187]	[0.128]	[0.151]	[0.190]	[0 .176]	[0.166]	[0.179]	[0.147]
Platform	-0.299	0.217	0.258	0.237	0.151	0.253	0.179	0.256
	[0.199]	[0.253]	[0.225]	[0.204]	[0.211]	[0.231]	[0.278]	[0.179]
GDP_growth_fdg	-0.037	-0.060	-0.063	-0.073	-0.076	-0.066	-0.076*	-0.070
	[0.042]	[0.043]	[0.050]	[0.051]	[0.049]	[0.046]	[0.048]	[0.044]
#Founders	0.044	0.030	0.037	0.049	0.031	0.043	0.025	0.016
	[0.056]	[0.062]	[0.054]	[0.052]	[0.056]	[0.042]	[0.054]	[0.054]
Whitepaper	0.084	-0.236*	-0.218*	-0.200	-0.232*	-0.219	-0.238**	-0.248**
	[0.144]	[0.116]	[0.111]	[0.129]	[.115]	[0.118]	[0.116]	[0.115]
preICO	4.897***	-0.065	-0.054	-0.005	0.120	-0.042	0.060	-0.160
	[199.198]	[0.366]	[0.367]	[0.446]	[0.380]	[0.390]	[0.418]	[0.120]
BTCprice_fdg	0.00002							
	[0.00003]							
Inverse Mill's ratio		0.515	0.586	0.771	1.041	0.712	0.791	
		[1.384]	[1.298]	[1.425]	[1.317]	[1.334]	[1.396]	
Independent variables								
VC_investor		0.545****					0.013	0.019
		[0.119]					[0.249]	[0.225]
lnDays1stVCinvtoICO			0.085****				0.019	0.020
			[0.030]				[0.040]	[0.038]
Reputation_IPO				391.0****			215.9	217.3****
				[98.702]			[166.76]	[82.679]
HHI					2.345****		2.065****	2.050****
					[0.314]		[0.449]	[0.392]
CVC_investor						0.790**	0.265	0.276
						[0.380]	[0.479]	[0.393]
Country controls	yes	yes	yes	yes	yes	yes	yes	yes
No. Obs.	731	649	649	649	649	649	649	649
Estimation method	Probit	OLS Reg	OLS Reg	OLS Reg	OLS Reg	OLS Reg	OLS Reg	OLS Reg
R^2 (pseudo R^2)	0.158	0.047	0.038	0.028	0.084	0.028	0.091	0.091
Wald χ^2	-	37.37****	20.55***	21.88***	69.94*****	11.84	60.03****	-

Standard errors are reported in brackets. Standard errors are based on bootstrap replications.
* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

Table 10 presents our main results referring to our focal variable *Ln_amount_ICO* as dependent variable which is a widely accepted success measurement for BTBFs (Fisch and Momtaz 2019; Fisch 2019), comparable to the amount of funding in crowdfunding campaigns or IPOs.

Model 1 presents thereby the results of the probit estimation which is used to generate the inverse Mill's ratio, i.e. the selection equation. Therefore, the binary dependent variable *ICO* is regressed on all control variables as well as the Bitcoin price during the founding quarter which has proved empirically to influence the likelihood for BTBFs to conduct an ICO. For reasons of brevity we present only one selection equation for all models as the probit estimation yields identical results for all models.

Models 2 to 6 show the hierarchical regressions in order to test our hypotheses whereas model 7 presents the full model including all controls and independent variables. Furthermore model 8 presents the results of a linear OLS with the natural logarithm of the funded ICO amount as dependent variable in order to provide comparability with the remaining results that consider potential selection bias and the occurrence of endogeneity.

Table 11: Determinants of BTBF success (bivariate probit regression with sample selection (Heckprobit))

The table reports the results of the Heckprobit models as average marginal effects [AME] (Bartus 2005). The usage of AMEs is more uncommon but seen as superior to the use of marginal effects at the mean when it comes to realistically interpreting the results (Greene 2000; Long 1997). While Model 1 shows the selection equation, Models 2–7 present the outcome equation. Model 8 displays a probit estimation without considering any endogeneity effects from a potential selection bias.

Dependent variable	**ICO Binary variable**	**Survived (w/ controls for endogeneity)**	**Survived (w/ controls for endogeneity)**	**Survived (w/ controls for endogeneity)**	**Survived (w/ controls for endogeneity)**	**Survived (w/ controls for endogeneity)**	**Survived (w/ controls for endogeneity)**	**Survived (w/o controls for endogeneity)**
Model	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Controls								
Ethereum	0.233	0.029*	0.027*	0.030*	0.031*	0.028*	0.028*	0.042**
	[0.187]	[0.017]	[0.016]	[0.017]	[0.017]	[0.017]	[0.016]	[0.019]
Platform	-0.299	0.051**	0.047**	0.051**	0.051**	0.050**	0.043*	0.069**
	[0.199]	[0.024]	[0.024]	[0.025]	[0.024]	[0.025]	[0.022]	[0.027]
GDP_growth_fdg	-0.037	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007	-0.009*
	[0.042]	[0.005]	[0.005]	[0.005]	[0.004]	[0.005]	[0.004]	[0.005]
#Founders	0.044	0.004	0.005	0.004	0.004	0.005	0.004	0.006
	[0.056]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]
Whitepaper	0.084	-0.029*	-0.029*	-0.029*	-0.031*	-0.030*	-0.031**	-0.025
	[0.144]	[0.016]	[0.016]	[0.016]	[0.016]	[0.016]	[0.015]	[0.017]
preICO	4.897***	-0.017	-0.018	-0.017	-0.015	-0.017	-0.014	0.004
	[199.198]	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]	[0.015]	[0.017]
BTCprice_fdg	0.00002							
	[0.00003]							
Independent								
VC_investor		-0.013					0.029	0.063*
		[0.015]					[0.029]	[0.033]
lnDays1stVCinvtoICO			-0.005**				-0.011**	-0.016***
			[0.003]				[0.005]	[0.005]
Reputation_IPO				-4.505			-5.827	-5.206
				[8.263]			[8.012]	[7.416]
HHI					0.101		0.142**	0.169*
					[0.069]		[0.072]	[0.089]
CVC_investor						-0.043	-0.026	-0.027
						[0.034]	[0.036]	[0.042]
Country controls	yes	yes	yes	yes	yes	yes	yes	yes
No. Obs.	731	731	731	731	731	731	731	731
Estimation method	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Pseudo R^2	0.158							0.097
Athrho	-	-1.461****	-1.634****	-1.563	-1.589**	-1.653****	-1.639	-
		[0.287]	[0.273]	[1.013]	[0.739]	[0.316]	[1.120]	
P		-0.898	-0.926	-0.916	-0.920	-0.929	-0.927	
Log-pseudolikelihood	-216.142	-328.111	-326.549	-328.398	-327.147	-327.696	-323.154	-129.517
Wald χ^2	-	12.93*	15.19**	12.57*	15.23**	14.09**	27.04***	-

Robust standard errors using Huber White sandwich estimator are reported in brackets
* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

Further, Table 11 presents our results when referring to our second dependent success measure variable *Survived*. Model 1 presents again the identical results from the first stage probit regression. Models 2 to 5 show the results of the hierarchical bivariate probit regression models. Due to brevity, we present only the coefficients for the outcome equations. Model 7 presents the results of the full model whereas model 8 presents the results of a probit model without considering any selection and treatment effects for reasons of comparability similar to the approach followed in the Heckman two step OLS regression.

When the amount of ICO funds raised is considered (Heckman two-step) as success measure (*Ln_amount_ICO*), model 2 reveals that the variable *VC_investor* has a positive and highly significant effect at the 0.1 percent level. This effect remains positive in the full model (model 7), however the statistical significance diminishes. In other words, the existence of a VC investor prior or during the ICO enables the BTBF to increase the amount of money that is received during the ICO funding event.

Further, we find that the time between the first VC investment and the ICO has a positive and highly significant effect at the 0.1 percent level on the success of the BTBF (model 3). The effect remains significant in model 8, however, with a negative sign at the 5.0 percent significance level. In addition to this, model 4 presents that the average IPO share of the investors prior or during the ICO as well as the respective degree of specialization (model 5) have a positive and highly significant influence on the amount of funding during the ICO at a 0.1 percent level. In particular the results regarding the degree of specialization expressed as Herfindahl index of the blockchain-specialized lead investor within the first three funding rounds (prior to the ICO) remains statistically significant at the 0.1 percent level in our full model (model 7).

Lastly, the empirical findings detect a positive and highly significant effect at the 0.1 percent level of the variable *CVC_investor* on the amount of funding raised during the ICO. Again, this effect is positive and significant at the 0.1 percent level when referring to models 6 and 7.

Concerning the control variables, we find that the dummy variable *Whitepaper* is negative on statistically weak levels throughout all models except for models 4 and 6. Second, the dummy variable *preICO* has a statistically positive effect in all models. Throughout all models the *Inverse Mill's ratio* remains positive without any relevant statistical significance which indicates

that sample selection does not play a major role. However, the results of the Wald χ^2 test indicate the appropriate use of a Heckman two step approach anyhow.

Further, when the binary dependent variable *Survived* is considered as success measure (bivariate probit models; Table 11), results differ from those presented above. First, we cannot find any statistically significant effect that the investment of a VC investor prior or during the ICO impacts the survival probability of BTBFs that have conducted an ICO (model 1). Second, we find that the time between the VC investment and ICO has a negative impact on the survival probability at a 5.0 percent level (model 2). This holds also in the full model (model 6). In addition, we do not find any statistically significant effect that the investor's reputation (model 3) or the existence of a CVC investor (model 5) has an impact on the survival probability. Despite of being statistically insignificant, we find in model 2 that having received funds from a VC investor prior or during the ICO lowers the likelihood to survive in the mid-term by 1.3%. Furthermore, we find ambiguous results for CVC investors as well as model 6 indicates that having received funds from a CVC investor prior or during the ICO lowers the likelihood to survive in the mid-term by 4.3%.

Generally, this raises the question why the results differ between the short-term (*Ln_amount_ICO*) and mid-term (*Survived)* view. Besides the fact that our results might be influenced by the rather short period of time between the ICO of respective BTBFs and the assessment whether they are still operating, we assume that the certification effect (Megginson and Weiss 1991; Baum and Silverman 2004) which results from the investment of VC investors prior or during the ICO is particularly important in the context of BTBFs. More precisely, based on the finding that the existence of a VC investor has a significantly positive influence on the success of an ICO, while the existence of an VC investor among the BTBF's investor universe has a negative, although statistically insignificant, influence on the mid-term survival probability of BTBFs, indicates that VC investors attract additional investors in ICO processes but that they are not able to support BTBFs appropriately in the mid-term. One potential explanation for this effect could be that most VC investors lack sufficient industry-specific knowledge and focus rather on attractive short-term exit opportunities. Furthermore, considering the results of VC investors' treatment time (time between VC investment and ICO), we find a statistically significant and positive influence on the success of ICOs, while we find in

contrast to this a statistically significant and negative influence on the mid-term survival probability of BTBFs. This effect can be regarded as in line with the prior finding and indicates to a certain extent that VC investors might be primarily interested in high valuations and support BTBFs on this path while they do not use an extended investment duration to anticipate mid-term development opportunities and support BTBFs' survival. On the other side and interestingly, we find again support in the full model (model 6) that the investor specialization has a positive and statistically significant impact at the 5.0 percent level on the survival probability of BTBFs. This finding underlines our assumption that technical knowledge is crucial to support BTBFs and that today's VC investors might face certain knowledge limitations and boundaries against the background of blockchain due to the novelty of this technology which implies that primarily specialized investors can give valuable advice and contribute to the development of BTBFs. The importance of technical knowledge in BTBF contexts gives also an indication why the reputation of investors seems not to be linked to the mid-term development of their BTBF portfolio companies as their reputation was initially built upon more established industries caused by past transactions (Nahata 2008). Further, networks of more reputable investors, which have historically proven to be beneficial for portfolio companies' development (Hsu 2004; Lindsey 2002) might be less effective due to the novelty and the decentralized structure of the blockchain sector.

Concerning the control variables, we find again a statistically negative impact (at the 5.0 to 10.0 percent level) of the control variable *Whitepaper* throughout all models. Further the dummy variables *Ethereum* and *Platform* show a statistically positive impact at the 5.0 to 10.0 percent level in all models. In contrast to the Heckman two-step OLS models, the bivariate probit models confirm clearly the assumption of an existing sample selection bias as in almost all models (except for model 3 and 6) athrho has a negative coefficient and is statistically significant at the 0.1 percent level and hence indicates that selection on unobserved variables is identified and present in the models (Holm and Jaeger Meier 2010). More specifically, that means that the completion of an ICO is non-random and the decision to execute an ICO is based on factors being unobservable. Thus, applying a Heckman correction method (Heckman 1979; Certo et al. 2016) accounts for this unobserved heterogeneity when focusing solely on BTBFs that have completed an ICO.

5.6.3 Robustness

In order to test the robustness of our results, we apply additional analyses to take care of a potential selection bias and unobserved heterogeneity arising from the nature of our dependent variable. Following Colombo and Grilli (2010) and Vella and Verbeek (1999), we apply a control function approach. For this approach, a control factor, literally the estimate of the generalized residuals, is computed for BTBFs that have conducted an ICO as well as for BTBFs that have not conducted an ICO using a probit regression regarding the existence of an ICO. We include the residual (ICO Lambda) into our outcome equation (in addition to all other covariates) including the dummy variable ICO. Subsequently, a positive correlation of the error terms in the selection equation and the success equation would lead to a positive coefficient for the residual lambda (Colombo and Grilli 2010) mitigating potential selection bias. Based on the control function approach, we can confirm our results widely. In particular, we can confirm that there exist obviously rarely systematic factors that foster the decision of BTBFs to conduct an ICO which impact the amount of received funding in the ICO event as we cannot find any indication for a potential selection bias. Furthermore, we can confirm that all effects remain significant except for the receipt of CVC. The respective results can be found in Appendix B.

In addition to the application of the control function approach, we apply additional variables measuring the reputation of investors as robustness tests. Based on previous research, we apply the average age of investors as well as the average number of portfolio companies as proxy for the reputation of investors. Both covariates show positive coefficients but lose their high significance. However, we assume that this could be mainly due to the fact that blockchain investors are rather young in general given the nascent state of the technology. The results are not tabulated but are available upon request.

Overall, we presume that our findings are robust but subject to the general limitations that every empirical contribution faces particularly in new research domains.

5.7 Discussion and conclusion

5.7.1 Discussion of the main results

Based on the introduced variables and methods, this section provides a summary of the empirical results derived from both the Heckman two-step models as well as from the bivariate probit models. Based on our results (Table 10 models 2-7), we find that obviously no material

selection bias exists when assessing if unobserved heterogeneity impacts the decision of BTBFs to conduct an ICO and the subsequent amount of funding. Following existing research, a potential selection bias is only weak or minor as the inverse Mill's ratio is not statistically significant throughout all our models (models 2-7). We assume that this can be an indication that BTBFs are facing lower hurdles when conducting an ICO compared to the hurdles which ventures are usually facing when accessing other means of funding as in other entrepreneurial research contexts often a selection effect can be observed (Certo et al. 2016; Bertoni et al. 2011). Furthermore, we assume that lower hurdle rates for completing an ICO compared to other funding types caused by a lack of due diligence processes (Kranz et al. 2019), lower or no regulatory requirements (Rhue 2018) and smaller influence of individual investors animate a considerable number of BTBFs to pursue an ICO including those of lower quality which may not fulfill required quality criteria of other funding events, e.g. VC financing rounds or IPOs. Hence, from an investor perspective (during an ICO), a diligent target firm evaluation is highly recommended.

However, in contrast to this finding, we find indications for a selection bias and obviously unobserved effects when examining BTBFs that have conducted an ICO and their later survival (Table 11). Actually, this means that unobserved effects influence the chance of completing an ICO as well as the likelihood to survive and thus that BTBFs that have completed an ICO differ from those that have not completed an ICO based on unobservable factors. Based on these results, we conclude that the ICO itself helps the BTBFs to survive at least in the mid-term as the ICO event provides usually sufficient proceeds, leading to the situation that BTBFs that have conducted an ICO exhibit a higher survival rate compared to those that have not conducted an ICO whereas the decision to conduct an ICO is less related to the amount of received funding.

Furthermore, we find strong support for hypothesis 1 that a VC investor increases the success of BTBFs (Table 10 model 2). This is in line with the findings of Fisch and Momtaz (2019) who also find strong evidence that financial investors are beneficial for the development of BTBFs. We presume that the provision of managerial capabilities and past experiences in the blockchain area helps their portfolio BTBFs to grow and to become more successful than others. This finding is further supported by findings in line with hypothesis 2 that longer treatment periods have a significantly positive impact on the success of BTBFs. We conclude from this

result that a longer provision of managerial capabilities and support can lead to a stronger transfer of knowledge and subsequently increases the BTBF's success measured as amount of ICO funding. However, we do not find similar results when reviewing the results of the bivariate probit models by applying *Survived* as dependent variable (Table 11). We find no significant effect for the existence of a VC investor prior or during the ICO and a negative effect for the time between the investment and the ICO event. Subsequently, VC investors seem not to influence the mid-term success of BTBFs if they have conducted an ICO. We assume again that the proceeds of ICOs conceal other influences, in particular as the time between the ICO event and the date of our assessment is rather short.

In addition to this, we find certain support for hypothesis 3 that more reputable investors increase the BTBF's success. However, we find this significantly positive effect only when considering the investor's IPO share as proxy for his reputation but not when considering the age or the number of portfolio companies. These mixed results might be explained by the material difference in those proxy measures of reputation. The investor's IPO share is a measure including a quality component by the investor's ability to conduct an IPO whereas measures such as simply the investor's age or its number of investments is a measure rather focusing on the investor's mere experience without a quality outcome. Another reason for these mixed results can be ascribed to the nascent stage of the blockchain technology. Investors in the blockchain area are assumed to be rather nascent as well and hence reputation proxies that have proved to be reliable historically might lead to these results. Hence, hypothesis 3 can be supported only partially but indicates that BTBFs that have received investments from renowned top investors exhibit higher ICO funding amounts, probably mainly due to a certification effect (Megginson and Weiss 1991) that boosts the ICO development. Further, assessing the mid-term influence of the reputation of investors (Table 11 model 4) adds to the mixed results as we do not find any support for hypothesis 3 in the bivariate probit models. This indicates again that the proceeds of ICOs might conceal other effects as well and hence that the investors' reputation plays a limited role due to the nascent technology.

In contrast to this, we find strong support for hypothesis 4 that more specialized investors increase the success of BTBFs. Based on our results, we conclude that blockchain-specialized investors are able to provide better support and guidance to their BTBF portfolio companies.

Hence, superior and specialized industry knowledge seems to be decisive in the area of blockchain which is in contrast to other research in the entrepreneurial finance area as investor specialization is usually considered less crucial (Hagendorff et al. 2009). This finding is also supported when assessing the results of the BTBFs' success measured as their mid-term survival (Table 11 model 5). Furthermore, we do not find any curvilinear relationship between the BTBFs' success and the investors' industry specialization as suggested by Matusik and Fitza (2012). Based on these findings, we conclude that maintaining a certain technology expertise helps investors to support their portfolio BTBFs by providing them with more and higher quality know-how and assets leading to more success in the short- as well as in the mid-term. Nevertheless, we cannot rule out completely or detangle from these findings that this knowledge helps also to identify more promising BTBFs and how fast existing knowledge ages due to the rapid technological development.

Lastly, we find support for hypothesis 5 that CVC investors have a positive influence on the development of BTBFs. We see that the investment of a CVC investor prior or during the ICO represents predominantly a certification for other investors signaling a certain level of quality. Combining the results regarding hypothesis 5 with the remaining results, we conjecture that the access to complementary assets is relevant and leads to positive influences on the BTBF's success. However, when regarding the variable *Survived* as dependent variable (Table 11 model 6), we cannot confirm these findings as we do not find any significant effect for the existence of CVC investors among the BTBF's investor universe prior or during the ICO. This points at the short-term nature of the relevance of certifications provided by the investments of CVC investors whereas effects resulting from the access to complementary assets might be more important in the long-term which is less observable in our sample yet due to the nascent nature of all BTBFs.

5.7.2 Contributions to theory and implications for practice

This study adds to the literature on entrepreneurial finance and more specifically on the relationship of ICOs and more established means of funding. While previous research has focused on ICOs as a new way of financing and compared characteristics of ICOs with more established funding procedures, research that examines the interplay of ICOs and financial investors is rather limited. To our knowledge Fisch (2019) is one of only very few studies that highlights

the influence of VCs on BTBFs. However, our study provides a more nuanced view on the success determining factors and studies different types of investors. From a theoretical perspective, we draw on two well-established concepts. First, our study is based on the resource-based view and second, we build upon the signaling theory.

By drawing on the resource-based view (Dushnitsky and Lavie 2010; Lavie 2006; Peteraf 1993), we can confirm the transferability of existing findings from a more general entrepreneurial finance context to the blockchain setting. Our results provide a clear indication that the provision of complementary assets is beneficial for the development of BTBFs which is in line with Alvarez-Garrido and Dushnitsky (2016), who demonstrate the impact of providing complementary assets on innovation rates. Thereby, our findings shed light on the benefits of different investor types indicating that more reputable investors are more beneficial than others. Combining these findings with the fact that CVCs seem to have a more significant influence on BTBFs' success suggests the superior importance of specialized technical and market knowledge leading to the conclusion that the access to complementary assets is key. Furthermore, our findings support the resource-based view by highlighting the fact that a longer investment period, i.e. a longer treatment period, has a positive influence on the BTBFs' success. In particular, if one combines our findings with earlier findings that VC investors are not able to select superior BTBFs per se but generate value through their treatment (Fisch and Momtaz 2019), our findings gain additional significance. Summarizing our findings, we can confirm the success relevance of investors in particular if they are able to provide access to complementary assets in order to close existing lacks of resources.

Furthermore, our results add also to the signaling theory established by Spence (1973), as we provide certain evidence that VC investors who are invested before or during the ICO send a signal to other ICO investors regarding the quality of the respective BTBF. By doing this, we can confirm existing research results that investors generate signals to other investors (Hoenig and Henkel 2015; Gulati and Higgins 2003; Stuart et al. 1999) and that those findings hold also in the area of blockchain technology. In addition to this, we assume also that the signal that is generated when a VC investor conducts an investment into a BTBF is received by other stakeholders of the BTBF supporting the BTBF's further development. Especially, the signal can help to attract new highly skilled employees and to broaden the customer base as the VC investment represents a certification (Megginson and Weiss 1991).

5.7.3 Limitations and avenues for further research

Although our study provides significant and robust results, this empirical contribution is subject to certain limitations. First, although we assume to have a rather comprehensive dataset, we are facing the general issue of data scarcity in the research area of entrepreneurial finance (Kaplan and Lerner 2016). In particular, this scarcity comprises detailed information about how the collaboration between BTBFs and potential VC investors is designed on an operational level. In addition, although our sample seems to exhibit a good coverage of relevant BTBFs, that is at least on the level of comparable research, we cannot rule out completely to miss small BTBFs that have stopped operations without conducting an ICO due to the availability of relevant data.

Second, as BTBFs are a rather new phenomenon, research opportunities remain limited whether the development of BTBFs is sustainable or not. Of course, by using the amount of ICO funding as success measure, our study applies an independently confirmed success evaluation. However, even in cases of high ICO funding amounts, a mid- to long-term outlook whether the respective venture remains successful is hardly possible due the overall nascent stadium of the technology. This is accompanied by the fact that many BTBF are in the product development phase or even in a concept phase when concluding their ICO (Kaal and Dell'Erba 2017). Hence, future research can investigate how ICO funding levels are connected with the future venture performance. Thereby, future research might provide answers to the question whether BTBFs with high ICO funding levels outperform their peers or whether BTBFs with higher ICO funding levels are able to release products earlier, i.e. they are able to generate operating cash-flows earlier. Further, when assessing the mid-term success of BTBFs by considering their survival rate, the significance of our findings might suffer from the rather short period of time between the date of the ICO event and the date for assessing whether the respective BTBF is still operating i.e. has survived. This effect might be further strengthened as potentially high proceeds from the ICO might conceal other influencing factors in the mid-term. We would like to encourage future research to expand the assessment period in order to provide more nuanced views on the mid- to long-term development of BTBFs.

Lastly, although existing research in the area of entrepreneurial finance and in particular in the area of blockchain has provided evidence that VC and other early stage investors are not per se able to select superior ventures (Puri and Zarutskie 2012; Bertoni et al. 2011; Colombo

and Grilli 2010; Cumming and Johan 2007), we cannot completely rule out that our findings suffer from a potential selection bias when interpreting effects arising from CVC and financial investors. In particular, although our findings provide clear evidence that financial and CVC investors are beneficial for the development of BTBFs, we cannot answer the question how investors should interact with BTBFs on an operational level, especially with regard to the anonymous business characteristics. Thus, we assume that providing a more nuanced view on these effects represents a good avenue for future research.

This aspect leads toward potential avenues for future research. We assume that future research will benefit largely if new empirical studies consider BTBF more generally instead of focusing on BTBFs that have received other means of financing in addition to their ICO. Although our study controls for unobserved heterogeneity arising from potential selection bias by including the inverse Mill's ratio, enlarging the dataset can provide additional and more nuanced insights, especially when taking BTBFs' characteristics into success consideration. Particularly, it can be interesting to see whether factors that have proven to influence the success probability of ventures are also valid in the research area of blockchain related research. Potential characteristics can be technical capabilities demonstrated by the possession of relevant patents as well as the influence of human capital on BTBFs' success. The latter presents an interesting avenue for future research as the blockchain principles rely on anonymity to a large extent but existing research in the entrepreneurial area has shown the significance of human capital for the venture itself as well as decisive criteria for investors (Homburg et al. 2013; Bottazzi et al. 2008).

Further, for BTBFs that have received funding from investors, we encourage future research to disentangle the effect that results from investors' treatment from the signal effect that may be generated by the investment and that attracts other investors. However, this does not only include VC and CVC investors but also all ICO investors instead. Currently, very little is known about ICO investors and it remains unclear whether the assumptions taken from the more general crowdfunding area can be transferred to the ICO context (Fisch 2019). An in-depth examination of ICO investors by conducting surveys or interviews can contribute to the understanding of ICO dynamics and shed light on the driving factors of high funding amounts.

6 Conclusion and contributions

For the last two decades, the amount of invested capital in PE and VC funds has been increasing considerably, mainly driven by investors' ambitions to obtain high financial returns and the growing number of newly founded ventures (Breuer and Pinkwart 2018). While the beneficial effect of a lively and venture-supportive environment was historically recognized predominantly in regions like Silicon Valley, today the positive impacts of ventures are widely acknowledged (Hellmann and Thiele 2019; Denis 2004). Apart from their role as economic growth drivers (Lerner 2009), ventures contribute in particular to the creation of jobs (Birch 1990; Lerner 1994), innovations (Scherer 1991) and their dispersion in general as well as productivity increases (van Praag and Versloot 2007). Furthermore, the occurrence of new ventures and their respective growth enables markets to gain new dynamics and to disrupt existing structures. However, due to the highly dynamic development of ventures as well as the large number of innovations which are introduced by them to the markets, new phenomena and research questions have arisen compared to the initial research in this area (Tykvová 2018). This mainly concerns questions about valuation levels (Festel et al. 2013; Heughebaert and Manigart 2012), financing sources (Cumming 2012), and the strategic benefits of ventures for incumbent market players (Chesbrough 2002), which cannot be answered satisfyingly by applying existing approaches from other research contexts. Hence, this dissertation sheds light on some of the most recent phenomena in the field of entrepreneurial finance. By elaborating on the combination of various sources of financing in the context of ICOs, this dissertation provides novel insights into the interplay of different investors as well as into their short- and mid-term impacts on a venture's development. Furthermore, this dissertation contributes to the understanding of how incumbent market players can exploit the strategic benefits of ventures with regard to the currently growing number of digitalization initiatives. Moreover, this dissertation examines the drivers of multibillion-dollar valuation levels. The main findings combine underlying developments and research objectives that will potentially impact and fundamentally change existing business models in a cross-sectoral manner, as the respective developments are not limited to distinct and narrow domains.

However, apart from the distinct results and findings which emerge from each of the individual essays, this dissertation finds overarching effects that hold in all respective contexts. It pro-

vides clear evidence that being backed by a corporate investor has a significantly positive impact on the development of ventures, which confirms to a wide extent existing findings (Colombo and Murtinu 2017). This positive influence seems to last during the development of ventures, as this dissertation finds a positive influence on rather young ventures as well as on rather mature ones, such as in the case of unicorns. However, the positive effect seems to decrease while ventures become more mature. A plausible reason for this finding is the diminishing influence of investors in later stages and lower flexibility (Ransbotham and Mitra 2010). Given that the significantly positive influence of corporate investor persists throughout all contributions, this dissertation indicates that this effect is irrespective of sectors or industries. While existing research often cites the threat that corporate investors pursue their own interests which might adversely affect the ventures in which they are invested (Dushnitsky and Shaver 2009), this dissertation does not find such indications. The results of this dissertation lead to the conclusion that corporate investors mainly contribute two levers to the development of ventures. Apart from providing non-financial support like managerial resources (Park and Steensma 2012), which is assumed to be the key driver, the certification effect (Megginson and Weiss 1991; LiPuma 2006) and respective signals sent by corporate investors to customers and other market participants seem to play a decisive role. The signals sent by corporate investors seem to exceed the strength of other investors as they have higher 'market credibility' (Dushnitsky and Lenox 2006; Chesbrough 2002).

Moreover, investment and collaboration with ventures provide the opportunity for incumbents to access new technologies and participate in innovations. In particular, collaborating and investing in new ventures enable incumbents to reduce or close existing knowledge gaps (Zhao 2009; Cefis and Marsili 2015). As corporate investors and ventures usually collaborate with various partners, this dissertation presents evidence of a paradigm shift from company-internal value creation and innovation toward the application of open innovation approaches (Aghasi et al. 2017; Berchicci 2013) and the co-creation of value within larger networks (Lavie 2006). This contrasts to the widespread understanding that R&D and innovation activities have to remain exclusively in-house (Berchicci 2013).

In line with Rossi et al. (2017, p. 349), this dissertation assumes that "many corporations are choosing to launch venture units because they have recognized how important such units can be for strategic innovation, with important financial return."

6.1 Theoretical contribution

First, this dissertation provides new insights into general research in the area of entrepreneurial finance. More precisely, the three projects contribute to the research on valuation levels of ventures (Festel et al. 2013; Heughebaert and Manigart 2012), the configuration of incumbent-venture relationships (Teece 1999), and the impact of different investors in ICO scenarios with regard to the influence of signals sent by them to other participants (Spence 1973).

The findings derived from the first research question— "What drives multibillion-dollar valuations?"—complement existing literature on the success critical factors that enable a favorable development of ventures. In particular, the results provide a more nuanced view of the valuation influence of a venture's strategy. While the strategy of ventures is considered an essential component of valuations (Festel et al. 2013; Meglio et al. 2017; Salamzadeh and Hiroko 2015), the contribution provides clear evidence that investors predominantly reward aggressive growth strategies, including the rapid gain of market shares. Furthermore, the answer to the first research question provides evidence that the foundation of ventures within cluster regions and particularly within Silicon Valley increases the chance of becoming a unicorn as well as the chance of obtaining a high valuation. This finding adds to the research on economic ecosystems and spatial distribution of economic development (Nicotra et al. 2018; Romanelli and Khessina 2005; Sternberg and Litzenberger 2004). At the same time, it highlights the heterogeneity of economic clusters regarding their benefits for the development of ventures. The results of the first research project confirm the beneficial effects of CVC in previous research (Rossi et al. 2017; Park and Steensma 2012). However, the dissertation's results demonstrate that the beneficial impact of CVC diminishes as ventures become more mature and that the benefit is higher in early development stages.

Turning to the second research question, incumbents have also identified collaboration with ventures as a seminal way to access external knowledge with regard to ongoing digitalization. The results provide evidence that incumbents increasingly use non-equity-based collaboration forms to enhance the acceptance of their approaches as well as to maximize the benefit of all participants. By shedding light on these non-equity-based collaborations, this dissertation enriches the existing literature which is mainly focused on CVC (Benson and Ziedonis 2009; Ernst et al. 2005; Gompers and Lerner 2000b) and university-industry collaborations (Gretsch et al. 2019). Thus, the dissertation helps to broaden the theoretical basis for future considerations.

Furthermore, this dissertation aims to develop new insights regarding incumbent-internal processes that impact the success probability of accessing external knowledge against the background of ongoing digitalization by drawing on the dynamic capabilities approach (Day 2014; Grimaldi et al. 2013; Teece 2016, 2014, 2017). The second contribution enhances the academic discussion on how incumbents can implement externally acquired knowledge (Lin and Wu 2014) by demonstrating what the practical application of dynamic capabilities looks like. This contribution develops a conceptual framework model and demonstrates the practical implementation of sensing dynamic capabilities in the context of digitalization.

With consideration of the impact of VC and CVC investors and the influence of their characteristics during ICOs, this dissertation provides novel insights with regard to signaling theory (Spence 1973, 2002). Investors that are invested in a BTBF previous to an ICO event send signals to follow-on investors about the BTBF's quality, which leads to higher levels of ICO funding and represents a certification of the venture (Megginson and Weiss 1991). The results of this contribution complement the literature on the influence of investors in ICOs (Fisch and Momtaz 2019) by providing a more nuanced view of investor-influenced success determinants. While the respective study confirms the success relevance of VC investors which is in line with Fisch and Momtaz (2019), it finds evidence that the provision of complementary assets is beneficial for BTBFs (Dushnitsky and Lavie 2010; Lavie 2006; Peteraf 1993). The third contribution thus demonstrates the beneficial influence of CVC investors and supports the transferability of more general research in this domain to the ICO and blockchain context (Galloway et al. 2017; Ivanov and Xie 2010; Park and Steensma 2012). Finally, this contribution finds that more reputable and more specialized investors increase the probability for BTBFs to receive a higher ICO funding amount. This adds novel aspects from the blockchain context to the academic discussion on the relevance of investor reputation (Nahata 2008; Hsu 2004; Lee et al. 2011) and specialization (Gompers et al. 2009; Hagendorff et al. 2009).

6.2 Practical contribution

Based on the first research question— "What drives multibillion-dollar valuations?"—clear evidence can be found that the foundation and location of ventures within clusters substantially

increase the chance of becoming successful. This dissertation finds that this holds true particularly in the case of Silicon Valley, driven by its respective economic ecosystem[10] (Rosenthal and Strange 2003; Saxenian 1994; Feldman 2001). Therefore, policy makers should consider more holistic approaches when establishing cluster regions around the world to foster the emergence of innovative and young ventures. Furthermore, as this dissertation identifies a beneficial impact of CVC investors, the relevance of providing non-financial support should be taken into account when designing future support programs for young ventures. In particular, the positive influence of providing complementary assets in early stages of venture development (Chemmanur et al. 2011; Chemmanur et al. 2014; Narayanan et al. 2009; Chesbrough 2000) can help the broader investor landscape to adjust their investment style and to put a stronger emphasis on this often-overlooked factor. Complementary assets are not limited to tangibles but also comprise intangible assets that can help to build strategic resources (Landau and Bock 2013). Finally, the findings from the first research project show that aggressive growth strategies with the overall goal to establish a market-dominating position are rewarded by investors (Solomon 2015; Kaplan and Strömberg 2000; Ramadan et al. 2014). Policy makers should contemplate thus how to face the challenges that may arise from the potential establishment of new monopolies without harming their current growth and development.

Two key practical contributions can be derived from the second contribution. First, the second contribution identifies the importance of incumbents' dynamic capabilities (Teece 2017, 2016) when accessing external knowledge to transform existing business models. From a practitioner's point of view, this implies that incumbent firms need to ensure that they are able to absorb acquired knowledge. Therefore, this dissertation suggests that incumbents focus on a process-centric perspective. This should include maintaining a respective corporate culture and reducing internal resistance to benefit, for example, from the collaboration with ventures. Combining these results with the findings from the first research project shows that the success factors for both incumbents and ventures are closely linked when conducting respective collaborations. However, they are not completely identical but are dependent on the incum-

[10] The economic ecosystem comprises, inter alia, public venture support, a sufficient number of capital providers, a society open-minded toward new technologies and highly qualified employees.

bent. Evidence from the German market shows that the number of non-equity-based collaborations increases overtime. Thus, established market players should rethink their existing approaches when accessing external knowledge. In particular, the conduct of hackathons and operating incubators seems to represent promising and fruitful collaboration models that can establish relationships with innovative ventures in very early development stages, which can be seen as a contradiction of the historical focus on CVC and respective investments (Gompers and Lerner 2000b; Ernst et al. 2005; Benson and Ziedonis 2009).

The fact that BTBFs achieve higher ICO funding amounts when backed by VC and CVC investors shows that such investors represent a signal to other investors. However, the results of this dissertation also indicate, in line with Fisch and Momtaz (2019), that these investors provide operational support and hence facilitate the development of respective BTBFs. However, a more detailed view of the results reveals that CVC investors have a positive influence on the amount of ICO funding as well as on the mid-term survival rate whereas the backing by a VC investor has only a positive influence on the ICO funding amount. Apart from the potentially different pattern of support, a possible reason for this effect can be that CVC investors have longer investment horizons which might be beneficial for ventures' development. As this dissertation finds additionally that the level of investor specialization has a positive effect on the success probability of BTBFs, it is concluded that ventures benefit mostly from tailored and operational support based on deep industry knowledge. Furthermore, the results indicate that specialized investors that maintain a larger industry-specific knowledge are more successful than general investors when operating in new markets, as blockchain technology represents an archetype of a nascent market. Thus, it is recommended that investors should establish and acquire market-specific knowledge to differentiate themselves from competitors and to generate higher returns.

With the results of all three research projects taken into consideration, it is concluded that the investor's provision of non-financial support should be regarded at least as relevant and important as the provision of sufficient financial means. This dissertation provides clear evidence that CVC investors are beneficial for invested ventures and might help incumbents to access new knowledge. To sustain the societal welfare emerging from innovations and successful developments, policy makers should increase support for such initiatives. From an incumbent's perspective, increasing the effort to operate a CVC arm or similar vehicles can be worthwhile

for financial as well as innovation reasons. However, incumbents should clearly ensure that their organizations possess sufficient and relevant capabilities, allowing them to engage in open innovation and value co-creation processes to achieve the greatest strategic benefit from such collaborations (Lin and Wu 2014; Sears 2017). This includes a rethinking of existing investment and activity patterns, as incumbents tend to follow cyclical investment behavior (Chesbrough 2002) and consider long-term options and the strategic relevance of such initiatives only to a limited extent. Due to the beneficial influence of CVC programs, incumbents should carefully consider how they design collaboration models with ventures to create a fruitful environment. In particular, the results of this dissertation emphasize that incumbents need to increase their focus on non-equity-based collaboration models. Generally, this includes that incumbents need to strengthen their networking and collaboration capabilities and to realign their strategy in the light of 'coopetition' (Brandenburger and Nalebuff 1996; Bengtsson and Kock 2000). It remains doubtful whether investors that rely purely on the provision of financial capital will be successful in the future as promising ventures might prefer other investors and investors that forgo the provision of non-financial support will not be able to leverage the full value potential of respective ventures.

Appendix

Appendix A

Applied key words:

- Start-up Collaboration
- Start-up Kooperationen
- Start-ups & Corporates
- Hackathon
- Idea Jam
- Accelerator
- Incubator
- Corporate Venture Capital
- Corporate Ventures
- Corporate Venture Activities
- Start-up Digitalisierung
- Corporate Digitalisierung
- Corporate Venturing
- Joint Ventures
- Open Innovation

Supplemental to the web searches which were performed by using the above listed key words only, additional searches were performed by combining the above listed key words with the following suffixes: “Dax 30”, “Dax 30 & company name” and “Year” such as “Hackathon Siemens”, “Hackathon BASF 2015” or “Accelerator Dax 30”.

Appendix B

Determinants of BTBF success (Control Function approach)

Dependent variable	**Ln_amount_ICO**	**Ln_amount_ICO**	**Ln_amount_ICO**	**Ln_amount_ICO**	**Ln_amount_ICO**	**Ln_amount_ICO**
Model	**1**	**2**	**3**	**4**	**5**	**6**
Controls						
Ethereum	0.210	0.139	0.296	0.270	0.338	0.271
	[0.20]	[0.13]	[0.26]	[0.25]	[0.32]	[0.26]
Platform	0.371	0.375	0.322	0.214	0.348	0.343
	[0.31]	[0.31]	[0.26]	[0.18]	[0.29]	[0.30]
GDP_growth_fdg	-0.058	-0.060	-0.076	-0.076	-0.069	-0.075
	[-1.21]	[-1.22]	[-1.56]	[-1.62]	[-1.44]	[-1.54]
#Founders	0.022	0.029	0.051	0.031	0.045	0.019
	[0.38]	[0.50]	[0.87]	[0.52]	[0.75]	[0.32]
Whitepaper	-0.252*	-0.231	-0.243*	-0.277**	-0.262*	-0.270*
	[-1.72]	[-1.60]	[-1.68]	[-1.96]	[-1.84]	[-1.92]
preICO	-0.208**	-0.218**	-0.217**	-0.167*	-0.237**	-0.159
	[-2.03]	[-2.08]	[-2.11]	[-1.67]	[-2.28]	[-1.60]
Inverse Mill's ratio	-1.397	-0.790	-1.685	-1.169	-1.871	-1.840
	[-0.11]	[-0.06]	[-0.12]	[-0.09]	[-0.14]	[-0.14]
ICO Lambda	1.325	0.751	2.552	2.151	2.714	2.161
	[0.11]	[0.06]	[0.21]	[0.18]	[0.23]	[0.19]
Independent variables						
VC_investor	0.548****					0.018
	[3.62]					[0.08]
lnDays1stVCinvtoICO		0.086***				0.019
		[2.83]				[0.54]
Reputation_IPO			391.6**			217.3
			[2.33]			[1.34]
HHI				2.339****		2.054****
				[7.64]		[5.13]
CVC_investor					0.796**	0.277
					[2.02]	[0.77]
Country controls	yes	yes	yes	yes	yes	Yes
No. Obs.	649	649	649	649	649	649
Estimation method	OLS Reg	OLS Reg	OLS Reg	OLS Reg	OLS Reg	OLS Reg
R^2	0.047	0.037	0.036	0.070	0.014	0.072
Wald χ^2	40.14****	29.64****	21.87***	92.81****	21.38	102.82****

Standard errors are reported in brackets. Standard errors are based on bootstrap replications.
* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

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