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Venture Capital

Relations with the Economy and Intellectual Property

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Relations with the economy and intellectual property

Durfkapitaal:
Relaties met de economie en intellectueel eigendom

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born in Ede.

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Preface

After completing my Bachelor's at Utrecht University, and spending subsequent time on traveling and working abroad, my "adventure" at the Erasmus University started with the Master "Entrepreneurship, Strategy and Organization Economics". Over the years my personal interest in economics and science had grown steadily. During the writing of my master's thesis, a PhD position became available at the department of Applied Economics, and my thesis supervisor, Sandra Phlippen, encouraged me to engage in it. Very thankful for the opportunity, I started my PhD in 2009, under Enrico Pennings as promotor. Looking back now, 4 years later, I would like to thank a number of people that contributed to this book and my PhD experience in their own ways.

Enrico, first of all thanks to you for taking me in. During the first period of my PhD you allowed me the freedom to pursue venture capital as a research topic. Through your econometric expertise, I was able to experiment with different techniques and fully exploit the data sources at hand. Your sharp views on tackling issues in the process of producing a sound paper developed me. Besides your academic qualities, your accessibility, pleasant personality and continuous support throughout the good and bad times of this trajectory are greatly appreciated.

I also owe thanks to Jörn Block, my second supervisor. First of all, he was an inspiration for me to start conducting research on venture capital. After some months into my PhD trajectory I had the great fortune that he suggested us to start co-authoring. Working with Jörn, I was in the luxurious position to learn a great deal on how to produce papers in a structured and effective manner. In 2011, Jörn introduced me to the chair of Joachim Henkel at the Technical University in Munich, where I stayed happily for 3 months during the summer of 2011 to gather the trademark- and patent data used in the second part of this thesis. Jörn, thank you for your guidance, approachability, inspiring ideas, and nice talks. I wish you all the best the coming time in Trier.

Besides my two promoters, Sandra Phlippen played a major role in my PhD. Sandra, thank you for triggering my interest, and for providing trust and confidence in the first part of my PhD track.

During my time in Munich I started working with Philipp Sandner and Jan Schumann. Philipp, we had a great collaboration in obtaining, matching, and structuring the IP data, a critical ingredient for completing this book. Jan, although most of our meetings were via skype, our working relation was highly productive and always pleasant.

Finally, I would like to thank Luca Berchicci, Harry Commandeur, Aard Groen, Justin Jansen, and Roy Thurik for being part of the committee. In particular, I would like to thank Roy Thurik, for keeping a friendly eye on me and for encouraging me over the years.

My colleagues at the Department of Applied Economics provided a great atmosphere. From day one, they made me feel at home at the department. It became a common activity for me to drop by their offices to exchange stories. Thanks go out to Ajay Bhaskarabhatla for our nice collaboration in teaching activities, to Bas Karreman, Kirsten Rohde, Martijn Burger, and Philipp Koellinger, for being an inspiration and for their great company over lunch, to Haibo Zhou, Ingrid Verheul and Jolanda Hessels, for the nice dinners and a highly entertaining trip to Germany, to Niels Rietveld, for his company during the last year on the 8th floor of the H-building. Of course, special thanks to Peter van de Zwan and Brigitte Hoogendoorn, as dropping by their office was always a highlight of the day. Thijs Nacken, for being a companion on this adventure, we started our PhDs almost simultaneously. My office mates Martin and Carolina, for the great atmosphere that we had during our years on the 9th floor. Finally, I would like to thank the secretary team, Gerda, Kim, Nita, and Ramona for their support and always friendly reception on the 12th floor!

My family and friends deserve lots of credits. Mom, dad, Benjamin and Suzan, thank you for always being there with love, support, and understanding. Friedhelm and Monika, thank you for making me feel accepted and at home in Germany. Alex and Vera, Joris and Joke, Reinier, Remko and Martine, Sven and Mieke, Thomas, thank you for the necessary distractions, which were always greatly appreciated, and your sincere support and interest.

One special day during my PhD I walked into the wrong lecture room at a summer school. Sarah, meeting you was the biggest blessing in life that this journey could ever bring me.

Geertjan de Vries
Utrecht, september 2013

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1

Introduction

Abstract

This thesis analyzes venture capital (VC) investments under changing economic conditions and in relation to start-up intellectual property (IP) filings. Studying the impact of the 2000-2001 dot-com crisis and the 2008-2009 financial crisis, Part I investigates how a period of economic downturn affects VC investment patterns across industries and countries (Chapter 2), and also analyzes changes in VC syndication activities as a result of economic fluctuations (Chapter 3). Part II of this thesis examines VC-backed start-ups' IP filings. In particular, the relation between IP filings and start-up valuations by VCs is addressed (Chapter 4). Part II further analyzes the impact of VC funding on a start-up's IP orientation, distinguishing between a trademark- and a patent orientated IP strategy (Chapter 5).

The remainder of this introductory chapter is organized as follows. Section 1.1 motivates the research presented in this thesis. Section 1.2 discusses existing research regarding VC's relation with the economy and the role of IP within VC financing. Section 1.3 introduces the data sources used throughout the thesis. Section 1.4 provides an outline of the thesis including the findings per individual chapter. Section 1.5 presents an overview of the publication status of the separate chapters. Each subsequent chapter of this thesis can be read independently.

1.1 Motivation

"The US venture capital industry is envied throughout the world as an engine of economic growth", as is recognized by Harvard Business Review (Zider, 1998). Venture capitalists (VCs) focus on the financing and advising of young innovative start-ups (Gompers and Lerner, 2004). Over the time period of 2000 to 2012, the United States' (US) VC market invested on average 32.6 billion USD on a yearly basis, divided over on average 4,001 separate deals (PWC Moneytree Report, 2012). Over the years, VC supported the creation of nowadays globally leading technology firms such as Google, Facebook, Microsoft, Intel and Apple. Overall, VC funds had a strong positive impact on firm growth, technological development, and the evolution of industries (Audretsch and Thurik, 2001; Bottazzi and Da Rin, 2002; Florida and Kenney, 1988a; Keuschnigg, 2004; Kortum and Lerner, 2000; Timmons and Bygrave, 1986). The contribution of VC to innovation is estimated by Kortum and Lerner (2000) as being three times more productive in terms of patenting in comparison to traditional corporate R&D expenditures.

The VC market is relevant to study because it is the primary source of capital for young innovative start-ups. Typically, innovative start-ups work with intangible assets and face many uncertainties, for example in the development towards a final product, in the establishment of a solid customer base, and with regard to the behavior of competitors (Berkery, 2008). Due to the uncertainties on many different fronts, chances of failure are high, and investments in innovative start-ups are perceived as risky. As a result, these start-ups are generally not funded by banks, which prefer to invest in more 'routine' start-ups that work with tangible assets (e.g. a cafe, or a retailer) (Amit et al., 1998; Bruns and Fletcher, 2008). Other sources of funds besides banks, such as public equity, are not accessible because start-ups are not developed enough for an IPO to be considered. Further, governmental funds reserved for the funding of innovative start-ups are only scarcely available (Cumming and MacIntosh, 2006; Lerner, 2002a). Overall, due to a lack of alternative funding sources, the VC market fills a gap in the funding of innovative start-ups (Gompers and Lerner, 2001; Sahlman, 1990; Zider, 1998).

This thesis contributes in particular to two literature streams. Firstly, literature regarding the functioning of VCs with general economic conditions (Part I of this thesis). Secondly, this thesis extends literature on the role of IP assets in VC financing (Part II of this thesis).

1.1.1 Venture capital and the economy

This thesis focuses firstly on the dependence of the VC market on the status of the overall economic climate (Part I, Chapters 2 and 3). The deal volume in the VC market is highly dependent on the general state of the economy, increasing rapidly under economic prosperous times, but also dropping promptly during times of economic crisis (Lerner, 2002b). Capital inflow from institutional investors, such as banks and insurance companies, and an active IPO market are important prerequisites for a functioning VC market (Black and Gilson, 1998; Jeng and Wells, 2000; Zider, 1998). However, where the economic climate is proven to be relevant for the VC market, we know little of the changes in VC investment behavior as a result of differing economic circumstances. Rather, mainly aggregate measures of the VC market have been studied such as the overall deal volume (Jeng and Wells, 2000), VCs' abilities to raise funds (Gompers and Lerner, 1998), and returns on VC investments (Lerner, 2002b). This thesis addresses this gap by showing how periods of economic downturn affect VC investment patterns across industries and countries (Chapter 2), and further analyzes changes in VC syndication activities as a result of economic fluctuations (Chapter 3). Economic shocks such as the 2000-2001 dot-com crisis and the 2008-2009 financial crisis are analyzed, which strongly affected VC fundraising- and exit opportunities (Block and Sandner, 2009; Lerner, 2002b), forcing VCs to re-evaluate their investment strategy. Among others, questions that are addressed in Part I include: How are the chances of new start-ups finding initial VC funding affected by economic fluctuations? How are the invested amounts within financing rounds affected? Are investments in early and later funding stages affected differently by economic fluctuations? How do VC firms adjust their investment strategies to the economic conditions faced?

1.1.2 Venture capital and intellectual property

Secondly, in addition to the relation of VC to the economy (Part I), this thesis addresses relations between VC and IP rights (Part II). IP rights are particularly relevant for VC-backed start-ups because of their high levels of innovative activities compared to other start-ups (Timmons and Bygrave, 1986). These innovative assets need protection from the impairment of others. When generating returns from an innovation, both marketing related assets, protected by trademarks, as well as technology related assets, protected by patents, are highly relevant and complementary (Sandner and Block, 2011; Teece, 1986). Despite the relevance of both dimensions in becoming successful, an only recently established literature stream has recognized and documented the role of trademarks (e.g., Greenhalgh and Rogers 2006b; Mendonça et al., 2004; Ramello and Silva, 2006). Through a trade-

marked brand name, consumers are able to identify the products that are offered by a specific firm. This form of identification allows a firm to build consumer loyalty, with the potential to charge a higher price (Flikkema et al., 2010). Trademarks function as the legal basis on which brand value can be built, securing benefits from future marketing investments (Sandner and Block, 2011). The importance of trademarks is further reflected in the large number of trademark applications. In 2012, 415,026 new trademark applications were filed at the United States Patent and Trademark Office (USPTO), and approximately 1.8 million trademark registrations were active in the US (USPTO, 2012c).

Thus far, little is known on the role of trademarks within the early development stages of a firm, nor on the role of trademarks in a VC context. This thesis investigates the role of trademarks in the start-up valuations by VCs (Chapter 4), and further examines how VC involvement affects a start-up's IP orientation, distinguishing between trademark and patent applications (Chapter 5). In addition to the effect of VC financing, Chapter 5 examines the effects of market competition and a start-up's customer type (business or consumer) on IP orientation.

1.2 Research context

1.2.1 Research addressing VC's dependency on the economy

The state of the VC market tends to be strongly related to the economic climate because the majority of funds flowing into the VC market are provided by private investors (Gompers and Lerner, 2004). Generally, during economically prosperous times, private investors have more funds available to invest, and will also be more willing to take on risks in the allocation of their funds. In contrast, under poor economic conditions, private investors will have fewer funds available, and are generally more prone to invest in relatively safer investment categories such as for example bonds and stocks (Block and Sandner, 2009; Lerner, 2002b). As a result, the availability of funds in the VC market is highly sensitive to the economic sentiment.

Besides the availability of funds, economic conditions affect VCs' exit opportunities (Cumming and MacIntosh, 2003). In order to generate returns, VCs aim to either sell a start-up to a large industrial firm, or, to conduct an IPO on the stock market. The likelihood that a large industrial firm is willing to acquire a VC-backed start-up, and also the price that this firm would be willing to pay for the start-up, will depend on its capital availability and its prospects with regard to economic developments. Further, the likelihood of a successful IPO is dependent on stock market conditions (Black and Gilson, 1998; Jeng and

Wells, 2000). For example, around the outbreak of the financial crisis, the number of VC-backed IPOs in the US dropped from 93 IPOs in the year 2007, to 7 IPOs in 2008, and 13 IPOs in 2009 (PWC Moneytree Report, 2012). Overall, a period of economic crisis strongly affects a VC's exit opportunities.

Lastly, economic conditions are likely to affect the performance of the start-ups invested in. In times of recession, potential customers of the start-up may chose to postpone their purchase to a point where economic conditions stabilize. This puts pressures on the start-up's growth rate and leads to lower start-up valuations.

Given that the working environment of a VC relies strongly on economic conditions, it seems plausible that a VC firm may have to adapt its investment strategy to the economic circumstances faced. This thesis studies the impact of both the 2000-2001 dot-com crisis and the 2008-2009 financial crisis on VC investment behavior (Part I, Chapters 2 and 3).

1.2.2 VC-IP research

IP rights are assets related to the start-up's inputs that are easily observable. VCs therefore partly base their evaluation of the start-up on such assets. A relatively large share of the literature addressing the relation between start-up assets and investment decisions of VCs focuses on the role of IP rights in the form of patents. Start-ups filing patents were more likely to receive VC funds (Audretsch et al., 2012; Cao and Hsu, 2011; Engel and Keilbach, 2007; Haeussler et al., 2012) and were valued higher by VCs (Baum and Silverman, 2004; Hsu and Ziedonis, 2008; Lerner, 1994a). Additionally, start-ups with patents demonstrated superior performance throughout the VC cycle when compared with other start-ups in terms of both their survival rate and the amount of money received for funding (Cao and Hsu, 2011; Mann and Sager, 2007). The novelty of this thesis with regard to the current literature lies in is its analysis of trademark applications in addition to patent applications (Part II, Chapters 4 and 5).

IP rights analyzed: Trademarks and patents. Through IP rights, a firm can exclude others from the use of its company-specific intangible assets. IP rights are therefore relevant to firms in the establishment and protection of a competitive advantage that should lead to greater profits (Hall and Hofer, 1993). IP rights can be filed in the form of patents, copyrights, trade secrets, trademarks, design rights, or trade dresses, each protecting a specific category of assets. *Patents* relate to the protection of specific technological knowledge, which can for example be associated with a new invention (WIPO, 2011). *Copyrights* relate to original works and grant their owner the exclusive right to copy a specific work, but also the right to decide who may adapt a work or reap benefits from it. A

copyright is an unregistered right, which means that the right is obtained automatically by the person creating the work (Greenhalgh and Rogers, 2010). A *trade secret* relates to specific information not known to the public from which its holder has an economic value. This can for example be a specific process (e.g., chemical processes in creating medicine) or formula (e.g., Coca Cola recipe). Trade secrets are protected through non-disclosure agreements and non compete clauses (Lemley, 2008). Interestingly, where patents generally expire after a period of 20 years, trade secrets can last indefinitely. Further, relating to marketing and branding, *trademarks* exclude others from the use of a firm's brand name, logo, symbol, or specific phrase (Mendonça et al., 2004). Lastly, *design rights* and *trade dresses* generally relate to the visual features of a product, for example the shape of a bottle, the packaging of a product, or to the interior design of a restaurant chain (Gifford, 1991; Greenhalgh and Rogers, 2010).

Overall, IP rights can be categorized broadly as protecting either the start-up's technology or knowledge base, versus protecting the start-up's marketing related assets. *Patents* and *trade secrets* are relevant in the protection of a start-up's unique knowledge. In comparison, *trademarks*, *trade dresses* and *design rights* generally relate to the commercialization of a product through the protection of brand names and product specific characteristics (e.g., design, packaging) (Friedman et al., 1991; Myers, 1999).[1] In its analysis of IP, this thesis will focus on patent- and trademark applications. First, comparing these two types of IP allows for a clear differentiation between the technical dimension protected by patents, and the marketing related dimension protected by trademarks. Second, trademarks are more commonly used, and represent more clearly a firm's willingness to protect marketing assets as compared to trade dresses and design rights, which are more narrowly applicable to a particular range of products (Greenhalgh and Rogers, 2010). Another reason is data availability. Trade secrets do not need registration in order to receive protection in the form of confidentiality agreements and non-compete agreements. Patents on the other hand do need registration, and are therefore more readily available. Lastly, by focusing on patents and trademarks this thesis connects to the existing literature which is also focused on these particular types of IP (e.g., Greenhalgh and Rogers 2006b; 2007; Helmers and Rogers, 2010; Kong and Seldon, 2004; Sandner and Block, 2011).

IP valuation. VC literature identifies two components with regard to the value embedded in IP rights owned by start-ups, distinguishing between the *protection value* and the

[1] There is the exception where a product's design is critical for it's functioning, for example the design of a semiconductor chip. Still, design rights are most commonly filed in categories such as home goods and clothing (Greenhalgh and Rogers, 2010).

signaling value. The protection value relates to the function as an exclusion right, protecting innovative assets from the impairment of others (Hoenig and Henkel, 2012). The signaling value relates to the function of an IP right as a signal of the start-up's quality (Audretsch et al., 2012). A start-up's trademark filings can be interpreted as a signal of the start-up's market orientation, growth ambition, and willingness to protect its marketing assets. Similarly, a start-up's patent filings can be interpreted as a signal of the quality of a start-up's technological or knowledge base (Hsu and Ziedonis, 2008).

Both the *protection value* and the *signaling value* may be reflected in valuations of young innovative start-ups by VCs. When start-ups are still at an early development stage, i.e., when credible information on the abilities of the start-up is only scarcely available to VCs, the *signaling value* of an IP right should be relatively larger. In comparison, as the start-up matures over the VC cycle, more tangible information becomes available to the VC, which should reduce the signaling value of the IP right. Further, when achieving initial sales records, the function of trademarks and patents as exclusion rights should become more relevant. Overall, as a start-up advances into later development stages, the *protection value* of IP rights should become more pronounced.

IP orientation. A start-up's IP orientation partly reflects its strategic intention, being either focused on marketing through the filing of trademarks or on knowledge development through the filing of patents. In start-up strategy literature, specifically Porter's (1980) differentiation typology, trademark applications can be linked to a marketing differentiation strategy, while patents are the primary protection mechanism for start-ups that operate under a technical or product differentiation strategy (see also Carter et al., 1994; McGee et al., 1995). In the case of a marketing differentiation strategy, a start-up specializes in marketing activities such as branding, promotion, design, service, image, and distribution (Carter et al., 1994; Miller, 1986). Under a product differentiation strategy, a start-up aims to achieve differentiation through R&D activities, creating a competitive advantage through product innovation (McGee et al., 1995). This thesis analyzes whether VCs affect a start-ups IP strategy after becoming involved as an investor (Chapter 5), connecting to previous studies that have examined the impact of VC funding on factors as financial performance of start-ups (Fitza et al., 2009; Schefczyk and Gerpott, 2001), the start-up's commercialization strategy (Hsu, 2006), the start-up's professionalization (Hellman and Puri, 2002), the start-up's time-to-market (Hellman and Puri, 2000), the start-up's growth rate (Davila et al., 2003), and the start-up's probability of surviving (Manigart et al., 2002).

1.3 Data

This thesis follows an empirical approach and connects a number of different data sources. Descriptions of the individual data sources are provided below. Throughout all chapters, analysis is conducted on the level of the funding round (i.e., the financing round in which start-ups raise money from a single or multiple investors). Further, with the exception of Chapter 2, this thesis focuses on the US as a regional restriction. First, the VC market in the US is appropriate to analyze because it is more developed as compared to other regions in the world (Bertoni and Pellón, 2011; Gompers and Lerner, 2001). Second, VentureXpert's coverage of the funding rounds occurring in the US is more complete as compared to non-US regions (Aizenman and Kendall, 2012; Popov and Roosenboom, 2012). Third, by focusing on the US, legal influences are held constant. Conditions such as countries' bankruptcy laws and tax policies can severely impact VC activities (Armour and Cumming, 2006). Lastly, findings of this thesis can be more easily connected to existing literature because the majority of works are focused on the US.

1.3.1 VC investment data

Venture capital investment data is obtained from the VentureXpert database (formerly known as Venture Economics) of Thomson Reuters. VentureXpert has been widely used in the entrepreneurial financing literature (e.g., Bygrave, 1988; Dimov and Milanov, 2010; Hochberg et al., 2007; Sorenson and Stuart, 2001; 2008). It is the largest available database on private equity and VC investments. Thomson Reuters started gathering data in 1977, and filed records back to the initial years of the existence of the VC market in the US at the beginning of the 1960s (Gompers and Lerner, 2001; Hochberg et al., 2007). Data are gathered through quarterly surveys of private equity firms, government filings, and public news releases. The database is updated on a daily basis.

VentureXpert reports information on the 'deal' level, i.e. the investment of the VC in a particular start-up. Details on the specific deal are included, e.g. the exact funding round date, the invested amount, the round number, and the number of syndicate partners. In addition, characteristics of the start-up and the VC investor are included such as for example their founding dates, industry classification, location, the type of VC investor (e.g., VC firm, business angel, industrial firm, financial company), and the development stage of the start-up (for example, indicating whether the start-up is still working on product development, or if initial sales have been achieved with a readily available product).

1.3.2 IP data

Analogously to the VC data, this thesis considers only US trademark and patent data.

Trademark data is retrieved from the USPTO (United States Patent and Trademark Office) trademark register. The data covers US trademark applications filed between 1884 and 2012. This data is available in the form of XML files.[2] These XML files have been decoded so that corporate trademark portfolios could be reconciled. Data includes detailed information surrounding the characteristics of the mark, including the filing party, the goods and service classes in which the mark is filed (commonly referred to as Nice classes), renewals of the mark, oppositions filed, and seniorities (referring to the geographical scope of protection).

Patent data are taken from the PATSTAT database. PATSTAT was created by EPO (European Patent Office) on behalf of the OECD Taskforce on Patent Statistics and provides information on patent applications in 80 countries (including the US, Japan and European countries). Records are comprehensive, including application and grant dates, citations, family links, IPC classes (industry classification), and bibliographic data.

In its analysis, this thesis considers IP applications, rather than IP registrations or granted IP rights. The application date refers to the point in time at which the start-up reveals its intention to protect its innovative assets. When coming to a valuation decision regarding the start-up (analyzed in Chapter 4), VC investors are more likely to take note of IP applications because the procedure towards the granting of an IP right can be lengthy. In addition, when measuring the impact of the involvement of a VC investor in the IP orientation of a start-up (analyzed in Chapter 5), the application date reflects the point in time at which the start-up came to the strategic decision to obtain a particular type of IP. The grant date is less suitable to determine this point in time because the length of the application procedure may vary from case to case and is generally more complicated and lengthy for patents (WIPO, 2011).

The IP application data of the VC-backed start-ups are gathered through a manual matching process using the start-ups' names and former aliases available in VentureXpert. Overall, the scope of both trademark and patenting activities could be determined for roughly 85% of the VC-backed start-ups taken from VentureXpert.

[2] Available at http://www.google.com/googlebooks/uspto-trademarks.html

1.3.3 Competition-, R&D-, and marketing intensity data

The specific market niche in which a start-up operates can be defined by the six-digit NAICS (North American Industry Classification System) code that is available from VentureXpert. Analyzing the determinants of start-up IP orientation, Chapter 5 of this thesis utilizes competition-, R&D-, and marketing intensity data on a six-digit NAICS level.

Competition intensity data is obtained from the US Census Bureau. Each firm in the US is required by law to respond to the US Census survey (see Ali et al., 2009, for a review).[3] The concentration measures are published every 5 years; Chapter 5 utilizes data published in 1997 and 2002. The C4 ratio is used as a measure of competition intensity for the specific market niche in which a start-up is operating (the Herfindahl index was only available for manufacturing sectors).

The COMPUSTAT database, provided by Standard and Poor's, is used to calculate R&D- and advertising intensity on a six-digit NAICS level. The COMPUSTAT data is commonly used in existing studies to calculate such measures (e.g., Chauvin and Hirschey, 1993; Waring, 1996). COMPUSTAT provides financial and accounting data filing back to the 1950s. Where the US Census Bureau considers both private and public firms, the COMPUSTAT data has the limitation of only including publicly listed firms. R&D- and advertising intensity are calculated on an annual basis as the total of expenditures over the total of sales of all firms within a specific six-digit NAICS class.

1.4 Thesis outline and findings per chapter

The following section summarizes each individual chapter. Figure 1.1 illustrates the outline of the thesis.

1.4.1 Part I: Venture capital and the economy

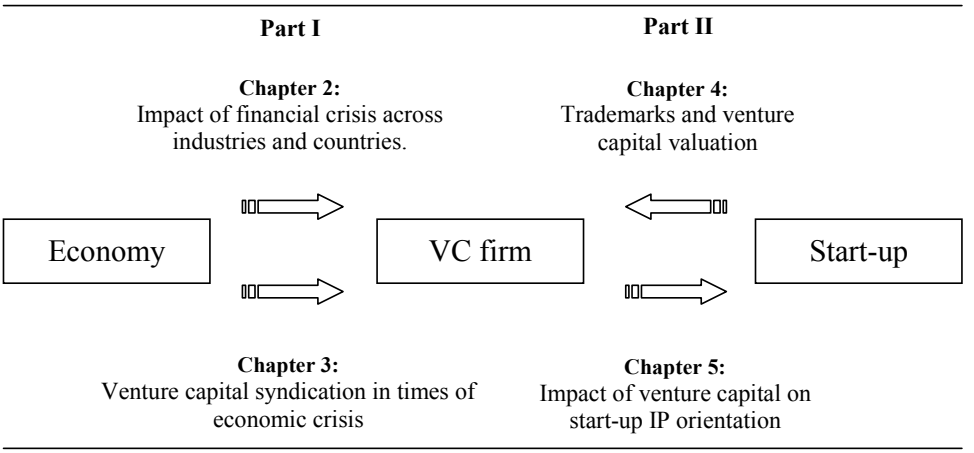
Chapters 2 and 3 in Part I of this thesis examine the investment behavior of VCs during times of economic crisis relative to more stable economic circumstances.

Chapter 2 analyses the effect of the 2007-2009 financial crisis on the US venture capital market. The crisis contributed to the failure of many well-known companies, led to a substantial decline in consumer wealth, produced enormous financial commitments incurred by governments, and resulted in a strong decline in economic activity. The crisis

[3] The US Census concentration measures are also used by the Federal Trade Commission when making decisions on anti-trust cases.

became visible with the bankruptcy of Lehman Brothers and the near-bankruptcy of American International Group (AIG) in September 2008. The worsened economic conditions led to a decrease in the supply of money to VC firms and made it more difficult to successfully exit a start-up through a trade sale or an IPO on the stock market. Chapter 2 analyses the effect of the financial crisis on the number of VC deals conducted, the amount of funds raised per funding round in early versus later stages, and also differences in these investment patterns across industries and countries. Findings indicate that the crisis is associated with a decrease in the number of initial funding rounds as well as with a decrease in the amount of funds raised in later funding rounds. These effects were confirmed across a variety of industries (i.e., VentureXpert classifications: "Internet", "Medical/Health Care", "Computer Software and Services", "Communications and Media" and "Other Products"), and were found to be more pronounced in the US as compared to countries outside the US.[4]

Figure 1.1: Outline of thesis



Chapter 3 analyzes the effects of the 2000-2001 dot-com crisis and the 2008-2009 financial crisis on VC syndications. A funding round is syndicated in case multiple VC firms simultaneously invest in a start-up. Syndication is used as a means to reduce uncertainty in the selection process of new investments (Bygrave, 1987; Brander et al., 2002; Lerner, 1994b), to increase the diversification of a VC's portfolio (Bygrave 1988; Lockett and

[4] The VC market showed a similar reduction in the amount of funds raised during the 2000-2001 dot-com crisis. During the dot-com crisis, however, the VC market came down from a more heated state (Green, 2004). The build-up in the number of rounds and the funded amounts prior to the bursting of the dot-com bubble was larger as compared to the rather stable state prior to the outbreak of the financial crisis.

Wright, 1999), and to establish relationships with other VCs, ensuring sufficient deal flow in the future (Lockett and Wright, 2001; Manigart et al., 2006; Sorenson and Stuart, 2001). In times of economic crisis, new uncertainties arise. With drastic reductions in the amount of funds flowing into the VC market as well as fewer opportunities to exit successful start-ups, VCs have to re-evaluate their investment strategy, including their syndication strategy. Chapter 3 shows that during both the 2000-2001 dot-com crisis and the 2008-2009 financial crisis, VCs had a lower tendency to syndicate their investments, and the size of the syndicates was smaller. This effect is primarily found for later-stage financing rounds. These findings are explained as follows. During a period of economic crisis, the priority of a VC is no longer to improve the selection process of new investments and to secure future deal flow but to ensure the survival of the current start-ups in its portfolio. When a VC's decision-making is focused on which portfolio companies to maintain and which to cut off from funding (Mason, 2009), a VC has little incentive to engage in new syndicates in order to expand its portfolio and thereby diversify its risk. Syndicating in order to secure future deal flow also becomes less relevant when the survival of a VC is more questionable. During crises, a shakeout occurs, leaving only room for skilled VCs to stay in business (Green, 2004). This way, the number of potential syndication partners decreases, making it more difficult for VCs to find suitable syndication partners.

1.4.2 Part II: Venture capital and intellectual property

Chapter 4 investigates the role of trademarks in the start-up valuations of VCs. Although trademarks might not produce immediate value for a start-up, the filing of trademarks nevertheless constitutes important information for VCs because it demonstrates a start-up's degree of market and growth orientation and its willingness to protect its current and future marketing efforts from the impairment of others (Sandner and Block, 2011). Using a large US firm-level transaction dataset from 1998 to 2007, Chapter 4 demonstrates a positive, but decreasing, effect of the number of a start-up's trademarks on VCs' financial valuation of the start-up. Results also indicate that the breadth of a start-up's trademark portfolio has a positive, but decreasing, effect on the VCs' start-up valuations. Trademark breadth refers to the number of distinct industries in which the trademark is filed and granted protection. The overall breadth of a start-up's trademark portfolio provides an indication of the diversification of a start-up's product portfolio (Mendonça et al., 2004; Sandner and Block, 2011). Furthermore, in later funding rounds, the positive effect of new trademark applications decreases when the start-up progresses into a more advanced development stage. This finding can be explained primarily by a decline in signaling value of trademarks due to the availability of other, more tangible, credible, and costly signals, such as planned marketing activ-

ities including budget information or initial sales data (Certo et al., 2001; Cohen and Dean, 2005; Connelly et al., 2011; Karamanos, 2003; Sliwka, 2007).

Chapter 5 examines the initial IP direction of 4,703 start-ups in the US, distinguishing between trademark and patent applications. Results show that the involvement of a VC investor leads to a greater likelihood of filing for a trademark rather than a patent. This could be explained by the ambition of VCs to commercialize a start-up's invention. VCs have a limited time period to turn a start-up into a functioning company (limited partners should receive their funds back within a predetermined time period). The filing of a trademark is likely to be one of the initial steps taken in the commercialization process, securing the start-up's brand name and protecting its future marketing efforts (Sandner and Block, 2011). The results also show that start-ups are more likely to file for a trademark instead of a patent when entering into more competitive market structures. In competitive markets, trademarks may receive priority when supporting a start-up's visibility among the variety of available products, where patents may be a more critical tool especially in "winner-take-all," i.e. less competitive, markets, where dominant technologies are industry standards. Start-ups that enter a rather concentrated market with novel, patented technological knowledge should pose a greater threat to the established incumbents (Abernathy and Clark, 1984; Christensen and Bower, 1996; Henderson, 1993; Hill and Rothaermel, 2003). Chapter 5 further shows that a start-up's customer type matters. Start-ups with a focus on distribution that serves end-consumers are more likely to file for a trademark, and start-ups that operate upstream and sell to other businesses are more likely to file for a patent. This finding is intuitive as trademarks are likely to be connected to a marketing differentiation strategy, where patents can be related to a technical or product differentiation strategy (Carter et al., 1994; McGee et al., 1995; Tan, 2001).

1.5 Publication status of chapters

Table 1.1 provides an overview of the publication status of each individual chapter. One chapter is published in a handbook (Oxford University Press). The other chapters are either published, or in the review process with international peer-reviewed journals (see Table 1.1). Co-authors of the chapters in this thesis are (in alphabetical order): Jörn Block, Enrico Pennings, Philipp Sandner, and Jan Schumann.

Table 1.1: Publication status of chapters

Chapter	Title	Data sources	Publication status
2	Venture capital and the financial crisis: an empirical study across industries and countries	VentureXpert	Published in *The Oxford Handbook of Venture Capital*
3	Venture capital syndication in times of economic crisis	VentureXpert	Published in *Venture Capital*
4	Trademarks and venture capital valuation	VentureXpert USPTO register PATSTAT	Published in *Journal of Business Venturing*
5	Trademark or patent? The effects of market structure, customer type and venture capital financing on start-ups' IP decisions	VentureXpert USPTO register PATSTAT US Cencus Bureau COMPUSTAT	Submitted for publication

PART I
Venture capital and the economy

2

Venture capital and the financial crisis: an empirical study across industries and countries

Based on Block et al. (2012).

Abstract

This study analyzes the effect of the 2007-2009 financial crisis on the venture capital market. We show that the crisis is associated with a decrease in the number of initial funding rounds as well as with a decrease in the amount of funds raised in later funding rounds. The effects of the crisis differed across industries and were stronger in the US than in other countries. We suggest that the crisis has led to a severe 'funding gap' in the financing of technological development and innovation.

2.1 Introduction

The years 2007–2009 will be known for a financial crisis regarded as one of the worst since the Great Depression of the 1930s (Almunia et al., 2009; Sinn, 2009). The crisis contributed to the failure of many well-known companies, led to a substantial decline in consumer wealth, produced enormous financial commitments incurred by governments, and resulted in a strong decline in economic activity. The crisis became visible to everyone with the bankruptcy of Lehman Brothers and the near-bankruptcy of American International Group (AIG) in September 2008. Following these events, many other financial institutions in the United States and around the world became affected and lost large portions of their value. Some of them could be saved from bankruptcy only by government intervention.

This chapter deals with the effects of the crisis on the venture capital (VC) market. Due to the strong links between the VC market and the financial markets in general, we expect a severe impact of the crisis on the VC market. VC is a very important source of funding for start-ups in innovative industries. VC is particularly important in the early phases of a firm's life, when it starts to develop innovative products and to commercialize its innovations (Gompers and Lerner, 2001; Jell et al., 2011; Zider, 1998). In this start-up phase, a firm does not have many other institutions to turn to in order to raise money. VC fills a void here. The inherent risks of a start-up in that phase are generally not accepted by banks (Bruns and Fletcher, 2008). To avoid risks, banks often require tangible assets, which are usually not available in young, innovative firms. The stock market and public equity are also not accessible at this stage, as the size of the firm is still too small for an IPO to be considered. Consequently if the crisis has led to a strong decrease in VC activity, a funding gap in the financing of technological development and innovation may have occurred or may continue to occur. This in turn may have negative effects on subsequent economic development and growth. Prior research has shown VC funding to have a strong positive impact on firm growth, technological development, and the evolution of industries (Audretsch and Thurik, 2001; Bottazzi and Da Rin, 2002; Florida and Kenney, 1988a; Keuschnigg, 2004; Kortum and Lerner, 2000; Timmons and Bygrave, 1986). For example, Kortum and Lerner (2000) find that an increase in an industry's VC activity leads to higher patent activity. It is estimated that VC is responsible for about 10% of US industrial innovation. Thus if VC activity decreases—and patent application volumes with it—adverse long-term effects on the economy may occur.

Except for Block and Sandner (2009) and De Vries and Block (2011), there is little empirical evidence regarding the impact of a financial crisis on VC activity. This chapter aims to shed more light on this issue. The following questions will be explored empirically:

1. Is the crisis associated with a reduction in the total volume of VC funds invested? Is there a strong decrease in the number of VC deals? Had the crisis already had an impact on VC activity before September 2008 (the month in which the historical event of the Lehman Brothers crash occurred)?

2. Did the crisis lead to a reduction in the amount of funds raised per funding round? If so, what was the size of this decrease?

3. Concerning the effects of the crisis, is there a difference between early- and later-stage financing?

4. How do the effects of the crisis on VC compare across industries and countries (US vs. non-US)?

The remainder of this study is organized as follows: We first describe the causes of the crisis and present a timeline of the events associated with it. We then summarize the arguments for why the crisis may have affected the VC market. We present and discuss the empirical study, discuss implications for start-ups and policymakers, and offer suggestions for further research.

2.2 The crisis: its causes and events

Many causes of the crisis have recently been proposed. The weight differs according to the expert questioned. We focus on three prominent explanations: the US housing bubble, the subprime crisis, and the deregulation of the financial markets in recent decades and the consequent creation of many complex financial innovations.

US housing bubble. The years prior to the outbreak of the crisis were characterized by a strong increase in US housing prices. This housing bubble was related to increasing financial incentives for banks to engage in mortgage loans. The decrease in the federal funds rate from the year 2000 onward coincided with larger profit margins for banks on mortgages. As a result housing prices peaked in 2006; their value had roughly doubled over the preceding decade. This boom period in the housing market was most importantly characterized by a strong increase in the amount of high-risk or subprime mortgages, which are provided to borrowers with relatively low credit ratings.

Subprime crisis. Between 2004 and 2007 the federal funds rate started to steadily increase again, rising from a 1 % level in 2004. This trend brought increasing expenses for borrowers holding adjustable-rate mortgages. The combination of an increasing federal funds rate with the growing share of (adjustable-rate) subprime mortgages led to a severe

increase in the number of homeowners defaulting on mortgage payments as well as an increase in the number of foreclosures on properties. In August 2007 the first hedge funds crashed (e.g., Bear Stearns), holding large shares of mortgage derivatives. Lending behavior among banks also became affected by the subprime crisis. Increasing insecurity with regard to the credibility of other institutions made banks more reluctant to lend, leading to a tightening of their lending requirements.

Deregulation and complex financial innovations. Government regulations did not prevent banks from providing larger shares of subprime mortgages. Rather, in 2004 the loosening of the net capital rule allowed banks to take on larger proportions of debt. Additionally the increasing importance of the shadow banking system as a driving economic force fell under different governmental regulations, allowing for larger debt ratios. The increasing share of subprime mortgages was pooled and bundled into new financial products, selling them off to investors as collateralized debt obligations (CDOs) and mortgage-backed securities. The relatively safe credit ratings of these products contributed to an increasing demand of investors for mortgage-based derivatives.

Many events are associated with the crisis. To see the historical development and to understand the decisions that we made to produce our empirical results, we provide the following overview (see also Orlowski, 2008).

August 2007: Outbreak of subprime crisis (bankruptcy of Bear Stearns' in-house hedge fund).

December 2007: Impact of subprime crisis starts to affect other asset areas. Aside from mortgage banks, a large number of financial institutions are affected.

March 2008: Run on Bear Stearns, resulting from a period of increasing liquidity problems for banks.

January 2008 to July 2008: With the decreasing value of CDOs, money begins shifting toward commodities. The commodity bubble reached its peak in July 2008.

September 2008: Increasing liquidity problems result in the bankruptcy of Lehman Brothers and the government takeover of AIG, which suffered from downgraded credit ratings. Along with the credit freeze, this led to a strong downturn in stock prices.

2.3 Why the crisis may have affected the VC market

There exist several arguments for why the crisis may have had an effect on VC activity. The arguments can be grouped into two broad categories.

A decrease in the supply of money to VC funds. Due to the crisis, VC funds (operated by VC firms) had difficulty finding investors. Investors in VC funds are typically pension funds, insurance companies, and large banks (Gompers and Lerner, 1998). Many of these institutions were themselves adversely affected by the crisis. Some of them went bankrupt (e.g., Lehman Brothers, Washington Mutual), (were) merged with other financial institutions to survive (e.g., Merrill Lynch), or received help from the government (e.g., AIG, Fannie Mae, Freddie Mac, Commerzbank, ABN AMRO). Most banks and insurance companies were forced to decrease the share of their investments in risky assets such as VC funds, often by selling stakes to alternative parties. This introduced VCs to new, less familiar limited partners, which were possibly less reliable when it comes to answering to capital calls (VCs ask limited partners for capital on an as-needed basis). A second option for these institutional investors was to simply not commit any more funds to VCs. Especially those institutions that just started investing in a VC fund were in this way cutting their losses (Business Week, 2008). Another argument concerns the exit channels for VC investments, which are IPOs, acquisitions, secondary sales, buybacks, and write-offs (Cumming and MacIntosh, 2003). Since the crisis had also affected the market for IPOs, VC firms faced severe exit challenges, which in turn reduced the supply of money for VC funds.[5] Black and Gilson (1998), for example, argue that the amount of funds raised depends on a vibrant market for IPOs.

A decrease in the valuation of VC-backed start-ups. The crisis has clearly led to one of the deepest recessions in recent years. The US GDP decreased by 5.4 % in the fourth quarter of 2008 from the previous quarter (Q1 2009: –4.6 %; Q2 2009: –0.8 %).[6] The German economy (the largest European economy) decreased by 1.8 % in the fourth quarter (Q1 2009: –3.4 %; Q2 2009: +0.8 %).[7] In times of recession VC-backed start-ups have problems generating sufficient revenues. End consumers and firms have less money to spend and may postpone purchases. This puts pressure on the start-ups' sales and leads to lower firm valuations. In addition the start-ups' bankruptcy risks increase, and VC firms apply higher discount rates. To summarize, the recession followed by the crisis has led to lower valuations of VC-seeking start-ups, which also correspond to declines in stock prices on public equity markets.

[5] See Ritter (2009) for detailed information about the market for IPOs in 2008 and 2009.
[6] See http://www.bea.gov (accessed January 9, 2010).
[7] See http://www.destatis.de (accessed January 9, 2010).

2.4 Empirical study

2.4.1 Measures and data

This section analyzes the effect of the crisis on VC activity across different industries and countries (US vs. non-US). The funding round will be our unit of analysis (i.e., the financing round in which start-ups raise money from one or multiple VC investors). We focus on two measures: the number of funding rounds per month and the amount of funds raised per funding round. Both measures will be calculated for the periods *before* and *during* the crisis.

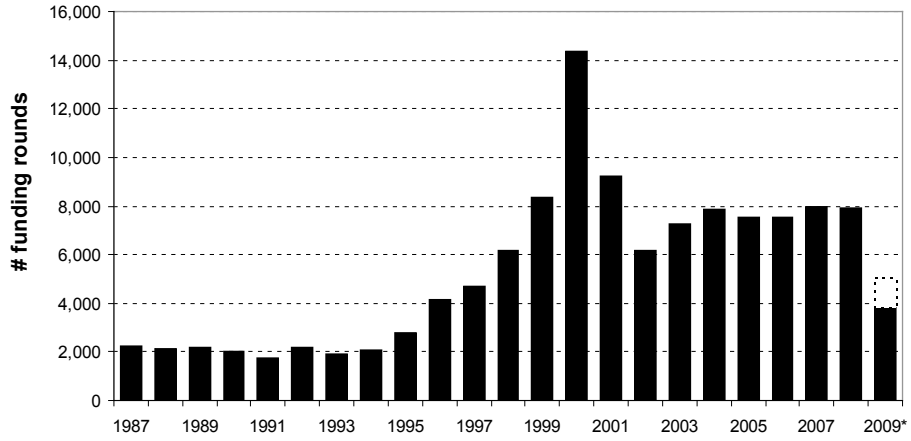
Our data originate from the Thomson VentureXpert database (formerly known as Venture Economics). This decision contrasts with that of Block and Sandner (2009), who used the database CrunchBase as a novel data set.[8] Compared to CrunchBase, VentureXpert goes further back in time and is thus the largest available database on private equity and VC investments.

2.4.2 The VC market over the past decades and the effect of the crisis

Figure 2.1 shows the number of annual funding rounds from 1987 to 2009. During the second half of the 1990s the VC market began to grow strongly. Favorable conditions in the IPO market and the exits of less experienced VCs encouraged investors to allocate money toward VC funds (Gompers and Lerner, 2001). This increase steepened during the late 1990s as Internet start-ups became favorable investment targets. The bursting of the Internet bubble in 2000 led to a strong decrease in the number of funding rounds, bringing the annual number of funding rounds back to the level of 1999. During the aftermath of the dot-com crash, venture capitalists remained active at a level of about 7,800 rounds per year. The effect of the crisis becomes visible during the final year of our sample, when the number of rounds decreased to about 3,800 for the year up until September 2009 (corresponding to an annual number of funding rounds of about 5,100). The effect of the 2008 crisis is thus sizable and comparable to that of the dot-com crash in the year 2000.

[8] See http://www.crunchbase.com (accessed January 11, 2010).

Figure 2.1: Number of funding rounds (Januari 1987 to September 2009)

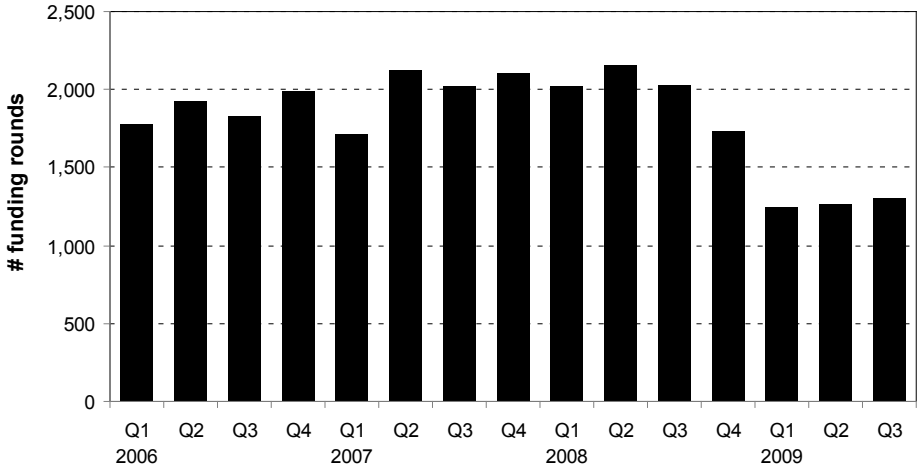


Notes: The year 2009 includes only the months from January to September. The dotted line indicates the number of funding rounds proportionally scaled to the whole year (3,817/3 * 4 = 5,090).
Source: VentureXpert (accessed November 11, 2009); all industries and countries are included.

2.4.3 The VC market immediately before and during the crisis

Figure 2.2 shows the number of funding rounds from January 2006 to September 2009 on a quarterly basis. A downward slope is visible starting from the third quarter of 2008, departing from 2,157 funding rounds and leveling off at 1,246 in the first quarter of 2009 (i.e., a decrease of 42 %).

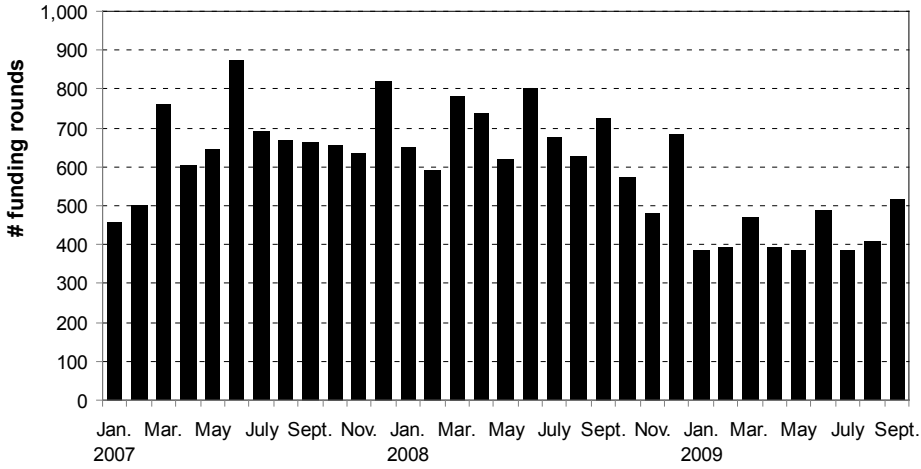
Figure 2.2: Number of funding rounds (quarterly basis, from Q1 2006 to Q3 2009)



Source: VentureXpert (accessed November 11, 2009); all industries and countries are included.

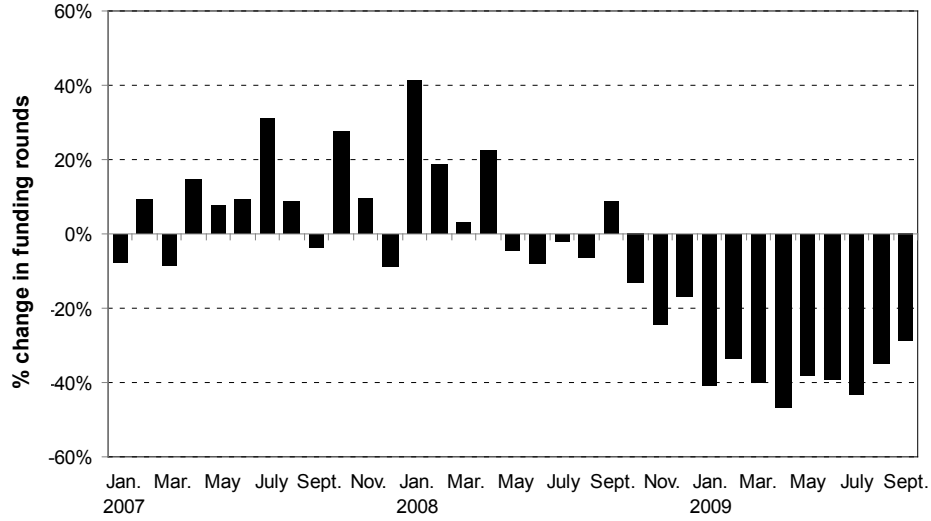
When looking at this period on a monthly basis (see Figure 2.3), we see that the VC market fluctuates in its activity, making it difficult to determine the exact date the crisis started to have an effect on VC activity. The impact of the crisis somewhat stabilizes from January 2009 onward, around a level of 400 funding rounds per month.

Figure 2.3: Number of funding rounds (monthly basis, January 2007 to September 2009)



Source: VentureXpert (accessed November 11, 2009); all industries and countries are included.

Figure 2.4: Change in the number of funding rounds (compared with previous year)



Source: VentureXpert (accessed November 11, 2009); all industries and countries are included.

To determine the date from which the crisis began to have an effect on VC activity, we need to take seasonal fluctuations into account. For example, throughout the five years preceding the crisis, the highest number of funding rounds always occurred in December and June, in contrast to the months of January and February, which often report the lowest amount of VC activity. Taking seasonal influences into account, Figure 2.4 compares the number of funding rounds for each month to the same time period in the previous year. This measure can be compared to the common measure of GDP growth, which is also not an absolute but a relative measure that compares the GDP of the current year with the GDP of the previous year. First, we see that the VC market was growing until April 2008. The turning point occurs in May 2008, when the VC volume began to decline. The VC market was thus already in decline when the crisis became monumentally publicly visible in September 2008 with the crash of Lehman Brothers.

2.4.4 The effect of the crisis on VC activity across different industries

To measure the impact of the crisis, it is necessary to choose a date that determines the precrisis period and the crisis period. Many events associated with the crisis occurred in September 2008, when many financial institutions became visibly affected by the crisis. Among others, the investment bank Lehman Brothers went bankrupt on September 15, 2008. A sharp decline in stock prices followed in the beginning of October. However, from our analyses above, we can see that the VC market was already declining when the crisis became visible in September 2008. Accordingly, for our analyses regarding the effect of the crisis across industries, we choose two different cutoff points to determine the crisis and precrisis periods: September 15, 2008, the date Lehman Brothers went bankrupt, and July 1, 2008. By July 2008 the commodity futures had already had their peak, and a shift toward US treasuries and gold started (Orlowski, 2008).

To analyze whether the amount of funds raised per funding round changed due to the crisis, we calculated the median *amount of funds raised* per funding round before and during the crisis. We then used a Wilcoxon rank-sum test to find out whether the differences are statistically significant. To avoid becoming unduly technical, we limit ourselves to this (rather simple) univariate analysis. Using multivariate regressions, Block and Sandner (2009) have shown that controlling for factors such as the presence of an investment consortium, the age of the funded company, and the type of VC investor (business angel or VC fund) did not change the results substantially.

Table 2.1 shows the effect of the financial crisis across different industries. We analyze the period from January 2007 to September 2009 and use July 1, 2008, as a cutoff date to determine the crisis and precrisis periods. During that period 14,355 funding rounds oc-

curred. We distinguish between the effects of the crisis regarding the first and later funding rounds, a distinction that has been shown to make a great difference (Block and Sandner, 2009). In initial funding rounds the funds raised provide initial money to start-ups. Second and later rounds equip start-up firms with additional funds so that they can continue with their development, marketing, or internationalization efforts.

Table 2.1 reports a drop in the number of funding rounds per month during the crisis. This decrease occurs within all industries and is larger for first rounds (–33.3%) than for later rounds (–17.7%). Especially in *Biotechnology* (–29.4%), *Internet* (–39.7%), and *Medical/Health Care* (–40.0%), we observe that VCs were more reluctant to provide first-round investments toward "new" start-ups during the crisis than during the precrisis period. Within these industries the percentage decrease in first-round investments is about four times larger than the decrease in later-round investments.

Table 2.1 also shows the median *amount of funds raised* per funding round. Using the median as an indicator robust to extreme values, a decrease is visible in the amount of funds raised during the crisis, especially within later funding rounds. The Wilcoxon rank-sum tests show that start-ups raise significantly lower funds within later funding rounds in *Internet*, *Medical/Health Care*, and *Computer Software and Service*. A significant decrease in the amount raised in first-round investments can be observed only in *Biotechnology*.

In summary, during the crisis VC activity slowed down. The crisis affected the number of first-round investments to a greater extent than the number of second- and later-round investments. The amount of funds raised in each funding round decreased to a greater degree in later funding rounds than in first rounds.

Table 2.2 uses the crash of Lehman Brothers on September 15, 2008, as a cutoff date to determine the crisis and precrisis periods. Overall, the decrease in the number of funding rounds is stronger than in Table 2.1, where July 1, 2008, is used as a cutoff point. This is in line with our expectations, as Figures 2.3 and 2.4 have already indicated that the number of funding rounds declined sharply during the months after September 2008. The findings regarding the *amount of funds raised* per funding round also became more pronounced. For example, in addition to the later funding round decreases in *Internet*, *Medical/Health Care*, and *Computer Software and Services*, we now observe a decrease in the amount of funds in *Communications and Media* and *Other Products*.

Table 2.1: The Effect of the Financial Crisis on VC Activity across Industries (Cutoff Point: July 1, 2008)

		Before crisis (Jan 2007 to June 2008)			During crisis (July 2008 to Sept 2009)			Change in …	
Industry	**Stage of funding round**	**N**	**Ø rounds/ month**	**Funds raised/ round in mln. USD (median)**	**N**	**Ø rounds/ month**	**Funds raised/ round (median)**	**…Ø rounds/ month (%)**	**…funds raised/ round Wilcoxon rank-sum test (Z-value)**
Biotechnology	First rounds	226	12.6	4.2	133	8.9	2.8	-29.4%	2.39*
	Later rounds	569	31.6	6.0	452	30.1	5.0	-4.7%	1.31
Communications and Media	First rounds	163	9.1	4.5	88	5.9	3.9	-35.2%	0.31
	Later rounds	493	27.4	5.0	274	18.3	4.5	-33.3%	1.72
Computer Hardware	First rounds	102	5.7	4.0	64	4.3	4.0	-24.7%	0.87
	Later rounds	203	11.3	3.7	148	9.9	4.1	-12.5%	-0.66
Computer Software and Services	First rounds	456	25.3	3.0	269	17.9	2.3	-29.2%	0.71
	Later rounds	1,100	61.1	3.6	689	45.9	3.0	-24.8%	2.04*
Consumer related	First rounds	243	13.5	3.6	126	8.4	3.4	-37.8%	0.14
	Later rounds	225	12.5	3.2	150	10.0	4.0	-20.0%	-1.05
Industrial/Energy	First rounds	320	17.8	5.0	241	16.1	4.0	-9.6%	1.23
	Later rounds	324	18.0	6.7	272	18.1	5.6	0.7%	1.10
Internet	First rounds	705	39.2	3.1	354	23.6	3.0	-39.7%	1.21
	Later rounds	961	53.4	5.0	715	47.7	4.0	-10.7%	3.12**
Medical/Health Care	First rounds	384	21.3	3.9	192	12.8	3.0	-40.0%	1.20
	Later rounds	783	43.5	5.0	567	37.8	4.5	-13.1%	1.98*
Other Products	First rounds	528	29.3	5.0	266	17.7	5.1	-39.5%	0.10
	Later rounds	341	18.9	5.0	204	13.6	3.0	-28.2%	1.85
Semiconductors/ Other Electr.	First rounds	158	8.8	2.6	93	6.2	2.8	-29.4%	1.03
	Later rounds	485	26.9	5.3	289	19.3	4.5	-28.5%	1.05
Total sample	First rounds	3,285	182.5	3.9	1,826	121.7	3.2	-33.3%	2.62**
	Later rounds	5,484	304.7	4.8	3,760	250.7	4.0	-17.7%	4.13**

Notes: * $p \leq 0.05$; ** $p \leq 0.01$; two-sided tests employed; Data source: VentureXpert (accessed November 11, 2009); includes both US and non-US funded ventures.

Table 2.2: The Effect of the Financial Crisis on VC Activity across Industries (Cutoff Point: September 16, 2008)

		Before crisis (Jan 2007 to Sept 15th 2008)			During crisis (Sept 16th 2008 to Sept 2009)			Change in …	
Industry	**Stage of funding round**	**N**	**Ø rounds/ month**	**Funds raised/ round (median)**	**N**	**Ø rounds/ month**	**Funds raised/ round (median)**	**…Ø rounds/ month (%)**	**…funds raised/ round Wilcoxon rank-sum test (Z-value)**
Biotechnology	First rounds	256	12.5	4.1	103	8.2	2.8	-34.0%	1.80
	Later rounds	652	31.8	6.0	369	29.5	5.1	-7.2%	1.11
Communications and Media	First rounds	179	8.7	4.5	72	5.8	3.9	-34.0%	0.45
	Later rounds	559	27.3	5.0	208	16.6	4.1	-39.0%	2.05 *
Computer Hardware	First rounds	113	5.5	4.5	53	4.2	2.1	-23.1%	2.62 **
	Later rounds	233	11.4	3.7	118	9.4	4.2	-16.9%	-0.75
Computer Software and Services	First rounds	517	25.2	3.0	208	16.6	2.5	-34.0%	0.61
	Later rounds	1,239	60.4	3.7	550	44.0	3.0	-27.2%	3.12 **
Consumer related	First rounds	274	13.4	3.6	95	7.6	3.3	-43.1%	0.20
	Later rounds	261	12.7	3.5	114	9.1	3.3	-28.4%	-0.63
Industrial/Energy	First rounds	375	18.3	5.0	186	14.9	4.0	-18.7%	1.15
	Later rounds	388	18.9	6.5	208	16.6	5.3	-12.1%	1.06
Internet	First rounds	797	38.9	3.0	262	21.0	3.0	-46.1%	0.92
	Later rounds	1,117	54.5	4.8	559	44.7	4.0	-17.9%	2.88 **
Medical/Health Care	First rounds	429	20.9	3.7	147	11.8	2.9	-43.8%	1.38
	Later rounds	902	44.0	5.0	448	35.8	4.4	-18.5%	2.27 *
Other Products	First rounds	588	28.7	5.0	206	16.5	5.2	-42.5%	-0.03
	Later rounds	391	19.1	5.0	154	12.3	2.8	-35.4%	2.44 *
Semiconductors/ Other Electr.	First rounds	178	8.7	2.6	73	5.8	2.5	-32.7%	0.83
	Later rounds	545	26.6	5.0	229	18.3	4.4	-31.1%	1.21
Total sample	First rounds	3,706	180.8	3.7	1,405	112.4	3.2	-37.8%	2.62 **
	Later rounds	6,287	306.7	4.8	2,957	236.6	4.0	-22.9%	4.93 **

Notes: * $p \leq 0.05$; ** $p \leq 0.01$; two-sided tests employed; Data source: VentureXpert (accessed November 11, 2009); includes both US and non-US funded ventures.

Table 2.3: The Effect of the Financial Crisis on VC Activity: US versus non-US (Cutoff Point: July 1, 2008)

		Before crisis (Jan 2007 to June 2008)			During crisis (July 2008 to Sept 2009)			Change in …	
Country	**Stage of funding round**	**N**	**Ø rounds/ month**	**Funds raised/ round (median)**	**N**	**Ø rounds/ month**	**Funds raised/ round (median)**	**…Ø rounds/ month (%)**	**…funds raised/ round Wilcoxon rank-sum test (Z-value)**
Funded venture located in US	First rounds	2,049	113.8	3.3	991	66.1	2.7	-42.0%	3.17**
	Later rounds	4,567	253.7	4.7	3,090	206.0	4.0	-18.8%	5.03**
Funded venture located outside US	First rounds	1,236	68.7	4.6	835	55.7	4.0	-18.9%	1.52
	Later rounds	917	50.9	5.0	670	44.7	5.1	-12.3%	-0.72
Total sample		8,769			5,586				

Notes: * $p \leq 0.05$; ** $p \leq 0.01$; two-sided tests employed; Data source: VentureXpert (accessed November 11, 2009); includes both US and non-US funded ventures.

Table 2.4: The Effect of the Financial Crisis on VC Activity: US versus non-US (Cutoff Point: September 16, 2008)

		Before crisis (Jan 2007 to Sept 15th 2008)			During crisis (Sept 16th 2008 to Sept 2009)			Change in …	
Country	**Stage of funding round**	**N**	**Ø rounds/ month**	**Funds raised/ round (median)**	**N**	**Ø rounds/ month**	**Funds raised/ round (median)**	**…Ø rounds/ month (%)**	**…funds raised/ round Wilcoxon rank-sum test (Z-value)**
Funded venture located in US	First rounds	2,286	111.5	3.2	754	60.3	2.6	-45.9%	2.90**
	Later rounds	5,225	254.9	4.6	2,432	194.6	3.7	-23.7%	5.50**
Funded venture located outside US	First rounds	1,420	69.3	4.6	651	52.1	3.9	-24.8%	1.80
	Later rounds	1,062	51.8	5.1	525	42.0	5.0	-18.9%	0.12
Total sample		9,993			4,362				

Notes: * $p \leq 0.05$; ** $p \leq 0.01$; two-sided tests employed; Data source: VentureXpert (accessed November 11, 2009); includes both US and non-US funded ventures.

2.4.5 The effect of the crisis on VC activity: US versus non-US

Although the crisis started in the United States, it became a global phenomenon. Through trade and capital flows, the crisis spread to other countries (Almunia et al., 2009). Some countries outside the United States experienced even larger drops in manufacturing production, exports, and equity prices. In Europe, the Baltic countries and Iceland in particular were hit extremely hard, leading these countries to a state of near-insolvency. Different countries have responded differently to the crisis, notably with varying monetary and fiscal policies. For these reasons we expect the effects of the crisis on VC to differ across countries. Due to the limited number of VC deals outside the United States (in our data set), we focus on a US versus non-US comparison. Although it would be preferable to look at the effects of the crisis in different countries in greater detail, we defer this question to future inquiry.

Tables 2.3 and 2.4 compare the consequences of the crisis for start-ups located in the United States to the consequences for those outside the United States. Table 2.3 defines the beginning of the crisis as July 1, 2008. It shows that the decrease in the number of funding rounds per month is stronger within than outside the United States. This difference is particularly strong for first-round investments (−42 % in the United States vs. −19 % outside the United States). The reductions in VC activity reported in Table 2.4, taking September 16, 2008, as the cutoff date, are similar. It seems that the VC market in the United States has been more strongly affected by the financial crisis than the VC market outside the United States. This finding is also supported by our second measure. The decrease in the amount of funds raised per funding round is significant for the VC market in the United States but insignificant for the VC market elsewhere.

2.5 Summary of main findings and discussion

2.5.1 Summary of main findings

The main findings from our empirical study are as follows:

The crisis led to a decrease in the number of funding rounds. This decrease was generally stronger for the first funding round than for later funding rounds. The effect can be observed across all industries. It was highest in *Internet* (−46%) and lowest in *Industrial/Energy* (−18%).

The amount of funds raised per funding round decreased. This decrease was generally stronger for later than for first funding rounds. In addition the decrease in the amount of funds raised per funding round differed across industries. Significant decreases can be observed in *Internet*, *Medical/Health Care*, *Computer Software and Services*, *Communications and Media*, and *Other Products*.

The slowdown of VC activity due to the crisis has been more severe in the United States than elsewhere. This applies to both the number of funding rounds and the amount of funds raised in each funding round.

2.5.2 Discussion of the results

Our results show that the crisis strongly impacted the VC market: the market is down in both the number of investment dollars and the number of deals (see Tables 2.1 and 2.2). Interestingly this effect differed with regard to the stage of financing. The decrease in the number of deals can primarily be observed in first funding rounds, whereas the decrease in the number of investment dollars occurred in later funding rounds. How can these results be explained? The lower number of deals in the first funding round is most likely due to stricter investment criteria by VC firms. Compared to the period before the crisis, the VC firms have less money to invest, are more critical about their VC investments, and tend to postpone their investments. Not surprisingly they are less willing to take risks than they were before the crisis. Accordingly, start-ups that still receive VC funding are at later development stages and are, *ceteris paribus,* thus associated with lower risks (i.e., they might already have developed a prototype or established first customer contacts). Additionally these entrepreneurs are in a different situation than they were before the crisis. If possible, they postpone their costly development and internationalization plans until the capital markets stabilize. Some entrepreneurs might even refrain from starting a company at all because they do not expect to obtain adequate financing. Entrepreneurs at early-stage companies might also consider alternative employment options. The situation is different for later-stage start-ups. These start-ups find themselves in a dilemma. Despite the lower valuations and the declining VC market, they still need later-stage funding to survive. In turn, the VC investors face the choice of either partly writing off their past investments or committing to providing fresh money in subsequent rounds of financing. Most likely the VC investors will commit to new rounds of financing, but they are prone to lower the amount of funds they invest. These start-ups are in a weak negotiation position vis-à-vis the VC firm(s). They need the VC capital to survive. In a nutshell, later-stage ventures find themselves in a kind of "lock-in situation" and cannot avoid the lower valuation of their firm by

VCs. Early-stage start-ups have more alternatives (including not starting the venture) and thus appear to be in a more comfortable and flexible position.

An alternative explanation for the drop in investment dollars is the following: An important difference between early- and later-stage ventures is associated with the unhealthy state of the IPO market. VC firms do not provide "patient" capital. Instead they intend to sell the firm in which they have invested after a few years. Conducting an IPO in a recession is not an attractive option. Following this logic, firms at later stages of the venture cycle become less attractive as investment targets, especially because the prospects of a revival of the IPO market in the short term are poor. Cumming et al. (2005) show that when exit markets are illiquid, VC investors invest proportionally more in early-stage projects. In turn, when exit markets are liquid, VCs invest more in later-stage ventures.

Another explanation not related to valuation issues concerns the process of staging itself. The crisis and the greater uncertainty about the prospects for the economy might have increased the tendency of VCs to stage their investments. This tendency should be stronger with start-ups in later stages of the venture cycle, as the money at stake for the VCs is larger.

Our empirical study also shows that the crisis had a stronger effect on the VC market in the United States than elsewhere. The fact that the outbreak of the financial crisis initiated from the US, and also had a larger impact on economic growth in the US as compared to other economies is in line with this (see Section 2.3). An alternative explanation of the larger effect within the US could be the higher exposure of limited partners to the VC market in comparison to other countries. The VC market in the US is more developed in comparison to other countries and has a larger inflow of funds (Bottazzi and Da Rin, 2002; The Economist, 2010). The initiation of a crisis may cause limited partners to reduce their exposure to risky investment categories such as VC, and focus on relatively safer categories such as bonds and stocks. In comparison, in Europe, a relatively larger share of the funds flowing into the VC market is provided by governments. Finally, the fact that the effect of the crisis seems to differ across countries shows market imperfections. In a world of efficient financial markets (Fama, 1970), there should not exist any differences. This can for example be explained by geographical distance to which VCs are bounded (Florida and Kenney, 1988b; Powell et al., 2002). VCs prefer to play an active role in the start-ups invested in, and therefore tend to select start-ups that are within commuting distance.

2.6 Implications and further research

2.6.1 Implications

The implications of our findings can be grouped into (1) implications for start-ups seeking VC funding and (2) implications for the evolution of innovative industries and technological development.

Implications for start-ups: Our results show that start-ups that sought VC were affected by the crisis. Start-ups that had already received initial funding and wanted (or needed) to raise further funds faced a discount as a result of the crisis (The extent of this discount varied between industries and countries; see Tables 2.1 to 2.4.). This discount was most likely a result of valuation changes by VC investors. One lesson of this crisis is that start-ups seeking later-stage financing should try to foresee such developments and adapt their business planning accordingly. Cutting costs or postponing expansion plans may be adequate reactions. In times of a financial and/or economic crisis, they will encounter difficulties in raising the funds required to further finance their product development, marketing, and internationalization efforts. Our results also show that the crisis led to a drop in the number of initial funding rounds. We suggest that VC firms became more selective as a reaction to the financial crisis. In other words, start-ups that sought VC during the crisis had to fulfill stricter criteria during the crisis than before it. Entrepreneurs who seek initial funding should keep this in mind and think about alternative sources of funds, such as angel investors and bank loans (Cassar, 2004; Harrison and Mason, 2000). If there exist no alternatives to VC money (as is often the case), entrepreneurs might consider changing the way they communicate to potential VC funders; for example, they might adjust their business plans and stress that the chances of success of their particular start-up are immune to the development of a crisis. They might also consider playing down some risks associated with their start-up. An alternative strategy would be to look for some sort of bridge financing from sources other than VC money.

Finally, our results show that the effect of the crisis on VC activity differed across industries and countries. Industry differences can be explained by the varying potential of business models in different areas; country differences can be explained by market imperfections. Start-ups seeking VC should be aware of these imperfections in their business planning.

Implications for the evolution of industries and technological development: VC is an important means of funding for start-ups in innovative and technology-driven industries

because it is the vehicle used to turn innovative ideas into products that can be sold to customers (Jell et al., 2011; Zider, 1998). VC particularly matters when firms conduct R&D and start to commercialize their innovations, that is, when they develop their products, apply for patents, look for distribution partners, seek initial customers, conduct their internationalization strategies, or simply scale up their operations (Gompers and Lerner, 2001; Zider, 1998). VC firms not only provide financial means but also offer nonfinancial benefits such as management support and access to experts or existing business networks (Alexy et al., 2012; Large and Muegge, 2008; Schefczyk and Gerpott, 2001). Florida and Kenney (1988a, 119) see VC firms as "technological gatekeepers accelerating the process of technological change." Thus the VC market's drying up can have long-lasting negative effects on the evolution of innovative industries (Audretsch and Thurik, 2001; Bottazzi and Da Rin, 2002; Kortum and Lerner, 2000). Innovative start-ups might face illiquidity, and the speed of commercialization of technological innovations might slow down. Ultimately a country's or an industry's path of evolution can be adversely affected. Governments should be aware of these negative side effects of the financial crisis, as they might determine their country's innovative capacity. Up to a certain level, governments can have a significant influence on the condition of their national VC market. Next to economic determinants (largely attached to business cycles across countries), VC supply and demand will depend on a country's legal framework. Some examples of regulations that are relevant to the VC market are bankruptcy laws (Armour and Cumming, 2006), tax policy (Da Rin et al., 2006; Keuschnigg and Nielsen, 2003), the ability of pension funds to invest in VC (Gompers and Lerner, 2004), and the amount of capital going to start-ups through subsidized governmental programs (Lerner, 2002a). The impact of a country's regulatory framework on VC activities is found to have an effect of similar size as the presence of a vibrant stock market and real GPD growth (Armour and Cumming, 2006). Hence legal reform can be an important interacting factor when considering the impact of an economic crisis on a country's VC market. Examples of policy measures are the adoption of more liberal bankruptcy laws, stimulating entrepreneurial demand for capital, and lowering the capital gains tax, making it more attractive for investors to submit capital to VC funds. Besides legal reform, governments can also set up public funds nurturing start-up companies. Under the right managerial incentives, public funds are able to stimulate entrepreneurial demand for capital and also encourage VCs to address a more diverse set of industries (Lerner, 2002a). There is, however, a potential downside when the government decides to become an actor in the VC market. Cumming and MacIntosh (2006) find that public funds are likely to substitute for or "crowd out" VC firms as a result of the increased competition for investment targets. We argue that this crowding-out effect will be less severe during a

period of economic crisis. Where capital is scarce and fewer entrepreneurs are likely to receive VC funding, public VC funds are more likely to have positive effects for the economy.

Overall the observed policy responses to the crisis have been designed to avoid a credit crunch (Gern and Janssen, 2009; Sinn, 2009), that is, to avoid a collapse of the credit market for small and large firms. Our results regarding the effect of the crisis on the VC market suggest that this may not be enough: many innovative firms do not rely on debt but rather on VC as a source of financing. Avoiding a credit crunch helps established (small and large) firms in established industries rather than start-ups in innovative industries.

2.6.2 Further research

This is one of the first studies to empirically document and analyze the effects of a financial crisis on VC activity (see also Block and Sandner, 2009). VC has become an element vital to the current economy and an important source of funding for innovative start-ups (Gompers and Lerner, 2001; Jell et al., 2011). In this study we show that a financial crisis can have a strong impact on VC activity. Unlike the last slowdown of VC activities following the collapse of the New Economy bubble in 2000, the 2008 slowdown came more as an exogenous shock to the VC market. In the 2007–2009 crisis, what initiated the downturn of VC activity were not unrealistic expectations regarding the "omnipotence" of the Internet and the New Economy but problems in the financial sector. We suggest that such an exogenous shock can lead to a severe funding gap in the financing of innovation.

A number of questions are left unanswered and provide good opportunities for future research. How do start-ups receiving funding during the crisis differ from start-ups that received funding before the crisis? For example, are the former more successful? Were they associated with lower bankruptcy risks? Or did they simply communicate in a better way? How did the start-up entrepreneurs react to the challenges of the crisis and the difficulties in the search for VC funding?[9] For example, did they look for alternative sources of funding such as money from business angels, or did they postpone their expansion plans? Have the fiscal stimulus packages of the US and other governments had any effect on the VC market?[10] What is the effect of the crisis on the performance of VC funds? And ultimately, over a longer time period, did the decrease of VC activity due to financial markets have severe consequences for the real economy? For example, did the number of innovations slow down?

[9] See Koellinger and Thurik (2012) for a discussion of entrepreneurship and the business cycle.
[10] See Van Roye and Wesselbaum (2009) for a study of the effect of the fiscal stimulus packages.

3

Venture capital syndication in times of economic crisis

Based on De Vries and Block (2011).

Abstract

This study analyzes the effects of the 2000-2001 dot-com crisis and the 2008-2009 financial crisis on venture capital (VC) syndication. Using propensity score matching analysis, we show that during the two crises, VCs had a lower tendency to syndicate their investments, and the size of the syndicates was smaller. This effect is primarily found for later-stage financing rounds. We explain the lower propensity to syndicate and the reduction in syndicate size by the existence of fewer exit opportunities for VCs and a lower supply of funds for the VC industry. Implications for VCs and start-up firms are discussed.

3.1 Introduction

Both the 2000-2001 dot-com crisis (hereafter, dot-com crisis) and the 2008-2009 financial crisis (hereafter, financial crisis) led to severe slowdowns in venture capital (VC) activities (Block and Sandner, 2009; Block et al., 2012; Chang, 2004; Mason, 2009; PWC Money Tree report, 2009). These slowdowns occurred because the VC market is closely linked to the general economic climate. Capital inflow from institutional investors, such as banks and insurance companies, and an active IPO market are important prerequisites for a functioning VC market (Black and Gilson, 1998; Jeng and Wells, 2000; Zider, 1998).

With the initiation of the financial crisis, the VC market entered a new dynamic, forcing VCs to downsize their activities (Mason, 2009). This led to a new set of research questions regarding VCs' strategies under changing conditions. While the VC market is rather dependent on its surrounding economic context, few studies have addressed the effects of changing economic conditions on the investment behavior of VCs. This study addresses this gap. Using syndication data from both the dot-com and financial crises, we explore the following related research questions. First, how does an economic crisis affect VCs' propensity to syndicate? Second, how does an economic crisis affect the size of VCs' syndicates? Third, is there a difference in the effects of an economic crisis on syndication propensity and size between early and later financing stages?

Existing empirical work on VCs' syndicates in relation to contextual factors has focused on the following aspects. First, regarding legal and institutional conditions, Cumming et al. (2010) found that better laws reduce agency costs between partners, increasing their likelihood to syndicate. Second, with regard to cross-border contexts, Meuleman and Wright (2011) found that syndication is a tool to address institutional differences when investing in new countries. Third, with respect to the level of competition for investment opportunities, Lockett and Wright (1999) found that a high level of competition, i.e., a lower number of available investment opportunities, is related to lower syndication levels. Finally, with respect to IPO conditions, Cumming et al. (2005) showed that the syndicate size of first funding rounds decreases under more liquid IPO market conditions. Contributing to this body of knowledge, we argue in this study that an economic shock (in the form of an economic crisis) reduces the propensity to syndicate and the syndicate size. We further argue that this effect is larger for later stage funding rounds relative to early-stage funding rounds.

Using propensity score matching analysis, correcting for selection bias regarding investments before versus during a crisis, we found that VCs had a lower tendency to syndicate during both the dot-com crisis and the financial crisis. We observed both a reduction in the share of syndicated rounds (-12% during the dot-com and -5% during the financial cri-

sis) and a reduction in the size of syndicates (-10% during both the dot-com and the financial crises). These effects were only found for second and later funding rounds. When including IPO and fund-raising variables in the propensity score matching analysis, the reductions in syndication propensity and size are no longer significant. Thus, the effect of an economic crisis on syndication propensity and size can be explained by the worsened IPO and fund-raising conditions VCs face in an economic crisis. When few funds are available for investment and few exit opportunities exist, VCs will focus on their main investments. Poor exit opportunities force VCs to provide continued funding for these investments. Compared to a non-crisis period, fewer financial means are available for participation in non-lead projects or to join new syndicates. Our results can be considered robust because similar patterns were observed during both the dot-com crisis and the financial crisis.

The remainder of this chapter proceeds in the following manner. Section 3.2 reviews the literature regarding the motives leading VCs to syndicate. Section 3.3 discusses how in syndication, propensity and size are affected by an economic crisis and develops our hypotheses. Section 3.4 describes the data sources, the variables, and the methods used. Section 3.5 presents univariate and multivariate results, which are discussed in Section 3.6. Section 3.7 concludes.

3.2 Why do VCs syndicate their investments?

The literature describes three principal reasons why VCs syndicate:

Financial perspective – portfolio diversification and state of liquidity. Through syndication, a VC is able to finance more start-ups, increasing the number of deals per invested dollar (Markowitz, 1952; Zider, 1998). The spread of capital over a larger number of start-up firms limits a VC's exposure to risk. Without syndication, it is difficult to reach optimal portfolio diversification. The deal value of a single investment target can account for a relatively large share of a VC's total capital under management. Through syndication, VCs reduce the sum invested per project, resulting in a more diversified investment portfolio. Another motive from a financial perspective is the non-liquid nature of a VC's investments (Lockett and Wright, 2001; Manigart et al., 2006). When VCs become engaged in a deal, the invested capital is non-liquid. The intended life cycle of a VC fund is usually 5 to 10 years (Armour and Cumming, 2006; Hochberg et al., 2007; Megginson, 2004). VCs can cash out by guiding a start-up toward an IPO, a new funding round (with new investors), or a sell-off. Before this level of maturity is reached, however, the invested funds are difficult

to reclaim. By spreading their money over several investments, VCs have more flexibility in terms of liquidity.

Networking perspective – status and future deal flow. In the VC community, it is expected that invitations by lead VCs will be reciprocated in the future (Lerner, 1994b; Manigart et al., 2006). Because of this reciprocity, prior syndicates are an important prerequisite for sufficient future deal flow. In addition to securing future deal flow, skilled VCs may acquire status and reputational advantages from previous syndicates (Dimov and Milanov, 2010). A positive reputation will allow a VC to more easily attract partners and will make a VC more likely to receive invitations to join syndicates. Especially during a phase of expansion, when "too much money is chasing too few deals" (Gompers and Lerner, 2000, p. 282), a VC's connections may be crucial when competing for new investment targets (Lockett and Wright, 2001). Finally, syndicates can lead to familiarity and trust between VCs, creating new opportunities for future investments. Sorenson and Stuart (2001) showed that this type of familiarity leads to investments in more spatially distant start-up firms.

Resource-based perspective – knowledge sharing. Syndicates can also provide a platform for VCs to share their specific knowledge and assets, which may be complementary. For instance, syndication partner A has technological knowledge, and syndication partner B has access to an important distribution network (Alexy et al., 2012; Brander et al., 2002; De Clerq and Dimov, 2008). Through the sharing of complementary assets and knowledge, syndicates can create value. When a VC considers investing in a new start-up, a syndicate partner can provide additional information and expertise in the due diligence process, improving the quality of the final investment decision. Low-performing companies will then be exposed earlier, reducing the risk of adverse selection (Lerner, 1994b). This argument holds especially true for early-stage or first-round investments, when the risk of adverse selection is high (Amit et al., 1998). After this pre-selection phase, syndicates can create value by sharing managerial experiences and industry-specific knowledge. This rationale is also referred to as the value-added motive behind syndicates (Brander et al., 2002).

Despite these financial, resource-based, and networking advantages, there are disadvantages to syndication. For example, syndication partners must be coordinated, creating additional transaction costs (Wright and Lockett, 2003). In addition, syndication can result in the free-riding behavior of some VCs. Agency problems among syndication partners

may arise (Fried and Hisrich, 1995). These agency problems increase when the syndication partners have different investment objectives and time horizons. VCs must be aware of the trade-off between the advantages and disadvantages of inviting co-investors.

3.3 Hypotheses regarding VC syndication in times of economic crisis

By means of syndication, VCs aim to handle and mitigate uncertainty regarding their current and future investments. It is unclear, however, how this motivation changes under differing economic contexts. We shall argue that the VCs' reasons for syndication as summarized in the previous section play a greater role in normal economic times relative to times of economic crisis. In a stable economic context, VCs can make predictions regarding the supply of funds and exit opportunities. In this context, syndication is used as a means to reduce uncertainty in the selection process of new investments (Brander et al., 2002; Bygrave, 1987; Lerner, 1994b), to increase the diversification of their portfolio (Bygrave, 1988; Lockett and Wright, 1999), and to establish relationships with other VCs, ensuring sufficient deal flow in the future (Lockett and Wright, 2001; Manigart et al., 2006; Sorenson and Stuart, 2001). In times of economic crisis, new uncertainties arise. These uncertainties are mainly related to a VC's fund-raising and exiting conditions. With drastic reductions in the amount of funds flowing into the VC market as well as fewer opportunities to exit successful start-ups, VCs have to re-evaluate their investment strategy, including their syndication strategy. The priority of VCs is no longer to improve the selection process of new investments and to secure future deal flow but to ensure the survival of the current start-ups in its portfolio. The investments made into the current start-ups in the VC portfolio will bear fruit only when the VC is able to reap possible exit opportunities at later stages. The work of Mason (2009) and the PWC Money Tree Report in 2009 as well as public news releases and conference presentations all suggest that VCs were indeed focusing on their lead or core investments during the more recent financial crisis (BioPharm International, 2009; European Venture Capital Association (EVCA), Growing Galileo Conference, 2009; FierceBiotech, 2010; The Economist, 2010).

To summarize, we argue that the portfolio expansion motives for syndication become less relevant during an economic crisis. When a VC's decision-making is focused on which portfolio companies to maintain and which to cut off from funding (Mason, 2009), a VC has little incentive to engage in new syndicates in order to expand its portfolio and thereby diversify its risk. Syndicating in order to secure future deal flow also becomes less relevant when the survival of a VC is more questionable. During crises, a shakeout occurs, leaving only room for skilled VCs to stay in business (Green, 2004). This way, the number of po-

tential syndication partners decreases, making it more difficult for VCs to find suitable syndication partners.

The above discussion leads us to formulate the following two related hypotheses:

Hypothesis 1: VCs are less likely to syndicate during times of economic crisis compared to non-crisis times.

Hypothesis 2: The size of VCs' syndicates is lower during times of economic crisis than in non-crisis times.

In addition to the general tendency towards fewer and smaller syndicates, we argue that the effect of an economic crisis on VCs' syndicates differs with respect to the funding round stage. We argue that the decreased tendency to syndicate is more likely to be observed for second- and later-round investments. The less favorable exit conditions and fund-raising possibilities due to the economic crisis particularly affect investments that are close to being exited (Giot and Schwienbacher, 2007; Gompers and Lerner, 2004; Jeng and Wells, 2000). With early-stage investments, the situation is different because the ultimate exit via IPO or trade sales is still far away and can likely occur after the economic crisis has passed. In contrast, joining later-stage syndicates in an economic crisis is a risky investment strategy.

This reasoning leads us to formulate Hypotheses 3 and 4:

Hypothesis 3: The negative effect of an economic crisis on the propensity to syndicate is larger for later-stage funding rounds relative to early-stage funding rounds.

Hypothesis 4: The negative effect of an economic crisis on the size of syndicates is larger for later-stage funding rounds relative to early-stage funding rounds.

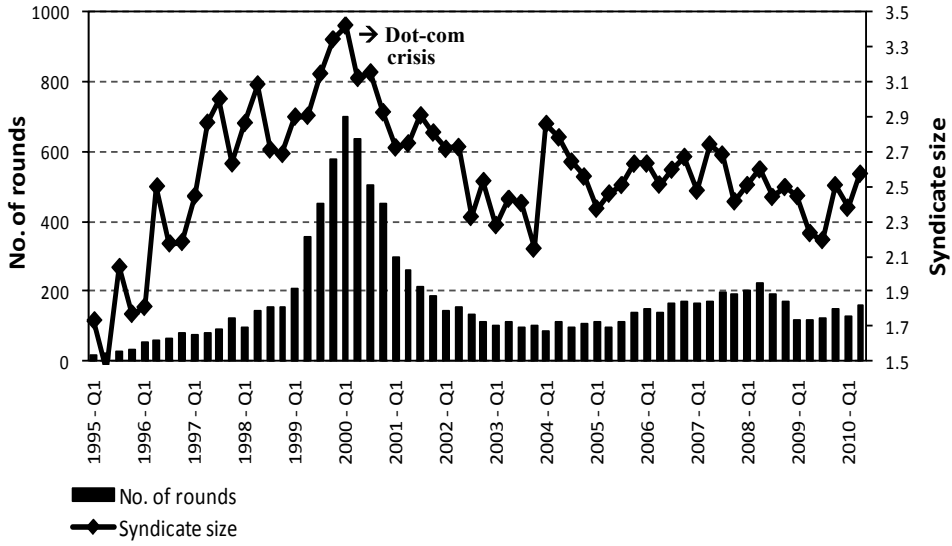
3.4 Data and methods

3.4.1 Construction of sample

Our data source was Thomson Reuter's VentureXpert database, which has been widely used in VC studies (Bygrave, 1987; Dimov and Gedajlovic, 2010; Hochberg et al., 2007; Sorenson and Stuart, 2001).

The funding round was used as our unit of analysis (i.e., the financing round in which start-ups raise money from a single or multiple investors). For both the financial crisis and the dot-com crisis, we compared the syndication activities *before* vs. *during* the respective crisis. We limited our sample to funding rounds in which at least one VC was an active investor (approximately 90% of funding rounds). As a regional restriction, we focused on funding rounds related to start-ups in the US.[11] The dot-com crisis sample comprised all internet-specific funding rounds that occurred between July 2000 and June 2001. As of July 2000, the VC market was visibly affected by the dot-com crisis, initiating a decline in internet-specific deal volume (see Figure 3.1).[12]

Figure 3.1: Development of VCs' Syndicate size - Internet specific deals (Jan 1995 - Jun 2010)



Data source: VentureXpert (accessed September 6, 2010).

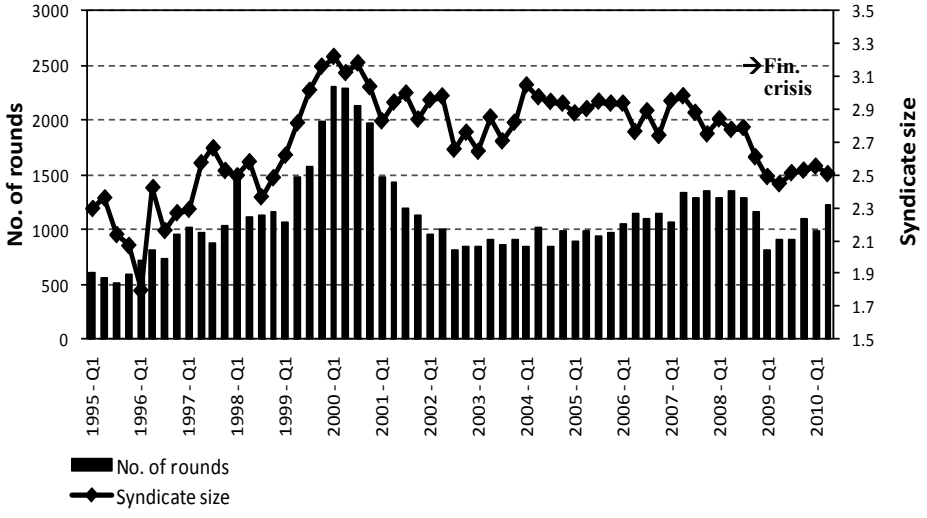
[11] This is done for two reasons. First, the impact of the current financial crisis on the VC market was found to be more severe in the US than elsewhere (Block et al., 2012). Second, this keeps legal influences constant. Conditions such as countries' bankruptcy laws and tax policies can severely impact VC activities (Armour and Cumming, 2006).

[12] See Block et al. (2012) for a discussion on the selection of an appropriate cutoff point.

We compared syndication activities during the dot-com crisis to syndication activities within the baseline period of January 1997 to December 1998. This comparison period was selected to represent the VC market in a relatively "normal," non-crisis state. As the deal volume was lower during these years, we adopted a period of 2 years in order to create a more balanced number of funding rounds *before* vs. *during* the dot-com crisis. During the late 1990s, the VC market showed a steady increase in deal volume (see Figure 3.1). Because the market became rather heated during 1999 and the beginning of 2000, we avoid this state as a comparison period for syndication activities. Additionally, we note that the deal volume after the burst of the dot-com bubble returned to a level closer to that of the years 1997 and 1998 (see also Green, 2004). To obtain our final sample, several steps of data cleaning were necessary. We excluded funding rounds for which the raised amount was not disclosed (225 rounds) and for which a founding date for the start-up firm could not be retrieved (464 rounds). The final sample consisted of 2,435 funding rounds for 1,637 start-ups.

The dot-com crisis resulted from an overly optimistic view about the internet and the dot-com firms involved (Ljungqvist and Wilhelm, 2003). In contrast, the financial crisis came more as an exogenous shock (Gern and Jannsen, 2009; Orlowski, 2008). The financial crisis sample was therefore not restricted to particular industries. The financial crisis sample covered funding rounds for a one-year period starting on September 16, 2008, the day after the investment bank Lehman Brothers went bankrupt (see Figure 3.2).

Figure 3.2: Development of VCs' Syndicate size - All industries (Jan 1995 - Jun 2010)



Data source: VentureXpert (accessed September 6, 2010).

We adopted the year 2004 as a baseline period to compare syndication activities during the financial crisis. The buildup of deal volume towards the financial crisis was initiated in the year 2005, after which a decrease can be observed in the beginning of 2009. The year 2004 is several years after the burst of the dot-com bubble, allowing time for the VC market to recover to a relatively more normal state. Again, we removed funding rounds for which the raised amount was not disclosed (1,160 rounds) and for which a founding date for the start-up firm could not be retrieved (423 rounds). The final sample consisted of 5,382 funding rounds for 4,183 start-ups.

Both samples compare funding rounds on a yearly basis *prior* to the outbreak of the economic crisis vs. funding rounds for one year *during* the respective crisis. We hereby balance out seasonal fluctuations that can play a role with respect to the deal volume in specific time periods in a single year.[13] Further, at a later stage in our analysis, we show that similar patterns in syndication activities were found when comparing the crisis periods to different baseline years, indicating that our results are robust for the time period selected.

3.4.2 Method: propensity score matching analysis

It can be argued that start-ups receiving funds *during* an economic crisis might differ from start-ups receiving funds *before* the occurrence of the respective crisis (e.g., they are older and have better developed business models). In this case, our results would suffer from a selection bias as the assignment of observations to our treatment group cannot be perceived as a random process.

We used propensity score matching analysis as a way to adjust for this selection bias (Rosenbaum and Rubin, 1983). Using propensity score matching, we were able to compare the *syndicate size* of funding rounds that were as similar as possible with respect to deal-specific, industry, and regional attributes, except for the fact that one funding round occurred during an economic crisis (treatment group) and the other did not (control group).

The first step of our propensity score matching analysis was to estimate the propensity score. The second step was to match the funding rounds in the control group (funding rounds before the crisis) to similar rounds in the treated group (funding rounds during the crisis). In the third step, we compared the matched funding rounds with respect to the size and the likelihood of being syndicated. In this manner, we were able to analyze the hypothesized effect of an economic crisis on VCs' syndicates, ruling out a potential selection bias.

[13] Block et al. (2012) found that the highest (lowest) deal volume is likely to occur in June and December (January and February).

For each respective crisis, propensity scores were estimated by a Probit regression including the crisis dummy as a dependent variable (0 = funding round date *before* crisis, 1 = funding round date *during* crisis). The explanatory variables were funding-round-specific characteristics as well as industry and regional classifications in the form of dummy variables (a detailed variable description is provided in the next section). By means of the estimated propensity scores, funding rounds *before* (control group) the respective crisis were matched with rounds *during* the crisis (treatment group). In the process of matching, it is crucial to match cases from both groups that have a comparable set of characteristics, i.e., they should fall in a propensity score region of "common support" (Dehejia and Wahba, 1999). We ensured this by excluding rounds during the crisis with propensity scores that are higher than the maximum or lower than the minimum of the rounds before the crisis. Secondly, to increase the reliability of our results, we excluded 5% of the treatment observations in our sample for which the density of the propensity scores in our control sample is the lowest. This is also referred to as trimming (Caliendo and Kopeinig, 2008; Leuven and Sianesi, 2003). As a matching algorithm, we used the nearest neighbor matching algorithm; thus, a funding round before the respective crisis was matched to the particular funding round during the crisis that is closest in terms of the propensity score (see also Becker and Ichino, 2002).[14]

To determine whether the effect of an economic crisis on VCs' syndicates can be attributed to the worsening IPO and fund-raising conditions, we estimated for each crisis two propensity score models: one including IPO and fund-raising variables and one excluding IPO and fund-raising variables.

3.4.3 Variables

We employed two (dependent) variables to measure the effect of an economic crisis on VCs' syndicates. The variable *syndicate size* refers to the number of participants in a specific funding round; the variable *syndication dummy* indicates whether syndication occurred. Table 3.1 provides a detailed overview of the variables used. The variables used in the calculation of the propensity scores are denoted by a star.

[14] A possible downside of the nearest neighbor matching is that it may give a poor match if the nearest neighbor is not found within a close range in the propensity score. Kernel matching on the other hand uses a weighted average of all cases in the control group, wherein weights relate to the inverse of the distance in propensity score. As we found similar patterns in our results for both matching algorithms, we used the results of nearest neighbor matching.

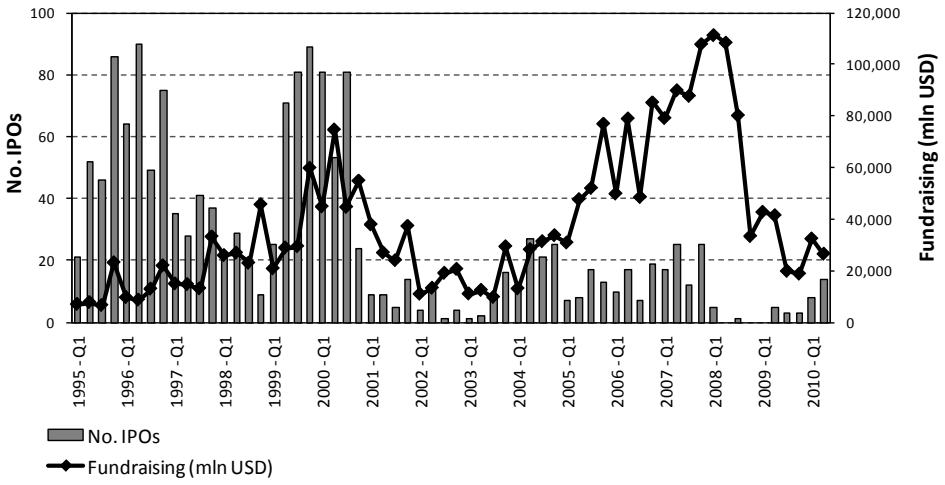
Table 3.1: Definition of variables

Variable name	Description
Syndicate size	The number of actors investing within a particular funding round.
Syndication dummy	Dummy variable, 1 if funding round consists of at least 2 investors.
Financial crisis	Dummy variable, 1 if funding occurred in the period from Sept. 16th 2008 to Sept. 2009.
Dot-com crisis	Dummy variable, 1 if funding occurred in the period from July 2000 to June 2001.
Raised amount in funding round	Amount of invested funds within a round (in million US $).
log (Raised amount) *	Natural log of the raised amount.
Round number *	Refers to the subsequent number of times that a start-up received VC funds.
Start-up age	Age of start-up in days at funding round date.
log (Start-up age) *	Natural log of start-up age.
New partners in round (in %) *	% share of new syndicate partners, investing in the start-up for the first time.
IPO market conditions *	The number of VC-backed IPOs within the respective month minus the monthly average of IPOs over the previous year within the USA.
VC fund raising conditions *	Compares raised funds of VCs within the respective month to the monthly average of funds raised over the previous year within the USA (% change compared to previous year).
Start-up stage: start-up/ seed stage *	Dummy variable, 1 if start-up is in 'start-up/ seed stage': Initial stage of the start-up. A management team is formed and the idea is developed and tested.
Start-up stage: early stage *	Dummy variable, 1 if start-up is in 'early stage': Development of idea to a product; product is either under testing or being produced and sold.
Start-up stage: expansion stage *	Dummy variable, 1 if start-up is in 'expansion stage': Start-up attempts to expand market share, and starts to examine possibilities of follow-up products and services.
Start-up stage: later stage *	Dummy variable, 1 if start-up is in 'later stage': Last stage of financing process, funding is used for larger scale expansion; the main goal is to exit the start-up and generate revenues.
Start-up stage: other *	Dummy variable, 1 if start-up is in 'other stages' such as 'acquired for expansion', 'acquisition', 'bridge loan', 'leveraged buyout', 'open market purchase', 'other acquisition', 'PIPE (Private Investment in Public Equity)', 'recap or turnaround', 'secondary purchase', and 'other'.
Industry dummies *	10 dummy variables indicating the industry category of the start-up: biotechnology, communications and media, computer hardware, computer software and services, consumer related, industrial/ energy, internet specific, medical / health, semiconductors / other elect., other products.
Region dummies *	17 dummy variables indicating the location of the start-up within the US: Colorado, DC/Metroplex, LA/Orange County, Midwest, NY Metro, New England, North Central, Northwest, Philadelphia Metro, Sacramento/ N. Cal, San Diego, Silicon Valley, South Central, Southwest, Southeast, Texas, Upstate NY.

Note: investment stage, industry and region classification were obtained from VentureXpert.
*=Variable is used to calculate the propensity scores

The propensity scores were estimated using Probit regression models to predict whether a funding round occurred before vs. during a crisis. As dependent variables in the Probit models, we used the variables *dot-com crisis* and *financial crisis* to indicate whether an investment occurred during a period of economic crisis (dot-com crisis: July 1, 2000 - June 30, 2001; financial crisis: September 16, 2008 - September 30, 2009). As explanatory variables, we used the raised amount of funds, the investment stage (round number), the age of the start-up, and the share of new syndicate partners within a funding round (indicating whether the funding round is related to a new syndicate or a continuation of a former collaboration). We also included variables relating to the venture cycle. Using dummy variables, five stages are controlled for, ranging from the "seed stage", during which the idea or product is developed and tested, to the final "later stage," in which the main goal is to achieve an exit vehicle for the start-up to go public. To differentiate between the effect of an economic crisis and the related effects regarding IPO and fund-raising conditions, we included the amount of funds raised by VCs as well as the number of IPOs in the US on a monthly basis (see Figure 3.3). As we wish to capture the (relatively) more stable conditions during our comparison periods versus the worsening IPO and fund-raising conditions during a period of crisis, we compared each monthly absolute value to its average value over the preceding year. Finally, effects regarding specific industries and regions are captured by 10 industry dummies and 17 US region dummies.

Figure 3.3: Development of VC fundraising and No. of IPOs (Quarterly, Jan 1995 - Jun 2010)



Data source: VentureXpert (accessed September 6, 2010).

3.5 Results

3.5.1 Univariate analysis

Tables 3.2 and 3.3 show descriptive statistics for both economic crises. We compared funding rounds before vs. during each crisis. During the dot-com crisis (Table 3.2), neither average syndicate size nor the share of syndicated rounds were significantly different as compared to the baseline period of 1997-1998. During the financial crisis (Table 3.3), the average syndicate size decreased from 3.0 to 2.5 with respect to the baseline year 2004, and the share of syndicated rounds decreased from 73% to 66%. In addition, during both crises, the VCs were more likely to invest in later funding rounds with fewer new syndicate partners involved. Further, during the financial crisis, the VCs invested more in older start-ups as compared to before the financial crisis. With respect to exit and fund-raising conditions, we observe that the conditions became worse during both crisis periods as compared to non-crisis periods.

Table 3.2: Descriptive statistics (2000-2001 dot-com crisis)

	Prior to dot-com crisis (Jan. 1997 to Dec. 1998)		**During dot-com crisis (July 2000 to June 2001)**			
Variable	**Mean (std. dev.)**	**Median**	**Mean (std. dev.)**	**Median**	**Diff. of mean test**	**Diff. of median test**
Syndicate size	2.8 (2.0)	3	2.9 (2.2)	2	-1.56	0.29
Syndication dummy	0.68 (0.47)	1	0.70 (0.46)	1	-0.84	
Raised amount (in million US $)	6.3 (7.6)	4	13.6 (25.4)	6.5	-8.40 **	-8.92 **
Round number	2.5 (1.5)	2	2.8 (1.7)	2	-4.58 **	-4.54 **
Start-up age (in days)	1,179.1 (1,874.2)	805	1,168.6 (1,503.0)	752	0.15	0.47
New partners in round (in %)	62.4 (39.8)	66.7	48.4 (41.2)	50	8.29 **	8.19 **
IPO market conditions	-4.2 (4.6)	-3.3	-8.8 (11.0)	-13.3	11.85 **	20.20 **
Fund raising conditions	-29.0 (112.4)	-6	-54.0 (68.5)	-38	6.82 **	12.02 **
Start-up stage (% of all funding rounds)						
Start-up/ seed stage	15.3		4.4		9.49 **	
Early stage	25.2		27.8		-1.35	
Expansion	43.9		52.0		-3.89 **	
Later stage	10.3		11.8		-1.14	
Other	5.2		4.0		1.45	
N funding rounds	921		1,514			

Notes: The differences in means (medians) are analyzed by two-sided t-tests (Wilcoxon rank-sum tests). Symbols * and ** denote significance levels of 5% and 1%, respectively. Data source: VentureXpert (accessed September 6, 2010).

Table 3.3: Descriptive statistics (2008-2009 financial crisis)

	Prior to financial crisis (Jan. 2004 to Dec. 2004)		During financial crisis (Sep. 16, 2008 to Sep. 2009)			
Variable	**Mean (std. dev.)**	**Median**	**Mean (std. dev.)**	**Median**	**Diff. of mean test**	**Diff. of median test**
Syndicate size	3.0 (2.1)	2	2.5 (1.7)	2	8.33 **	7.71 **
Syndication dummy	0.73 (0.44)	1	0.66 (0.47)	1	5.61 **	
Raised amount (in million US $)	10.2 (37.1)	5.3	8.8 (23.5)	4.0	1.63	6.60 **
Round number	3.4 (2.3)	3	4.0 (2.8)	3	-8.09 **	-7.07 **
Start-up age (in days)	2,053.2 (2,349.9)	1,599	2,290.7 (2,240.1)	1,749	-3.79 **	-6.00 **
New partners in round (in %)	45.2 (41.9)	33.3	35.1 (41.1)	16.7	8.87 **	9.27 **
IPO market conditions	2.4 (3.6)	1.3	-0.4 (1.5)	-0.2	37.15 **	26.38 **
Fund raising conditions	-13.0 (75.2)	1.0	-158.6 (157.6)	-95.0	43.50 **	38.46 **
Start-up stage (% of all funding rounds)						
Start-up/ seed stage	4.6		8.6		-5.91 **	
Early stage	24.3		24.3		0.06	
Expansion	36.4		25.5		8.68 **	
Later stage	26.2		29.7		-2.84 **	
Other	8.5		12.0		-4.24 **	
Industry categories						
Biotechnology (in %)	8.0		12.8		-5.85 **	
Communications and media (in %)	11.0		6.7		5.61 **	
Computer hardware (in %)	4.1		3.7		0.67	
Computer softw. and services (in %)	26.6		19.7		6.02 **	
Consumer-related (in %)	2.5		3.2		-1.61	
Industrial / energy (in %)	3.8		5.9		-3.72 **	
Internet-specific (in %)	14.6		21.5		-6.61 **	
Medical / health (in %)	14.3		14.8		-0.58	
Other products (in %)	4.3		4.9		-0.92	
Semiconductors / other electr. (in %)	10.9		6.8		5.33 **	
N funding rounds	2,738		2,644			

Notes: The differences in means (medians) are analyzed by two-sided t-tests (Wilcoxon rank-sum tests). Symbols * and ** denote significance levels of 5% and 1%, respectively. Data source: VentureXpert (accessed September 6, 2010).

When examining the raised amount of funding, the crises show different patterns. While we observed an increase in the average round amount during the dot-com crisis (Table 3.2), we observed a decrease during the financial crisis (Table 3.3). The difference in the patterns between the two crises can be explained by the fact that the VC market came down from a heated state in the dot-com crisis (Green, 2004), whereas it came down from a normal state in the financial crisis (see Figures 3.1-3.3). The decrease in the round amount

for the dot-com crisis period (July 2000-June 2001) was not enough to offset the increases observed in the dot-com bubble (January 1999-June 2000). In other words, the funding amount was still relatively high compared to the funding amounts in the baseline period (1997-1998).

With respect to the development stages of start-ups, we found that, in the dot-com crisis, the start-ups that received funding were more mature as compared to the start-ups that received funding in the benchmark period. Similarly, during the financial crisis, we observed an increase in the share of start-ups classified in later stages.

3.5.2 Multivariate analysis: propensity score matching analysis

Table 3.4 reports the mean values of *syndicate size* and *syndication dummy* before versus during the respective crisis. First, the original mean values are reported as descriptive statistics, followed by the mean comparisons of the matched funding rounds. Second, to determine whether the effect of the economic crisis on VCs' syndicates can be explained by worsening IPO and fund-raising conditions, we conducted propensity score matching analyses both including and excluding IPO and fund-raising variables. In a third step, we distinguish between the effects of the crisis on first vs. later funding rounds. Our hypothesis is that the effect of an economic crisis on syndication propensity and size is larger in later-stage versus early-stage funding rounds.

Regarding first funding rounds, we found no significant differences between matched cases before versus during each period of crisis. Regarding later funding rounds, when matching on round-specific, industry, and regional characteristics, we found that both the syndicate size and the likelihood to syndicate were lower during an economic crisis versus a non-crisis period. *Syndicate size* decreased from an average of 3.50 before the crisis to 3.16 during the dot-com crisis (-10%, $p < 0.05$) and from 3.00 before the crisis to 2.70 during the financial crisis (-10%, $p < 0.01$). The variable *syndication dummy* decreased from 0.81 to 0.71 during the dot-com crisis (-12%, $p < 0.01$). The reduction during the financial crisis (from 0.73 to 0.69) was not significant; however, with a t-value of 1.93, it was very close to a 5% significance level.

When including measures for IPO and fund-raising conditions in the propensity score matching analysis, the effect of an economic crisis was no longer significant, indicating that the effect of an economic crisis on VC syndication can be explained by worsening exit and fund-raising conditions.

Table 3.4: Propensity score matching – effect of the dot-com and financial crises on VCs' syndicates

	First rounds only				Later rounds only			
	Syndicate size		Syndication dummy		Syndicate size		Syndication dummy	
	N	Mean	N	Mean	N	Mean	N	Mean
Dot-com crisis								
Descriptive statistics								
Before crisis ('97-'98)	299	2.09	299	0.57	622	3.13	622	0.74
During crisis (Jul '00 – Jun '01)	348	2.18	348	0.67	1,166	3.16	1,166	0.71
t-statistic		*(-0.76)*		*(-2.48)* *		*(-0.27)*		*(-1.25)*
Matched cases - excl. IPO- and fund inflow conditions								
Before crisis ('97-'98)	283	2.36	283	0.66	591	3.50	591	0.81
During crisis (Jul '00 – Jun '01)	331	2.13	331	0.66	1,108	3.16	1,108	0.71
t-statistic		*(-1.34)*		*(0.00)*		*(-2.05)* *		*(-3.38)* **
Matched cases - incl. IPO- and fund inflow conditions								
Before crisis ('97-'98)	283	2.43	283	0.68	591	3.42	591	0.78
During crisis (Jul '00 – Jun '01)	331	2.11	331	0.66	1,108	3.14	1,108	0.71
t-statistic		*(-1.48)*		*(-0.23)*		*(-1.39)*		*(-1.85)*
Financial crisis								
Descriptive statistics								
Before crisis (2004)	696	2.09	696	0.62	2,042	3.27	2,042	0.77
During crisis (Sep '08 - Sep '09)	497	1.90	497	0.57	2,147	2.68	2,147	0.69
t-statistic		*(2.86)* **		*(1.78)*		*(-9.38)* **		*(-6.36)* **
Matched cases - excl. IPO- and fund inflow conditions								
Before crisis (2004)	655	1.71	655	0.56	1,939	3.00	1,939	0.73
During crisis (Sep '08 - Sep '09)	472	1.92	472	0.57	2,041	2.70	2,041	0.69
t-statistic		*(0.61)*		*(0.38)*		*(-3.07)***		*(-1.93)*
Matched cases - incl. IPO- and fund inflow conditions								
Before crisis (2004)	655	1.95	655	0.46	1,939	2.35	1,939	0.53
During crisis (Sep '08 - Sep '09)	472	1.92	472	0.57	2,041	2.68	2,041	0.69
t-statistic		*(-0.28)*		*(0.73)*		*(0.63)*		*(1.42)*

Notes: Propensity scores were estimated by both excluding as well as including IPO and VC fund inflow measures. The symbols * and ** indicate significance levels of 5% and 1%, respectively. Two-sided tests were employed. Data source: VentureXpert (accessed September 6, 2010).

3.5.3 Robustness checks

Our findings are based on a comparison of VCs' syndicates during an economic crisis to an earlier baseline period selected to represent the VC market in a "normal" state. For the financial crisis, this baseline year was 2004; for the dot-com crisis, we chose the years 1997

and 1998 (two years were used to create a more balanced sample with respect to the number of funding rounds). As a robustness check, we used different baseline years. Table 3.5 extends our previous analysis by reporting the results of propensity score matching for multiple baseline years, focusing on second and later funding rounds. For the dot-com crisis, the year 1999 is taken as an additional year. Because the VC market was heating up during 1999, the number of rounds was larger than in the years 1997 and 1998 combined. For the financial crisis, we used the years 2005, 2006, and 2007 as separate baseline periods. To summarize, Table 4 reports patterns similar to those of our main analysis; we observe a reduction in the variables *syndicate size* and *syndication dummy* during the crisis in comparison to the baseline period. When controlling for IPO and fund-raising conditions, the effects became insignificant.

Table 3.5: Propensity score matching – robustness checks

	Later rounds only	
	Syndicate size	**Syndication dummy**
Robustness checks	**Diff. in mean (t - Stat)**	**Diff. in mean (t - Stat)**
Dot-com crisis		
Comparison period: 1997-1998		
Excl. IPO- and fund inflow cond.	-10% (-2.05) *	-12% (-3.38) **
Incl. IPO- and fund inflow cond.	-8% (-1.39)	-9% (-1.85)
Comparison period: 1999		
Excl. IPO- and fund inflow cond.	-9% (-2.04) *	-4% (-1.25)
Incl. IPO- and fund inflow cond.	-2% (-0.04)	-22% (-0.90)
Financial crisis		
Comparison period: 2004		
Excl. IPO- and fund inflow cond.	-10% (-3.07) **	-5% (-1.93)
Incl. IPO- and fund inflow cond.	+14% (0.63)	+30% (1.42)
Comparison period: 2005		
Excl. IPO- and fund inflow cond.	-12% (-4.04) **	-5% (-1.96) *
Incl. IPO- and fund inflow cond.	-2% (-0.08)	-15% (-0.88)
Comparison period: 2006		
Excl. IPO- and fund inflow cond.	-5% (-1.74)	-1% (-0.67)
Incl. IPO- and fund inflow cond.	+10% (0.50)	+28% (1.53)
Comparison period: 2007		
Excl. IPO- and fund inflow cond.	-13% (-4.94) **	-5% (-2.41) *
Incl. IPO- and fund inflow cond.	+3% (0.08)	-21% (-0.94)

Notes: This table reports % differences in means of matched cases for *syndicate size* and *syndication dummy* variables for before versus during the dot-com and financial crises. Propensity scores were estimated by both excluding and including IPO and VC fund inflow measures. The symbols * and ** denote significance levels of 5% and 1%, respectively. Two-sided tests were employed. Data source: VentureXpert (accessed September 6, 2010).

3.6 Discussion

This study addressed the influence of economic context on VC syndication. In particular, we analyzed the effect of an economic crisis on the likelihood of syndicate creation and syndicate size. When exploring VC syndication, previous studies have considered contextual aspects such as legal and institutional conditions (Cumming et al., 2010), cross-border contexts (Meuleman and Wright, 2011), the competition for new investment opportunities (Lockett and Wright, 1999), and the liquidity state of the IPO market (Cumming et al., 2005). We considered the effect of the dot-com crisis and the recent financial crisis on the likelihood of syndication as well as the syndicate size. The main findings of this study can be summarized as follows: (1) VCs have a lower tendency to syndicate their investments during a period of economic crisis, (2) in addition to a decrease in the share of syndicated rounds, syndicate size (the number of participants within a funding round) also decreased during both the dot-com and the financial crisis, and (3) the effect of an economic crisis on VCs' tendency to syndicate and syndicate size was primarily found for later-stage rounds.

Previous literature has shown that the principle motives for VCs to engage in syndicates are characterized by portfolio diversification (Bygrave 1988; Lockett and Wright, 1999), the securing of future deal flow (Lockett and Wright, 2001; Manigart et al., 2006; Sorenson and Stuart, 2001), and knowledge sharing (Brander et al., 2002; Bygrave, 1987; Lerner, 1994b). Our study contributes to this literature by examining VCs' tendencies to syndicate under changing economic contexts over time. We found that the formation of syndicates, as driven by the motives stated above, receives a lower priority during economically turbulent times. Propensity score matching analysis supported Hypotheses 1 and 2, which state that both the likelihood to syndicate and the size of syndicates decreased during the dot-com and the financial crises. When controlling for less favorable fund-raising and IPO market conditions, differences in syndicate formations before versus during a crisis were no longer significant. We suggest that the worsened fund-raising and exit conditions during an economic crisis lead VCs to prioritize their engagement towards their core projects. As less money was available for non-lead or new syndicate projects, a reduction in syndication was observed during both the dot-com and the financial crises. The reduction in VCs' syndicates was only found for second and later funding rounds, supporting Hypotheses 3 and 4. This result is consistent with the notion that exit markets are more likely to influence later-round versus first-round investments (Giot and Schwienbacher, 2007; Gompers and Lerner, 2004; Jeng and Wells, 2000).

Our findings do not support the argument that a rapid increase in the supply of capital leads to a lower tendency to engage in syndication (Lerner, 2002b). It has been argued that a VC is tempted to increase the amount of invested funds per start-up, keeping the number

of portfolio firms on a manageable level. The potential advantages of syndication in this case would not be fully utilized. Our findings suggest the opposite: syndication is higher during economically prosperous times versus crisis times.

Previous research has shown that VCs engage in syndicates primarily to reduce and mitigate uncertainty (Brander et al., 2002; Bygrave, 1987; 1988; Lerner, 1994b; Lockett and Wright, 1999; 2001; Manigart et al., 2006; Sorenson and Stuart, 2001). Consistent with this argument, we should observe more syndication in times of economic crisis. A period of crisis may trigger a greater need for information and a sense of security. Grouping together with other VCs may address this need. Still, we found the opposite to be the case. Syndication seems to decrease during an economic crisis. We suggest that, during a crisis, a new type of uncertainty arises as fund-raising and exiting become more uncertain and threaten the very existence of the VC. VCs adjust to this situation not through more syndication but by "retreating" to their existing portfolio and concentrating on their existing investments.

3.7 Conclusions

This chapter contributes to the syndication literature by examining VCs' tendencies to syndicate under differing economic contexts over time. We compared VC syndication under more typical economical circumstances to VC syndication during the dot-com crisis and the financial crisis.

The observed decrease in syndication during an economic crisis can have consequences for both VCs and start-up firms. First, lead VCs will find it increasingly difficult to acquire sufficient external funds for their start-ups. Second, they will become increasingly dependent on their own knowledge and expertise. Third, portfolio performance may be negatively affected because more connected VCs are likely to have better performing start-ups (Hochberg et al., 2007). For start-ups, fewer syndicate partners are likely to provide fewer financial means. Further, start-ups may experience a lower availability of industry-specific knowledge (Saetre, 2003), managerial experience (Kanniainen and Keuschnigg, 2004; Schefczyk and Gerpott, 2001), and access to distribution networks (Timmons and Bygrave, 1986). A start-ups business plan may need to be reassessed; cutting costs or postponing expansion plans may be necessary countermeasures to survive a period of economic crisis.

Further research could be directed toward the question of whether VCs syndicate relatively more with familiar partners in familiar start-ups during periods of economic crisis. In the alliance literature, the concept of relational embeddedness (Uzzi, 1997) indicates that partners who have collaborated more frequently in the past are more likely to engage in

joint problem-solving. In addition, during times of increased uncertainty, collaboration with familiar partners is preferred over the formation of new relationships (Gulati, 1995; Gulati and Gargiulo, 1999). Network analysis may confirm that VC syndicates are more explorative during periods of economic prosperity, and focus more on existing relationships during periods of economic crisis. Second, the identity of a VC's syndicate partners may change during economically prosperous vs. turbulent times. Co-investors, such as banks, insurance companies, industrial firms and pension funds, are likely to be more passive and less engaged in comparison to the leading VC (see also Sorenson and Stuart, 2008). They may therefore have a greater incentive to reduce their exposure to the VC market during more turbulent times. Lastly, where our analysis has been on the funding round level, we were not able differentiate in the effect of a crisis for lead- versus non-lead syndicate partners. Lead VCs hold the highest stakes in a startup and therefore have a greater incentive to assure the survival of a startup during a crisis.

PART II
Venture capital and intellectual property

4

Trademarks and venture capital valuation

Based on Block et al. (2013).

Abstract

This chapter investigates the role of trademarks in the start-up valuations of venture capitalists (VCs). The results from an analysis of trademark application data from 4,816 funding rounds of 2,341 start-ups show that the number and breadth of trademark applications have a positive yet decreasing effect on the financial valuations of start-ups by VCs. The findings also indicate that in later funding rounds, the value of trademark applications decreases when the start-up progresses into more advanced development stages. Start-ups should consider these findings when seeking funding from VCs and should stress their market and growth orientations and their willingness to protect their marketing investments by highlighting their trademark activities.

4.1 Introduction

Venture capitalists (VCs) face challenges when observing the quality of start-ups as investment targets. These challenges result from the considerable information asymmetries that exist between VCs and start-ups (Kollmann and Kuckertz, 2010; Leland and Pyle, 1977). Start-ups are new to the marketplace and do not have an observable track record (Hannan and Freeman, 1984; Morse et al., 2007; Shepherd et al., 2000) that the VCs can use as a criterion to make their investment decisions (Macmillan et al., 1985; Muzyka et al., 1996). To overcome these information asymmetries, VCs evaluate, among other factors, the intellectual property (IP) assets of start-ups. However, previous research regarding the role of IP assets in VC financing has primarily focused on patents (Audretsch et al., 2012; Baum and Silverman, 2004; Cao and Hsu, 2011; Engel and Keilbach, 2007; Haeussler et al., 2012; Hsu and Ziedonis, 2008; Lerner, 1994a; Mann and Sager, 2007). Although patents are an important criterion to consider when investing in start-ups (especially technology start-ups), the literature suggests that other IP assets, such as trademarks, might also have a considerable effect on a firm's market value (Greenhalgh and Rogers 2006a; 2006b; Sandner and Block, 2011). Trademarks grant their holders the right to exclude others from the use of the protected word, sign, or symbol (Besen and Raskind, 1991; Landes and Posner, 1987). Thus, trademarks serve as a means of protecting a firm's brands and marketing assets (Barth et al., 1998; Mendonça et al., 2004; Sandner and Block, 2011; Wood, 2000). Although this exclusion right might not produce immediate value for a start-up, the filing of trademarks nevertheless constitutes important information for VCs because it demonstrates a start-up's degree of market and growth orientation and its willingness to protect its current and future marketing efforts from the impairment of others (Sandner and Block, 2011).

Studying the role of trademarks in VC financing decisions is therefore also a highly relevant marketing issue. Trademarks are marketing assets that reflect market access and should, therefore, be linked to future cash flows and should drive company value, thus impacting VCs' investment decisions. Documenting the link between marketing efforts and start-up valuation would be an important contribution to the existing research on the marketing-finance interface. There is already an established strand of research on the marketing-finance interface that provides empirical evidence for the link between investment decisions and a broad range of marketing assets and actions (for an overview, see, e.g., Srinivasan and Hanssens, 2009). Previous research has demonstrated that investing in building marketing assets, such as brand equity (e.g., Joshi and Hanssens, 2010; Mizik and Jacobson, 2007), customer satisfaction (e.g., Fornell et al., 2006; Luo and Bhattacharya, 2006), customer metrics (e.g., customer lifetime value) (e.g., Gupta et al., 2004), or product

quality (e.g., Li et al., 2009; Tellis and Johnson, 2007), has a positive effect on investor responses. However, most previous studies focus on established and publicly traded firms and link these metrics to changes in stock returns (Srinivasan and Hanssens, 2009). However, research in the field of entrepreneurial marketing suggests that marketing investments are also highly relevant for the success of young entrepreneurial ventures (Gruber, 2004; Hills, 1984; Kraus et al., 2011). Research on VC financing decisions supports this claim by indicating that VCs consider a start-up's market orientation to be an important investment criterion (Douglas and Shepherd, 2002; Hills, 1984; Hisrich, 1989; Wortman et al., 1989). Nevertheless, few empirical studies have examined the actual impact of entrepreneurial marketing actions on VC financing decisions (Gruber, 2004; Kraus et al., 2011). Empirical evidence on the strength of this effect and its boundary conditions is relevant from both a theoretical and a practical perspective and would help start-ups optimize their use of resources toward maximizing their VC valuation.

This chapter seeks to analyze the role of trademarks in VCs' valuations of start-ups. More specifically, we investigate whether the number and breadth of a start-up's trademark applications influence the VC's financial valuation of the start-up. We also investigate the effect of trademark applications in later funding rounds when the start-up progresses into more advanced development stages.

Using a large US firm-level transaction dataset from 1998 to 2007, we demonstrate a positive, but decreasing, effect of the number of a start-up's trademarks on VCs' financial valuation of the start-up. Our regressions also indicate that, in later funding rounds, the positive effect of new trademark applications decreases when the start-up progresses into a more advanced development stage. Furthermore, we find tentative evidence that the breadth of a start-up's trademark portfolio has a positive, but decreasing, effect on the VCs' start-up valuations.

These findings contribute to entrepreneurship and venture capital research. Our study contributes to the growing literature on VCs' financial valuations of start-ups (Dittmann et al., 2004; Manigart et al., 2000; Miloud et al., 2012). VCs appear to regard trademarks as an (input-based) indicator of the start-up's future sales. A start-up's trademark filings can also be interpreted as a signal of the start-up's market orientation, growth ambition, and willingness to protect its marketing assets. In addition to their signaling value, trademarks also have a protection value, i.e., they protect a start-up's brands and marketing assets through the right to exclude others from the use of the protected word, sign, or symbol. This exclusion right remains even when the start-up fails. Our study also contributes to the literature on entrepreneurial finance (e.g., Baum and Silverman, 2004; Janney and Folta, 2003; Leland and Pyle, 1977; Prasad et al., 2000). A number of papers have investigated

the role of a start-up's patents (Audretsch et al., 2012; Baum and Silverman, 2004; Cao and Hsu, 2011; Engel and Keilbach, 2007; Haeussler et al., 2012; Hoenig and Henkel, 2012; Hsu and Ziedonis, 2008; Lerner, 1994a; Mann and Sager, 2007) and alliances (Baum and Silverman, 2004) in securing VC financing. Our results show that VCs also value marketing-oriented IP rights, such as trademarks. Finally, our study contributes to the entrepreneurial marketing literature (Boag, 1987; Carson, 1985; Gruber, 2004; Hills and LaForge, 1992; Hills et al., 2008; Kraus et al., 2011) both by quantifying the repeatedly proposed effect of the market and growth orientations of start-ups and their willingness to protect their marketing assets on VC valuation and by showing that trademarks are valid signals of this orientation.

The remainder of this chapter is organized as follows: Section 4.2 reviews the related literature. Section 4.3 develops hypotheses regarding the effect of trademarks on VC valuation. Section 4.4 presents our data. Section 4.5 provides the descriptive and multivariate results, which are then discussed in Section 4.6. Section 4.7 discusses the limitations of this study and suggests avenues for further research. Section 4.8 presents the conclusions of the chapter.

4.2 Related literature

4.2.1 VC investment process and the financial valuation of start-ups by VCs

The VC investment process can be divided into the deal, origination, screening, evaluation, and structuring phases (Kollmann and Kuckertz, 2010; Petty and Gruber, 2011). The evaluation criteria of VCs and their importance change throughout the investment process (Petty and Gruber, 2011) and include the personality and experience of the entrepreneur, product and business model characteristics, and market and financial characteristics (Franke et al., 2006; 2008; Ge et al., 2005; Macmillan et al., 1985; Zacharakis and Meyer, 2000). These evaluation criteria, however, are often characterized by high levels of uncertainty. Start-ups are new to the marketplace and do not have an observable track record (Hannan and Freeman, 1984) that VCs can use in the investment process. Information asymmetries exist that often hinder the establishment of a VC-start-up relationship (Kollmann and Kuckertz, 2010; Leland and Pyle, 1977). Kollmann and Kuckertz (2010) show that the evaluation uncertainties with respect to certain evaluation criteria vary throughout the investment process. For example, in the early phases of the investment process, criteria related to the start-up's management are uncertain, whereas in later phases of the invest-

ment process evaluation criteria such as market acceptance and profitability are associated with uncertainty. Our study focuses on the role of trademarks with respect to the financial valuation of start-ups. Thus, our research primarily concerns the evaluation phase, where the VCs must establish the start-up's financial value.

After the initial information asymmetries in the early phases of the investment process have been overcome and the VC has principally decided that the start-up meets the basic investment criteria with respect to management, business concept, and industry dynamics (Baum and Silverman, 2004; Franke et al., 2006; 2008; Ge et al., 2005; Hall and Hofer, 1993; Hsu, 2007; Macmillan et al., 1985; Muzyka et al., 1996), the VCs must establish the start-up's financial value. This later phase of the investment process is less concerned with the evaluation of the management team and the feasibility of the business concept and more concerned with the ability of the start-up to transform the business concept into sales and profits that matter for the VCs' financial valuation of the start-up (Kollmann and Kuckertz, 2010). VCs are interested in financial returns, which can be achieved in several ways, e.g., through the start-up engaging in product market competition, through licensing, or through collaboration with established firms by means of alliances or acquisitions (Baum and Silverman, 2004; Gans et al., 2002). Previous studies show that in the process of establishing a financial value for start-ups VCs use evaluation criteria such as the start-up's network and alliance capital, potential patent applications, and the venture concept (e.g., Baum and Silverman, 2004; Ge et al., 2005; Hall and Hofer, 1993; Hsu, 2007; Miloud et al., 2012). Nevertheless, because of the substantial uncertainties associated with start-ups, the process underlying VC valuations of start-ups remains more of an educated guess based on the information at hand (Berkery, 2008; May and Simmons, 2001). The results obtained by Kollmann and Kuckertz (2010) suggest that VCs face evaluation uncertainty in the later phases of the investment process, particularly regarding market acceptance and profitability.

Because of the substantial evaluation uncertainty, VCs often employ a combination of multiple valuation methods in the technology evaluation process (Dittmann et al., 2004; Manigart et al., 2000) that range from Discounted Cash Flow (DCF) techniques to internal rates of return (IRR), book values, multipliers, and discounted exit price techniques. Interestingly, Dittmann et al. (2004) find that, despite the difficulties of its use in concrete applications, the majority of VCs apply some form of DCF technique. However, there are substantial differences in the discount rates used by VCs. Only a minority of VCs employ an objective discount rate that is related to the start-up's cost of capital. Instead, most VCs apply a subjective discount rate that can range from 30% to 70%, which is also known as the venture capital method (Dittmann et al., 2004; Sahlman, 1990).

4.2.2 The role of IP in VC financing

Most prior work on the role of IP in VC funding has focused on patents. Start-ups filing patents are more likely to receive VC funds (Audretsch et al., 2012; Cao and Hsu, 2011; Engel and Keilbach, 2007; Haeussler et al., 2012) and be valued more highly by VCs (Baum and Silverman, 2004; Hsu and Ziedonis, 2008; Lerner, 1994a). Additionally, start-ups with patents demonstrate superior performance throughout the VC cycle compared with other start-ups, in terms of both their survival rate and the amount of funding they receive (Cao and Hsu, 2011; Mann and Sager, 2007). From these studies, it remains unclear whether VCs value patents as a signal of the start-up's quality (the signaling value of patents) or as a property right (i.e., the right to exclude others from making, using, offering for sale, or selling the patent's underlying invention) (the protection value of patents). If patents have a signaling value, VCs would attribute higher quality to a start-up with patents because the quality of the start-up and its technology are unobservable. In a recent study, Hoenig and Henkel (2012) use a conjoint-based survey of 102 European VCs to disentangle these two effects and found that patents primarily affect VC decision-making through their function as an exclusion right. In another study, Audretsch et al. (2012) find that VCs and business angels (BAs) only value patent applications as a quality signal if prototypes are also available. Audretsch et al. (2012) argue that the signaling value of patents is contingent on feasibility. Although the patent-VC interface has received considerable attention in the literature, little is known about the role of trademarks in VC funding. The paucity of research on trademarks in VC funding is surprising given the strong increase in trademark applications in recent years (OHIM, 2011; Sandner and Block, 2011; USPTO, 2012b).

A trademark is defined as "a distinctive sign, which identifies certain goods or services as those produced or provided by a specific person or enterprise" (World Intellectual Property Organization (WIPO), 2011). A trademark is typically a word, phrase, symbol, or logo, but it can also reflect a color, sound, or smell as long as a graphical representation is feasible (Mendonça et al., 2004). Trademarks allow consumers to distinguish a firm from its competitors. Additionally, trademarks provide a legal basis from which a firm can develop brand security for future marketing investments (Economides, 1988; Mendonça et al., 2004; Phillips, 2003). Similar to patents, trademarks provide exclusion rights that secure not only a competitive advantage but also the identity of the start-up in its relationship with its customers (Chasser and Wolfe, 2010; Mendonça et al., 2004). While patents relate to a start-up's technological base, trademarks reflect the start-up's preparedness, its plan to engage in marketing activities and its willingness to protect its marketing assets (Brahem et al., 2013; Krasnikov et al., 2009; Sandner and Block, 2011). The number and breadth of trademarks also relate to a start-up's growth or diversification ambitions (Sandner and

Block, 2011). These trademark-related aspects are highly relevant and complementary to patents when generating and securing returns from innovation (Fischer and Henkel, 2013; Harabi, 1995; Rujas, 1999; Teece, 1986). Few empirical studies have jointly addressed patents and trademarks (Bosworth and Rogers, 2001; Greenhalgh and Rogers, 2006a; 2006b; Sandner and Block, 2011). Prior research proposes that trademarks are an indicator of innovative activities; trademarks are suggested to capture the commercial and marketing side of an innovation (Malmberg, 2005; Mendonça et al., 2004). Rujas (1999) also argues that after a firm's patent protection has expired the firm can continue to appropriate returns from its previous invention through its trademarks. Over time, firms can establish a bond of familiarity and trust with their consumers, which can continue to exist at later stages. With respect to the value reflected in trademarks, prior research indicates that trademarks are positively related to the market values of large, publicly listed firms (Greenhalgh and Rogers 2006a; 2006b; Sandner and Block, 2011). Sandner and Block (2011) suggest that the heterogeneous value of trademarks can be further divided into trademark value indicators, such as trademark seniorities (references to earlier trademarks registered in other jurisdictions), the number of oppositions filed by competitors, and the breadth of a trademark.

4.3 Theory and hypotheses

4.3.1 Trademarks and VC valuation

The filing of trademarks by start-ups constitutes a strategic decision that is aimed at both building and protecting marketing assets. VCs can observe the trademark activity of start-ups and use this information for start-up funding and valuation. Similar to patents, the value of trademarks for start-ups with regard to VC financing can be divided into a signaling value and a protection value (Hoenig and Henkel, 2012; Hsu and Ziedonis, 2008).

The filing of trademarks can be interpreted as a signal that is sent from the start-up (the sender) to the VC (the receiver). This signal might be sent unintentionally (Janney and Folta, 2003) and could contain multiple messages (Bell et al., 2008; Park and Mezias, 2005), e.g., market orientation and growth orientation. According to signaling theory (Connelly et al., 2011; Spence, 1973; 2002), the better-informed party sends a quality signal to the less informed party and, in this way, can reduce the information asymmetry that exists between the two parties. Signals can be sent intentionally or without parties actually being aware of it (Janney and Folta, 2003; Spence, 2002). Signals help the receiver of a signal form an opinion about an unobservable or difficult to observe indicator that is correlated with the signal. Signaling depends on two characteristics: the signal should be observable,

and the cost of acquiring the signal has to be negatively related to the quality of the start-up for the signal to have information value (Connelly et al., 2011). We shall argue that start-ups with marketing expertise have more experience and thus have lower costs of filing trademarks. We further argue that the filing of trademarks provides the VC with valuable information regarding the start-ups' degrees of market orientation and growth ambition. By registering trademarks, start-ups demonstrate their awareness of the importance of protecting their marketing assets to the VC before they have even been developed. This awareness also implies that the start-ups have realized the importance of developing these assets and investing in marketing in the first place. Prior research has demonstrated that VCs value the market orientations of start-ups (Hisrich, 1989; Wortman et al., 1989).

The signaling value of trademarks must be distinguished from the protection value that trademarks grant their holders as an exclusion right, i.e., the right to protect the start-up's marketing assets (especially its brands) from competitors. That is, start-ups filing trademarks can prevent rival firms from using their signs, names, logos, etc. and thus protect their marketing investments. The exclusion right of trademarks remains valid even when the start-up fails. Thus, the VC can continue to benefit from the start-up's marketing investments in case the start-up does not survive.

We suggest that the marginal value of trademark applications is positive but decreases with the number of trademarks that a start-up files. As argued above, the filing of trademarks reduces the information asymmetry that exists between VCs and start-ups. Start-ups that file numerous trademarks instead of only a few plan to establish many products (and have higher growth ambitions than other start-ups (Mendonça et al., 2004)). VCs value the fact that a firm plans to establish several products or product lines (Miloud et al., 2012), and they consider having high growth ambitions a positive characteristic of start-ups (Macmillan et al., 1985). However, we argue that the value of trademarks decreases in the number of trademarks filed. Prior research on signaling suggests that the strength and value of a signal is not constant but instead depends on the environment (Connelly et al., 2011; Karamanos, 2003; Sliwka, 2007), the expectations of the receiver, the ability of the receiver to interpret the signal (Fischer and Reuber, 2007; Ryan et al., 2000), and the costs for the sender to send the signal (Certo et al., 2001; Cohen and Dean, 2005). Signals can also have a negative value (Perkins and Hendry, 2005), meaning that the receiver reduces its valuation of the sender when the signal is observed. More generally, signals are information goods that lose their novelty and information value once the signal has been sent from the sender to the receiver. Within the context of the relationship between VCs and start-ups, we argue that filing a few trademarks should have a relatively high information value and should help the VC distinguish between start-ups with low and high market orientations or

growth ambitions. However, beyond a certain level of trademark activity, VCs do not gain any additional information from observing another trademark being filed by the start-up. The positive, but decreasing, marginal value of additional trademark applications can also be derived from the protection value perspective of trademarks. We will argue that the additional marginal protection value of a trademark decreases as a larger number of trademarks are filed. The cost-benefit ratio (additional protection granted versus additional costs to file the trademark) deteriorates.

The above arguments – derived from both a signaling and a protection value perspective of trademarks – lead us to formulate the following hypothesis:

Hypothesis 1: The number of trademarks a start-up files has a positive, but decreasing, effect on the financial valuations of VCs.

4.3.2 Value of trademarks in later funding rounds

We argue that the signaling value of trademarks and its particular mechanism differs across the various VC funding stages. We suggest that in later funding rounds, the value of trademark applications as signals of market and growth orientation depends on the progression of the start-up in the venture cycle. Trademarks might lose their signaling value when an initial valuation decision (in an early funding round) has been made and the start-up has progressed into a more advanced development stage. Start-ups in more advanced development stages are able to replace trademarks as signals with more tangible, credible, and costly signals (Certo et al., 2001; Cohen and Dean, 2005; Connelly et al., 2011; Karamanos, 2003; Sliwka, 2007). Trademarks lose their value as predictors for start-up success when other hard indicators of marketing and growth orientation become available, such as planned marketing activities, the budget used for marketing activities, and initial sales data. Through their VC affiliation in the first funding round, the start-up is likely to have progressed toward more mature stages of marketing activities (Gruber, 2004; Hellman and Puri, 2002; Tyebjee et al., 1983). Prior research shows that VCs actively support the professionalization of start-ups (Bygrave and Timmons, 1992; Kaplan and Strömberg, 2001).

To summarize, the value of trademarks as a signal of growth and market orientation in later funding rounds should decrease if the start-up has moved into a more advanced development stage. Moreover, in later funding rounds, only new trademarks should matter, that is, trademarks that were filed after the start-up has received its first VC funding.
The following hypothesis is formulated:

Hypothesis 2: In later funding rounds, the positive effect of filing trademarks on the financial valuation of start-ups by VCs decreases when the start-up progresses into a more advanced development stage.

4.3.3 Trademark breadth, product diversification, and VC valuation

Trademarks can differ in their breadth, i.e., the number of distinct industries in which the trademark is filed and granted protection. The overall breadth of a start-up's trademark portfolio provides an indication of the diversification of a start-up's product portfolio (Mendonça et al., 2004; Sandner and Block, 2011). Prior entrepreneurship research suggests that there is a curvilinear relationship between start-up product diversification and performance (Fernhaber and Patel, 2012; Li et al., 2012; Qian, 2002).

Product diversification has a variety of benefits for start-ups. An increased level of product diversification can help start-ups develop a stronger competitive position and appropriate the returns from its investments in innovation (Teece, 1986; Thomä and Bizer, 2013). A broad, complex, and diversified product portfolio makes it difficult for competitors to imitate the start-up. Furthermore, increased product diversification can help a start-up benefit from its brand reputation over a range of product lines (Barney, 1997; Markides and Williamson, 1994). With respect to brand protection, a broader trademark portfolio will protect multiple facets of a brand, reducing the risk of counterfeiting by competitors. Another advantage of increased product diversification for start-ups is associated with increased sales from a broader range of products. In this way, the start-up is able to accumulate cash reserves and overcome the liability of newness (Hannan and Freeman, 1984). Finally, a higher level of product diversification reduces the risk of bankruptcy due the failure of a single product. VC-financed start-ups typically enter dynamic, competitive, and growing markets where customer demands and technologies may change rapidly. A higher level of product diversification enables the start-up to better withstand technological and market uncertainties. Through increased product diversification, start-ups generate additional possibilities to generate revenues and gain additional strategic options to cooperate with established firms through licensing, alliances, or acquisition (Baum and Silverman, 2004; Gans et al., 2002). VCs are interested in financial returns and value the increased cooperation possibilities with established firms. The likelihood of a trade sale to an established firm increases (Giot and Schwienbacher, 2007).

Despite the numerous benefits of product diversification for the start-up, excessive levels of product diversification could also have detrimental effects. Due to the increased product complexity, the investments in innovation and product development may increase substantially (Hobday, 1998) and may exceed the start-up's financial resources. Another

disadvantage of increased product diversification concerns increased coordination costs. Start-ups often have little experience in operations and lack formalized routines and procedures (Hannan and Freeman, 1984; Morse et al., 2007; Shepherd et al., 2000) to address the increased coordination challenges arising from higher levels of product diversification. Start-ups may also suffer from role ambiguity (Jamal, 1997; Wincent and Örtqvist, 2009), which can further increase the coordination costs associated with high levels of product diversification (Fisher et al., 1999). Sine et al., (2006), for example, argue that young firms often rely on decision making by consensus, as they lack clear lines of responsibility. High levels of product diversification can slow the decision making process and increase its costs. Finally, higher levels of product diversification may exceed the new venture team's management skills and capabilities (Rothaermel et al., 2006). The management of the start-up can end up in a situation of information overload, leading to suboptimal decisions (O'Reilly, 1980).

To summarize, we suggest that VCs value moderate levels of product diversification. A broader product portfolio and a broader business strategy serve as an insurance policy: in case of a setback in one market segment, there are still alternative routes available (Berkery, 2008). However, overly broad levels of product diversification and business strategy are likely to weaken a start-up because of the start-up's limited resources and the increasing coordination and information costs of rising product diversification mentioned above. We will argue that there comes a point at which the marginal costs of increased product diversification outweigh its marginal benefits. Using trademark breadth as a proxy for product diversification, we can formulate the following hypothesis:

Hypothesis 3: There is a positive, but decreasing, effect of trademark breadth on the financial valuation of start-ups by VCs.

4.4 Data and variables

4.4.1 Data

Our dataset consists of US-based start-ups and is created from several data sources. The information on VC-funded start-ups is obtained from the VentureXpert database (see also Dimov and Milanov, 2010; Hochberg et al., 2007; Sorenson and Stuart, 2008). Trademark and patent portfolios are compiled through a manual matching process using the start-ups' names and former aliases. Imperfect matches are verified using the start-ups' locations and industry records. Trademark data are gathered through the United States Patent and Trade-

mark Office (USPTO). US patent data were retrieved from the worldwide patent database PATSTAT.[15]

Sample and VC data. Our observation unit is the funding round in which the start-up received VC funding. A total of 50,596 funding rounds of US-based start-ups over the 1998-2007 period are extracted from VentureXpert. Funding rounds that occur after the year 2007 are dropped from the data because complete patent portfolios can only be compiled until 2007. This cutoff is necessary because the time between the filing of patent applications and granting of international patent protection is long (Greenhalgh and Rogers, 2010). After the patents are filed, the filings are kept secret for 18 months. Thus, patent applications filed in 2007 became "visible" in 2009.

In the next step, we drop funding rounds with missing values for the start-ups' founding date[16], the amount of funds invested, or the start-ups' valuations. Those observations in which two funding rounds occurred within a period of 30 days or less are also dropped. Following these steps, our sample comprises 13,269 funding rounds. Finally, we select the start-ups that received their initial funding round in the seed or early investment stage, ensuring that all start-ups in our sample have the same starting point. This leaves us with a sample of 5,467 funding rounds that involve 2,671 start-ups. For these 2,671 start-ups, we then compile both trademark and patent portfolios.

Trademark and patent data. Because of the regional scope of our study, we consider only US trademark and patent applications. The trademark data available through the USPTO cover the US; analogously, we also restrict the patents to this region. The patent data are taken from the PATSTAT database.[17] PATSTAT was created by EPO on behalf of the OECD Taskforce on Patent Statistics and provides comprehensive information on patent applications in 80 countries (including the US, Japan and European countries).

The scope of trademark and patenting activities can be identified for 2,348 (or 87.9%) of the 2,671 start-ups taken from VentureXpert. Observations are excluded for cases in which a start-up's name or one of its former aliases did not generate a correct, unique search result. However, those start-ups that do not file trademarks or patents are retained in

[15] The VentureXpert database was accessed on October 28, 2011. The EPO Worldwide Patent Statistical Database (PATSTAT) is available under license from the OECD-EPO Task Force on Patent Statistics. The April 2011 version was employed.

[16] We exclude those cases in which the start-up's founding date was missing or in which the startup's founding date was reported to be later than the investment date (9.6% of rounds).

[17] See http://www.epo.org/patents/patent-information/raw-data/test/product-14-24.html (accessed December, 2012).

the dataset. Because of missing information regarding the trademark Nice classes, seven start-ups are excluded from our sample. Our final estimation sample comprises 4,816 VC funding rounds from 2,341 start-ups.

4.4.2 Variables

Dependent variable. Our regression analysis is performed at the funding round level. As provided by VentureXpert, our dependent variable is *start-up valuation*. This variable discloses the post-money valuation of the start-up at its funding date (i.e., the equity value of the start-up that includes the amount of funds that are provided in that round). During the VC funding round, the start-up is valued to calculate the equity shares that are acquired by investors (Hsu, 2004). Start-up valuation data have been available in VentureXpert since April 2010, and the data date back to the early 1980s.

Independent variables. Table 4.1 provides an overview of the variables. Our key independent variables are the number of *trademark applications* and the variable *trademark breadth*. The latter variable indicates the number of goods and service classes (commonly referred to as Nice classes) in which a start-up filed its trademarks. Generally, trademarks can be filed in 34 goods and 11 service classes (WIPO, 2006), and application fees increase with the number of classes covered. The number of classes in which a trademark has been filed determines the breadth of its legal protection.

Both *trademark applications* and *trademark breadth* are assessed at the time the start-up receives funding. Thus, these values reflect the start-up's accumulated trademark activities. Trademarks filed after the funding date are not considered. A *trademark dummy* variable is used to compare the expected valuation of start-ups that filed at least one trademark with that of other start-ups that have no trademark activities.

The start-up's progress with respect to its product development, sales, and its maturity towards exit is captured by the *start-up development dummy*. VentureXpert categorizes the start-up's development stage at the time of funding using four main categories: The earliest development stage of a start-up is referred to as the 'seed stage', during which a start-up's concept or product is developed and tested. The second development stage is the 'early stage', where funds are used for product development and initial marketing, manufacturing, and sales activities. The third stage is the 'expansion stage'. At this point, a start-up's product is readily available, and funds are used to expand production and increase revenues. Finally, the fourth stage is referred to as the 'later stage', during which the primary goal is

to achieve an exit vehicle for the start-up to go public.[18] The variable *start-up development dummy* distinguishes rounds where the start-up is at the 'seed' or 'early' stage (=0) from rounds where the start-up is at the 'expansion' or 'later' development stage (=1). Including information on the start-up's sales is relevant because sales may be related to both trademark applications and the VC's valuation of the start-up. In addition, when testing Hypothesis 2, these four stage categories allow us to monitor the progression of a start-up into more advanced development stages.

We include the following control variables in our regressions. The number of *patent applications* is included because previous empirical studies have indicated that a start-up's patent applications affect VC valuation (e.g., Haeussler et al., 2012; Hsu and Ziedonis, 2008). The variable *funding stage dummy* distinguishes the initial funding round (=0) from the second and later funding rounds (=1). Start-ups that reach later funding stages are likely to be more successful and have grown in size and are, therefore, often valued more highly (Gompers, 1995). *Syndicate size* captures the differences in valuation that are related to the number of investors investing in a specific funding round (Wright and Lockett, 2003). To control for market conditions, the *Morgan Stanley Capital International (MSCI) index* is used (see also Cumming, 2007, Cumming et al., 2010). This index reflects the USA Index of equity return for the year in which the funding round occurred. *Investment year* dummy variables indicate the year in which the funding round occurred. Changing conditions in the VC market over time, such as the amount of capital inflow into VC funds, can affect VC-backed start-up valuations (Block and Sandner, 2009; De Vries and Block, 2011; Gompers and Lerner, 2000).

The different investor types are captured using six dummy variables. We distinguish among the presence of *VC firms*, *business angels*, *industrial firms*, *financial firms*, *governmental actors*, and *other actors*. Prior work suggests that these actor types differ in their investment behavior and can value start-up characteristics in a different manner (Sorenson and Stuart, 2008; Van Osnabrugge and Robinson, 2000). Because these different actors might jointly invest in one funding round, these categories are not mutually exclusive. *VC age* and *VC experience* control for the skills and experience of the investors. Older, more experienced VCs might have developed strong management skills and extensive networks that them to contribute to the success of the start-ups in their portfolios (Hochberg et al., 2007). *VC age* is calculated in years based on the difference between a VC's first investment date and the current funding round date. *VC experience* counts the number of previ-

[18] Definitions of the start-up development stages are taken from ThomsonReuters' VentureXpert glossary page: http://vx.thomsonib.com/VxComponent/vxhelp/VEglossary.htm (accessed May, 2013).

ous deals that a VC conducted until the funding round date. In the case of a syndicate, the average age and experience of the investing VCs are calculated. We are unable to compute VC experience for 12.8% of the investments because the respective VC actor was anonymous. We replace these cases with the average VC experience in our sample. In our regression analysis, we use the logarithm of age and experience.

We also include *start-up age*, which is measured in years at the time of funding. Prior empirical research (e.g., Block and Sandner, 2009) shows that older start-ups are valued more highly than younger start-ups. This variable also captures some start-up heterogeneity with respect to maturity. Finally, the variation in start-up valuation across different industries and regions (Florida and Kenney, 1988b) is captured using ten industry dummies and 17 US region dummies (see Table 4.1).

4.5 Results

4.5.1 Descriptive results

Descriptive statistics for the different variables in our regressions are provided in Table 4.2. The variable *trademark dummy* shows that start-ups applied for a trademark in 58.9% of the cases in our dataset. Interestingly, this percentage is lower for patent applications. In only 47.2% of cases is at least one patent application filed. The finding that trademarks are more commonly applied for is also confirmed in the study of Helmers and Rogers (2010), who examine the IP activities of start-ups based in the UK. A likely explanation behind this finding is that, whereas patents are mainly appropriate for technically oriented start-ups, trademarks are also relevant for the service sector and low-tech industries. Service-related start-ups are typically less R&D intensive and, therefore, result in fewer patents (Greenhalgh and Rogers, 2006a). Another reason is that alternatives to patenting exist (e.g., secrecy, Harabi, 1995; Teece, 1986), and patents are more costly to obtain than trademarks (see USPTO, 2012a). When comparing the numbers of trademark and patent applications, the variance in applications per start-up is larger for patents. The mean values are 3.1 trademarks and 4.4 patents; the maximum values are 361 trademarks and 1,436 patents. Overall, the descriptive statistics show that trademark filing strategies are more homogeneous among start-ups, whereas patent filing strategies appear to be more diverse. For established firms in the UK, Greenhalgh and Rogers (2006a) analyze both trademark and patenting activities and report similar patterns in their data. Furthermore, the allocation of trademark and patent applications across industries appears to be intuitive. Patents are most

Table 4.1: Definition of variables

Variable	Description
Dependent variable	
Start-up valuation	Post-investment valuation of start-up at date of funding round (in million USD), i.e., the equity value of the start-up, plus the amount of funds invested.
Independent variables	
Intellectual property characteristics	
Trademark applications	Number of US trademark applications filed by start-up until investment date.
Trademark breadth	Number of unique Nice classes covered by the trademark portfolio (i.e., by trademark applications filed by start-up until investment date).
Patent applications	Number of US patent applications filed by start-up until investment date.
Investment characteristics	
Funding stage dummy	Refers to the subsequent number of times that a start-up received VC funds. Coded in first rounds (=0), and second and later rounds (=1).
Syndicate size	The number of actors investing within a particular funding round.
Investment year dummies (10 cat.)	10 dummy variables referring to the year in which the funding round occurred, ranging from 1998 to 2007.
MSCI index	Morgan Stanley Capital International (MSCI) USA Index of equity return in investment year. Variable reflects index in units of one-thousand.
VC characteristics	
VC age	Age of VC in years at funding round date. When multiple VCs are investing in a round jointly in a syndicate, the average age is taken.
VC experience	Number of deals conducted by VC until investment date. When multiple VCs are investing in a round jointly in a syndicate, the average experience is taken.
Investor type dummies (6 cat.)	6 dummy variables indicating which actors are investing within a funding round, ranging from: 'VC firm', 'business angel', 'industrial firm', 'financial firm', 'governmental actor', or 'other' actor is investing in funding round.
Start-up characteristics	
Start-up age	Age of start-up in years at date of funding round.
Start-up development dummies (4 cat.)	4 dummy variables referring to the development stage of the start-up. Stages are categorized as 'seed stage', 'early stage', 'expansion stage', or 'later stage'.
Start-up development dummy	Reflects the development stage of the start-up. Coded in seed- and early stage (=0), versus expansion and later stage (=1).
Start-up industry dummies (10 cat.)	10 dummy variables indicating the industry category of the start-up: 'biotechnology', 'communications and media', 'computer hardware', 'computer software and services', 'consumer related products', 'industrial/ energy', 'internet specific services', 'medical/ health care', 'other products', 'semiconductors/other elect'.
Start-up US region dummies (17 cat.)	17 dummy variables indicating the location of the start-up within the US: 'Colorado', 'Washington Area', 'Los Angeles/Orange County', 'Midwest', 'New York Area', 'New England', 'North Central', 'Northwest', 'Philadelphia Area', 'Sacramento/North California', 'San Diego', 'Silicon Valley', 'South Central', 'Southwest', 'Southeast', 'Texas', 'Upstate New York'.

Table 4.2: Descriptive statistics

Variables	Mean	S.D.	Median	Min.	Max.	Skewness
Start-up valuation	48.6	92.9	20.1	0.1	1,400	6.0
Trademark applications	3.1	8.0	1	0	361	22.4
Trademark dummy (in %)	58.9		1	0	1	
Trademark breadth	1.0	1.1	1	0	13	2.1
Patent applications	4.4	22.8	0	0	1,436	51.6
Funding stage dummy (in %)	51.4		1	0	1	
Syndicate size	3.3	2.4	3	1	23	
MSCI index	3.7	0.5	3.8	2.9	4.7	
Start-up age (in years)	2.7	3.4	1.8	0	76.7	6.8
Start-up development dummy (in %)	39.2		0	0	1	
VC age (in years)	11.9	7.2	11.2	0	47.3	0.9
VC experience	283.7	318.8	192.4	1	2,917	3.0
Investor types [a] (in %)						
VC firm	94.0		1	0	1	
Business angel	14.7		0	0	1	
Industrial company	21.4		0	0	1	
Financial company	16.1		0	0	1	
Governmental actor	5.7		0	0	1	
Other actor	9.1		0	0	1	
Start-up industry (in %)						
Biotechnology	10.5		0	0	1	
Communications and media	11.5		0	0	1	
Computer hardware	2.8		0	0	1	
Computer software and serv.	21.7		0	0	1	
Consumer related products	1.2		0	0	1	
Industrial / energy	1.4		0	0	1	
Internet specific services	26.6		0	0	1	
Medical / health care	13.2		0	0	1	
Other products	2.4		0	0	1	
Semiconductors / other elect.	8.7		0	0	1	

Notes: N = 4,816 observations of 2,341 start-ups. Sample includes funding rounds during the period 1998-2007.
[a] Indicates the actor(s) that invested (jointly) within the funding round. In case of a syndicate including different actor types, multiple categories take on value 1, i.e., the categories are not mutually exclusive.

Table 4.3: Correlations

Variables		1	2	3	4	5	6	7	8	9	10	VIFs [a]	VIFs [b]
1.	Start-up valuation												
2.	Trademark applications	0.200*										2.9	5.1
3.	Trademark breadth	0.225*	0.561*										4.5
4.	Patent applications	0.080*	0.078*	0.073*								1.1	1.1
5.	Funding stage dummy	0.305*	0.190*	0.314*	0.097*							2.7	2.8
6.	Syndicate size	0.356*	0.113*	0.172*	0.093*	0.368*						2.2	2.2
7.	MSCI index	0.126*	0.002	0.009	-0.019	-0.055*	0.016					3.1	3.1
8.	Start-up age	0.059*	0.161*	0.202*	0.079*	0.220*	0.076*	-0.021				1.5	1.5
9.	Start-up development	0.361*	0.219*	0.332*	0.116*	0.781*	0.417*	-0.026	0.243*			2.9	2.9
10.	VC age	0.058*	0.022	0.021	0.038*	0.099*	0.003	-0.008	-0.017	0.107*		3.9	3.9
11.	VC experience	0.085*	0.014	0.004	0.028	0.064*	-0.031	-0.026	-0.049*	0.080*	0.700*	4.1	4.1

Notes: N = 4,816 observations of 2,341 start-ups. Sample includes funding rounds during the period 1998-2007. For start-up age, VC age, and VC experience, the VIF relate to their logged values in the regression.

* Significance level $p \leq 0.01$

[a] VIFs relate to Model 4, Table 4.4.

[b] VIFs relate to Model 3, Table 4.6.

common among start-ups that operate in the biotech industry, followed by start-ups from the semiconductor industry. In line with previous research, we find trademarks to be most common among start-ups that are engaged in industries that have a higher level of competition, such as consumer products, which are followed by start-ups from computer and Internet-related industries (De Vries et al., 2013; Malmberg, 2005; Mendonça et al., 2004).

The mean start-up valuation in our sample is USD 48.6 million (median: 20.1). Relatively low valuations (minimum: USD 100,000) are observed in the initial financing rounds, whereas higher valuations are associated with start-ups in later funding rounds (the highest valuation is USD 1,400 million).

Concerning investor types, we find that the VC firms are the most active investors (present in 94.0% of the funding rounds), followed by industrial firms, including corporate venture capital (21.4%) and financial firms (16.1%). Internet-specific and computer software industries received the most funding, jointly accounting for 48.3% of the funding rounds.

The correlations and variance inflation factors (VIFs) are presented in Table 4.3. The highest reported VIF is found for *trademark applications* in Model 3 of Table 4.6 (VIF= 5.1), which is still acceptable (Hair et al., 2006; Rust et al., 2004).

4.5.2 Multivariate results

We use simple OLS regression techniques that are based on the natural log of the *start-up valuation* as the dependent variable to compress the highly skewed distribution of the start-ups' valuations. Table 4.4 estimates the effect of the number of trademark applications on the start-ups' valuations. Model 1 is the baseline model; it only includes the control variables. The reported effects in our baseline model are intuitive: the expected start-up valuation increases with the funding stage, start-up age, syndicate size, and the quality of market conditions. More experienced VCs are associated with higher start-up valuations, suggesting that experience leads to a greater ability to select and obtain more promising start-ups. The groups of industry- and investor-type variables show significant effects ($p < 0.01$). The *start-up development dummy* shows that start-ups engaged in selling a readily available product are valued more highly compared with start-ups that remain focused on product development.[19] Finally, in Model 1 the effect of patent applications is not significant ($p = 0.11$). The existing literature addressing patents and VC valuations of start-ups suggests a

[19] Throughout all our models (Tables 4-8), results remain similar when including either one dummy for start-up development (*Start-up development dummy*) or using separate dummy variables for each of the four development stages.

Table 4.4: Trademark applications and VC start-up valuation (Hypothesis 1)

Model:	**Clustered OLS regression**				**Fixed-effects regression**
Dependent variable:	**Log (start-up valuation)**				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Independent variables					
Trademark variables					
Trademark dummy		0.247**			
		(0.030)			
Trademark applications			0.016**	0.034**	0.031**
			(0.006)	(0.004)	(0.005)
Trademark applications squared				-0.0001**	-0.0002**
				(0.000)	(0.000)
Patent applications	0.003	0.002	0.002†	0.002†	0.015**
	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)
Investment related variables					
Funding stage dummy	0.340**	0.297**	0.337**	0.327**	0.374**
	(0.037)	(0.038)	(0.037)	(0.037)	(0.034)
Syndicate size	0.132**	0.130**	0.131**	0.130**	0.092**
	(0.009)	(0.009)	(0.008)	(0.008)	(0.010)
MSCI index	0.584**	0.583**	0.579**	0.578**	0.738**
	(0.040)	(0.040)	(0.039)	(0.039)	(0.074)
Investment year dummies	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
VC related variables					
log (VC age)	0.008	-0.002	0.005	0.007	-0.047
	(0.049)	(0.049)	(0.048)	(0.047)	(0.070)
log (VC experience)	0.133**	0.137**	0.131**	0.130**	0.053
	(0.024)	(0.024)	(0.024)	(0.024)	(0.033)
Investor type dummies (6 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
Start-up related variables					
log (Start-up age)	0.194**	0.160**	0.164**	0.138**	0.525**
	(0.028)	(0.027)	(0.029)	(0.027)	(0.092)
Start-up development dummy	0.570**	0.539**	0.539**	0.509**	0.281**
	(0.045)	(0.045)	(0.046)	(0.044)	(0.036)
Start-up US region dummies (17 cat.)	$p = 0.17$	$p = 0.06$	$p = 0.06$	$p < 0.05$	
Start-up industry dummies (10 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$	
N funding rounds	4,816	4,816	4,816	4,816	4,816
N start-ups	2,341	2,341	2,341	2,341	2,341
F value	107.51**	107.93**	110.42**	109.32**	154.41**
R-squared	0.528	0.537	0.540	0.548	
R-squared within, between, overall					0.674; 0.182; 0.392
Increases in model fit (LR-test)[a]		91.08**	121.29**	84.84**	

Notes: Standard errors are clustered on start-up firms (in parentheses). Reference group for investment year: 2000; reference US region: 'Silicon Valley'; reference industry: 'computer software and services'. Sample includes funding rounds during the period 1998-2007.

† Significance level $p < 0.1$.; * Significance level $0.05 > p \geq 0.01$.; ** Significance level $p \leq 0.01$.

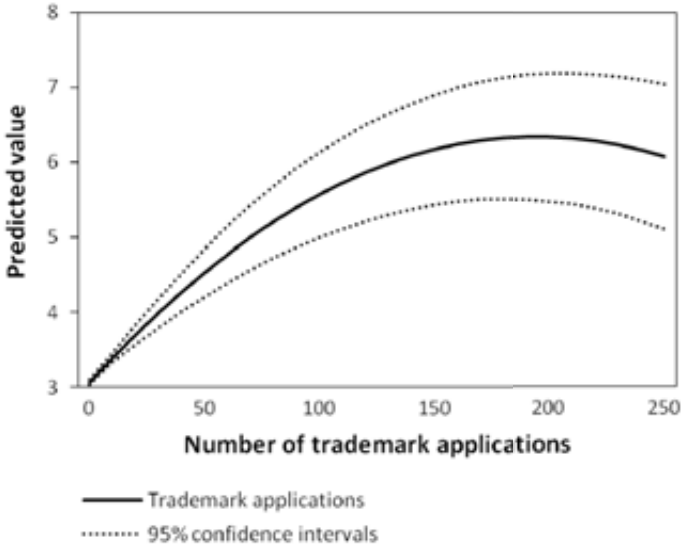
[a] Likelihood ratio tests relate to the preceding nested model.

significant positive relationship (e.g., Baum and Silverman, 2004; Haeussler et al., 2012; Hsu and Ziedonis, 2008; Lerner, 1994a). The effect of patents becomes significant at the 10% level when adding trademarks to our model (models 3 and 4) and at the 1% level when including start-up fixed effects (Model 5).

In Model 2, we introduce the *trademark dummy* variable. An increased valuation of 24.7% is estimated for start-ups that applied for at least one trademark ($p < 0.01$). Model 3 uses the number of *trademark applications*, which indicates that each subsequent trademark application was associated with a 1.6% increase in start-up valuation ($p < 0.01$). The term *trademark applications squared* is included in Model 4. This term suggests that the positive effect of a trademark on start-up valuation decreases with the number of trademarks filed ($p < 0.01$). Hypothesis 1 is thus supported. Finally, Model 5 shows that this result is robust to including start-up fixed effects. Interestingly, the effect of patent applications increases substantially in size and becomes highly significant.

Figure 4.1 illustrates the diminishing marginal effect of trademark applications on the predicted value (based on Model 4, Table 4.4). A start-up's first 10 trademark applications lead to an increase in the predicted value of 0.32, which resembles approximately one quarter of a standard deviation of the dependent variable (mean of *log (start-up valuation)* = 3.17; standard deviation = 1.14).

Figure 4.1: Trademarks and average predicted value



Note: Figure based on Table 4.4, Model 4.

Table 4.5 focuses on the effect of trademarks in later funding rounds and analyzes the effect of trademarks as the start-up progresses into more advanced development stages (Hypothesis 2). In Table 4.5, the dependent variable is the difference in start-up valuation relative to the previous funding round. Similarly, the independent variables represent differences, e.g., the new trademarks filed by the start-up (Δ *Trademark applications*), and whether the start-up progressed to a more advanced development stage (= 1) relative to the previous round (e.g., from the 'seed stage' to the 'early stage') versus remaining in the same development stage (= 0). The variable takes the value 0 if the start-up remained in the same development stage (*Advancement in development dummy*). Hypothesis 2 is tested via the interaction term of these two variables, indicating whether the effect of new trademark applications differs significantly when a start-up progresses to a more advanced development stage. The *Advancement in development dummy* considers all four development stages defined by VentureXpert. Finally, Table 4.5 includes an additional control variable, which indicates the amount of time elapsed since the previous funding round (*log (N days since previous round*)).

Model 1 reports the result of a simple OLS regression on the natural logarithm of the difference in start-up valuation. The negative and significant interaction termΔ *Trademark app. X Adv. in dev. dummy* shows that the positive effect of newly filed trademark applications decreases when the start-up progresses to a more advanced development stage. This result supports Hypothesis 2. Model 2 obtains a similar result when conducting a quantile regression on the absolute difference in start-up valuation. Note that there is a difference in sample size between models 1 and 2. The reason for this is that we are unable to take the natural logarithm of negative differences in start-up valuation in Model 1.

A plot of the interaction term in Model 1 is presented in Figure 4.2. Figure 4.2 depicts the slope differences in the effect of new trademark applications on the difference in start-up valuation; the solid line shows the effect of trademark applications on start-up valuation when the start-up is in the same development stage, while the dotted line shows the effect when the start-up progressed to a more advanced development stage. We see that the effect of newly added trademark applications on the difference in start-up valuation is lower when the start-up progressed to a more advanced development stage, providing support for Hypothesis 2.

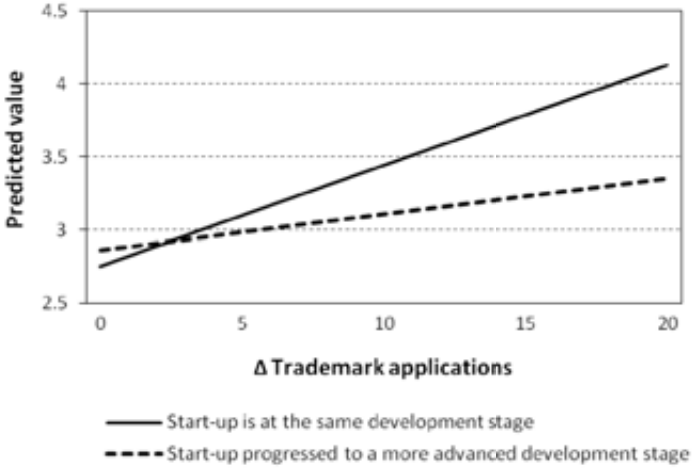
Table 4.5: Trademark valuation and start-up development in follow-on rounds (Hypothesis 2)

Model:	**Clustered OLS**	**Quantile regression**
Dependent variable:	**log (Δ Start-up valuation)**	**Δ Start-up valuation**
	Model 1	**Model 2**
Independent variables		
Δ Trademark applications	0.069**	1.370**
	(0.011)	(0.369)
Advancement in development dummy	0.104	1.650
	(0.073)	(1.913)
Interaction term		
Δ Trademark app. X Adv. in dev. dummy	-0.044**	-1.207**
	(0.013)	(0.416)
Δ Patent applications	0.023**	0.508**
	(0.005)	(0.143)
Investment related variables		
log (N days since previous round)	0.102*	-2.297
	(0.046)	(1.217)
Δ Round number	-0.021	-0.228
	(0.037)	(1.043)
Δ Syndicate size	0.043**	2.327**
	(0.012)	(0.290)
Δ MSCI index	-0.058	7.257**
	(0.068)	(1.972)
Investment year dummies	$p < 0.01$	$p < 0.01$
VC related variables		
log (VC age)	-0.145	-3.997
	(0.093)	(2.206)
log (VC experience)	0.242**	3.241**
	(0.047)	(1.142)
Investor type dummies (6 cat.)	$p < 0.01$	$p < 0.01$
Start-up related variables		
log (Start-up age)	-0.263**	-2.618
	(0.073)	(1.723)
Start-up development dummies (4 cat.)	$p < 0.01$	$p < 0.01$
Start-up US region dummies (17 cat.)	$p < 0.05$	$p = 0.88$
Start-up industry dummies (10 cat.)	$p = 0.12$	$p = 0.92$
N funding rounds	2,194	2,475
N start-ups	1,294	1,309
F value	36.53**	
R-squared	0.406	
Pseudo R-squared		0.116

Notes: Standard errors are clustered on start-up firms (in parentheses). Reference group for investment year: 2000; reference start-up stage: 'expansion stage'; reference US region: 'Silicon Valley'; reference industry: 'computer software and services'. Sample includes funding rounds during the period 1998-2007.

† Significance level $p < 0.1$.; * Significance level $0.05 > p \geq 0.01$.; ** Significance level $p \leq 0.01$.

Figure 4.2: Interaction plot: Trademark applications X Advancement in development dummy



Note: Figure based on Table 4.5, Model 1.

Table 4.6 indicates the effect of the trademark breadth on start-up valuation (Hypothesis 3). Model 1 reports our earlier result from Table 4.4. Model 2 introduces *trademark breadth*, which indicates that an additional Nice class being covered by the start-up's trademark portfolio increases the expected start-up valuation by 5.0% ($p < 0.05$). The significant effect of the squared term of the Nice classes covered in Model 3 supports the claim of a non-linear relationship proposed in Hypothesis 3. Model 4 shows that the effect of *trademark breadth* is robust to including start-up fixed effects. However, the squared term of trademark breadth is no longer significant when start-up fixed effects are included. Hypothesis 3 is thus only partially supported by our data.

Figure 4.3 illustrates the diminishing marginal effect of trademark breadth on the predicted value (based on Model 3, Table 4.6). The marginal effect of trademark breadth is positive up to a breadth of 3 Nice classes, which would increase the predicted value by .22. The size of this effect corresponds to approximately one-fifth of a standard deviation of the dependent variable. Overall, from the likelihood ratio tests shown in Tables 4.4 and 4.6, we find an increase in fit for each subsequent model with respect to the previous nested model. This finding underpins the importance of trademarks in investment processes.

Table 4.6: Trademark breadth and VC startup valuation (Hypothesis 3)

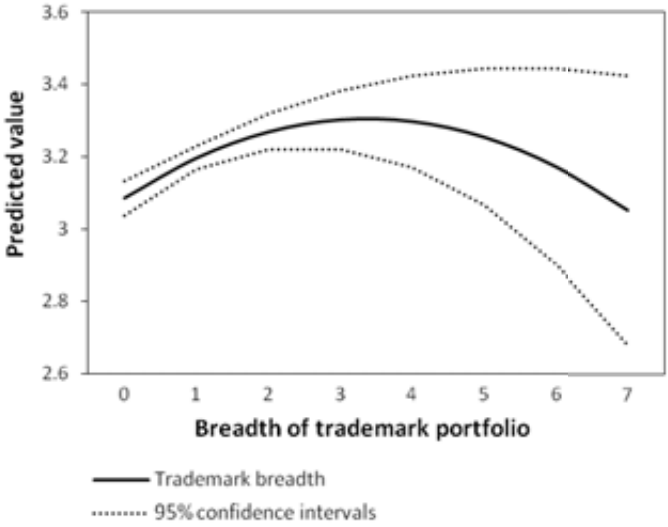
Model:	**Clustered OLS regression**			**Fixed effects regression**
Dependent variable:	**log (Start-up valuation)**			
	Model 1	**Model 2**	**Model 3**	**Model 4**
Independent variables				
Trademark variables				
Trademark applications	0.034**	0.027**	0.029**	0.016**
	(0.004)	(0.005)	(0.005)	(0.006)
Trademark applications squared	-0.0001**	-0.0001**	-0.0001**	-0.0001
	(0.000)	(0.000)	(0.000)	(0.000)
Trademark breadth		0.050*	0.130**	0.163**
		(0.020)	(0.025)	(0.044)
Trademark breadth squared			-0.019**	-0.012
			(0.005)	(0.011)
Patent applications	0.002†	0.002†	0.002†	0.014**
	(0.001)	(0.001)	(0.001)	(0.003)
Investment related variables				
Funding stage dummy	0.327**	0.317**	0.303**	0.361**
	(0.037)	(0.037)	(0.037)	(0.034)
Syndicate size	0.130**	0.130**	0.129**	0.090**
	(0.008)	(0.008)	(0.008)	(0.010)
MSCI index	0.578**	0.577**	0.577**	0.722**
	(0.039)	(0.039)	(0.039)	(0.074)
Investment year dummies	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
VC related variables				
log (VC age)	0.007	0.004	0.002	-0.053
	(0.047)	(0.048)	(0.047)	(0.070)
log (VC experience)	0.130**	0.131**	0.131**	0.053
	(0.024)	(0.024)	(0.024)	(0.033)
Investor type dummies (6 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
Start-up related variables				
log (Start-up age)	0.138**	0.134**	0.123**	0.458**
	(0.027)	(0.027)	(0.027)	(0.094)
Start-up development dummy	0.509**	0.505**	0.494**	0.269**
	(0.044)	(0.044)	(0.044)	(0.036)
Start-up US region dummies (17 cat.)	$p < 0.05$	$p < 0.05$	$p < 0.05$	
Start-up industry dummies (10 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$	
N funding rounds	4,816	4,816	4,816	4,816
N start-ups	2,341	2,341	2,341	2,341
F value	109.32**	107.30**	108.64**	151.03**
R-squared	0.548	0.549	0.552	
R-squared within, between, overall				0.678; 0.213; 0.415
Increases in model fit (LR-test)[a]	84.84**	12.60**	29.41**	60.32**

Notes: Standard errors are clustered on start-up firms (in parentheses). Reference group for investment year: 2000; reference US region: 'Silicon Valley'; reference industry: 'computer software and services'. Sample includes funding rounds during the period 1998-2007.

† Significance level $p < 0.1$.; * Significance level $0.05 > p \geq 0.01$.; ** Significance level $p \leq 0.01$.

[a] Likelihood ratio tests relate to the preceding nested model.

Figure 4.3: Trademark breadth and average predicted value



Notes: Figure based on Table 4.6, Model 3.

4.5.3 Additional analyses and robustness checks

As noted above, we include the trademark dummy variable in Model 2 of Table 4.4 to compare the valuation of start-ups that applied for trademarks with that of other start-ups that have no trademark activities. The coefficient indicates that start-ups filing for trademarks were estimated to have a 24.7% higher valuation ($p < 0.01$).

Several robustness checks are conducted (Table 4.7). Models 1 and 2 produce regression results using only the first funding rounds (N = 2,341). It might be argued that investors influence the start-up's trademark activities through their capital injections. Thus, an endogeneity problem may arise in later funding stages. Therefore, Model 1 reduces the sample and only includes the first funding rounds. The effect of the variable *trademark applications* is slightly smaller than the results obtained from our main analysis (e.g., 0.033 in Model 1, Table 4.7 versus 0.034 in Model 4, Table 4.4).

Table 4.7 also presents the results from quantile regressions on the median (Models 3 and 4), which use *start-up valuation* as a dependent variable to estimate the effect of trademarks on absolute start-up valuation. We use a quantile regression because, as outlined above, the distribution of *start-up valuation* is highly skewed. Compared with a regression on the mean, a quantile regression on the median is more robust to outliers (Koenker and Hallock, 2001). We find that an additional trademark increases median valuation.

Table 4.7: Robustness checks

	Sample: first funding rounds only		Quantile regressions	
Dependent variable:	**log (Start-up valuation)**		**Start-up valuation**	
	Model 1	**Model 2**	**Model 3**	**Model 4**
Independent variables				
Trademark variables				
Trademark applications	0.033**	0.028**	1.137**	1.237**
	(0.004)	(0.006)	(0.094)	(0.126)
Trademark applications squared	-0.0001**	-0.0001**	-0.002**	-0.003**
	(0.000)	(0.000)	(0.000)	(0.000)
Trademark breadth		0.127**		1.623*
		(0.029)		(0.823)
Trademark breadth squared		-0.019**		-0.530**
		(0.005)		(0.143)
Patent applications	0.001†	0.001†	0.313**	0.294**
	(0.001)	(0.001)	(0.020)	(0.020)
Investment related variables				
Funding stage dummy			4.494**	4.298**
			(1.451)	(1.479)
Syndicate size	0.160**	0.158**	5.535**	5.485**
	(0.014)	(0.014)	(0.272)	(0.276)
MSCI index	0.497**	0.500**	11.660**	11.690**
	(0.058)	(0.058)	(1.457)	(1.477)
Investment year dummies	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
VC related variables				
log (VC age)	0.074	0.068	-0.959	-0.849
	(0.042)	(0.041)	(1.306)	(1.325)
log (VC experience)	0.086**	0.089**	2.192**	2.178**
	(0.022)	(0.022)	(0.678)	(0.688)
Investor type dummies (6 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
Start-up related variables				
log (Start-up age)	0.201**	0.186**	0.983	0.858
	(0.026)	(0.026)	(0.852)	(0.869)
Start-up development dummy			14.550**	14.504**
			(1.532)	(1.556)
Start-up US region dummies (17 cat.)	$p = 0.12$	$p = 0.11$	$p = 0.86$	$p = 0.92$
Start-up industry dummies (10 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
N funding rounds	2,341	2,341	4,816	4,816
N start-ups	2,341	2,341	2,341	2,341
F value	22.79**	22.43**		
R-squared	0.318	0.324		
Pseudo R-squared			0.208	0.209

Notes: Reference group for investment year: 2000; Reference US region: 'Silicon Valley'; reference industry: 'computer software and services'. Sample includes funding rounds during the period 1998-2007.
† Significance level $p < 0.1$.; * Significance level $0.05 > p \geq 0.01$.; ** Significance level $p \leq 0.01$.

Furthermore, it can be argued that the effect of trademarks as a signal could vary depending on the level of risk a VC associates with a start-up's activities (Ruhnka and Young, 1991). Prior works suggest that technology-based start-ups are perceived to be more uncertain because their specialized activities give rise to larger information asymmetries between the VC and the start-up (Munari and Toschi, 2011; Murray and Lott, 1995). In VentureXpert, 247 of the rounds in our sample were directed to non-high-technology start-ups. For these startups, we find that the effect of trademarks on start-up valuation remains positive but is reduced in size. Interestingly, the fact that the activities of non-high-tech start-ups are easier for VCs to monitor and understand suggests that the signaling value embedded in trademarks is reduced under circumstances characterized by a lower degree of information asymmetry between the VC and the start-up. As a further analysis and robustness check, we employed a more detailed categorization in VentureXpert (the MONEYTREE classification), differentiating between 17 different industry types. The results regarding the relationship between trademarks and start-up valuations were identical to those obtained previously.

Finally, the results obtained under a different treatment of missing observations for VC experience are considered. In our main analysis, we replace the missing values for VC experience with the sample mean. Additional regressions were conducted, and these missing values are replaced first with the minimum values and then with the maximum values in our sample. The results of our hypothesized variables are consistent with the results of the main analysis. We also obtain similar results when using a dummy variable that indicates the rounds involving an anonymous investor or when we simply exclude the rounds with an anonymous investor from our analysis.

4.6 Discussion

4.6.1 Implications for research

Our findings contribute to research on the role of entrepreneurial marketing and IP assets in VC valuation (Baum and Silverman, 2004; Douglas and Shepherd, 2002; Gruber, 2004; Haeussler et al., 2012; Hellman and Puri, 2000; 2002; Hills, 1984; Hisrich, 1989; Hsu and Ziedonis, 2008; Miloud et al., 2012; Wortman et al., 1989) and research on the value of trademarks (Greenhalgh and Rogers, 2006a; 2006b; Sandner and Block, 2011) in at least four ways.

First, we contribute to the literature on the role of IP in VC financing by showing that the number and breadth of trademark applications in start-ups are positively related to VC

valuation. Previous studies on VC valuation provide evidence for criteria by which VCs evaluate start-ups, such as the quality of the start-up's business plan, its venture team, its patents, and its network and alliance capital (e.g., Baum and Silverman, 2004; Franke et al., 2006; 2008; Haeussler et al., 2012; Hall and Hofer, 1993; Hsu and Ziedonis, 2008; Macmillan et al., 1985). Our finding extends this literature by demonstrating the impact of trademark activity on VC valuation. This finding also supports and adds to the research on the value of trademarks. Sandner and Block (2011) and Greenhalgh and Rogers (2006a; 2006b) demonstrate that trademarks have a positive effect on the market valuations of large publicly listed technology firms. Our study shows that trademarks are not only associated with the market valuations of large firms but are also associated with the VCs' financial valuations of start-ups. Our findings on the effects of trademarks furthermore add to the research on entrepreneurial marketing and its effect on VC evaluations. The literature has repeatedly highlighted the relevance of the market orientations of start-ups for VC financing and valuation decisions. Both Hisrich (1989) and Wortman et al. (1989) note that VCs consistently rate marketing management as an important success factor. The failure rates of start-ups could be greatly reduced through improved analysis of the target market (see also Hills and LaForge, 1992; Hills et al., 2008). More recent research on this topic analyzes the marketing readiness of start-ups as one of the primary dimensions on which VCs base their investment decisions (Douglas and Shepherd, 2002). VCs are more willing to finance start-ups with high marketing readiness because they appear to be more credible and 'investor ready' (Wright et al., 2004). Whereas these arguments already hinted at the importance of market orientation for VC financing, to the best of our knowledge we are the first to show that a start-up's advancement in marketing activities as reflected by trademark activity is a relevant characteristic that is valued by VCs.

We also find that the effect of the number of trademark applications is greater than the effect of patent applications. An explanation for the stronger effect of trademarks might be that, for start-ups, trademark application data are more reliable indicators than patent applications. Patents primarily affect VC decisions via their function as an exclusion right (Hoenig and Henkel 2012). However, in the application stage, a patent does not yet have this exclusion right. It is unclear whether and when the patent application will eventually lead to a granted patent. Trademark applications have a higher success rate than patent applications (OHIM, 2011; USPTO, 2012b) and thus constitute reliable signals for market and growth orientation, especially for start-ups. Moreover, they represent exclusion rights that have ultimate and direct applicability and validity.

Further analyses reveal that the effect of the number of trademarks on VC valuation is especially pronounced for high-technology start-ups and is less strong for non-high-

technology start-ups. A potential explanation for this effect might therefore be that the signaling value of trademarks in high-technology start-ups is higher because of the much higher levels of uncertainty experienced by the VC compared with non-high-technology start-ups (Munari and Toschi, 2011; Murray and Lott, 1995; Wright et al., 2004). However, further research is required to understand the underlying reasons for the stronger effect of trademarks on VC valuation in high-technology versus non-high-technology industries.

Second, we show that the number of trademarks that a start-up files is non-linear in nature and has a positive but decreasing effect on VC start-up valuation. Initially, the marginal additional information of each additional trademark is very high and signals a start-up's higher growth ambition and market orientation. This finding is in line with prior research arguing that VCs value start-ups' growth ambitions (Macmillan et al., 1985; Mendonça et al., 2004; Miloud et al., 2012). This effect, however, does not increase infinitely but diminishes with the number of trademarks filed due to a decline in novelty and information value. The same declining effect applies to the protection value of trademarks. Initially, each trademark adds to the protection of the marketing assets of the firm by protecting different facets, such as product names, brand names, logos, and the like. This effect also decreases with each additional trademark filed and vanishes when all relevant aspects are protected. The decreasing effect of the number of trademarks extends research by Sandner and Block (2011), who did not consider such non-linear effects.

Third, our regressions provide evidence that, in later funding rounds, the effect of trademarks on start-up valuation decreases when the start-up progresses into a more advanced development stage. This finding can be explained primarily by a decline in signaling value due to the availability of other, more tangible, credible, and costly signals, such as planned marketing activities including budget information or initial sales data (Certo et al., 2001; Cohen and Dean, 2005; Connelly et al., 2011; Karamanos, 2003; Sliwka, 2007).

Fourth, we show that trademark breadth has a positive effect on VC start-up valuation. We furthermore found partial support for our prediction that this positive effect decreases with higher levels of trademark breadth. We interpret trademark breadth as an indicator of a start-up's level of product diversification. Little research exists that has analyzed the relationship between the level of a start-up's product diversification and its valuation by VCs. However, the positive, but decreasing, effect we find is in line with prior research. Based on prior research on start-ups' levels of product diversification and performance (e.g., Fernhaber and Patel, 2012; Li et al., 2012; Qian, 2002), we suggest and find that a moderate level of start-up product diversification leads to a higher valuation by VCs. Above a certain level, however, the additional costs of increased product diversification (e.g., coordination and information costs, complexity, and unsystematic appearance of a brand) out-

weigh its benefits, and the effect of product diversification on start-up valuation decreases. Accordingly we find a positive, but decreasing, effect of trademark breadth on VC valuation. Thus, our findings differ from the research of Sandner and Block (2011), who find that trademark breadth was not significantly related to an increase in market value in the context of large, publicly listed firms. This difference between our findings and those of Sandner and Block (2011) might be explained by the different functions trademarks serve at different stages of the firm. In start-ups, trademarks primarily have a signaling value; in more mature firms, this signaling value decreases (as more tangible success indicators become available) and the protection value accordingly gains importance.

4.6.2 Implications for start-ups

Our findings are especially instructive for start-ups seeking VC financing. The findings strongly highlight the relevance and financial impact of market-orientation and its communication in VC valuation. Start-ups that can demonstrate to VCs that they have clear business objectives will be valued more highly and will receive more funding compared with start-ups that lack this focus. One way of documenting this market-orientation is to begin defending owned marketing assets by filing trademarks, even before these assets have been developed. Start-ups should therefore not only engage in trademark filing but also communicate these activities prominently and clearly to VCs. This task is especially important for high-technology start-ups, among which the trademark effect is particularly pronounced. The findings also reveal the boundary conditions of the effect of trademarks. First, the positive effect of trademarks decreases in the number of trademarks. VCs perceive the decision to file an excessive number of trademarks and filing trademarks in an excessive number of Nice classes as unfocused. Start-ups should therefore attempt to determine their optimal numbers of trademarks and Nice classes. Finally, start-ups should be aware that the positive effect of trademarks decreases as other marketing-related information becomes available to the VC. Thus, to obtain the strongest return from filing trademarks, start-ups are well advised to begin their trademark activities prior to the first funding round.

4.7 Limitations and further research

This chapter contains a number of limitations that suggest avenues for further research. First, whereas we argue that the signaling and protection values of trademarks differ in their effects, our data do not allow us to clearly differentiating between these value dimensions. Future research should aim to disentangle the two value dimensions and analyze their development over the course of the firm's development. Second, trademark applica-

tions are merely a broad proxy for a start-up's marketing activities. It would be interesting to use more inclusive information concerning a start-up's marketing expenditures, its level of market orientation, and its customer base. Although our work addressed the role of IP in greater detail by using trademarks, future research should use different measures (e.g., advertising spending or marketing expenditures) when exploring the role of marketing in start-ups. Third, our final dataset, which held the IP portfolios of VC-funded start-ups, had to be constructed from several data sources. This process relied on the manual creation of company name patterns and the matching of trademark and patent applications. Although this method proved to be highly reliable and was individually checked with the records in the USPTO trademark register, we cannot completely rule out possible mismatches or the failure to include relevant IP applications in our dataset (we were able to identify patent or trademark data for 87.4% of the start-ups taken from VentureXpert). Fourth, this research exclusively focuses on publicly available data and does not include information on the characteristics of the start-up team, such as its quality and composition (Baum and Silverman, 2004; Beckman et al., 2007; Franke et al., 2006; 2008). It is, for example, plausible to suppose that if the firm's team is composed of members with a high level of experience in the marketing field, the presence of a trademark portfolio and perhaps its breadth are less important (Munari and Toschi, 2011). We also lack information on the background of the start-up (e.g., academic vs. non-academic spin-off) and the motivations of start-ups' trademarking and other marketing activities that go along with them. Further research should include such factors to improve our understanding of the dynamics and motivations that underlie such observable data. Another interesting aspect concerns the start-ups' motivations for filing trademarks. We expect there are a number of different motivations for start-ups to file trademarks, such as signaling, value appropriation, and marketing orientation. Survey-based research could be conducted to categorize these different motivations to file trademarks. Finally, we adopted a rather general approach using a sample covering a broad range of industries. Future research could address the role of trademarks for innovative start-ups across different industries and customer types. Improvements in marketing activities might be more relevant in consumer-intensive, service-related industries that have large numbers of buyers and sellers (Malmberg, 2005; Mendonça et al., 2004). With respect to customer types, the value reflected by the trademarks might differ between start-ups that serve consumers and those that serve other businesses (i.e., "business to consumer" vs. "business to business" relationships). Another related research direction could concern the type of Nice classes in which the trademarks are filed. Compared with the trademarks filed in service Nice classes (11 classes), those filed in Nice classes that are related to goods (34 classes) might have a different relationship with VC valuations. Fur-

thermore, beyond the VC valuation of start-ups, it would be interesting to examine the relationship between a start-up's IP and its progress throughout the VC cycle. Although Mann and Sager (2007) examine patents in relation to several measures, such as a start-up's longevity, its arrival in later development stages and its total amount of funds and rounds received, future scholars should jointly examine these measures for trademarks and patents. It has been suggested that trademarks and patents are complementary (Rujas, 1999).

4.8 Conclusions

Based on trademark and patent data on 4,816 funding rounds for 2,341 start-ups, we show that trademarks are strong predictors of the VC valuations of start-ups. We argue that trademarks not only have a protection value but are also signals of start-ups' market orientations. The number of trademarks and the breadth of their applications, as reflected by the Nice classes, provide additional information on the scope and direction of the start-ups' marketing strategies. These effects are positive, but decreasing, because of the marginal additional information they provide beyond a certain point. The findings also indicate that the signaling value of trademarks decreases over the venture cycle; when more tangible success factors become available, the VC gains deeper insight into the start-up and begins to exert influence on its strategies. We believe that the findings of this study will motivate further research on the role of IP rights in the VC financing of start-ups. Future research should, for example, disentangle the signaling and protection values of trademarks and their development over time. Future studies should also shed further light on the relative impacts of trademarks and patents at this early stage of the firm development. We believe it is especially promising to collect data on actual R&D and marketing activity or strategies to better understand the underlying mechanisms.

5

Trademark or patent? The effects of market structure, customer type, and VC on start-ups' IP decisions

Based on De Vries et al. (2013).

Abstract

This chapter analyzes the initial intellectual property (IP) right of 4,703 start-up entrants in the US, distinguishing between trademark and patent applications. The results show that start-ups are more likely to file for a trademark instead of a patent when entering into more competitive market structures. Further, we find that start-ups with a focus on distribution that serves end-consumers are more likely to file for a trademark and that start-ups that operate upstream and sell to other businesses are more likely to file for a patent. Lastly, the external influences on a start-up's management, such as the involvement of a venture capitalist (VC), affect IP applications. The increased incentive of VC-backed start-ups to become operational on the market makes them more likely to file initial IP in the form of a trademark rather than a patent. Among other factors, we control for R&D and advertising intensity in the industry and distinguish between more technical and more service-driven industries.

5.1 Introduction

During the previous decade, research on intellectual property rights expanded from being mainly patent-oriented to establishing a significant role for trademarks: similar to patents, trademarks were found to be positively related to firm valuations (Greenhalgh and Rogers 2006b; 2007; Sandner and Block, 2011) and firm survival (Helmers and Rogers, 2010; Wagner and Cockburn, 2010). For example, Apple's brand value, which is protected by trademarks, was estimated at a value of $182 billion in 2012[20], while the value of its patents was estimated at a value of $90-$100 per device by John Hauser of MIT in the court case between Apple and Samsung. This type of complementarity between patents and trademarks is examined and confirmed in Amara et al., (2008), Graham and Somaya (2004) and Kong and Seldon (2004). Further, in addition to patents, trademarks have been suggested to be indicators of innovative activities (Flikkema et al., 2010; Malmberg, 2005; Mendonça et al., 2004). Finally, in addition to patents, trademarks were found to function as an entry barrier for new start-up firms (Davies, 2009; Kong and Seldon, 2004; Ramello, 2006; Ramello and Silva, 2006).

It is of interest to analyze patents and trademarks because they each reflect specific strategic intentions: while patents relate to the protection of technological assets (Greenhalgh and Rogers, 2010), trademarks relate to the commercialization of an invention and the protection of a firm's brand and marketing assets (Sandner and Block, 2011). Thus far, the common explanation of intellectual property (IP) strategy is that firms that are active in R&D-intensive and more technical industries will file for patent protection (Griliches, 1984; 1998; Kortum, 1993), while firms that are active in advertising-intensive, consumer- and service-related industries are more likely to file for trademark protection (Malmberg, 2005; Mendonça et al., 2004). This explanation, however, only considers the type of activity in which a firm engages, and no other determinants have been either theoretically or empirically explored. We address this research gap by examining the initial IP direction (trademark or patent) of 4,703 start-up entrants in the US that filed for initial IP rights between 1998 and 2007.

According to the start-up strategy literature, specifically Porter's (1980) differentiation typology, trademark applications are mostly used by start-ups that operate according to a marketing differentiation strategy, while patents are the primary protection mechanism for start-ups that operate under a technical or product differentiation strategy (see also Carter et al., 1994; McGee et al., 1995). Although both patents and trademarks are important in the protection of a firm's intangible assets, we still have little knowledge about the determi-

[20] According to Millward Brown Optimor's 2012 BrandZ study.

nants of a firm's IP strategy. Sutton's (2007) work on endogenous sunk costs provides a theoretical base for advertising and R&D as strategies to increase consumers' willingness to pay for a product. Appropriating the benefits from these strategies requires filing for trademark and patent protection, respectively. In addition to these endogenous sunk costs, Sutton (2007) states that economies of scale impose an exogenous sunk cost on firms that intend to enter an industry. The way in which exogenous and endogenous sunk costs interact with each other determines firm concentration in an industry. As economies of scale in the production of a good or service can arise for various reasons, it is generally difficult to measure. Given that endogenous sunk costs (in the form of R&D and advertising costs) and exogenous sunk costs (in terms of entry barriers) jointly determine industry concentration, we include industry concentration in our analysis to control for endogenous sunk costs at the industry level (and beyond the control of an individual firm). In this way, we indirectly examine how exogenous sunk costs affect a start-up's choice of IP strategy.

Because trademarks are an important tool in establishing the communicative link to consumers (Economides, 1988; Sandner and Block, 2011), trademarks should be more relevant in markets with differentiated goods where exogenous sunk costs are low, supporting a start-up's visibility among the variety of available products. In contrast, patents may be a more critical tool especially in "winner-take-all," i.e. less competitive, markets, where dominant technologies are industry standards. In these markets, start-ups that enter a market with novel, patented technological knowledge pose a greater threat to the established incumbents (Abernathy and Clark, 1984; Christensen and Bower, 1996; Henderson, 1993; Hill and Rothaermel, 2003).

The firm perspective that we take in this study also allows us to consider firm-level explanations in addition to industry-level explanations. We argue that IP strategy is partly related to a start-up's customer type. Start-ups that operate upstream in the supply chain and sell to other businesses are more likely to operate under a technical or product differentiation strategy because they provide relevant inputs for the product development process (McGee et al., 1995). Such company assets are protected by patents. In comparison, downstream start-ups that serve end-consumers are more focused on marketing and distribution, and are thus more likely to operate under a marketing differentiation strategy (Carter et al., 1994; Tan, 2001). Brand and marketing assets are typically protected by trademarks.

Thirdly, we argue that the influences on a start-up's management, such as the involvement of a venture capital (VC) investor, may influence IP orientation. VCs hold significant decision power and spend most of their time advising and monitoring the start-ups in which they invest (Gompers and Lerner, 2004; Sahlman, 1990). When engaging with a start-up, VCs are likely to prioritize the commercialization of a start-up's invention by setting mile-

stones that are related primarily to market orientation and the generation of initial revenues (Berkery, 2008; Hellman and Puri, 2000; 2002; Hills, 1984; Hisrich, 1989). Such a focus on commercialization may push a start-up toward a more trademark-oriented IP strategy.

Analyzing a sample of 4,703 start-ups in the US, we show that as market competition intensifies, start-ups will be more likely to file initial IP in the form of a trademark and less likely in the form of a patent. Secondly, start-ups that serve end-consumers are more likely to file for trademark protection, as compared to start-ups that serve other businesses, which are more likely to file for patent protection. Thirdly, we find that the involvement of a VC investor leads to a higher likelihood of filing initial IP in the form of trademark as compared to a patent. In our analysis, we control for the R&D and advertising intensity within a start-up's market niche and sector fixed effects.

We provide significant contributions to several literature streams. Firstly, our findings contribute to the start-up strategy literature (Carter et al., 1994; McGee et al., 1995), as we are, to the best of our knowledge, the first study to examine the determinants behind start-up IP direction reflecting strategic intentions. These findings connect to previous works, as patents can be associated with more technical or product differentiation strategies and trademarks, which protect brand and marketing assets, can be associated with marketing differentiation strategies (see also Carter et al., 1994; Chaganti et al., 1989; Li, 2001; McGee et al., 1995; Miles and Snow, 1978; Miller, 1986; 1991; Porter, 1980; Schrader and Siegel, 2007). Secondly, as mentioned above, by providing empirical evidence on the influences of firm- and industry-level characteristics on trademark and patent filings, we contribute to the growing body of literature that addresses the relevance of trademarks in comparison with the role of patents in the protection of innovative assets (e.g., Amara et al., 2008; Davies, 2009; Ramello, 2006; Sandner and Block, 2011). Thirdly, we contribute to the IP-market structure literature. A main discussion point in this literature lies in the relationship between market structure and the incentive to innovate and file for IP protection. Schumpeter (1950) and Arrow (1962)'s hypotheses in this respect have been tested and discussed in many follow-up works (e.g., Arora, 1997; Acs and Audretsch, 1987; Greenhalgh and Rogers, 2006a; Levin et al., 1985; Loury, 1979; Malerba and Orsenigo, 2002; Scherer, 1984). However, little is known thus far about how market structure may affect the type of IP protection that is filed. Depending on the intensity of competition, start-ups may behave differently, filing the type of IP that is most suitable given exogenous sunk costs and the build toward a competitive advantage. Overall, this literature stream has solely addressed the role of patents. Fourthly, we contribute to the VC-IP literature. In the VC-IP literature, it is shown that start-ups that file for IP rights have a higher likelihood of receiving VC funds in the first place (Cao and Hsu, 2011; Engel and Keilbach, 2007;

Haeussler et al., 2012) and that IP rights have a positive relationship with subsequent start-up valuations by VCs (Baum and Silverman, 2004; Block et al., 2013; Hsu and Ziedonis, 2008; Lerner, 1994a). However, the influence of a VC investor on a start-up's type of IP application has thus far not been explored. VCs have powerful decision rights and spend most of their time as advisors to start-up companies (Gompers and Lerner, 2004). VCs are therefore likely to influence the strategy of a start-up, which is partly reflected in its IP decisions.

The remainder of this chapter proceeds as follows. Section 5.2 discusses the relevant background information on trademarks and patents. Section 5.3 develops our hypotheses with regard to the effects of market competition, customer type, and the involvement of VC investors on a start-up's IP preferences. Section 5.4 describes our data. Section 5.5 presents descriptive and multivariate results, which are discussed in Section 5.6. Section 5.7 discusses the limitations and avenues for future research. Section 5.8 presents the conclusions of our study.

5.2 Background information on trademarks and patents

Because many previous works have addressed the role of patents for start-ups, we will elaborate somewhat more on the topic of trademarks in this section. Relevant comparisons to patents are made.

A trademark is "a distinctive sign, which identifies certain goods or services as those produced or provided by a specific person or enterprise" (World Intellectual Property Organization (WIPO), 2011). Trademarks are most commonly filed in the form of a logo, symbol, name or phrase, but they can also be filed as a specific color, sound, smell or a combination of these factors. Most importantly, a trademark should be distinctive, i.e., it should not confuse consumers by being too identical or similar to an already granted trademark (Economides, 1988; Mendonça et al., 2004). The primary motivation behind filing a trademark is the ability to distinguish a firm's products or services from the competition. Through a trademarked brand name, consumers are able to identify the products that are offered by a specific firm. This form of identification allows a firm to build consumer loyalty, with the potential to charge a higher price (Flikkema et al., 2010). Trademarks function as the legal basis on which brand value can be built, securing benefits from future marketing investments (Sandner and Block, 2011).

Both patents and trademarks protect the elements that are relevant for an innovative start-up. A trademark is important for the commercialization and the diffusion of a start-up's innovation, and a patent protects a start-up's technological knowledge, reflecting the

start-up's willingness to protect its invention. Patents and trademarks can therefore be understood as complementary assets in the allocation of returns from an innovation (Teece, 1986). Along these lines, both patents and trademarks can be a signal of new product development (Mendonça et al., 2004). Further, with regard to their exclusion right, patents have been widely discussed as relevant protectors of competitive advantage, providing the immediate power to exclude competitors from the use of critical technological knowledge (e.g., Greenhalgh and Rogers, 2010). Similarly, trademarks can also serve as exclusion mechanisms, providing market power (Davies, 2009; Kong and Seldon, 2004; Ramello, 2006; Ramello and Silva, 2006). A relevant difference, however, is that the market power that is embedded in trademarks has to be built through frequent consumer interactions over time, whereas the filing of a patent immediately excludes competitors from producing and offering a product in the first place. Another relevant difference between patents and trademarks pertains to their duration: patents offer temporary protection, usually for a period of twenty years. Trademarks can be renewed indefinitely, as long as a renewal fee is paid every ten years and under the condition that its holder has been actively using the trademark. Furthermore, patents and trademarks differ with regard to the related investments that they protect. Investments that lead to an invention are conducted before a patent's filing date. In contrast, branding and marketing investments that are protected by a trademark are generally conducted after a trademark's filing date (Sandner and Block, 2011).

When explaining IP strategy, a start-up's type of activity should be an important explanatory factor. When a start-up's activities are more R&D-intensive, it will have a greater likelihood of filing for a patent (Griliches, 1984; 1998; Kortum, 1993), whereas a start-up that is more consumer-oriented and advertising-intensive is more likely to file for a trademark (Malmberg, 2005; Mendonça et al., 2004). The following section develops hypotheses that consider additional explanatory factors that may drive the type of IP applications that are filed.

5.3 Hypotheses development

5.3.1 Market competition and IP strategy

We argue that the intensity of competition within a market may affect an entering start-up's IP strategy. We distinguish between a trademark- and patent-oriented IP strategy.

We suggest that a start-up is more likely to adopt a trademark-oriented strategy when entering a more competitive market. Because it supports the connection between firms and

consumers, the filing of a trademark should become more relevant when consumers have several similar firms to choose from in their purchasing decisions. When there are more competing firms, a start-up's visibility in the market becomes more relevant due to the increased need to persuade consumers to purchase its product. A trademark is primarily a tool that is used to establish a link of communication between a firm and consumers (Economides, 1988; Flikkema et al., 2010). A second argument relates to the finding that more competitive markets are likely to have lower entry barriers in place (Caves and Porter, 1977; McAfee et al., 2004). Within a market that lacks powerful exclusion mechanisms, it is easy for new start-ups to become operational. It has been shown that competition can occur at the level of branding and competitive advantage can become embedded into trademarks, especially in markets that lack a strong entry barrier such as a patented technology (Davies, 2009; Onkvisit and Shaw, 1989; Ramello and Silva, 2006; Schmalensee, 1978). Trademarks introduce differentiation into a market, as consumers can perceive one brand as being superior to another (DeYong and Örs, 2004; Ramello, 2006). In competitive markets, start-ups tend to rely more heavily on trademarks as a basic branding instrument to create a competitive advantage (Abimbola, 2001). Because a start-up's resources are limited, it focuses first on the designing of logos, symbols, and a suitable brand name, which are protected by trademarks. At this stage, few funds are available for more advanced tools such as advertising. Overall, the above discussion suggests that start-ups entering more competitive markets are likely to have a trademark-oriented IP strategy.

In contrast, we suggest that a patent strategy becomes more crucial for start-ups when the level of market competition is lower. Under weak competition, entry barriers are likely to be in place, allocating market power to incumbent firms. Explanations for more concentrated markets include the presence of economies of scale, limited market size, or superior access to inputs (Besanko et al., 2010). When entering a more concentrated market, a patent will exclude incumbent firms from the use of a start-up's technological knowledge. A patent also suggests that a start-up's invention is novel, non-obvious, and useful (WIPO, 2004). This suggests that patents can play a critical role for start-ups that attempt to capture some initial market share. Prior studies indicate that start-ups that enter the market with protected novel technical knowledge are likely to pose a greater threat to established, powerful incumbents (Abernathy and Clark, 1984; Christensen and Bower, 1996; Henderson, 1993; Hill and Rothaermel, 2003). On the contrary, a trademark does not directly exclude competitors from a new technology. In this case, the only requirement is that competitors should do business under a different, unique brand name than the start-up, and thus they will not mislead consumers (Mendonça et al., 2004). Overall, without the strong protection of the core qualities of a start-up, it becomes more difficult to pose a threat to the incum-

bent firms that are in control of the resources within an industry. The above discussion suggests that start-ups that enter into less competitive industries are more likely to have patent-oriented IP strategies. We propose the following hypothesis:

Hypothesis 1: As market competition increases, start-ups are more likely to file an initial IP right in the form of a trademark rather than a patent.

5.3.2 Customer type and IP strategy

IP strategy may also be explained by a start-up's type of customer and its relative position within the supply chain. We distinguish between start-ups that operate downstream in the supply chain, serving end-consumers, and start-ups that operate more upstream in the supply chain, serving other businesses (Beamon, 1998; Harland, 1996). Whereas product development is generally conducted upstream, it seems likely that start-ups that sell to other businesses provide relevant inputs to the product development process. In contrast, start-ups that sell to end-consumers should already own a marketable product, and thus they have a greater need to focus on distribution and marketing (Tan, 2001).

Product development and marketing as core types of activity are recognized as strategic typologies in the start-up strategy literature. Porter's (1980) differentiation typology distinguishes between technical or product differentiation strategy, on the one hand, and marketing differentiation strategy, on the other (Carter et al., 1994; Chaganti et al., 1989; Li, 2001; McGee et al., 1995; Miller, 1991; Schrader and Siegel, 2007). Under a product differentiation strategy, a start-up aims to achieve differentiation through R&D activities, creating a competitive advantage through product innovation (McGee et al, 1995), which is an upstream activity. In the case of a marketing differentiation strategy, a start-up specializes in marketing activities such as branding, promotion, design, service, image, and distribution, which are more downstream activities. Furthermore, start-ups are highly unlikely to come up with a new product (Carter et al., 1994; Miller, 1986). Accordingly, we expect that start-ups that engage in downstream activities and serve end-consumers are more likely to work under a marketing-oriented strategy, and they will therefore be in need of trademark protection. Start-ups that supply to other businesses are more likely to be involved in product development, and they should therefore benefit more from patent protection. We thus formulate the following hypothesis:

Hypothesis 2: Compared to start-ups that sell to other businesses, start-ups that sell to end-consumers are more likely to file an initial IP right in the form of a trademark rather than a patent.

5.3.3 The impact of VC funding on IP strategy

The external influences on a start-up's management may also affect IP orientation. VCs are active investors who not only provide funding but also spend most of their time advising and monitoring the management of the start-ups in which they invest. VCs often sit on boards of directors and have powerful rights, such as, for example, the ability to fire the members of a start-up's management team (Gompers and Lerner, 2004; Sahlman, 1990). We argue that the involvement of a VC is likely to shift a start-up's focus toward the commercialization of its inventions. The extant literature shows that VCs find early-stage start-ups to be overly focused on the development of their inventions. VCs are of the opinion that start-ups should be more consumer-oriented and conduct market analysis (Hills, 1984; Hills et al., 2008; Hisrisch, 1989; Wortman et al., 1989). When deciding to invest, a VC sets milestones that a start-up needs to achieve to receive subsequent funding rounds. In the early stages, such milestones are likely to be directed toward market orientation, making the product more consumer-friendly and localizing initial consumers who are willing to buy the product (Berkery, 2008). Accordingly, the involvement of a VC investor is likely to shorten a start-up's time-to-market and speed up the professionalization of marketing activities as compared to non-VC funded start-ups (Hellman and Puri, 2000; 2002). VCs have a limited time period in which to turn a start-up into a functioning company that can either conduct an IPO or be sold to an industrial firm. The VC seeks to bring a product to market as early as possible. The filing of a trademark is likely to be one of the initial steps that is taken in the commercialization process, securing the start-up's brand name and protecting its future marketing efforts (Sandner and Block, 2011). Hence, we derive the following hypothesis:

> **Hypothesis 3:** VC-backed start-ups are more likely to file an initial IP right in the form of a trademark rather than in the form of a patent.

5.4 Data and variables

5.4.1 Data sources

We analyzed the influence of market competition, a start-up's customer type, and the engagement of VC investors on a start-up's type of initial IP application, distinguishing between trademarks and patents. We used several data sources but restricted our data searches to the Unites States. VC-funded start-ups were taken from Thomson Reuters' VentureXpert database. Using the six-digit NAICS industry classification codes that are available from

VentureXpert, we merged R&D- and advertising intensity measures calculated from COMPUSTAT and competition intensity data accessed through the US Census Bureau. Next, patent and trademark filing records were manually matched to the start-up's name and former aliases reported in VentureXpert.

Sample and NAICS data. We selected the US-based start-ups that received VC funds in the period from 1998 to 2007 from VentureXpert, which resulted in a sample of 11,808 start-ups. We focused on start-ups with a valid reported NAICS classification, their foundation dates, and the amounts of VC funds that they received. We were unable to take into account data beyond 2007 because of the lengthy process surrounding patent applications and the successive granting of international patent protection. Patent filings are kept secret for 18 months, after which it may take several more years to secure international protection (Greenhalgh and Rogers, 2010).

We define the market niche in which a start-up operates by the six-digit NAICS code that is available from VentureXpert. For each NAICS classification, we used the COMPUSTAT database to calculate the three-year averages of R&D and advertising intensity over our sample period (1998-2007). COMPUSTAT data is commonly used in existing studies to calculate such measures (e.g., Chauvin and Hirschey, 1993; Waring, 1996). We were able to determine the R&D and advertising intensity measures for the market niches of 11,582 start-ups. Next, we obtained the competition intensity data that is published by the US Census Bureau every five years. The competition data that is provided by the US Census bureau is reliable, as each firm in the US is required by law to respond to the US Census survey (see Ali et al., 2009, for a review). The competition intensity data was available for the market niches of 9,678 start-ups. Finally, we gathered US trademark and patent data for this sample.

Trademark and patent data. The IP searches were done through a manual process. The trademark applications were obtained from the United States Patent and Trademark Office (USPTO) (see also Graham et al., 2013). The US Patent applications were accessed through the PATSTAT database. The extent of the IP activities could be determined for 8,247 of the remaining start-ups (85.2%). A start-up was excluded when its name or one of its former aliases did not give a unique search result. Imperfect matches were verified through the industry and location records that are available from VentureXpert. We selected the start-ups that filed a first IP application in the period from 1998 to 2007, leading to a final sample of 4,703 start-ups, which are active in 333 separate NAICS classes.

5.4.2 Variables

Our dependent variable was the binary variable *trademark or patent*, indicating whether a start-up filed its first IP application in the form of a trademark (=1) or a patent (=0). We used the application dates because they relate to the point in time at which the start-up made the strategic decision to obtain a specific type of IP. The publication date is less suitable to determine this point in time because the length of the application procedure may vary from case to case and is generally more complicated and lengthy for patents (WIPO, 2011). Because our dependent variable was binary, we used logistic regression models. As our main independent variables, we measured competition intensity using the *C4 ratio*, which is the sum of the market share of the four largest firms that are active within a particular NAICS class.[21] The C4 ratio is widely accepted as a measure of competition intensity (e.g., Domowitz et al., 1986; Harris, 1998). Because, as noted above, competition data is published every five years by the US Census Bureau, we used the C4 ratio that was published in 1997 for the start-ups in our sample that had applied for an initial IP up until 2002. We used the C4 ratio that was published in 2002 for the start-ups that filed an initial IP up until 2007. Further, we measured the effect of a VC investor on a start-up's IP strategy with the *VC dummy* variable, indicating whether the start-up received any VC funds up until the date of its first IP application. A start-up's customer type was captured by the *Business-to-consumer dummy*, which indicates whether the start-up serves consumers (=1) or other businesses (=0). The information on a start-up's customer type is reported by VentureXpert at the date at which the start-up received VC funding. Of the 1,895 VC-backed start-ups in our sample, 1,438 start-ups were defined as serving either consumers or other businesses. Our hypothesis addressing the relationship between a start-up's customer type and its initial IP application will therefore be analyzed through this subsample. To capture the other factors that may influence the initial IP application of a start-up, we used the following control variables.

We control for the average *R&D intensity* and the average *advertising intensity*, which is calculated for each individual market niche in COMPUSTAT. We calculated the average R&D and advertising intensity within the market niche over the three years prior to a start-up's initial IP application. Start-ups that operate in research-intensive market niches are more likely to file patent applications (Griliches, 1984; 1998). Similarly, a higher advertis-

[21] The Herfindahl index was also available from the US Census Bureau, but it is only published for the manufacturing sectors. We used the four-firm-ratio because it was available for a broader range of industries. The correlation between the Herfindahl index and the four-firm-ratio was 0.93. Also, previous works suggest that there are no substantial differences between the two measures (e.g., Scott, 1993).

ing intensity within a market niche may be related to a more trademark-oriented IP strategy (Malmberg, 2005; Mendonça et al., 2004).

Further, we calculated *start-up age* in years at the date of a start-up's first IP application. To control for time trends in trademark or patent applications, we use ten *application year dummies* indicating the year in which the start-up applied for its first IP. Time-related shifts in environmental, management, or legal conditions may affect IP applications (Kortum and Lerner, 1999). We distinguished *six industry dummies*, categorized by VentureXpert, which are "biotechnology," "communications and media," "computer related," "medical/health/life science," "non-high-technology," and "semiconductors/other electronics," as IP protection regimes may vary across different industry types (Dushnitsky and Shaver, 2009). Lastly, possible regional influences are controlled for by seventeen *US region dummies*, as the type and degree of regional technology orientation (e.g., Silicon Valley, New England) may affect IP behavior (Audretsch and Feldman, 1996).

5.5 Results

5.5.1 Descriptive results

Table 5.1 shows descriptive statistics across industries. As can be expected, patents are more likely to be filed as a first IP right within technology-based industries such as the biotech, semiconductor, and medical/life science industries. Having a trademark as a first IP right is more likely in non-high-tech-, communications-, and computer-related industries.[22] Concerning a start-up's customer type, we found that start-ups are most likely to sell to consumers in the medical and life science industry (37.8%) and in the non-high-tech industry (35.1%). Start-ups supply to other businesses most frequently in the semiconductor industry (98.4%). This percentage seems to be in line with the suggestion that start-ups that serve other businesses are more likely to operate under a technical or product differentiation strategy. Further, the average R&D intensity (NAICS-based) is highest for markets that are related to biotech (44.2% of sales on average), whereas advertising intensity is highest in the computer-related and semiconductor industries (1.6% of sales on average). Lastly, the C4 ratio reveals that competition is least intensive in the more technical, patent-driven markets such as semiconductors (C4 of 50.2%) and biotech (C4 of 41.3%). This

[22] Computer-related start-ups were mainly engaged in computer software and services and internet-related activities.

finding is in line with previous studies that underscore the role of patents as powerful exclusion rights (Besanko et al., 2010; Greenhalgh and Rogers, 2010).

Table 5.1: Descriptive statistics – Industry categories

Industry category	% of start-ups in sample	% start-ups filing a trademark first or a patent first	Start-ups' customer type (in %)	Av. R&D intensity (in %)	Av. Advert. intensity (in %)	Av. C4 ratio
Biotechnology	6.5	trademark: 35.2 patent: 64.8	Consumer: 27.2 Business: 72.8	44.2	1.0	41.3
Communications and media	14.1	trademark: 61.2 patent: 38.8	Consumer: 7.3 Business: 92.7	11.0	1.3	37.8
Computer-related	47.9	trademark: 72.4 patent: 27.6	Consumer: 14.3 Business: 85.7	12.5	1.6	34.6
Medical/life science	11.6	trademark: 39.4 patent: 60.6	Consumer: 37.8 Business: 62.2	10.0	1.0	33.5
Non high-tech	10.4	trademark: 73.5 patent: 26.5	Consumer: 35.1 Business: 64.9	14.4	1.3	30.4
Semiconductor/ other elect.	9.5	trademark: 30.9 patent: 69.1	Consumer: 1.6 Business: 98.4	12.2	1.6	50.2

Notes: N = 4,703 start-ups (customer type is based on 1,438 start-ups). Sample includes start-ups that filed first IP during the period 1998-2007.

Table 5.2 presents the descriptive statistics for our full sample. Of the start-ups in our sample, 61% filed for a trademark first instead of a patent. This preference can be explained by the slightly broader applicability of trademarks, which is potentially relevant for both the technology- and service-related markets, whereas patents are especially relevant in technology-based markets (Greenhalgh and Rogers, 2006a).[23] Further, we found that different types of competition intensity are represented in our sample. The average C4 ratio of the market niches that were entered is 36.4% (median 34.9%). Interestingly, the most competitive market niche is dental services, with a C4 ratio of 0.7% (NAICS classification = 621210). In contrast, the least competitive market niche is the manufacturing of space vehicles, with a C4 ratio of 91.6% (NAICS classification = 336414). With regard to VC financing, we observed that 40% of the start-ups in our sample had received VC funding before applying for their first IP right. Further, the market niches show on average a higher R&D (14.2% of sales) than advertising intensity (1.4% of sales). Both measures are right-

[23] 34.6% of the start-ups filed only for trademarks during our sample period, i.e., these start-ups did not engage into patenting. Similarly, 7.3% of the start-ups filed only for patents.

skewed (e.g., maximum R&D intensity = 2,456.7%, mean = 14.2%). In the additional analysis section, we correct for this by taking only those NAICS sectors into account for which we have R&D and advertising intensity information for at least five firms (which resulted in a mean R&D intensity of 11.5% and a maximum value of 38.9%). Lastly, the average start-up's age when applying for a first IP right was 2.3 years. We use the logarithm of start-up age in our regression analysis.

Table 5.2: Descriptive statistics

Variables	Mean	S.D.	Median	Min.	Max.	Skewness
Trademark (=1) or patent (=0)	0.61		1	0	1	
C4 ratio	36.4	18.0	34.9	0.7	91.6	0.3
VC dummy	0.40		0	0	1	
Business to consumer dummy	0.17		0	0	1	
R&D intensity	14.2	73.0	11.7	0	2,456.7	25.3
Advertising intensity	1.4	1.7	1.2	0	32.4	4.6
Start-up age (in years)	2.3	4.8	1.0	0	86.1	6.8

Notes: N = 4,703 start-ups (*Business to consumer dummy* regards 1,438 start-ups). Sample includes start-ups that filed first IP during the period 1998-2007.

Table 5.3 shows the correlations and variance inflation factors (VIFs). The reported correlations are in line with our hypothesized effects. The VIFs in our regression models are well below the critical level of ten, indicating that multicollinearity is not a problem in our models (see also Hair et al., 2006; Neter et al., 1985).

5.5.2 Multivariate results

Table 5.4 shows the logistic regression results for our dependent variable trademark or patent. Model 1 only includes our control variables, but it still excludes the industry dummy variables. Interestingly, *log (start-up age)* shows that relatively newer start-ups are more likely to file for patents first. This seems intuitive, as R&D and product development activities tend to take place at an earlier stage than marketing, which involves the commercialization of an already sellable product. This effect is also in line with existing studies, which show that start-ups tend to be overly focused on their inventions rather than on market orientation during the early stages (Hisrich, 1989; Wortman et al., 1989). In the subsequent models, we test our hypothesized effects. Model 2 includes the *C4 ratio*, which is close to being significant at the 5% level, with a p-value of 0.053 (two-sided test). Its coefficient indicates that an increase in competition is likely to lead to a higher likelihood of filing the first IP right in the form of a trademark rather than a patent. More specifically, a decrease

Table 5.3: Correlations

Variables		1	2	3	4	5	6	7	8	9	10	11	12	VIFs [a]
1.	Trademark or patent													
2.	C4 ratio	-0.09*												1.14
3.	VC dummy	0.13*	0.02											1.20
4.	Business to consumer	0.05*	-0.10*	-0.07*										1.17
5.	R&D intensity	-0.03	0.01	-0.02	0.01									1.02
6.	Advertising intensity	0.05*	0.19*	0.03	0.06*	-0.01								1.09
7.	Log (Start-up age)	0.18*	-0.03	0.35*	-0.04	-0.01	-0.01							1.24
8.	Industry: biotechnology	-0.14*	0.07*	-0.04*	0.06*	0.11*	-0.06*	-0.07*						1.45
9.	Industry: communic. and	0.00	0.03	0.05*	-0.11*	-0.02	-0.02	-0.03	-0.11*					
10	Industry: computer-related	0.23*	-0.10*	0.05*	-0.07*	-0.02	0.10*	0.06*	-0.25*	-0.39*				2.34
11	Industry: medical/life sci-	-0.16*	-0.06*	-0.06*	0.18*	-0.02	-0.09*	-0.05*	-0.10*	-0.15*	-0.35*			1.71
12	Industry: non high-tech	0.09*	-0.11	-0.03	0.16*	0.00	-0.03	0.12*	-0.09*	-0.14*	-0.33*	-0.12*		1.66
13	Industry: semicond/other	-0.20*	0.25*	-0.01	-0.14*	-0.01	0.04	-0.07*	-0.09*	-0.13*	-0.31*	-0.12*	-0.11*	1.59

Notes: N = 4,703 start-ups (*Business to consumer dummy* regards 1,438 start-ups). Sample includes start-ups that filed first IP during the period 1998-2007.

* Significance level $p \leq 0.01$.

[a] VIFs relate to Model 5, Table 5.4; VIF of *Business to consumer dummy* is reported from Model 3, Table 5.5.

Table 5.4: The effect of market structure and VC funding on a start-up's initial IP (Hypothesis 1 and 3)

Dependent variable:	**Trademark(=1) or patent(=0)**				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Independent variables					
C4 ratio		-0.012†		-0.012*	-0.005†
		(0.006)		(0.006)	(0.003)
VC dummy			0.385**	0.405**	0.402**
			(0.070)	(0.073)	(0.074)
R&D intensity	-0.001	-0.001*	-0.001	-0.001*	-0.001
	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
Advertising intensity	0.093	0.127†	0.090	0.125†	0.071**
	(0.063)	(0.070)	(0.062)	(0.070)	(0.026)
Log (Start-up age)	0.535**	0.535**	0.434**	0.430**	0.339**
	(0.048)	(0.049)	(0.043)	(0.045)	(0.049)
IP applic. year dummies (10 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
US region dummies (17 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
Industry: biotechnology					-0.982**
					(0.159)
Industry: computer-related					0.481**
					(0.130)
Industry: medical/life science					-0.887**
					(0.214)
Industry: non high-tech					0.439**
					(0.160)
Industry: semiconductors/other elect.					-1.110**
					(0.174)
N start-ups	4,703	4,703	4,703	4,703	4,703
N NAICS sectors (6-digit)	333	333	333	333	333
Chi-squared (model fit)	486.59**	489.60**	520.49**	527.66**	1,433.41**
Pseudo R-squared	0.055	0.062	0.060	0.067	0.125
Increases in model fit (LR-test)[a]		44.22**	30.33**	46.98**	365.83**

Notes: Standard errors are clustered on 6-digit NAICS sectors (in parentheses). Reference group for IP application year: 2001; reference US region: 'Silicon Valley'; reference industry: 'communications and media'. Sample includes start-ups that filed first IP during the period 1998-2007.

† Significance level $p < 0.1$.; * Significance level $0.05 > p \geq 0.01$.; ** Significance level $p \leq 0.01$.

[a] Likelihood ratio tests relate to the preceding nested model.

in the C4 ratio of 1% is likely to lead to a 1.2% increase in the likelihood of filing a trademark first. Further, Model 2 shows a negative and significant coefficient for *R&D intensity*, indicating a positive effect of this variable on filing for a patent. The effect of *advertising intensity* is positively significant at the 10% significance level, indicating a positive effect of this variable on filing for a trademark. In Model 3, we introduce the *VC dummy* variable, of which the coefficient shows that VC-backed start-ups are more likely to file their first IP right in the form of a trademark rather than a patent ($p < 0.01$). This provides support for

our third hypothesis. Next, Model 4 includes both the *VC dummy* and the *C4 ratio*, revealing that the *C4 ratio* is significant at the 5% significance level while also controlling for the influence of VC investors on start-up management. This provides support for our first hypothesis. Finally, Model 5 checks the robustness of our results when introducing the industry dummy variables. Because the industry dummies capture variance in competition, the coefficient of the *C4 ratio* decreases and becomes significant at the 10% level. The *VC dummy* variable remains highly significant.

Table 5.5: Subsample analysis: The effect of customer type on a start-up's initial IP (Hypothesis 2)

Dependent variable:	**Trademark(=1) or patent(=0)**		
	Model 1	**Model 2**	**Model 3**
Independent variables			
C4 ratio	-0.015**	-0.014*	-0.004
	(0.006)	(0.006)	(0.003)
Business to consumer dummy		0.579*	0.608*
		(0.247)	(0.251)
R&D intensity	-0.001*	-0.001**	-0.001*
	(0.000)	(0.000)	(0.000)
Advertising intensity	0.202*	0.200*	0.107†
	(0.089)	(0.093)	(0.059)
Log (Start-up age)	0.345**	0.355**	0.262**
	(0.078)	(0.076)	(0.075)
IP applic. year dummies (10 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$
US region dummies (17 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$
Industry: biotechnology			-1.068*
			(0.522)
Industry: computer-related			0.568**
			(0.189)
Industry: medical/life science			-0.486
			(0.334)
Industry: non high-tech			0.576
			(0.328)
Industry: semiconductors/other elect.			-1.203**
			(0.294)
N start-ups	1,438	1,438	1,438
N NAICS sectors (6-digit)	174	174	174
Chi-squared (model fit)	269.06	275.11**	559.29**
Pseudo R-squared	0.069	0.074	0.129
Increases in model fit (LR-test)[a]		9.00**	96.29**

Notes: Standard errors are clustered on 6-digit NAICS sectors (in parentheses). Reference group for IP application year: 2001; reference US region: 'Silicon Valley'; reference industry: 'communications and media'. Sample includes start-ups that filed first IP during the period 1998-2007.
† Significance level $p < 0.1$.; * Significance level $0.05 > p \geq 0.01$.; ** Significance level $p \leq 0.01$.
[a] Likelihood ratio tests relate to the preceding nested model.

Table 5.5 presents results with regard to a start-up's customer type (Hypothesis 2). We analyze the subsample of the 1,438 VC-backed start-ups for which we have customer type information. Model 1 is a baseline model that also includes the C4 ratio ($p < 0.01$), which is again negative and significant. Model 2 includes the *Business to consumer dummy*. Its positive coefficient indicates that start-ups that sell to consumers are more likely to file an initial IP right in the form of a trademark, whereas start-ups that sell to other businesses are more likely to file an initial IP right in the form of a patent. When including the industry dummy variables in Model 3, the *business to consumer dummy* remains significant ($p < 0.05$). The C4 ratio, which is constructed on a sector level, is no longer significant when including the industry dummies. This finding is likely to be related to the lowered statistical power that is the result of focusing on the VC-backed subsample.

5.5.3 Additional analyses and robustness checks

We conducted several additional analyses. A first robustness check is related to the R&D and advertising intensity measures, which are right-skewed. As noted, these measures are calculated for each NAICS class based on COMPUSTAT data. For some sectors, however, the COMPUSTAT data holds information for only a few individual firms. We corrected for this by using only the average R&D and advertising intensity measures that are based on sectors that hold at least five firms, thereby reducing the volatility of these measures. This reduction in volatility reduced our sample to 3,966 start-ups that are active in 216 different NAICS classifications. The regression results are presented in Table 5.6, showing a more intuitive coefficient for the R&D intensity (e.g., -0.001 in Model 1, Table 5.4 versus -0.029, in Model 1, Table 5.6). Table 5.6 shows similar results for our hypothesized effects.

As a second robustness check, we excluded the start-ups in our sample for which the dates of the first patent and trademark applications were recorded within six months of each other. Given that these start-ups applied for both types of IP within a short period of time, there may be no clear preference for either a trademark or a patent. Further, by excluding these start-ups, we reduced the possibility that our dependent variable is incorrect due to errors or delays in the recording of the application dates or due to the differences between the filing systems of patents and trademarks. This step reduced our sample to 3,891 start-ups that are active in 319 NAICS sectors. The results of our hypothesized effects remain similar to the results from our main analysis.[24]

[24] The result of this robustness check and subsequent regressions are available upon request.

Table 5.6: Additional analysis – using average R&D and advertising intensity based on at least 5 firms

	Full sample			**Subsample: start-ups with customer type information**	
Dependent variable:	**Trademark(=1) or patent(=0)**				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Independent variables					
C4 ratio		-0.018**	-0.006†	-0.020**	-0.005
		(0.007)	(0.003)	(0.007)	(0.005)
VC dummy		0.407**	0.399**		
		(0.088)	(0.086)		
Business to consumer dummy				0.547*	0.596*
				(0.264)	(0.275)
R&D intensity	-0.029*	-0.017	-0.019*	-0.010	-0.008
	(0.012)	(0.013)	(0.008)	(0.012)	(0.012)
Advertising intensity	0.132	0.142	0.094**	0.223†	0.148*
	(0.096)	(0.092)	(0.032)	(0.114)	(0.075)
Log (Start-up age)	0.551**	0.436**	0.360**	0.328**	0.252**
	(0.054)	(0.055)	(0.056)	(0.088)	(0.086)
IP applic. year dummies (10 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
US region dummies (17 cat.)	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
Industry: biotechnology			-0.712**		-0.860
			(0.172)		(0.566)
Industry: computer-related			0.540**		0.650**
			(0.126)		(0.201)
Industry: medical/life science			-0.863**		-0.374
			(0.204)		(0.336)
Industry: non high-tech			0.409*		0.760†
			(0.180)		(0.388)
Industry: semiconductors/other elect.			-1.036**		-1.151**
			(0.209)		(0.305)
N start-ups	3,966	3,966	3,966	1,181	1,181
N NAICS sectors (6-digit)	216	216	216	126	126
Chi-squared (model fit)	396.04**	528.16**	1,593.79**	398.12**	751.94**
Pseudo R-squared	0.064	0.079	0.132	0.077	0.132
Increases in model fit (LR-test)[a]		81.38**	285.97**		81.30**

Notes: Standard errors are clustered on 6-digit NAICS sectors (in parentheses). Reference group for IP application year: 2001; reference US region: 'Silicon Valley'; reference industry: 'communications and media'. Sample includes start-ups that filed first IP during the period 1998-2007.

† Significance level $p < 0.1$.; * Significance level $0.05 > p \geq 0.01$.; ** Significance level $p \leq 0.01$.

[a] Likelihood ratio tests relate to the preceding nested model.

Thirdly, our results may be driven by the large number of start-ups that are active in the same NAICS class. Overall, our sample holds 4,703 start-ups that are active in 333 separate NAICS classes. Because the *C4 ratio*, *R&D*, and *advertising intensity* are measured per NAICS category, the variance in our sample becomes limited in cases where many start-ups are active within the same NAICS classes. The distribution of start-ups over NAICS classes is highly skewed (1,267 start-ups were active in the most prominent NAICS class, followed by 441 start-ups in the second most prominent NAICS class). We checked for the impact of the sector distribution by excluding the NAICS classes that held more than fifty start-ups. We found similar results with regard to our hypothesized effects. Shifting the cut-off point in terms of the number of start-ups per NAICS class further down, for example excluding NAICS classes with more than twenty-five start-ups, also led to similar results.

Finally, the VentureXpert database, reporting VC investments, contains additional information on the start-ups in our sample, which may be relevant to control for. We conducted a subsample analysis, considering only the start-ups that received VC funds before applying for their first IP right.[25] For these start-ups, we were able to control for more information that we gathered from the reported funding round in VentureXpert. VCs categorize a start-up as being in a specific stage, differentiating whether a start-up is still working on its first proto-type, or if it is already in a later stage, working on initial sales, expanding its market share, or, ultimately, looking for an exit. Furthermore, we were able to control for the funding stage (round number), the amount of VC funds received, the number of investors involved, the VCs' experience and maturity levels, and the different types of VC investors (VC firms, business angel, corporate investor, financial institution, governmental investors). Each specific VC actor type operates under a different set of incentives and may therefore influence the start-up's management in a different manner (Dushnitsky and Shapira, 2010; Sorenson and Stuart, 2008). Controlling for these additional factors, we find similar effects for the *C4 ratio* ($ß = –0.015$, $p < 0.01$) and the *Business to consumer dummy* ($ß = 0.649$, $p < 0.01$).

5.6 Discussion

Our study is the first to analyze the determinants of IP orientation by distinguishing between patent and trademarks applications. We examine the initial IP direction (a trademark

[25] 40% of the start-ups received VC funds before their first IP application.

or a patent) of 4,743 start-up entrants in the US between 1998 and 2007. Our findings contribute to several literature streams.

Firstly, we extend the literature on market structure and IP rights. Previous studies have focused mainly on the relations between market structure and patenting (e.g., Arora, 1997; Acs and Audretsch, 1987; Greenhalgh and Rogers, 2006a; Levin et al., 1985; Loury, 1979; Malerba and Orsenigo, 2002; Scherer, 1984), and, more recently, also considered the role of trademarks (Davies, 2009; Kong, and Seldon, 2004; Ramello, 2006; Ramello and Silva, 2006). We contribute to this literature by addressing trademarks and patents jointly, considering the effect of market structure on the IP strategy of entering start-ups. We show that entering start-ups are more trademark-oriented in competitive markets and become more patent-oriented as market competition decreases.

Previous studies that address the relationship between patents and market structure suggest that market power provides an increased incentive to invest in R&D, which leads to increased patenting (Schumpeterian view). Moreover, in a similar vein, patents are suggested to be one of the main determinants of market structure (Arora, 1997; see also Cohen and Levin (1989) who discuss empirical studies on both relationships). With regard to these prior findings, we argue that reverse causality should not be an issue in our analysis. We consider the initial patent and trademark applications of new entering start-ups. These IP applications are unlikely to have affected the given C4 ratio, which is measured prior to the application dates. Further, the controls that have been included regarding industry types and the average R&D intensity within the specific market niche should reduce the likelihood that the effect that was found for the C4 ratio is determined by patenting.

Secondly, we contribute by providing empirical evidence for the intuition that the protection of brand and advertising assets by trademarks is more relevant for start-ups that operate downstream and distribute products to end-consumers (Carter et al., 1994; Miller, 1986; Tan, 2001). Correspondingly, we show that patents, protecting inputs in the production process, are more likely to be used upstream when a start-up sells to other businesses (Lambert, 2008; McGee et al., 1995).

Thirdly, our findings contribute to the literature on the role of IP rights in venture capital financing by showing that VC-backed start-ups are more likely to file an initial IP right in the form of a trademark rather than a patent, as compared with start-ups that are not yet under the care of a VC. Previous works in this area show that VC investors positively value patents, and they also suggest that patented start-ups should be able to attract VC funds more easily than other start-ups (Audretsch et al., 2012; Baum and Silverman, 2004; Cao and Hsu, 2011; Engel and Keilbach, 2007; Haeussler et al., 2012; Hsu and Ziedonis, 2008; Lerner, 1994a; Mann and Sager, 2007). The work of Block et al. (2013) is the first to ad-

dress trademark valuations by VCs, and they showed that trademarks are valued positively in a start-up's early stages. Our study extends this literature by showing that VCs also affect the type of IP that is filed by the start-ups in which they invest. The preference of VCs for filing trademarks is understandable when we consider the timeline that a VC has to relate to (generally five to ten years to exit a start-up) and thus the need for start-ups to become operational on the market (see also Hellman and Puri, 2000). The results also contribute to the literature by addressing the impact of VC financing on the development of start-up firms. Previous studies have shown that VCs are likely to affect the financial performance of the start-up in which they invested (Fitza et al., 2009; Schefczyk and Gerpott, 2001), the start-up's professionalization (Hellman and Puri, 2002), the start-up's time-to-market (Hellman and Puri, 2000), the start-up's growth rate (Davila et al., 2003), and the start-up's probability of surviving (Manigart et al., 2002). Our findings add that VCs are likely to influence the IP management of start-ups, increasing the likelihood of filing an initial IP in the form of a trademark rather than a patent.

5.7 Limitations and further research

Although we provide novel contributions, this chapter contains a number of limitations that lead to several suggestions for future research. First, our analysis only considers the very first IP applications that are filed by start-up firms. Though early-stage entrants have the advantage of not being likely to influence market structure (as measured by the C4 concentration index), we have to be careful in drawing conclusions regarding the IP strategies of later-stage, more mature companies. Future research could analyze the interactions of IP strategies and market structure over time, taking into account the causality issues that are discussed in the patent-market structure literature (Cohen and Levin, 1989). Second, our dataset, which contains information on market dynamics and start-up firm-level characteristics, had to be constructed from several data sources. With regard to the IP data, the matching process relied on the manual creation of company name patterns that were used to extract information on trademark and patent filings. This method proved to be highly reliable, and it was individually checked against the records in the USPTO trademark register. Still, we cannot completely rule out possible mismatches or the failure to include relevant IP applications in our dataset (IP data can be identified for 85.3% of the start-ups that were taken from VentureXpert). Third, we have only limited information with regard to the background of the entrepreneurs that were involved in the start-ups. Such information could be relevant; for example, venture founding teams with more technical backgrounds might be more focused on patenting in early stages, whereas founders with more previous

experience in the marketing field may be more likely to recognize the relevance of trademarks (see also Munari and Toschi, 2011; Wright et al., 2006). As our work solely employs publicly available data sources, survey-based data could help us understand IP decisions more thoroughly at the firm level.

As we expect that trademarks play a relevant, potentially powerful role in the protection of innovative assets, especially in combination with patents, we encourage future work to help us understand IP strategies at a portfolio level and in later company stages.

5.8 Conclusions

Analyzing the initial trademark and patent applications of 4,703 start-up entrants, we find that market structure, a start-up's customer type, and the involvement of a VC investor have a significant influence on a start-up's initial IP direction. Our findings show that as market competition intensifies, entering start-ups will be more likely to file initial IPs in the form of a trademark and less likely to file an initial IP in the form of a patent. Our results further show that trademarks are a greater priority for start-ups that serve end-consumers, as compared with patents, which are more likely to be filed by start-ups that operate more upstream when selling to other businesses. Lastly, we find that the ambition of VC investors to bring a start-up's product to market leads to a greater likelihood of filing an initial IP right in the form of a trademark.

6

Conclusion and discussion

6.1 Main findings

Analyzing venture capital (VC) activities around the 2000-2001 dot-com crisis and the 2008-2009 financial crisis, Part I of this thesis shows that the economic climate has a strong influence on VC activities. A period of economic crisis is associated with a decrease in the number of initial funding rounds and also with a decrease in the amount of funds invested in later funding rounds (Chapter 2). These effects differed across industries and were stronger in the US than in other countries. With regard to syndication strategies, VCs had a lower tendency to syndicate investments during a period of economic crisis, and the size of the syndicates was smaller (Chapter 3). The effect on syndication activities is primarily found for later-stage financing rounds. Overall, the findings of Part I can be explained by the worsening fund raising- and exit opportunities during a period of economic crisis, forcing VCs to adjust their investment strategies.

Part II of this thesis analyses intellectual property (IP) assets of VC-backed start-ups, showing that the number and breadth of a start-up's trademark applications have a positive yet decreasing effect on the financial valuations of start-ups by VCs. Findings also indicate that in later funding rounds, the value of trademark applications decreases when the start-up progresses into more advanced development stages (Chapter 4). Further, Part II of this thesis examines the impact of VC funding on a start-up's IP orientation, distinguishing between a trademark- and a patent orientated IP strategy (Chapter 5). Results show that the incentive of a VC to start generating revenues on the market makes VC funded start-ups more likely to file initial IP in the form of a trademark rather than a patent. Further, next to VC, also market competition and a start-up's type of customer are found related to IP orientation. Trademark applications become more likely when the start-up operates in competitive market structures and when the start-up is focused on downstream distribution, serving end-consumers, where patent applications become more likely in concentrated market structures and when the start-up operates upstream and serves other businesses.

6.2 Main Contributions

6.2.1 Part I: VC and the economy

VC has become an element vital to the current economy and an important source of funding for innovative start-ups (Gompers and Lerner, 2001; Jell et al., 2011). This thesis is one of the first studies that provides empirical evidence regarding the impact of an economic crisis on VC activities. Findings in Part I of this thesis provide empirical support for the suggestion published in business magazines and the work of Mason (2009) that, as a result

of the 2008-2009 financial crisis, VCs are forced to focus their scarcer funds to the most important investment targets in their portfolios (see for example BioPharm International, 2009; FierceBiotech, 2010; The Economist, 2010). The fact that VCs become less prone to adopt new start-ups in their portfolio (Chapter 2), tend to cut back on the amount of funds provided to start-ups in later funding stages (Chapter 2), and tend to scale down in their syndication activities (Chapter 3) confirm this behavior. The latter result further contributes to the VC syndication literature, which suggests that VCs tend to syndicate investments in order to further diversify their portfolio (Bygrave 1988; Lockett and Wright, 1999), to secure future deal flow (Lockett and Wright, 2001, Manigart et al., 2006; Sorenson and Stuart, 2001), and to share knowledge with other VCs (Brander et al., 2002; Bygrave, 1987; Lerner, 1994b). This thesis extends this literature by showing that the formation of syndicates, as driven by the motives stated above, receives a lower priority during economically turbulent times.

Interestingly, the negative effect of a crisis on both the funded amounts (Chapter 2) and syndicate size (Chapter 3) was found strongest in later stage investments relative to early stage investments. This is in line with the notion in the existing literature that exit market conditions are more likely to influence later-round versus first-round investments (see also Giot and Schwienbacher, 2007; Gompers and Lerner, 2004; Jeng and Wells, 2000).

6.2.2 Part II: VC and Intellectual property

Merging trademark and patent information to the VentureXpert database resulted in a unique dataset opening up several new research avenues. The main contributions of Part II are firstly to VC-IP literature, which thus far considered solely the role of patents in VC financing (e.g., Audretsch et al., 2012; Baum and Silverman, 2004; Hsu and Ziedonis, 2008; Lerner, 1994a; Mann and Sager, 2007). This thesis contributes to this literature by showing that besides patents VCs also value marketing-oriented IP rights, such as trademarks (Chapter 4). In addition this thesis shows that the involvement of a VC investor is related to a higher likelihood of start-ups filing for a trademark rather than a patent (Chapter 5). This latter result extends the literature addressing the impact of VC on the development of the funded start-up (e.g., Davila et al., 2003; Fitza et al., 2009; Hellman and Puri, 2002; Manigart et al., 2002; Mann and Sager, 2007; Schefczyk and Gerpott, 2001).

Secondly, besides contributing to VC literature, these results extend entrepreneurial marketing literature. Where the relevance of market orientation in early start-up stages has been stressed repeatedly (e.g., Boag, 1987; Carson, 1985; Gruber, 2004; Hills et al., 2008;

Kraus et al., 2011), this thesis provides empirical support of this effect measured by trademarks.

Thirdly, a main contribution to IP literature is the analysis of trademarks within early firm development stages. Thus far, the role of trademarks has been analyzed in a context of large, publicly listed firms (e.g., Greenhalgh and Rogers 2006b; 2007; Ramello and Silva, 2006; Sandner and Block, 2011).

Finally, this thesis is, to the best of our knowledge, the first study that examines the determinants of start-up IP orientation (trademark or patent), partly reflecting strategic intentions (Carter et al., 1994). Besides confirming the common explanation behind IP orientation of the intensity of R&D activities, leading to the filing of patents (Griliches, 1984, 1998; Kortum, 1993), and the intensity of advertising activities, leading to the filing of trademarks (Malmberg, 2005; Mendonça et al., 2004), this thesis shows that VC financing, market competition, and a start-up's customer type are related to IP orientation.

6.3 Implications

6.3.1 Implications for start-ups

VCs become more selective in the adoption of new investment targets during a period of economic downturn. New start-ups looking for first-time funds should increase their effort in emphasizing the quality of their innovative idea and in playing down the risks of the business plan toward the VC in order to obtain funds. New start-ups could also focus their efforts on alternative funding sources such as business angels and governmental funds. Yet, inescapably, due to the increased scarcity of funds, more entrepreneurs will be forced to postpone the launch of a company to a period where economic conditions have stabilized.

Start-ups that are already engaged with a VC should take into account that the VC is likely to reduce funded amounts when the condition of the economy worsens. In addition, fewer syndicate partners will be investing in the start-up which results in a reduction in non-financial resources such as industry-specific knowledge, managerial experience, and access to distribution networks. For these start-ups, cutting costs and postponing expansion plans may be critical in order to survive a period of crisis.

With regard to start-ups' IP applications, findings of this thesis suggest that VCs value marketing orientation in addition to the start-up's innovative idea (see also Gruber, 2004; Hills et al., 2008). Start-ups should take note of this. One way of documenting market-orientation is to begin defending owned marketing assets by filing trademarks, even before these assets have been developed. To obtain the strongest return from filing trademarks,

start-ups are well advised to begin their trademark activities prior to the first funding round, before other marketing related information becomes available to the VC.

6.3.2 Implications for VCs

VCs should note that the working conditions on the VC market can shift drastically over time. Limited partners providing funds to VCs are likely to react strongly to information regarding the condition of the economy, allocating excessive funds relative to the available investment opportunities during economically prosperous times, and retracting strongly from the VC market when a downturn occurs (see also Lerner, 2002b). In addition, economic sentiment has a clear link to conditions on M&A- and stock markets, which are important exit vehicles for VC-backed start-ups (see also Black and Gilson, 1998; Cumming and MacIntosh, 2003). Worsened exit conditions will force VCs to provide additional funds toward later stage start-ups in order to keep them operational until a reasonable exit opportunity presents itself. Finally, during a period of downturn, fewer syndicate partners will be willing to invest, implying that VCs will become increasingly dependent on their own financial resources, knowledge and expertise.

VCs should be aware of the volatility of the VC market, and take changing conditions into account as early as possible when deciding on the appropriate time to set up a new fund, or, when already engaged with a portfolio of start-ups, on planning and prioritizing the available funds to the right investment targets.

6.3.3 Implications for governments

Where the inflow of funds into the VC market is dependent on economic conditions, governments could assist with the providence of funds especially during a period of downturn. During a period where the supply of funds to VC is low, returns are generally higher because the start-ups with the highest potential return receive funding first (Gompers and Lerner, 2000). Recent work suggests that government funds should in particular be provided through co-investment schemes where independent VC firms take the lead (Colombo et al, 2011). It is critical to have the expertise of the VC firm on board in selecting and advising the entrepreneurial team.

Besides setting up public funds backing up innovative start-ups, government can also create the appropriate regulatory framework for VC to develop. Next to economic determinants (largely attached to business cycles across countries), VC supply and demand will depend on a country's legal framework. The impact of a country's regulatory framework on VC activities is found to have an effect of similar size as the presence of a vibrant stock

market and real GPD growth (Armour and Cumming, 2006). Examples of policy measures are the adoption of more liberal bankruptcy laws, stimulating entrepreneurial demand for capital, and lowering the capital gains tax, making it more attractive for investors to submit capital to VC funds (Da Rin et al., 2006; Keuschnigg and Nielsen, 2003).

6.4 Limitations

Even though this thesis provides novel insights, there are several limitations to bear in mind.

First, where the VentureXpert database provides comprehensive information around VC funding rounds, it does not provide information on the characteristics of the start-up's founding team, such as its quality and composition (e.g., Franke et al., 2006; 2008), which could help explain VC valuations as well as the received funded amounts. Characteristics of the founding team could also be relevant for the estimated effect of trademark applications on VC valuations. For example, the presence of extensive marketing experience could make trademark applications less relevant for VCs. Further, information on the founding team should help to explain a start-up's IP orientation. For example, a team with a more technical backgrounds might be more focused on patenting in early stages, whereas a team with more previous experience in the marketing field may be more likely to recognize the relevance of trademarks (see for example Wright et al., 2006).

Secondly, in Part I, the impact of the 2000-2001 dot-com crisis and the 2008-2009 financial crisis was analyzed by comparing funding rounds before to funding rounds during each respective crisis. In these analyses, the point in time at which each respective crisis initiated was defined based on argumentation (e.g. the bankruptcy of Lehmann Brothers on September 16th, 2008). This has the limitation of not being able to rule out alternative time related explanations that could have caused the observed effects on the funded amounts and syndicate activities.

Thirdly, the trademark and patent portfolios of VC-backed start-ups were constructed from several data sources via the manual creation of company name patterns (Chapters 4 and 5). This method is proven to be reliable, yet potential mismatches cannot be ruled out (IP activities could be determined successfully for about 85% of the start-ups taken from VentureXpert).

Fourthly, conclusions with regard to a start-up's IP orientation regard only the very first IP application filed by the start-up. This has the advantage that the measured market structure is not influenced by the start-ups IP filing. Yet, these findings therefore do not apply to a later stage, IP portfolio level.

Finally, the results in this thesis apply primarily to the US. We should therefore be careful in the generalization of these results to regions where the VC market is relatively less developed.

6.5 Future research

The VC market is relevant in the commercialization of innovative ideas and in the evolution of industries (e.g., Kortum and Lerner, 2000). Future research could attempt to assess the damage of the volatile nature of the VC market on the real economy. Is the effect on the real economy less severe because the most promising start-ups are still receiving VC funds during a period of downturn? Related to this, future works could focus on the appropriate strategy for governments in dampening the changing conditions affecting the VC market.

Regarding VC syndicate activities, future research could conduct network analysis on VC syndicate data and show how VC networks emerge and evolve. In particular, it would be interesting to analyze how the network structure in the VC market responds to the occurrence of an economic shock. The shakeout and also the reduction in syndicate activities that occurs during a period of economic downturn could lead to a disintegration of the network. Further, from alliance literature, it could be expected that VCs may choose to fall back on their familiar ties instead of forming new relationships during times of increased uncertainty (Gulati, 1995; Gulati and Gargiulo, 1999; Uzzi, 1997).

Further, the findings in Part II could be better understood by including more encompassing data. Trademark applications are a rather broad proxy for start-up marketing activities. For example, information on the start-up's marketing expenditures, its level of market orientation, and its customer base could be included in order to improve our understanding of the dynamics and motivations that underlie the results of Part II. Lastly, where the results of this thesis with regard to start-up IP orientation only regard the very first IP filings of start-ups, future research could address the determinants driving IP filings also into later development stages.

Thesis in short

English

This thesis analyzes venture capital (VC) investments under changing economic conditions and in relation to start-up intellectual property (IP) filings.

VC has become an element vital to the current economy and an important source of funding for innovative start-ups. This thesis is one of the first studies that provides empirical evidence regarding the impact of an economic crisis on VC activities. Studying the impact of the 2000-2001 dot-com crisis and the 2008-2009 financial crisis, Part I (Chapters 2 and 3) of this thesis investigates how a period of economic downturn affects VC investment patterns. Chapter 2 analyses the effect of an economic downturn on the number of VC deals conducted, the amount of funds raised per funding round in early versus later stages, and also differences in these investment patterns across industries and countries. Findings indicate that a crisis is associated with a decrease in the number of initial funding rounds as well as with a decrease in the amount of funds raised in later funding rounds. These effects were confirmed across a variety of industries and were found to be more pronounced in the US as compared to countries outside the US. Chapter 3 analyzes the effect of an economic crisis on VC syndications. Chapter 3 shows that during a period of crisis, VCs had a lower tendency to syndicate their investments, and that the size of the syndicates was smaller. This effect is found to be stronger for later-stage financing than for early-stage financing. Overall, the findings in Part I of this thesis can be explained as follows. With drastic reductions in the amount of funds flowing into the VC market as well as fewer opportunities to exit successful start-ups, VCs will be forced to prioritize the scarcely available funds toward the current start-ups in their portfolios, rather than toward the adoption of new start-ups. Related to this, VCs have to re-evaluate their syndication strategy. When a VC's decision-making is focused on which portfolio companies to maintain and which to cut off from funding, a VC has little incentive to engage in new syndicates in order to expand its portfolio. Also syndicating in order to improve the selection process of new investments and to secure future deal flow becomes less relevant when the survival of a VC is more questionable.

Part II (Chapters 4 and 5) of this thesis examines VC-backed start-ups' IP filings. Part II provides novel insights by analyzing trademark applications in addition to patent applications within early firm development stages. Chapter 4 investigates the role of trademarks in the start-up valuations of VCs. Although trademarks might not produce immediate value for a start-up, the filing of trademarks nevertheless constitutes important information for VCs because it demonstrates a start-up's degree of market and growth orientation and its willingness to protect its current and future marketing efforts from the impairment of oth-

ers. Using a large US firm-level transaction dataset from 1998 to 2007, Chapter 4 demonstrates a positive, but decreasing, effect of the number of a start-up's trademarks on VCs' financial valuation of the start-up. Results also indicate that the breadth of a start-up's trademark portfolio has a positive, but decreasing, effect on the VCs' start-up valuations. Trademark breadth refers to the number of distinct industries in which the trademark is filed and granted protection. The overall breadth of a start-up's trademark portfolio provides an indication of the diversification of a start-up's product portfolio. Furthermore, in later funding rounds, the positive effect of new trademark applications decreases when the start-up progresses into a more advanced development stage. This finding can be explained primarily by a decline in signaling value of trademarks due to the availability of other, more tangible, credible, and costly signals, such as planned marketing activities including budget information or initial sales data.

Chapter 5 examines the initial IP direction of start-ups, distinguishing between trademark and patent applications. Results show that the involvement of a VC investor leads to a greater likelihood of filing for a trademark rather than a patent. This could be explained by the ambition of VCs to commercialize a start-up's invention and the limited time period to turn a start-up into a functioning company. The filing of a trademark is likely to be one of the initial steps taken in the commercialization process, securing the start-up's brand name and protecting its future marketing efforts. The results also show that start-ups are more likely to file for a trademark instead of a patent when entering into more competitive market structures. In competitive markets, trademarks may receive priority when supporting a start-up's visibility among the variety of available products, where patents may be a more critical tool especially in "winner-take-all," i.e. less competitive, markets, where dominant technologies are industry standards. Lastly, Chapter 5 shows that a start-up's customer type matters. Start-ups with a focus on distribution that serves end-consumers are more likely to file for a trademark, and start-ups that operate upstream and sell to other businesses are more likely to file for a patent. This finding is intuitive as trademarks are likely to be connected to a marketing differentiation strategy, where patents can be related to a technical or product differentiation strategy.

The findings of this thesis are relevant for start-ups and VCs. Both should take the documented volatile nature of the VC market into account and aim to recognize changing conditions as early as possible and adapt planning accordingly. Similarly, governments should be aware of the strong effect of economic sentiment on the VC market and should attempt to limit further damage to the economy. Lastly, where market orientation tends to be valued by VCs, one way of documenting market orientation by start-ups is to begin defending their marketing assets by filing trademarks as soon as possible.

Nederlands

Dit proefschrift analyseert venture capital (VC) investeringen in relatie tot de status van de economie (Deel 1), en in verband met intellectuele eigendomsrechten (IE) van ondernemers (Deel 2).

VC is van belang voor de economie omdat het een belangrijke bron van financiering is voor innoverende ondernemers. Dit proefschrift is een van de eerste studies die empirisch onderzoek doet naar de invloed van economische crises op VC activiteiten. Het eerste deel van dit proefschrift analyseert het effect van een periode van economische neergang op VC investeringspatronen aan de hand van de 2000-2001 internet crisis en de 2008-2009 financiële crisis. Hoofdstuk 2 onderzoekt het effect van een periode van crisis op het aantal investeringen dat plaatsvindt, de hoeveelheid kapitaal ontvangen door ondernemers in eerste- versus latere investeringsronden, en de impact van een crisis over industrieën en landen. De bevindingen in Hoofdstuk 2 tonen aan dat een periode van crisis leidt tot een daling in het aantal nieuwe ondernemers die gefinancierd worden door VCs (eerste ronde investeringen), en tot een daling in de hoeveelheid kapitaal geïnvesteerd in tweede- en latere investeringsronden. Deze resultaten worden bevestigd in verschillende industrie classificaties en treden sterker op binnen de Verenigde Staten (VS) in vergelijking tot andere landen. Hoofdstuk 3 analyseert het effect van een periode van economische crisis op VC syndicatie activiteiten. Er is sprake van syndicatie wanneer twee of meer VCs gezamenlijk in een onderneming investeren. Hoofdstuk 3 laat zien dat VCs gedurende een periode van crisis minder geneigd zijn om te syndiceren, en ook dat de grootte van syndicaties daalt. Deze effecten zijn hoofdzakelijk significant waargenomen in tweede- en latere investeringsronden. De bevindingen in het eerste deel van dit proefschrift kunnen als volgt worden verklaard. Door een verslechtering in de exit mogelijkheden op de acquisitie- en aandelen markten tijdens een crisis, hebben VCs moeite om ondernemingen tegen een aantrekkelijke winst te verkopen. Deze ondernemingen moeten echter wel operationeel blijven wat additionele investeringen vergt van VCs. Hiernaast zorgt een crisis voor een afname in de hoeveelheid kapitaal waarover VCs beschikken, waardoor minder nieuwe ondernemingen in aanmerking komen voor financiering. VCs moeten tijdens een crisis ook de syndicatie strategie herevalueren. Omdat het tijdens een crisis onzeker is welke ondernemers in een VC's portfolio überhaupt nog in aanmerking komen voor kapitaal, ligt de focus van de VC niet meer op het toetreden van nieuwe syndicaties om de portfolio uit te breiden. Zo ook zijn andere motieven om te syndiceren, bijvoorbeeld het gezamenlijk beoordelen van nieuwe investeringstargets, en de toevoer van investeringsmogelijkheden in de toekomst, minder relevant wanneer het bestaan van de VC tijdens een crisis onder druk komt te staan.

Deel twee van dit proefschrift analyseert de IE applicaties van ondernemers die door VCs gefinancierd worden, en draagt bij aan de huidige literatuur door naast patenten ook handelsmerken binnen de beginfasen van een bedrijf te analyseren. Hoofdstuk 4 onderzoekt of handelsmerken een effect hebben op de waardebepaling van VCs betreffende de ondernemingen waarin ze investeren. Hoewel handelsmerken niet onmiddellijk waarde creëren voor een beginnende onderneming, kunnen ze toch een signaal zijn voor markt- en groei oriëntatie. Hiernaast zegt het aanvragen van handelsmerken iets over de bereidheid en het bewustzijn van de onderneming om de baten van marketing activiteiten te beschermen. Hoofdstuk 4 analyseert een VC transactie dataset van 1998 tot 2007, en laat allereerst zien dat nieuwe handelsmerken een afnemend positief effect hebben op de vastgestelde waarde van ondernemingen door VCs. Hiernaast is het aantal verschillende industrie classificaties waarbinnen de handelsmerken bescherming bieden positief gerelateerd aan de waardering van de ondernemingen. Het aantal industrie classificaties kan geassocieerd worden met de diversificatie van de productportfolio van de onderneming. Een derde bevinding van Hoofdstuk 4 is dat de waarde van handelsmerken afneemt in latere investeringsronden, wanneer de onderneming nieuwe mijlpalen bereikt in zijn ontwikkeling. Wanneer een onderneming zich ontwikkelt, komt er voor VCs meer betrouwbare informatie vrij met betrekking tot markt- en groei perspectief, en zal dus de informatiewaarde van handelsmerken als signaal naar de VC investeerder afnemen.

Hoofdstuk 5 richt zich op de IE oriëntatie van beginnende ondernemingen, en maakt hierin onderscheid tussen handelsmerk- en patent applicaties. Resultaten laten zien dat de betrokkenheid van een VC leidt tot een hogere kans op het aanvragen van een handelsmerk in plaats van een patent. VCs hebben een begrensde tijdsperiode waarbinnen de gefinancierde onderneming operationeel moet worden en groei moet doormaken zodat aandelen tegen een aantrekkelijke winst verkocht kunnen worden. Het aanvragen van een handelsmerk is een van de eerste stappen binnen het commercialiseren van het product van de ondernemer. Naast het effect van VC, onderzoekt Hoofdstuk 5 de intensiteit van competitie binnen de markt waarin de ondernemer actief is. Resultaten tonen aan dat ondernemingen die in competitieve markten actief zijn, eerder een handelsmerk aanvragen in plaats van een patent. Door het aanvragen van een handelsmerk valt een beginnende onderneming voor de consument eerder op tussen de variëteit aan producten binnen een markt. Patenten zijn van groter belang wanneer een onderneming in een geconcentreerde markt actief is, waarbinnen dominante technologieën de standaard bepalen. In dit geval kan een beginnende onderneming zonder een patent weinig beginnen tegen grote, zittende bedrijven. Ten slotte vindt Hoofdstuk 5 een relatie met betrekking tot het type klant van de beginnende onderneming. Ondernemingen die zich richten op distributie naar eindconsumenten vragen

eerder een handelsmerk aan, waar ondernemingen die andere bedrijven dienen de preferentie geven aan een patent. Deze bevinding is intuïtief aangezien handelsmerken gerelateerd zijn aan een marketing differentiatie strategie, waar patenten samengaan met een technische- of product differentiatie strategie.

De bevindingen van dit proefschrift zijn relevant voor beginnende ondernemingen en VCs. Beiden ondervinden gevolgen van de volatiliteit van de VC markt, en zouden verschuivingen in het economische klimaat zo vroeg mogelijk moeten signaleren en meenemen in de strategische planning. Overheden moeten zich bewust zijn van de volatiliteit van VC en proberen schadelijke gevolgen voor economische groei te beperken. Ten slotte, voor beginnende ondernemingen kunnen handelsmerken, naast het opbouwen en beschermen van toekomstige marketing activiteiten, een goede eerste stap zijn in het communiceren van markt oriëntatie naar mogelijke investeerders.

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This thesis analyzes venture capital (VC) investments under changing economic conditions and in relation to start-ups' intellectual property (IP) filings. Studying the impact of the 2000-2001 dot-com crisis and the 2008-2009 financial crisis, the first part of this thesis investigates how a period of economic downturn affects VC activities across industries and countries. The second part of this thesis examines VC-backed start-ups' IP filings. The relationship between IP filings and start-up valuations by VCs is addressed. In addition, part two analyzes the impact of VC funding on a start-up's IP orientation, distinguishing between a trademark- and a patent orientated IP strategy. Findings show a strong link between economic conditions and funding stages, funded amounts, and syndication activities in the VC market. With regard to IP, this thesis shows that VCs attach significant value to start-ups' trademark applications.

Geertjan de Vries (1984) obtained his Master's degree in Economics & Business at Erasmus University Rotterdam in 2008. In 2009 he started his PhD in Economics at the Tinbergen Institute. His work is published in *Journal of Business Venturing, Venture Capital, and Oxford University Press.* Currently, Geertjan works as an assistant professor at the Department of Applied Economics at Erasmus University Rotterdam.