ERASMUS UNIVERSITY ROTTEDAM

Erasmus School of Economics

Master Thesis

THE RISE OF CLEANTECH IN THE VENTURE CAPITAL INDUSTRY

Name: Aivaras Kovalenka
Student number: 359199
Supervisor: Geertjan de Vries
Rotterdam, 2012 08 01

Abstract

This research investigates the venture capital activity in the U.S. cleantech industry in the last decade. It concentrates on the participation of governmental VC actor types in the funding of cleantech start-ups; VC firms experience levels and the likelihood to syndicate cleantech investments. The results suggest that the presence of governmental VC actor in the funding round increase the odds that the funded company is from the cleantech sector. I also find that cleantech start-ups are more likely to be funded by more experienced VCs. However, there is no evidence of syndication in the sector.

Table of Contents

FIGURES

TABLES

1 Introduction

This study examines Venture Capital (VC) investments in the clean technology sector within the United States. The clean technology sector, also referred to cleantech, contains products and services that either makes processes more efficient or that decrease the damage to the environment. Venture capitalists (VCs[1]) serve as investors for entrepreneurial companies, that use new technologies or unproven business models. This study examines the rise of the cleantech in VC industry in the past decade and keeps focus on the characteristics of VCs that invest in the cleantech sector.

The interest from VC firms to the cleantech sector is constantly rising. From experimental VC investments destination the cleantech shortly became the mainstream investment category (Burtis, 2006). Besides the raising attention, the cleantech sector still lacks profitable exits and therefore, investments are shifting towards the later stage deals (Freed and Stevens, 2011). While the VC investment in the cleantech is troubling, it might be valuable to know more about the characteristics of venture capitalists investing in the cleantech sector. However the research done in this field is minimal. One of the few papers in the cleantech by Ghosh and Nanda (2010) suggests that the capital requirements in the sector are huger; therefore government intervention in the field is welcome (Jenkins et al., 2012). Unknown sector for VCs also causes uncertainties, which are better held by more experienced VCs (Sorensen, 2007) and minimized using more intense syndication (Brander et al., 2002).

This leads to the following research question: "*Can the venture capital industry support the growth of the cleantech sector?"* To answer the research question, I use the VentureXpert database, which contains large amounts of data on the VC industry and is widely used among VC industry researchers.

Using the database, I looked for confirmation that the government is likely to participate as a VC investor in the funding of cleantech start-ups. This might be the case since the government and the cleantech sector both have similar environmental goals. Therefore, the government has incentives to urge the growth of the cleantech sector. Government also carries deeper capital reserves to fund the sector's growth.

[1] term venture capitalists (VCs) and VC firm are used interchangeably in the text

Cleantech, as a sector, is relatively new and most of the companies in it are young. It is expected that, for venture capitalists, it might be an unknown field and raise various unexplored uncertainties and risks; therefore it is highly possible that cleantech start-ups are financed by experienced venture capitalists, which are able to deal with risks better (Sorensen, 2007). Experienced VCs usually carry wider networks and higher background in managerial know-how compared to new business owners.

To deal with risks, VC investors are likely to fund single company with one or more partners in one funding round – to syndicate the investment. Syndication can mitigate risks involving investors with different strengths (Hochberg et al., 2007). VCs widely use it, because it increases the likelihood of success at the same time lowering the capital and management requirements. For the cleantech sector, syndication might prove to be helpful, since more VCs are likely to provide solutions for the cleantech sector problems.

My empirical analysis shows evidence that the governmental VC actor is likely to participate in the cleantech sector funding rounds. Firstly, the government's support is visible and it could be immensely useful to continue the growth of the cleantech sector. Secondly, I find that experienced VCs are more likely to finance cleantech companies. Experienced VCs could foster the growth of the sector with more appropriate methods. Third, this study was unable to bring any evidence of more syndicates in the cleantech sector. The reason could be that the cleantech sector still lacks networks of venture capitalists, since it is relatively young sector. Nevertheless, this study proves that the cleantech sector is growing and receives increasing attention from investors.

The paper continues with structure of venture capital industry in part 2; in part 3 and 4 the VC cycle and relevance of the industry for start-ups is described. It is followed by part 5, where the cleantech sector is introduced. After it, in part 6, hypotheses are derived from the literature. Part 7 consists of the data and methods used in the empirical analyses and followed by the results. Finally, the paper ends with discussion and conclusion about results of the study and provides remarks on the study's limitation, policy implications and possible future research.

2 Venture Capital industry

Venture capital firms provide capital for young companies with high-growth potential. These companies are called start-ups and have the tendency to exploit innovative technologies or unproven models, which are led by people with an entrepreneurial attitude. However before receiving VC investments start-ups have to go through careful due diligence followed by intensive monitoring and direct assistance at a later stages. VC firms' goal is to build companies which could mature to go public and bring sufficient returns. Well-known firms like Amazon, Apple, FedEx, Genentech, Intel, Microsoft, Netscape, Starbucks and many other received venture funding at their time.

To get the main idea of how VC industry works I used the following example by Zider (1998). The following description briefly introduces all participants in VC industry: "entrepreneurs who need funding; investors who want high returns; investment bankers who need companies to sell; and the venture capitalists who make money for themselves by making a market for the other three" (p. 135). It is illustrated in Figure 1.

Figure 1 The structure of Venture Capital industry (Bob Zider, 1998)

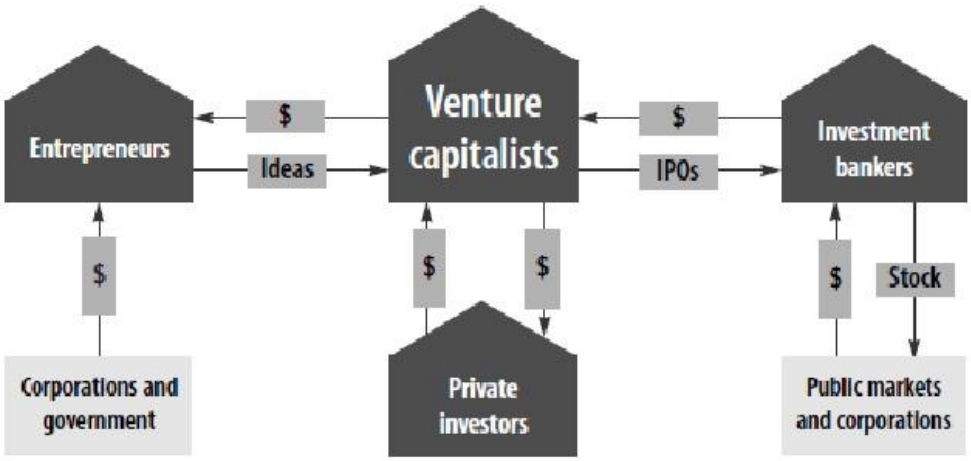


Figure 1 shows clear visualization of how the VC industry works. Entrepreneurs here represent founders of newly established start-ups. They can receive money from Venture capitalist firms or other institutions and government. VC firms gather money from private investors, which include large corporations, government, etc. The government can participate as a single venture capital provider. More often it supports

in terms of tax exemptions, subsidies or tries to accelerate the growth in the particular industry by the other type of policy implications (i.e. Feed-In-Tariffs). The private investors, which are also representatives of pension funds, insurance companies, financial firms, university endowments etc., set a part of their total investment portfolio for risky investments aside. That part goes to the funds managed by the venture capital firms. An investment banker in this picture serves as another industry intermediate between VC firms and public stock markets. Bankers can earn great interests from these deals; therefore they are constantly seeking fresh companies to bring to the stock market. (Zider, 1998)

The venture capital managers are the joining part for all these participating players. They take care that the transactions are made to the proper end. They oversee that entrepreneur would stick to the path. They provide bankers with ready to go public companies. Finally, they grant investors with high interests. As a reward, they receive commissions and interests on the profitable deals.

2.1 Venture Capital in the Global Financial System

Venture capital firms serve a unique role in the financial system. It is one of the few instruments that are able to finance risky but promising companies making progress within industries. Besides creating new jobs and generating wealth through small business venturing, venture capital can serve as a practical tool to employ innovations that are discovered but not yet made predominant (Keuschnigg, 2004).

Besides the higher risk, venture capital investments tend to be long-term and illiquid. Thus, it is considered to be as an alternative investment compared to the traditional investments. The most risky property of venture investing is the possibility of losing the investment completely (NVCA, 2010).

2.2 Financial constraints of start-ups

A company can finance its interests either by issuing equity or debt. However, new companies face difficulties obtaining working capital, and this is especially the case for innovative and entrepreneurial start-ups. New firms confront challenges relating to moral hazard, adverse selection and collaterals. The venture capital market then serves as a perfect intermediate between the high-risk seeking investors and the high-risk firms having potential to bring high returns (Schroder, 2009).

To get a little deeper understanding, I am going to go through VC history. Then I will explain the core points of how the VC industry works through the venture capital cycle. That is followed by an introduction to the cleantech industry and how VC interacts with it.

3 History of the VC industry

The successful Venture Capital model everyone tries to replicate today was developed in the United States of America. The first VC company was established in 1946. The company was named American Research and Development Corporation, well known as ARD (or ARDC), by MIT President Karl Compton, Harvard Business School Professor George F. Doriot, and other local business leaders. Their goal was to commercialize technologies developed for World War II (Gompers and Lerner, 2004).

The business model ARD used at a time was pretty simple and also different from the one used now. As Gompers and Lerner (2004) described "ARD was structured as a publicly traded close-end fund". Such funds would raise capital by selling its shares to investors upfront with no investments made by the fund so far. The shares could be traded among investors as individual stock. After ARD raised the capital, the company had a freedom to invest it into illiquid assets of their choice. Because investors were able to trade these stocks easily, anyone could invest in it. ARD and other newly emerging close-end funds activity was considered to be off high risk; therefore institutional investors were avoiding ARD shares and shares were more popular among individual investors (Liles, 1977). After all, such structure brought disadvantages, especially for amateur investors, who were unable to evaluate the risk of this type investment (Gompers and Lerner, 2004).

First venture capital partnerships as we know it today evolved in 1958, which were Draper, Gaither, and Anderson. Partnerships were limited in liability, meaning shares of such partnerships could only be dispersed from the issuing firm and not on the markets. However, the majority of 1960s and 1970s VCs were still working as the closed-end funds or small business investment companies (Gompers and Lerner, 2004). During these years, the industry was still very marginal and did not saw substantial increase in funds.

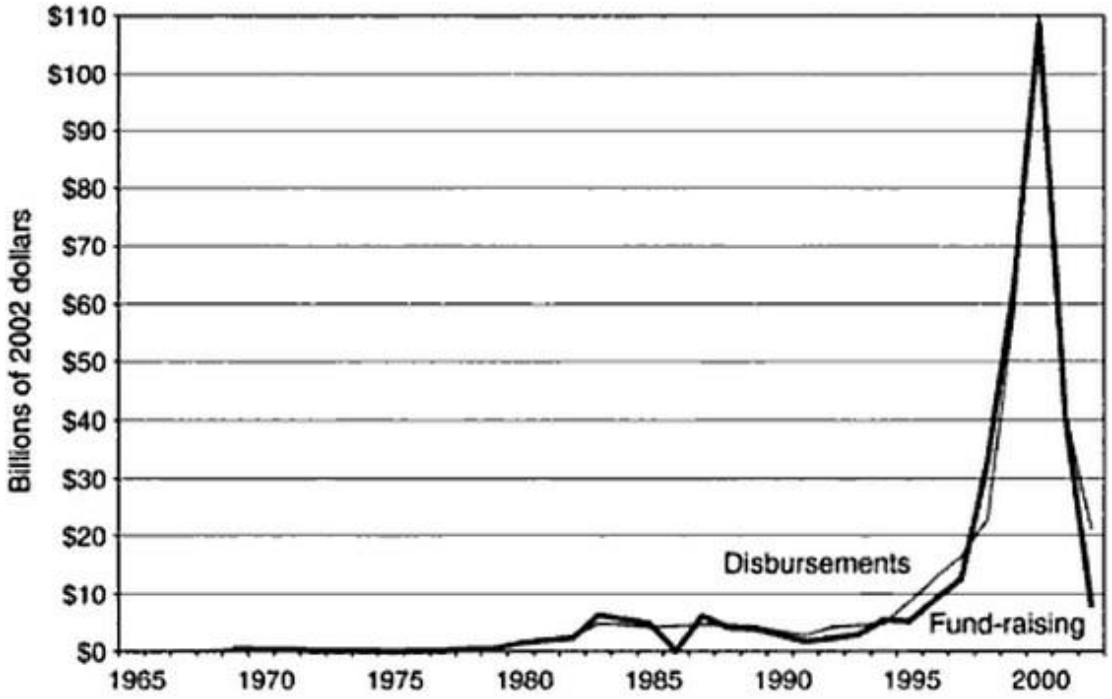
It was in 1980s that the VC industry felt its first rise in funds. Figure 2 illustrates that, from 1979, the funds flowing to VC industry started to increase. Gompers and Lerner (2004) suggest this might happened due to changes in governing of pension funds and newly introduced laws in favor for institutional investors. This added up enormous amounts of capital to VC funds and accounted for more than one forth of total VC fund size (Gompers and Lerner, 2004).

During 1990s, the limited partnerships were becoming the dominant form of VC firms. In words of Gompers and Lerner (2004), the limited partnership of a VC firm consists of the venture capitalists, which are general partners and control the fund's activities; and the investors, which serve as limited partners. Partnerships were based on agreements which pointed out governing terms for venture capital company managers. The duration of such partnerships were settled upfront and had definite ending. They lasted ten to thirteen years at that time.

In the period from 1980s to 1990s, the VC sector experienced various fluctuations. In year 1985 VC sector was almost demolished and merely any funds were raised that year. Even though it started to take off just after, suddenly it started continuously decline till the beginning of 1990s (Figure 2). This happened mainly because of decreasing returns, caused by inexperience and inaccurate over investments by managers (Gompers and Lerner, 2001). Later in the 1990s VC industry cleaned itself from inexperienced venture capitalists and that led to steady growth of returns within the industry in the beginning of the decade (Gompers and Lerner 2004). VCs gained more advantage over investors, as the amounts of capital VCs invested per company increased, the compensations of VCs also increased, and moreover VCs managed to favor terms of partnership agreements for themselves (Gompers and Lerner 2004).

Loosening of investment behavior constraints for VCs proved to be premature. Valuations of the companies in which VCs were investing multiplied unnaturally. That was due to overoptimistic attitude towards IT and especially the internet related companies causing 2000-2001 dot-com crisis (Ljungqvist and Wilhelm, 2003). In year 2000, those valuations declined dramatically bringing shaky environment for VCs and leaving them with worthless investments.

Figure 2 Funds raised and funds disbursements during the years 1965-2000 (Gompers and Lerner, 2004)



In a later period till economic crisis of 2007-2008 VC industry grew on a small pace. The financial crisis affected the industry more by exogenous shock than by internal disruptions (Block et al., 2010). The number of potential investors decreased, lowering new capital availability and causing VC funds to shrink. Moreover, the opportunities for exit also declined due to financial difficulties in the global markets. Downturn of the economy not just slowed down the VC industry but also contracted it, even though the industry was on the rise again (Block and Sandner, 2009).

At the moment, VC industry is recovering globally, and industry analysts expect this to continue (Thomson Reuters and NVCA 2011). Although the pre-crisis levels are not yet reached, there are clearly signs that new growth line is going to pass previous boundaries. The expectations to achieve further growth in emerging markets like China, India and Brazil are much higher compared to traditional markets like U.S. or Europe (Deloite and NVCA 2010). However, recent slim upturn in the U.S. venture capital industry is still raising doubtful expectations about the industry future. Therefore investors, as well as venture capitalists themselves, started to broaden their attitudes and look for the investment opportunities abroad (Guler and Guillen, 2010).

4 How Venture Capital works: Venture cycle

Venture capital cycle is a natural way to explain working mechanisms of a VC industry. Briefly it consists of (1) fundraising, (2) venture investing and (3) exiting venture capital investments; then it starts again (Gompers and Lerner 2001). All these parts of the cycle interact with each other. On a VC firm level, exiting the previous venture investment has a substantial impact on the following fundraising and venture investing. However, each part of the venture cycle covers different and additional aspects of the VC industry.

Therefore, I chose the venture capital cycle theory to illustrate the VC industry, expanding it where necessary. This chapter includes the following parts: (1) the fundraising, which compiles of its causes, the structure of funds and partnerships, and the compensation of VCs; then (2) the investment part is analyzed, where the industry problems and solutions to them are introduced; lastly (3) the exit of investments, the IPO market, its conditions and start-ups performance towards it are described. The venture capital cycle makes clear how the VC investments are organized and executed.

4.1 Fundraising

Fundraising is a building base of the VC cycle. During it, VCs raise capital from the investors that are seeking high returns in exchange of their money. These investors usually are public or corporate pension funds, insurance companies, banks, high net-worth individuals, university or other institution endowments, sovereign wealth funds and other familiar sources (Gompers and Lerner, 2004). Gompers and Lerner (2004) also presented evidences that till 1995 more than one forth of capital was provided by private pension funds. More recently major capital providers for VC funds are predominantly becoming wealthy individuals, corporations and endowments. These investors choose VC funds as risky investments in their portfolio. Therefore they expect for higher returns on these investments and evaluate the possibility of profit. All these investors are main providers of a VC funds.

The fundraising is usually driven by fund's characteristics and past performance. However, the government can also affect the process with passing favorable laws for the VC industry (i.e. Small Business Investment Act of 1958; Employee Retirement Income Security Act (ERISA) in 1978), thus, enhancing growth and financial inflows to VC

funds. In one of Gompers and Lerner (1998) papers, they went into details about supply and demand side of fund raising. The authors mentioned essential elements on VC firms' level that does affect the size of the fund. These are: past fund performance; larger equity stakes in companies which went public recently; reputation, which is measured by funds size and age, etc. Moreover, in accordance with Gentry and Hubbard (2002), Gompers and Lerner (1998) explicitly excluded the capital gain tax rate. When the rate decreased - higher amounts of capital were raised. External economic factors, like national GDP growth or governmental R&D expenditures, also have a stimulus to increase funds raised by VCs. All these causes are the main influencers of the monetary size of the VC fund.

4.1.1 Fund structure

Capital accumulated during the fundraising is devoted for certain VC fund, which has its own strategy and lifespan. VC funds are the main instrument through which VC firms make investments to the start-ups. Each new fund distributes its portfolio over the first three-five years. VC funds usually have clear ending dates that are agreed before fund investment decisions are made, the term is about ten-to-twelve years (Gompers and Lerner, 2004). This helps to spend time efficiently on companies which are able to reach desirable and profitable exits and not on those start-ups which are underperforming. Usually VC funds set upfront its investment goals and selects industries, whenever it is biotechnology, communication services, computer software or any other. Funds may reflect limits set by the VC firm, if there are any. These could be: to invest in a certain stage of a venture or a specific geographical region (Sahlman, 1990). Additionally those selected companies that VCs invest in are trying to exploit complex or unprecedented technologies with vague aftermaths (Gompers and Lerner, 2004). This is probably the most important fact which raises most of the risks of such investments. The goal of a fund is to reach liquidity when the fund terminates. After investments are converted into cash or other liquid assets, it is spread among investors and not reinvested into new ventures (Gompers and Lerner, 1999). Funds are raised on ongoing bases with some restrictions. While one fund is just in the middle of its lifespan, the other is newly raised. Therefore, the distribution of returns and investment phases overlap. However, projects of one fund do not alternate or transfer to the other funds.

4.1.2 The structure of partnerships

Interaction between VCs and investors happens through private limited partnerships. As were mentioned before, the most prevailing form of partnerships in recent years have two participants: VCs – the general partners and investors – the limited partners. Prior agreements define the duties of both parties. These agreements are strict and renegotiated on exceptionally rare occasions. General partners – VC mangers operates the funds. The returns of investments are divided among limited partners – the investors. Investors have an ability to monitor the progress of the fund, attend annual meetings and have the voting right on key issues (Kaplan and Strömberg, 2004). To maintain the limited liability, investors do not have influence on everyday decision and VC managers keep the power over decisions. Such structure includes the possibility for investors to lose all their invested capital if no profitable outcome is reached (Gompers and Lerner, 2004). Therefore VCs are forced to commit as well. However, their contribution usually is in the form of obligatory note and not cash (Sahlman, 1990).

4.1.3 Venture capitalist compensation

The partnership agreements include the clearly defined financial compensation of the activity done by the VC fund managers. Two main sources of VCs remunerations are management fees for handling everyday issues and a portion of profitable fund outcomes (Gompers and Lerner, 2004). In numbers, the fixed fees tend to be approximately 2.5% of the funds accumulated capital through its lifespan. The share from realized gains of the fund dedicated to VCs is fluctuating from 15% to 25% in different partnerships (Sahlman, 1990). Although compensations are based on returns from the venture funds, investors, more often than general partners, have the priority to profit disbursements.

4.1.4 Principal-Agent problem: Funds' investor – Venture Capitalist case

The relationship between investors and venture capitalists raises the principal-agent problem. The VC managers serve as agents for investors, who are the principal in this situation. However, due to the VCs active role and close insights in portfolio companies, this problem becomes especially challenging within the VC industry. The limited partners are left with much less information about the actions that VCs are undertaking. The problem is addressed in governing agreements and other mechanisms

of supervision, in order to avoid VCs putting their interest against the limited partners' interests. However Sahlman (1990) proved, with mathematical calculations, that terms in the contracts between VCs and investors do encourage VC managers to maximize the value of carried interests. In this case, the main interest is increasing the value of the VC fund and this is the very same thing investors seek.

All these issues mentioned above relate to fundraising – the first step of venture cycle. It involves legal and monetary issues, which are solved in the contracts between the general partners – VC managers and the limited partners – investors. After the capital is raised VCs start to look for and screen investment possibilities.

4.2 Venture Investing

Venture investing is the next stage after VC funds have raised capital and set its goals. This stage is the core of VC business model and involves vast amounts of managerial work. After long due diligence of many applications and acceptance of just a few, VCs start to monitor, advise and shift the direction of the startups – these activities take most of the VCs time (Zider, 1998). The involvement of VCs in this part is highly crucial for both parties. VCs usually add value to the company (Gomper and Lerner, 2001) and increase the possibility to reach better exit opportunities. In a mean time, they have to deal with problems and uncertainties caused by new and fast growing start-ups. Thus, VC industry serves a unique role providing solutions to these issues.

4.2.1 The role of Venture Capital

First of all, it is necessary to understand, why entrepreneurs are unable to find finance elsewhere besides venture capital and why venture capital is so suitable for entrepreneurs developing innovative ideas. Want-to-be entrepreneurs rarely have the capital to begin their business. Even if they do have enough capital, entrepreneurs still prefer VC financing for better discipline, more knowledge, networks, etc. (Andreessen, 2012). Financial support of banks poorly satisfies the needs of risky startups, which do not have collateral or cannot promise any revenues during the first years. Those entrepreneurs pursue technologies and strategies which might have never been used before but have promising growth potential. Here the presence of VCs makes sense, since they have goals to bring maximal value to the VC funds and earn living practicing

risky investments. This way VCs fills a financial void for entrepreneurs at the same time employing investor money.

Investors, who do have capital but do not have time to analyze or monitor potential ideas, trust VCs, who serves as capital distributors from investors to entrepreneurs. Gompers and Lerner (2004) also distinguished four main difficulties which affect the possible choice of financing of new venture. These are: uncertainty, asymmetric information, nature of firms' assets and conditions of financial and product markets.

4.2.2 Trust issues

However, one of the biggest issues in venture investing is the relationship between VCs and entrepreneurs. This relationship reflects the principal-agent problem similar to one mentioned in general and limited partners' relations. The difference now is that venture capitalists are the principals and entrepreneurs are the agents. VCs, being in the principal position, have intentions to believe that their interest might not be served to the full potential and have doubts about the possible existence of the hold-up problem. That is when one of the participants stops achieving maximal value for both parties because trust issues occur about the other party's intentions to maximize outcome for both. Situation might create issues such as adverse selection, asymmetric information or moral hazard. Therefore VCs, besides maximizing investment value, also seek to prevent the rise of the potential problems.

4.2.2.1 Asymmetric information

Asymmetric information, in VCs – entrepreneurs' relation, reflects the issue that entrepreneurs know much more about the likely success and everyday issues of the start-up than VCs (Hall and Lerner, 2010). Thus, they are able to use that information for their personal goals minimizing the value creation of VC investment. VCs realizes the situation and introduces its own mechanisms to prevent this from happening.

4.2.2.2 Adverse selection

Adverse selection – when entrepreneurs are likely to inflate the perception of firms proposal for which they are seeking investment to secure the funding. Venture capitalists are not sure whenever investment to the new start-up is going to be bad or good. They must be aware that entrepreneur might try to sell them a "lemon". As described by Akerlof (1970), VC industry is the marketplace for financing the

development of innovative ideas that are like "lemons". Therefore, VCs assume that investment is of average quality and offer conditions accordingly. Because investors have difficulties differentiating good projects from bad ones. This especially seems to hold for the market to finance start-up firms that have a long-term lifespan and risky R&D investments (Hall and Lerner, 2010). However, following-up the "lemons" problem, the above-average firms then withdraw from the market, what causes average of firms in the market to drop. VCs know this and raises the average valuation of a firm accordingly in a next phase. Again the above-average firms will withdraw, and this will continue till the market for financing ventures disappears (Klausner and Litvak, 2001).

4.2.2.3 Moral Hazard

Moral Hazard – as known in economic theory, it is the situation when risks are taken by the party which is not responsible for the cost of those risks taken (Dembe and Boden, 2000). In a VCs' – Entrepreneurs' relations such a situation might be when entrepreneurs find incentives to act egoistical and endeavor self-centered goals. The following simplified possible forms of a conflict between management of a start-up and VCs are suggested by Klausner and Litvak (2001, p. 4): "(a) managers failing to exert optimal effort; (b) managers using firm resources, or neglecting opportunities, to create private benefits for themselves; (c) managers adopting strategies that entail too little (or sometimes too much) risk relative to the expected return and (d) managers departing from the firm at a time when replacement is costly." The situation is likely to increase the agency costs – capital or other company assets used for personal goals of the entrepreneur, increasing conflicts between parties (Hall and Lerner, 2010).

Moreover in VCs' – Entrepreneurs' relations moral hazard issue are beyond the traditional framework as suggested by Repullo and Suarez (2003). They refer to double-sided moral hazard, because venture capitalists are equally or even more interested in success of an investment. This is the issue because VCs have the power to share knowledge and networks of their own in order to prosper the value of a start-up. In order to solve this issue properly, incentives have to be arranged for both parties.

4.2.3 Solutions to trust issues

Venture capitalists have their own way to deal with all the trust issues mentioned. In order to avoid buying 'lemons', VCs have profound screening process and long

valuation negotiations. The selected companies then receive the investment together with close managerial involvement of VCs, what helps to deal with asymmetric information. To reach the goals and lower the agency costs, VCs injects only a portion of money at a time; the other portion is injected only after certain deadlines are met. Finally, to lower the risk, investments are made together with several other VC firms. VCs actively use these instruments to pick and grow the most valuable start-ups.

4.2.3.1 Screening

The process of investment begins with screening possible options. VCs has to go through many applications of the investment opportunities provided by the entrepreneurs. Researchers have agreed on several factors, which influence the decision whenever VC is going to financially back-up the start-up or not. Namely they are: (1) the experience and reputation of entrepreneur; (2) the attractiveness of investment opportunity provided by the firm; (3) the stage of the company at which investment takes place; (4) negotiating skills of both parties; (5) and the overall state of the VC market, what is considered essential and having pivotal weight (Christopher, 2001; Megginson, 2004; Kaplan and Strömberg, 2004). Screening is activity done by VCs, and this duty has extremely little time in VCs schedule, compared to other VC activities. Therefore, VCs has to be truly efficient with their time in order to achieve the best investment outcome, since only remarkably small portion of all candidates receives funding (Zider, 1998).

4.2.3.2 Investment valuations

The other noteworthy aspect in venture financing is the valuation of a start-up. Gompers and Lerner (2000) proved that increased inflows into VC funds inflate start-up valuations. On contrary, Hsu (2004) finds that the higher the reputation of VC, which dependents on experience, information network and assistance to portfolio companies, more likely the VC will invest at a higher discount, meaning lower valuations for the start-ups getting the investment. The valuation of a start-up is also influenced by its past efforts, the current level of sales revenue, the tangible assets, the present value of expected future profits and other similar factors (Megginson, 2004).

Valuation shows the perceived present monetary value of a firm that is negotiated by both parties, the entrepreneur and the venture capitalist. It is necessary for both, because entrepreneurs most of the time tries to multiply the value of a company while

VC tries to minimize it. At a particular agreed value, VC decides to invest into the firm taking respective part of equity to the valuation. This is the main reason of valuations - knowing the exact value each participant obtains. This process is done repeatedly from the first investment round through all the consecutive funding rounds till the exit of the investment is reached (Stancill, 1986).

4.2.3.3 VC participation in the start-up

Since the investment is made, quite often venture capitalists enter the management board of private company or in some cases become the direct managers (Gorman and Sahlman, 1989). Their involvement increases when the need to oversight firms' managers is greater and at a time when chief executive officer is replaced (Lerner, 1995). The desire of VC to monitor portfolio companies helps to go through obstacles and increase the value of investment, while lowering the possibility of risks. VCs share experience and their networks with employees in order to achieve faster growth and increase the value of a firm. The higher involvement of VCs - the better performance of financed venture (Sapienza, 1992). Study by Kaplan and Strömberg (2003) confirms that VCs are able to provide help in setting the goals which benefit main stakeholders – managers, owners and investors, even though it is complex and time consuming. Active participation is not common for other types of company finance (Hellman and Puri, 2002). Therefore, the VC industry is specifically perspective for innovative and entrepreneurial start-ups.

4.2.3.4 Staging investments

Staging the capital to the start-ups is one of the main mechanisms used by venture capitalists that helps handle their investments and get qualitative response from the entrepreneurs (Wang and Zhou, 2002). Staged investments in venture investing are meant to provide capital for ventures in portions and not all of it in one round. During each stage entrepreneurs receives sufficient amount of money to reach later stage and not more. Staging of investments for VCs helps to gather information and monitor the progress of a firm on a periodical basis, while at the same time keeping the possibility to quit the investment if necessary (Gompers and Lerner, 2004). Staging of investments also keeps entrepreneurs interests to act wisely and seek for maximum value in order to achieve further funding. However, there might be a drawback, since entrepreneurs have

the possibility to increase performance just before new stage in order to achieve further funding.

Gompers and Lerner (2004) in their work present that VCs usually invest in early-stage companies and high-technology companies, where monitoring is of high value. Kaplan and Strömberg (2004) then add that investment staging is practical and viable instrument to do so. Moreover, Gompers (1995) provides empirical evidence that staging has potential to lower agency costs. Also Bergemann and Hege (2003) add up that the process of staging is likely to increase entrepreneurial effort and mitigates financial constraints. Staging is one of the most substantial control mechanism a venture capitalist can apply (Sahlman, 1990).

4.2.3.5 Investment syndication

The main way for VCs to diminish the investment risks is to syndicate them. Syndication is the prevalent feature among venture capitalists to diversify portfolio or increase knowledge sharing among VCs. Syndication gives a possibility for venture capitalists to invest in the same equity together with one or more other VC companies. Syndicates usually have the leading investor, which is more actively involved with the targeted venture (Wright and Lockett, 2003). De Vries and Block (2010) describes the main reasons for syndication in the literature as following perspectives: financial perspective, which includes portfolio diversification (Markowitz, 1952) and liquidity (Lockett and Wright, 2001; Manigart et al., 2007); networking perspective, that is status (Dimov and Milanov, 2009) and the flow of future deals (Sorenson and Stuart, 2001); and resource-based perspective associated with knowledge sharing (Brander et al., 2002).

However, syndicating investments has some disadvantages. For instance, additional transaction costs, because of the need to coordinate with others when syndicating (Wright and Lockett, 2003). It also increases agency problems between venture capitalists (Fried and Hisrich, 1995). Syndication is a practical tool which should be used cautiously by venture capitalists.

Screening and setting valuations, participating, staging and syndicating investments is the main parts of VC investment activity. With these instruments, VC industry can cope with various trust issues bringing the maximal value out of the start-

ups. This helps to build young companies properly and bring them closer to the better exit opportunities while fulfilling the investor expectations.

4.3 Exiting Venture Capital Investments

VCs seek to liquidate their funds after it reaches maturity, usually a fund exits in an eight to ten years. Researchers agree that the most profitable exit of a VC investment is initial public offering (IPO) through which company issues shares to the public, while the next best option is usually the trade sale (Venture Economics, 1988) involving the M&A activity. Additionally there is a redemption option, when the founder buys back the equity of a company, but this is used on a very rare occasions (Fellers, 2001).

More recently the new liquidity option emerged. That is the secondary market on which shares of a non-public company can be traded among the private investors. Author – Ibrahim (2012) calls it the direct market for start-up stocks. However, the IPO is recognized as the most "profitable and prestigious option for the venture capitalists" (Megginson, 2004, pp 104).

Initial public offering as the most popular exit option for VC investments is prevalent in the United States. While Europe lacks behind and relies on M&A as the most popular exit option (Black and Gilson, 1998). The unavailability of a suitable IPO market for high-growth entrepreneurial companies in Europe might be the reason of slow development of the venture industry within the old continent.

The logical way for VCs to maximize their investment is to issue shares when equity is at its highest value. Lerner (1994) in his paper proved that, in most cases, companies go public when their valuations are high, but when they are low companies are trying to employ more private financing and increase the value. The good timing of an IPO brings advantages to both, the VC and investors. When valuations are high, and the company goes public, this situation minimizes the possible decrease in the value of investment (Barry et al. 1990). Moreover, as venture capitalists are likely to be much more experienced at bringing companies to the IPO compared to firms' management, they are more likely to bring most of the value from the process. VCs do have the power to put their intentions in action since they often own the board seat with managing rights (Barry et al. 1990).

Nevertheless venture capitalists do not sell off their fund equity shares at a time of an IPO. The time between issuing shares of a start-up and reaching the liquidity for investors is called the lock-up. The lock-up happens because of contract agreements with underwriters as well as to signal higher quality of a company (Brav and Gompers, 2003). However, the main reason in the research by Brav and Gompers (2003) is that lock-ups play a role in diminishing the moral hazard problems which can result from an IPO. After the lock-up, which can take several months or even years, earnings of investment are distributed among the limited partners in the form of shares or cash from selling shares on an open market (Gompers and Lerner, 1998).

The quality of the exit might be the performance measure of a venture capital firm. Therefore VCs tries to time and execute it correctly. The legal framework in the region where the exit is made is also relevant. Thus, it might be the reason why the U.S. VC industry is still in front and have highest potential to remain there (Gompers and Lerner, 2004).

As can be understood, all venture capital cycle parts relate to one another, while, at the same time, they refer to the different and distinct goals. Nevertheless all of the stages play the equally vital role in the VC industry. These stages highly affect further growth and development of a company.

5 The cleantech industry

Because of rising attention to environment issues and sustainability, it might be the best time for the cleantech sector to emerge. The nature of venture capital focuses on risky and innovative industries. VC played a crucial role in the emergence of biotechnology, computer services and semiconductor industries. The clean technology industry might develop to a promising market and serve the sustainability issues in the contemporary society. The last decade trend shows an increasing interest from investors to provide capital for companies within the clean technology industry (Stack, 2007). At this point, venture capital can serve as a perfect intermediate to distribute funds from investors to the entrepreneurial firms in newly emerging industries like cleantech.

Clean technology, or shortly cleantech is a relatively new term. Cleatech Group, which is a leading company in cleantech market research, defines cleantech as a product and/or service that (1) provides superior performance at a lower cost; (2) greatly reduces

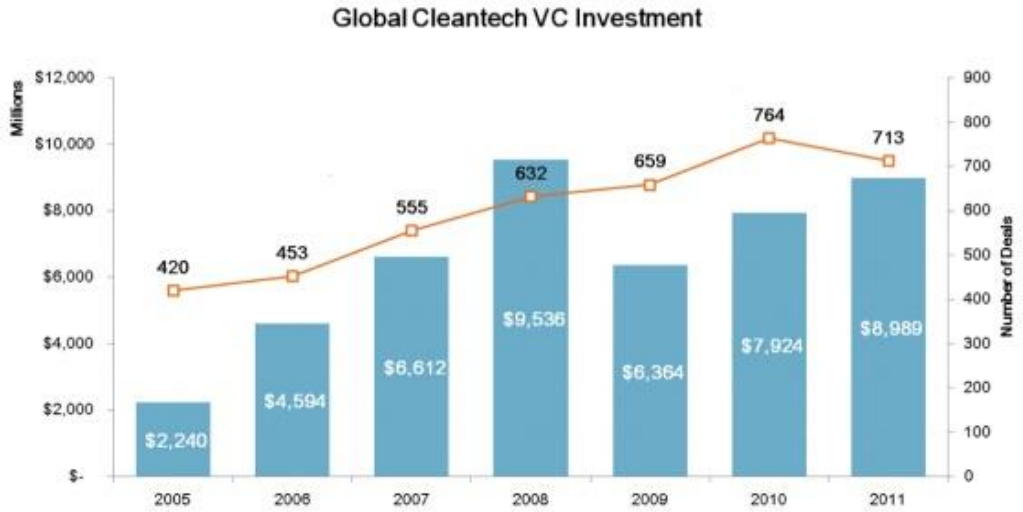
or eliminates negative ecological impact and (3) improves the productive and responsible use of natural resources. Moreover, all technologies or business models under the definition of cleantech offers competitive returns for investors. For practical understanding companies from cleantech sector usually are either from one of the following sectors: agriculture, air and environment, biofuels and biomaterials, energy efficiency, energy storage, materials, recycling and waste, smart grid, solar, transportation, water and wastewater or wind (Cleantech Group, 2012).

5.1 Overview of the past decade

Cleantech Group has collected some valuable information of cleantech industry growth in the past. The Figure 3, which is shown below, pictures the growth of venture capital investments in the cleantech industry globally. The growth of the last decade is clearly visible as well as the negative effect of the 2008 financial crisis. However, the industry quickly got back to its pre-crisis levels and the new rise is apparent.

Moreover, the results of the survey done by Deloitte and NVCA (2010) suggest promising future for the cleantech, as venture capitalists plan to keep investing and increase investments in it. The company did the survey asking VCs what sectors according to them are going to receive most investments from VCs in the next five years.

Figure 3 Global Cleantech Venture Capital Investments (Cleantech Group, 2011)



The visualized results of the survey are shown in Figure 4. Clean technology sector clearly stands out from others and is the leading future investment destination for VCs.

As VCs expectations for the future of the cleantech sector are high it might be expected to attain more investments in the sector; more VC investments and managerial competences provided by VCs then could bring more successful exits.

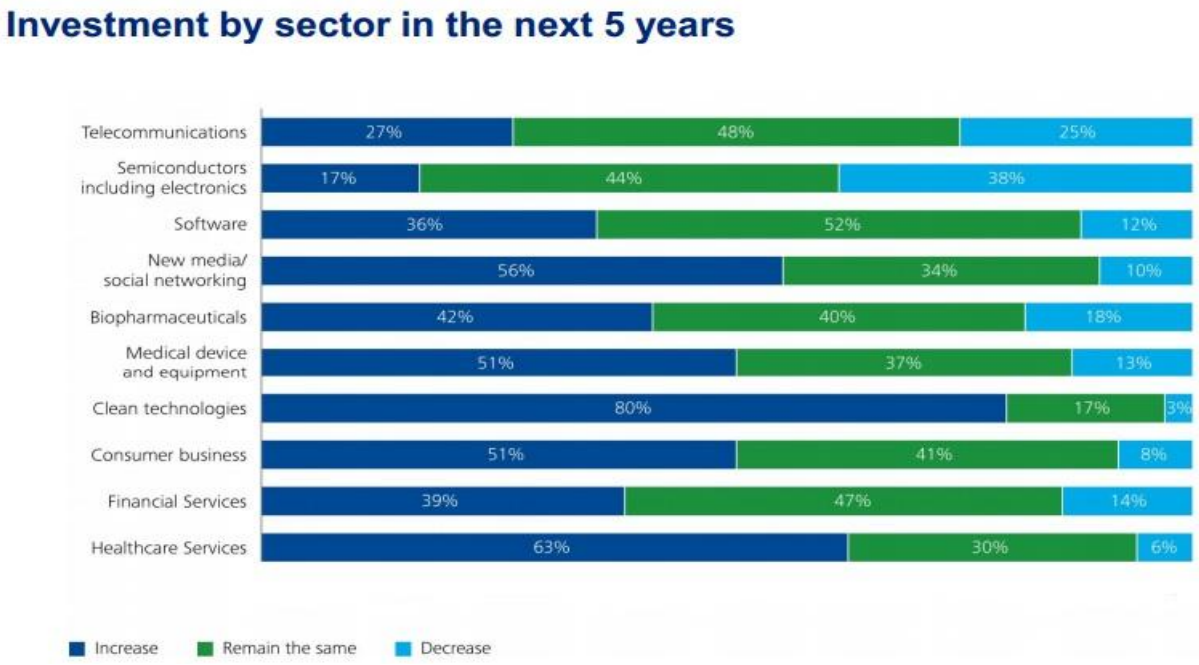


Figure 4 VC Survey: Investment by sector in the next five years (Deloitte and NVCA, 2010)

6 VC Investments in Cleantech: hypotheses development

The cleantech sector has a promising future according to the surveys and expert opinions. However, to know more about present performance of the sector, I am going to derive hypotheses about the governments' participation in its funding, investor's experience levels in the sector and whenever they are willing to invest in the cleantech with other partners or alone.

6.1 The role of the government

In venture capital cycle processes, the government plays a key role as the financial and legal framework builder. The government also has an ability to participate as a successful venture capital provider. One of the most influential governmental interventions to VC industry is considered to be the historical Small Business Innovation Research (SBIR) program which took place in the U.S. since 1982. Firms receiving SBIR grants showed much better performance compared to non-receiving ones (Lerner, 1999). The other study done by Jeng and Wells (2000) proved that the

government has a strong impact by setting the regulatory framework and by maintaining investments during the downturn.

However, other authors (O'Shea, 1996; Gans and Stern, 2003) pointed out that direct government support has drawbacks or might interrupt the private VC market. It might crowd out the private venture financing and does not provide additional support or increase employment (OECD, 2010). The situation could possibly transfer the costs from private financing to the government (Wallsten, 2000). Moreover, governmental actors usually lack efficiencies and governance skills provided by private VCs (OECD, 2010). Deeper results by Grans and Stern (2003) of the SBIR program performance concluded that governmental grants were given to the companies already receiving financial support from other sources and not the ones needing it most (Wallsten, 1998 and 2000), therefore, distorting the real influence of the program. Brander et al. (2008) then raised discussion whenever government should intervene the VC market at all. The selection process might be less of a problem while it is possible to choose from already growing and funds receiving companies. However, the forthcoming treatment, after the funding is made, might be more crucial and less effective from the government than from the regular VC firm (Brander et al., 2008). It is hard to conclude, because it remains unclear whenever it is efficient and necessary for the government to support industries or not. The prevalent situation raises suggestions that maybe the government should only stimulate the VC activity by clearing out regulatory obstacles.

Nevertheless governments' can be uniquely useful at spinning off new industries. Cleantech is an example of an industry, which interests the government, because it constitutes of companies in various areas, which relate to the problems governments are trying to solve. Cleantech includes companies that are working on renewable energy, energy storage and efficiency, improving biofuels and developing agricultural processes. The results brought by these companies might have a direct impact on solving comprehensive global issues like reducing green gas emissions or improving environmental sustainability. These are in line with governmental goals (Office of the Press Secretary, 2010; UNFCCC, 2011). These common goals that cleantech start-ups pursue, and the government tries to achieve, are the joining particle that brings capital from the government to the cleantech sector. This might help grow the sector to the point, where it could support itself (Jenkin et al., 2012).

The support by the government varies from country to country depending on the technology. It can take a form of direct spending, as in the U.S. (Jenkins and Mansur, 2011); feed-in-tariffs for renewable energy, what is popular in Germany, Spain and other European countries (IEA, 2008); or other type of industry incentives like direct funds in China (Tan, 2009). For the additional support, the government can lead the demand side as a consumer of new products or services (Jenkins et al., 2010). Such huge and important first customer as the government might be crucial for the evolvement and growth of a new industry. While for the government – industry growth may be relevant for its domestic economy at the present and in the future. Therefore, the government has the incentive to be the first to recognize and promote industries like the cleantech.

The government can ease the financial constraints of highly priced technologies at their introduction, especially when the new technology is acknowledged and widely used in public. Those new technologies face risk barriers, which might be too difficult for private capital to overcome (Ghosh and Nanda, 2010). That is the financing gaps which are killing promising technologies too early in the development or the commercialization processes. As Jenkins and Mansur (2010) name it, these are "the early-stage "Technological Valley of Death" and the later stage "Commercialization Valley of Death". Authors agree that the private funds have to be much bigger (Ghosh and Nanda, 2010) and institutional arrangements have to be adopted (Jenkins and Mansur, 2010) to meet requirements of cleantech companies to thrive. Therefore in the U.S. the main cleantech investor remains the government.

During last years the U.S. government heavily supported the clean tech industry. In the period from 2002 till 2008 the federal government of U.S. spent $44 billion cumulatively. The following year 2009 alone was the peak year, then spending reached $44.3 billion. In the next period 2009-2014 U.S. government plans to spend $150 billion additionally. The vast majority of those funds (59%) spent in 2009-2014 will be as direct spending from governmental institutions. Although spending decelerates, the direct government support is still viable (Jenkins et al., 2012).

In accordance with evidence from the past and close future prospects of the prevalent situation, I hypothesize the following:

H1: Cleantech start-ups are more likely to be financed by governmental investors.

6.2 Venture Capital firm experience

The venture capital investments might foster the development of a new industry. Even though VCs invest in high risk start-ups, cleantech might cause additional risks, as it is less known industry, whereas VCs are still unfamiliar with this relatively young sector. To make sure that the returns will be appropriate, VCs need additional insights before making decisions.

As in any other industry VCs invest to, cleantech also involves various forms of risks and uncertainty about returns. However, the opinion about risk met in the finance literature is more often associated with losses than profits (March and Shapira, 1987). Teppo and Wüstenhagen (2006) simplified and summed long list of risks up to five. The risks are from various VC investment stages of a technology sector. That is market adoption risk, technology risk, people risk, exit risk and regulatory risk. Teppo and Wüstenhagen (2006) then identified the complexity and relevance of those risks and possible solutions for managing them. What is common among all those risks is uncertainty, which is probably the main factor of increasing risks. That is uncertainty about the market demand; about technologies ability to work; about the management competence; about future market regulations and most important – the unclear exit path. The possible solutions to manage all these uncertainties caused by the various risks include staging investments; avoiding too early investments; increasing coaching and monitoring etc.; in some occasions - even lobbying.

All these actions seem to be better undertaken by more experienced VCs (Casamatta and Haritchabalet, 2007). As more experience increases VCs managing abilities to cope with new challenges (Bergemann and Hege; 1998; Sorensen, 2007). It is likely that more experienced VCs would be willing to accept investments with higher risks, as those mentioned, to gain higher returns.

Teppo and Wüstenhagen (2006) also suggested the possible return structure within the cleantech sector. The return - as in any other investment - is based on three things: price of investment, sale price at the exit and time between those two. Therefore the best investment would be when buying low, selling high and within minimum time.

For the cleantech sector it seems that there are enough start-ups waiting for money but too few VC firms willing to finance those companies. The main reason for this seems to be that VCs are unable to exit their past investments successfully in the sector (Ghosh and Nanda, 2010). This might be because of less experienced VCs in the sector. Nevertheless if the cleantech sector could attract more experienced VC firms, those should perform better, as more expernced VC firms with high reputation have higher chances to succeed (Kaplan and Schoar, 2004).

The exit price usually is never known in advance. Especially in case of an IPO, as it depends on market fluctuations and cyclicality. VCs are not likely to sell their investment on first days of an IPO because of lock-ups and contract agreements or fund structure (Barry et al., 1990); therefore, the situation involves more future risks. In case of the sale to the other company, price would depend on the value created by the start-up, which might be influenced by VCs and managers, and value it has to the acquirer, which might be less influential, as it can depend on the market and region, where the sale takes place.

Finally, the time of investment from buying to selling also might have variance. As the sector of cleantech is relatively young (it just started to catch attention), it is hard to evaluate VC deal time span. However, the time of investment could be hard to influence because of complexity in the technology used. Some cleantech start-ups might use advanced technologies that require high capital intensity and do not always fulfill scheduled expectations, as the project might fail too early or increase the time required for the technology to develop. This might be the case for renewable energy projects development or complex software algorithms used in cleantech devices. Thus, this part might significantly vary from company to company depending on the technology used and capital required.

As it can be understood, the return part is not directly affected by VCs efforts. Therefore, VCs could not influence the return but can significantly improve assessing and overcoming risks of the deal. Thus, experienced VCs should be able to cope better with these struggles. According to the literature and observations found, I hypothesize the following:

H2: Cleantech start-ups are more likely to be financed by more experienced VCs.

6.3 Syndication in Cleantech Investments

One of the possible solutions to overcome various risks emerging from the deals done by VCs might be to syndicate investments. One of many advantages suggested by Lerner (1994b) for the syndication of investments is to have a better selection process. According to him, it might be far better having two or more VCs evaluating same project before selecting it for an investment. It might be more effective because two or more VCs have a different experience and can see same start-up in a more broad view. Consequently, screening the investments is done more accurate.

The other crucial advantage of syndication refers to the value-added hypothesis (Brander et al., 2002). Different skills and information from more VCs may help boost new ventures growth and increase its value. Some VCs have improved managerial skills, while others may provide useful networks and international contacts. In the perfect occasions, this may cause synergies, therefore benefiting the start-up. Moreover, the single fact that two or more VC firms are willing to invest in one single start-up, may signal the favorable information to the other capital market participants. (Brander et al., 2002)

In contrary for syndication, sole investments may be more preferable by VCs if there are clear signals of high quality investment. In the other cases, syndication may work better: more than one VC can estimate the performance of a start-up better, assess the risks more accurate and lower the financial contribution of each participant.

As opposed by Tykvova (2005), syndication causes complexity when implementing and entails additional agency and transaction costs. Moreover, as an effort of each investor is hard to observe and evaluate, the effort itself can decrease. Furthermore, investors might be afraid to discuss syndication of the most profitable deals, as those might be stolen by partner and executed on their own.

For start-ups in the cleantech sector, syndication might be used as a solution to the sector's problems. Big portion of start-ups within the cleantech sector are using capital intensive technologies (Ghosh and Nanda, 2010). Investment syndication can be used to mitigate capital constrains, as most of the VC funds are not large enough that could solely finance such cleantech ventures (Bygrave, 1987). As cleantech can require massive capital intensity, investors may need to have greater levels of syndication.

Syndication could reduce the asymmetric information risks when investment is shared between multiply VCs. There are considerably more asymmetric information problems and more uncertainty in early stage start-ups than in close to the IPO ventures. As suggested by Seppä and Jääskeläinen (2003), syndication brings significantly more efficiency gains when there is much uncertainty. Moreover, ventures using high technology and requiring higher levels of investment (Cumming, 2006), as well as the riskier and younger ones (Tian, 2011), are more likely to receive syndicated investments. It is highly possible that cleantech companies posses exactly the same requirements.

Moreover, some research (Brander et al., 2002; Hochberg et al., 2007) provide evidence that syndication is positively associated with the returns and successful exit possibilities. Another research (Seppä and Jääskeläinen, 2003) proved that higher numbers of a syndicate partners increase the VCs ability to bring portfolio companies to the public. This is the case as mentioned above that VCs with diverse types of strengths creates the additional value for a start-up therefore bringing it closer to more attractive exits.

As clean technology start-ups still lacks representative exit examples, cause risk of high uncertainty and often include innovative technologies and processes, I hypothesize the following:

H3: VC investments in the cleantech are more likely to be syndicated than not syndicated.

7 Data and Methods

This chapter contains the description of data sample and source, followed by main variables used in the empirical analysis. The second part contains descriptive statistics of the data sample and presents the results of the study.

7.1 Data source and sample

In empirical analyses of this paper, I will try to provide the answer to the research question "*Can the venture capital industry support the growth of the cleantech sector?"* To do that, I will follow the hypothesis derived earlier. I will use Thomson Reuters

VentureXpert database, which is well known and used in venture capital research papers (Gompers and Lerner, 2004; Block et al. 2010).

VentureXpert is the largest and most used database for private equity and VC investments (Gompers and Lerner, 2004). It is updated on a daily basis. Even though the dataset dates investments since 1960s, in my work I am concentrating on cleantech industry investments made in the period from 2002 to 2011 to see how the industry changed over this period. In my analyses, I concentrate on funding rounds in which start-ups receive money (from single or multiple investors) as observation unit. I was able to collect data on 81,106 funding rounds in this period.

I am narrowing my sample on the activity of start-ups in the U.S. only. The VC industry in the country is oldest and the most advanced in the world, as well as the start-up community is the most prosperous in the U.S. The sample excludes missing values on start-ups and VCs age, which I used as control variables. Lastly the regressions are clustered by the unique start-up numbers to correct for dependence of funding rounds related to the same start-up. This final sample used in regression analysis contains data on 12,730 start-ups that received 36,229 funding rounds.

7.2 Dependent variable

The dependent variable used in the empirical analysis is cleantech. It is binary variable with a targeted group – companies within the cleantech sector – marked as "1" and reference group as "0" - all the other available start-up sectors within database. Although dependent variable is categorical, the order is not relevant; therefore ordered logarithmic regressions are not used. For regression analysis I use logarithmic logistic regression. To better visualize interactions between variables I used odds ratio to present the results.

7.3 Independent variables

The main three independent variables are *government*, VCs actor *experience* and *syndication*. Variable government is a dummy, where 1 means that at least one governmental actor is present in the funding round and 0 if none. This variable will let understand how government's participation in funding round affects the cleantech sector. What other institutions are under governments' VC actor type can be found in Appendix I.

The number of investments was used to measure *VC experience* levels. Variable was transformed to the natural logarithm, because it is highly skewed. It is a continuous variable, which shows the number of investments made by VC firm until the round date, on which start-up received money. As observation unit is funding round and if there are more than one VC participating in it (syndicated round), variable represents the average of all VCs in a round. Number of investments was chosen as a better representative of experience compared to the venture capitalists age. If I were to concentrate on the age of VC firm, one VC might have exceptionally low number of investments during a period of one year, while the other VC might have much higher number of investments during the same period of one year. This might depend on the number of funds managed, funds sizes, funds targeted investment group etc. Therefore, the number of investments provides more accurate and measurable metric and in some manner includes time frame, as it is expected that older VC firms would have more investments executed.

The last main explanatory variable shows whenever funding round is *syndicated* or not. It provides information on whenever company received funding from more than one investor in the same funding round. It is dummy variable, where 1 means that funding round was syndicated by more than one investor and 0 that in funding round there was only one investor. This variable will show if funding rounds in the cleantech sector are more likely to be syndicated.

I also control for the *start-up age* and *VC age*. Both age variables are transformed to natural logarithms as they are highly skewed. *Round number* is included as a continuous control variable to see whenever cleantech start-ups reach later financing rounds. I also control for three additional groups of dummies: *investment stage dummies* (6 cat.), *round year dummies* (10 cat.) and the *region of U.S.* (18 cat.) where start-up headquarter is. Detailed explanation of each variable can be found in Table 1. The correlation coefficients are low including the variance inflation factors (VIF test) (details in Appendix II). All of the statistical estimates are robust to start-up's unique number assigned to every start-up.

Table 1 Variables description

Dependent variable	
Clean Technology	Dummy variable, indicating whether the start-up is from the cleantech sector
Independent variables	
Government	Dummy variable, indicating whether governmental VC actor is present in the funding round
VC Experience	Continuous variable, indicates the average number of deals conducted by the investing VCs until round date
Syndication	Dummy variable, indicating whether the funding round is syndicated
Control variables	
Log start-up age	Continuous variable, natural log of the start-up's age
Log VC age	Continuous variable, natural log of the VC's age
Round number	Continuous variable, refers to the subsequent number of times that a start-up received VC funds
Start-up stage dummies (6 cat.)	6 dummy variables referring to the stage of funding. Stages are categorized as: 'seed', 'early', 'expansion', 'later', 'exit' and 'other'.
Investment year dummies (10 cat.)	10 dummy variables referring to the year in which funding round occurred, from 2002 to 2011.
US region dummies (18 cat.)	18 Dummy variables 1 – if a start-up location headquarters is in one of the following regions: 'Alaska/Hawaii/Puerto Rico', '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'.

7.4 Descriptive statistics

7.4.1 Capital intensity in clean technology sector

To get a deeper understanding of the cleantech sector structure, I checked other sectors that overlap with the cleantech. This shows how many start-ups within the cleantech sector are also categorized under other type of industries. Table 2 shows the summary of results. The industry in which appears the most of the cleantech investment rounds is the energy industry. 65% of funding rounds were performed in industrial/energy sector. While the second most overlapping cleantech industry – semiconductor and other electronics – encountered only 8% of total rounds. This clearly illustrates that cleantech sector closely relates to the energy industry. The fact might fulfill suspicions from the literature, that the cleantech companies require high capital

intensity investments, since energy industry is understandably considered as demanding large amounts of capital. The practical relations are also visible in the products and services of the cleantech sector – it involves manufacturing of renewable energy equipment and their maintenance etc.

Table 2 Number of cleantech rounds overlapping with other sectors. Investment period 2002-2011Q3, U.S. based start-ups

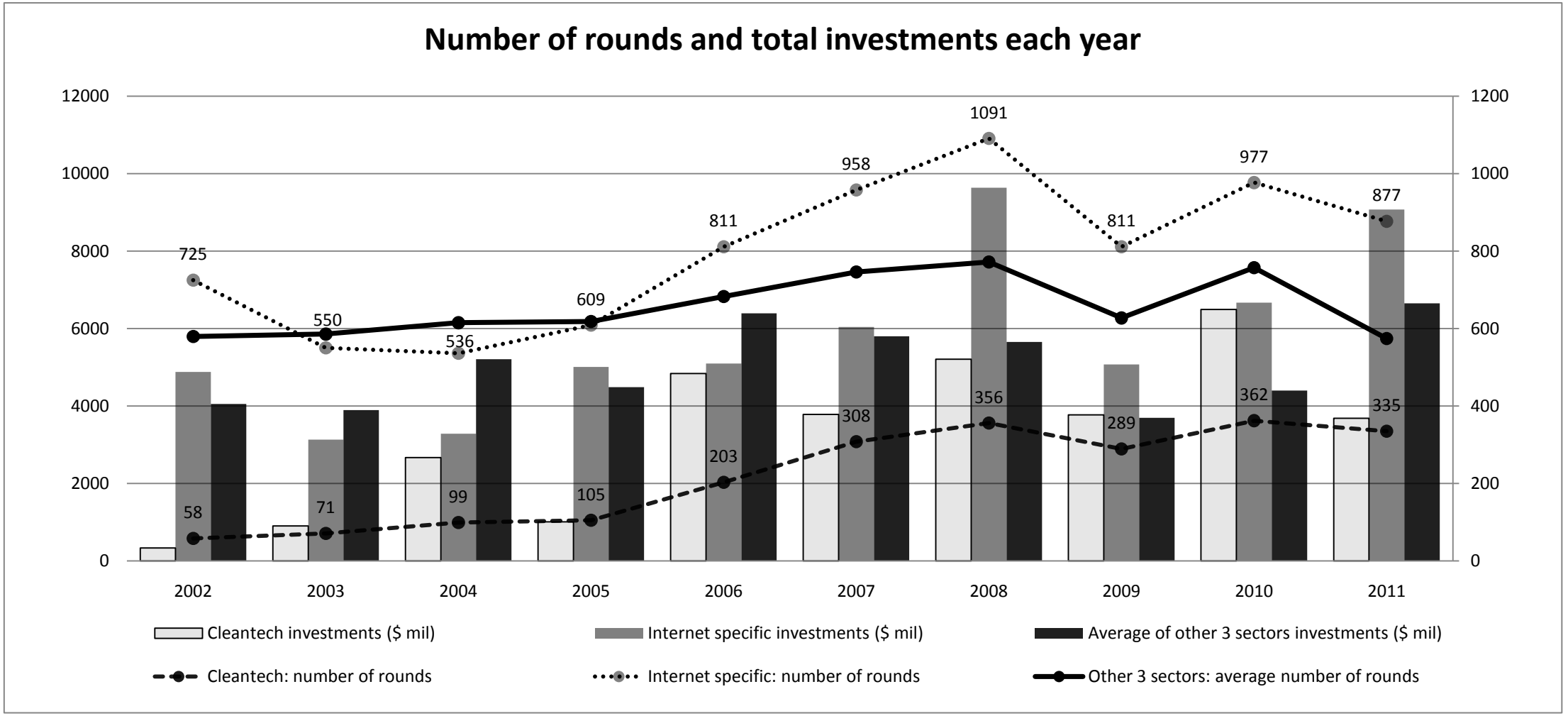
	Total rounds		Energy		Semiconductor and other electronics		Biotechnology		Computer software, hardware and services		Other	
Cleantech	2,185	100%	1,410	65%	175	8%	169	7.7%	96	4.3%	335	15%

7.4.2 Rounds and their values

The following descriptive data that I did provides other insights into the cleantech sector. Comparison between cleantech and other top industries in which VCs invest can be found in Figure 5 (detailed numbers in Appendices III and IV). Figure 5 shows total investments per year for cleantech (1st column, white), internet specific sector (2nd column, grey) and the average of other three (3rd column, black) sectors. The other three sectors represented as average by the third column in Figure 5 are from: biotech, computer software & services and medical/health sectors. Columns represent the total value of all deals that year in millions (left axis) and the dot line shows the number of deals that took place during the particular year (right axis). To avoid misunderstandings in the Figure 5, the numbers on straight black dot line are excluded, since this line is used as a rough comparison to other sectors.

The differences between industries are well visible in Figure 5. For the cleantech sector, the number of finance rounds (dot lines) is comparatively lower than in the other sectors through all the years. The average number of rounds per year for the cleantech sector was 206 (excluding 2011). While the internet specific sector's average was 785 rounds per year, and average of other three was 665 (excluding 2011). Meaning the other sectors gets funded at least two times more often. The effect of financial crisis was similar to all sectors number of rounds and round values decreased for all of them. However, internet specific sector saw larger losses, as round values almost halved and number of rounds decreased by almost a third.

Figure 5 The number of rounds and total investments each year, Cleantech, Internet specific and average of 3 other industries. Investment period 2002-2011Q3, U.S. based start-ups. Source VentureXpert database



The round number of cleantech sector since its peak in 2008 (356 rounds) managed to recover quickly. Already in 2010 the U.S. cleantech sector received 362 finance rounds. Although in 2011 (335), the number of rounds, have not reached that of 2010 (362). As it is only the first three quarters of 2011, nevertheless, these three quarters of 2011 (335 rounds) outpaced the number of rounds in first three quarters of 2010 (284). This was the biggest gain in number of rounds in first three quarters of 2011 in comparison to the other sectors.

The volume of past investments (columns in Figure 5) fluctuates more. The amount of money invested in the cleantech through all years was varying and saw its peak in 2010. However, the biggest increment through years was in 2004 and 2006 when sector saw growth of 196% and 379% respectively. Similarly as with investment round numbers, the capital inflows managed to recover rapidly after crisis and in year 2010 saw growth of 72%, almost doubling the previous year investment size. In terms of investment values, in first three quarters of 2011, the cleantech sector received less than in year 2010, but other three sectors, except for biotechnology, managed to outgrow previous year (2010) in size of investments. On the other side, cleantech saw bigger growth from 2009 to 2010 than any other comparable sector. This might suggest that the cleantech was a savior VC investment destination in after-crisis period.

The overall impression is that attention to the cleantech from investors increased significantly since 2006. However, year-over-year fluctuations might signal that sector is still struggling to settle down, proposing that there is space to grow. Nevertheless the number of rounds almost doubled and the amount invested more than quadrupled from year 2005 to 2006. In 2010 cleantech saw its peak when investment volumes were almost highest of all comparable sectors, in that year cleantech conceded only to internet specific sector, which might be the most adaptable and flexible sector in the period.

The last year (2011) might show slow down of investments for the cleantech sector. In first three quarters of 2011, the number of deals (335) outpaced that of three quarters in 2010 (284), but volume of investments did not achieve such result. As in 2011 first three quarters investments reached almost $3.7 billion, while in first three quarters of 2010 there was a little more than $5.5 billion invested already. It is an early estimate, but the signs of slow down might be emerging. It might also provide evidence

that increasing number of deals executed and less capital invested in the sector, means investors are shifting towards less capital intensive start-ups.

Another difference that might be extracted from Figure 5 is the ratio of rounds to investments throughout the years and sectors. As can be seen, the cleantech sector experienced smaller frequency of rounds through all the years, compared to others. Nevertheless the capital amounts invested were rising and are roughly in alignment with other sectors average, while deal number is stagnating. The average value-per-round ratio for first three years in the cleantech sector was $15.1 million per round, while the average of last three years (excluding 2011) increased slightly to $15.2 million per deal (detailed calculations Appendix V). Other sectors did not experience such high value-per-round ratio, neither a decade ago nor 3-4 years back. This clearly shows that cleantech start-ups are much more capital intensive compared to established VC investment sectors, what might be a problem for cleantech sector to grow. However, the fact that VCs invest high amounts of capital in the period, and at the same time, the number of finance rounds is slightly rising, suggests that VCs are not avoiding risky and capital intensive cleantech investments.

7.4.3 Government support, experience levels and syndication in VC investments

To get the impression about the investors that are interested in cleantech sector, I did the following calculations. Table 3 contains the number of total companies that received funding from VCs in the period from 2002 to 2011 3rd quarter through all interested sectors within the U.S. Table 3 also includes data on average VC experience in years, government participation in VC activity, number of finance rounds and syndicated rounds count. This will help to comprehend the data that I am working with in this paper.

First line of table 3 shows, that there are fewer companies that receives VC funding in the U.S. cleantech sector, compared to the other sectors. The number presents the count of companies which received funding during the 2002-2011Q3 period and is the smallest for cleantech (811). Most attention from VCs receives companies in computer software and services (3491) and internet specific (3249) sectors, while the biotech sector (1232) and medical/health (1962) remains in the middle. This may already signal that cleantech is not receiving enough attention from

VCs or the sector is requiring more resources from the VC industry, thus remains unattractive and might be less suitable for such finance mechanism.

The second line shows the percentage of companies that received financial support from the government within the sector and in the period. 14% of the companies within the cleantech sector receive funding from the U.S. government authorities. Only 6% of internet specific start-ups receive financial aid. Biotech in this table is sector number one with every fifth company (20%) receiving part or all of their funds from the government. One could expect similarities between cleantech and biotech sectors in terms of capital requirements; however, the picture in the table shows differently. It may be that companies in the biotech sector have already established framework for financial support from the government, while cleantech sector is still emerging.

Table 3 Number of companies based in U.S. by sector, VC experience, government participation in VC activity, number of rounds and syndicated rounds in the period of 2002-2011Q3

	Cleantech	Biotech	Computer software and services	Internet specific	Medical/Health
Total number of companies in period	811	1,232	3,491	3,249	1,962
Percentage of companies receiving financial support from Government	14%	20%	10%	6%	13%
Avg. VC age (in years) investing in sector	19.6	19.4	18.2	19.1	18.1
Total number of finance rounds	2,185	4,121	9,822	8,010	5,915
Percentage of rounds that are syndicated	56%	67%	62%	61%	64%

Source: VentureXpert database.

One more revealing result from the descriptive analysis is the experience level of venture capitalists that invest in the cleantech. On average, VC experience in the cleantech is 19.6 years, which is the largest among other comparable industries. No other sector receives funding from such experienced VCs. Meaning young and inexperienced VC firms are probably less prone to invest in the sector, hence VC firms are more likely to mature before investing in the cleantech. However, the difference

among investors experience levels is not that visible when comparing cleantech to other sectors. Highest VC experience disparity is between cleantech and medical/health (18.1 avg. exp. years) sector start-ups; difference here is one and a half year. Properties like intensive capital requirements or necessity for advanced management skills may be the causes that attract older VC firms. As literature proved, some start-ups within the cleantech might have higher levels of risk and to manage that, VCs might need higher levels of experience which increase with age.

The second part of the table includes numbers of total finance rounds and percentage count of syndicated rounds during the period. The total number of companies receiving venture capital funds is lowest for the cleantech (811, first line); the same is with finance round counts (2,185). In comparison, other sectors attain two or three times more finance rounds (biotech – 4,121; medical/health – 5,915) and computer software and services sector (9,822) more than four times more rounds. The reason behind this situation could be that the cleantech sector is slowly emerging in the period, while others are already matured as VC investment targets. Therefore, number of companies receiving venture capital and number of finance rounds remains small.

The unanticipated results are for syndicated investments count. It was expected to see more syndicated investments for the cleantech, as it is likely to be capital intensive and require higher levels of experience. Nevertheless, the cleantech is least syndicated sector of all. Only 56% of total investment rounds are syndicated in the U.S. While the internet specific and software and services start-ups are financed through 61% and 62% syndicated rounds respectively, and biotech and medical/health even more – 67% and 64% respectively. However, the percentage number is not that low from the average of other four.

The insights from Table 3 provide information about characteristics of the cleantech sector and the other four sectors that are popular among venture capitalists. Although older VCs invest in the cleantech sector and the sector receives governmental support, it still lacks behind on the number of companies financed and funding rounds count, when compared to others. The cleantech start-ups are also less syndicated. Thus if cleantech sector is likely to succeed in VC funding it has lots of space to grow.

7.5 Results

For regression analysis, I used logarithmic logistic regression with the dependent variable - cleantech dummy; however for result interpretation I used odd ratios instead of logarithmic coefficients. Table 4 represents odd ratios of all explanatory variables. Model 1 is a baseline model where only control variables are included. Model 2 includes variable showing the effect of government's participation in a funding round. As expected, the government support is likely to be directed towards cleantech start-ups. All else fixed, when a governmental actor is present in a funding round, it becomes 50% ($p<0.01$) more likely that this round is directed to the cleantech. This is consistent through all the models therefore hypothesis 1 is supported. In Model 3, the effect of VC experience in a funding round is shown. Results show that all else being fixed, an additional percentage point of VC experience is related to a 5% ($p<0.01$) increase in the likelihood of the investment originating from the cleantech industry. Very familiar result for VC experience is also found in Model 4 with highest significance levels. These results support hypothesis 2, that cleantech companies are likely to be financed by more experienced VCs. When syndication variable was included odds ratio showed different effect than for the first two investigated issues. The effect was negative, considering all else are fixed, cleantech funding round is about 8% less likely to be syndicated than not syndicated. These results provide entirely the opposite effect than was expected, however, since the odds ratio is not significant the third hypothesis could not be rejected.

Other explanatory variables show odd ratios for start-up and VC ages, and round number. The odds coefficient for a start-up age says that we will see around 3% increase in the odds of the company in the funding round to be a cleantech start-up for a one-year increase in the age of the start-up, if other variables are fixed. However, the coefficient is not significant at a 10% significance level. For a VC age, the odd ratios raise doubts, since results are significant in Model 3 and 4, while in the first two it is not significant. The coefficient in Model 3 and 4 says that all other variables holding fixed with every additional year in VC age the company in a funding round has 10% ($p<0.01$) less likely odds to be the cleantech start-up. Meaning older VCs might be avoiding rounds where cleantech companies are funded. Round number variable odd ratios are highly significant in all models. Its ratio claims that the odds for the company in a funding

round to be from a cleantech sector decreases with every consecutive round by about 8% ($p<0.01$), in favor for companies in other sectors, holding all else at a fixed values. The results suggests that cleantech start-ups hardly reach later funding rounds.

Table 4 Logarithmic logistic regression results table, odds ratios

Dependent variable: *Cleantech*	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Explanatory variables				
Main independent variables				
Government dummy		1.493***	1.518***	1.529***
		(0.236)	(0.247)	(0.250)
Log (VC experience)			1.050***	1.058***
			(0.015)	(0.018)
Syndication dummy				0.918
				(0.072)
Control variables				
Log (start-up age)	1.027	1.027	1.034	1.031
	(0.059)	(0.060)	(0.060)	(0.061)
Log (VC age)	0.962	0.965	0.903***	0.897***
	(0.036)	(0.036)	(0.035)	(0.036)
Round number	0.915***	0.916***	0.914***	0.915***
	(0.020)	(0.020)	(0.020)	(0.021)
Start-up stage dummies (6 cat.)	'Yes'	'Yes'	'Yes'	'Yes'
Start-up investment year dummies (10 cat.)	'Yes'	'Yes'	'Yes'	'Yes'
Start-up U.S. region dummies (18 cat.)	'Yes'	'Yes'	'Yes'	'Yes'
N funding rounds	36,229	36,229	36,229	36,229
N start-ups	12,730	12,730	12,730	12,730
Wald chi2	285.64	298.26	309.34	314.88
Pseudo R-squared	0.0677	0.0689	0.0703	0.0704
Increase in model fit (LR-test)		15.79***	19.44***	2.01

Notes: Standard errors are clustered on start-up firms (in parentheses). Reference for investment stage: Later; reference U.S. region: Silicon Valley. Data source: VentureXpert database. Sample includes funding rounds during the period 2002-2011.
* Significance level $0.10 \geq p > 0.05$
** Significance level $0.05 \geq p \geq 0.01$.
*** Significance level $p < 0.01$.

The overall fit statistics provide positive and significant results. The likelihood-ratio test (LR test in table 4) shows an increase in fit for each subsequent model when nested to the previous one. Wald chi2 and pseudo R-squared statistics also show an overall increase for every subsequent model.

8 Discussion

The odd ratios from my statistical analysis partly confirm the theoretical evidence found in the literature. The research supports two out of three hypotheses. The active

government presence in funding rounds as claimed by Jenkins et al. (2012) is proven to be true. Whenever governmental actor participates in a funding round, the odds that this round is directed towards the cleantech company are 50%. Despite the possible drawbacks of investments by the government, the fact supports the suggestion that the government is in favor of goals that cleantech start-ups are trying to achieve. The result could also point to the fact that the cleantech sector is still not ready to sustain itself and finance its future projects on its own. Therefore, the government is still sponsoring the sector. The other finding, that later funding rounds are significantly less likely to be directed to the cleantech, might show the inability to overcome one of "Valleys of Death" (technological or commercialization) as suggested by Jenkins and Mansur (2010). The government can play a crucial role by pushing companies to overcome these problems. However, the government lacks resources that private VC firms can deliver, such as better managerial assistance (OECD, 2010). Encouraging the government to invest jointly with other, more experienced VC firms in the same funding round, could be the possibility to minimize the negative effect of the government support (Brander et al., 2008).

The results for VC experience also proved to be as expected. More experienced VC firms have higher odds to finance the cleantech companies. It seems to be true that VCs with more experience are able to cope with the risks involved in the cleantech sector (Casamatta and Haritchabalet, 2007). The odds ratio for VC experience was positive, meaning that every additional unit of VC experience increases the likelihood that investment is made into the funding round where cleantech company is present. Thus, suggests that uncertainties met in the sector become less problematic for more experienced VCs and they should be able to make better investment decisions. More experienced VCs then could maximize returns from the cleantech sector compared to those with less experience. Considering the odds ratio for the age, older VC firms are less likely to finance the cleantech companies. The rationale behind this could be that younger VC firms seek successful deals, which later could stand as their representative reputation cases (Tykvova, 2005) in the sector. While older VCs might be settled around their usual industries and avoid unknown risks of the cleantech sector. Situation like this would require even more young VCs that are willing to experiment in the cleantech sector.

This study was unable to provide evidence that the funding is likely to be syndicated in the cleantech sector. It might be that experienced VCs are unable to find proficient enough partners to syndicate more investments, thus meaning the network of VCs that invest in the cleantech is still small. It could also be that there are more reasons to avoid syndication, as everybody investing alone might expect that this is their chance to have a successful investment. Avoiding syndication on purpose would mean that investment is of high value. However, the odds ratio for funding round number suggests that the cleantech sector lacks high quality companies that could reach later stage investments. The opinion provided by Seppä and Jääskeläinen (2003) should hold, they claimed that a higher number of syndicate partners is more likely to bring companies to the IPO. Thus, lack of syndication could be the reason why cleantech start-ups struggle to reach later funding stages and successful exits. The situation may reflect the weak selection process, mentioned by Lerner (1994b). The absence of syndication also lowers the possible value added from different VC firms with different skills (Brander et al., 2002). Therefore, the cleantech sector still lacks recognizable investment examples to trigger the sector's growth.

Although the cleantech start-ups are receiving high support from the government and interest from experienced VCs, they still struggle to reach successful exits. Improving syndication in the sector could enrich overall quality of the start-ups, help them reach IPOs and increase the growth of the cleantech sector.

9 Conclusion

My research contributes to the relatively new academic literature of the cleantech industry. In recent years the cleantech gains more and more venture capital attention and the attention is only growing. The novelty of this academic field inspired my research paper. The research builds up on all the precedent papers (Casamatta and Haritchabalet, 2007; Ghosh and Nanda, 2010; Tian, 2011) and expands in characteristics of venture capital firms that invest in the cleantech. Those characteristics include VC experience and the likelihood to syndicate investments in the cleantech. The research also investigates the government's participation in industry's funding.

The government's participation in the finance of young companies in the cleantech sector is quite common activity in the United States. This was proved by the

preceding literature and my research. Further it was expected that VC actors investing in the cleantech should be more experienced, as VC proficiency could improve dealing with unknown problems in relatively new sector. Evidence from the research fulfilled VC experience expectations. Other findings revealed that cleantech start-ups have struggles reaching later funding rounds. Moreover, the research could not prove presence of syndicated investments. This could be the underlying reason of sector's difficulties to reach successful exits. Absence of syndication may inhibit the growth of the sector (Seppä and Jääskeläinen, 2003). Thus, the government's spending could be directed towards jointly investments with experienced VCs in the cleantech industry.

10 Limitations, future research and policy implications

The main limitation in my research is the concentration on the geographical area of the U.S.. Same research could be executed on Europe or Asia as those regions have different government support for the industry. The other limitation is the time period that I analyze. The results are based on the period from 2002 to 2011 third quarter. The study does not separate investments done solely by the government from jointly investments done by the government with other VCs. Nevertheless this research is done on the most advanced VC data that is available, therefore could be used as an example for other regions worldwide.

One of the possible ways to extend this research is to dig to the effect of the government support. One could be interested whenever companies that received funding from the government are successful after a decade or not. The other option could be to find a portion of companies that received support and measure how well the governments' grants and other financial incentives support industries. More concentrated study on financial government support could reveal whenever granted start-ups reach later stages; or maybe they fail to reach later funding rounds because of lack of managerial experience from governmental VC actors. Whatever the case alleys for future research are wide.

For policy implications, the research provides suggestions that it is still early for the government to stop supporting the cleantech industry. The financial support of the government could be shifted towards maturing cleantech start-ups as results showed that the industry struggles to reach later finance rounds. The variety of support could be

wider as different methods could provide different results, thus finding the best way to foster the industry. To raise the governments' investment quality, funding could be executed jointly with more experienced VC firms; this could help increase performance of the cleantech start-ups. Therefore, improving legal framework for jointly private and governmental VC investments could be advised.

References

Amit, R., Brander, J. and Zott, C. (1998). Why do Venture Capital firms exist? Theory and Canadian evidence. *Journal of Business Venturing*, 13 (6), 441-466.

Andreessen, M. (2012). *When a founder is already worth a billion dollars, why would they need or want to seek Venture Capital for a new start-up?* [Internet], Quora. Available from: <http://www.quora.com/Venture-Capital/When-a-founder-is-already-worth-a-billion-dollars-why-would-they-need-or-want-to-seek-Venture-Capital-for-a-new-start-up> [Accessed 14 May 2012]

Barry, C. B., Muscarella, C. J., Peavy, III, J. W. and Vetsuypens, M. R. (1990). The role of venture capital in the creation of public companies: evidence from the going-public process. *Journal of Financial Economics*, 27 (2), 447–472.

Bergemann, D. and Hege, U. (1998). Venture capital financing, moral hazard, and learning. *Journal of Banking & Finance*, 22, 703-735.

Bergemann, D. and Hege, U. (2003). The Value of Benchmarking. Working Paper of Risk Capital and the Financing of European Innovative Firms.

Black, B. and Gilson, R. (1998). Venture Capital and the Structure of Capital Markets: Banks versus Stock Markets. *Journal of Financial Economics.* 47, 243-277.

Block, J. and Sandner, P. G. (2009). What is the Effect of the Current Financial Crisis on Venture Capital Financing? Empirical Evidence from US Internet Start-ups. *Venture Capital – An International Journal of Entrepreneurial Finance.* 11 (4), 295-309.

Block, J., De Vries, G. and Sandner, P. (2010). Venture capital and the financial crisis: an empirical study across industries and countries. Handbook of Venture Capital, Oxford University Press, Forthcoming. *MPRA Paper No. 2028*

Brander, J., Amit, R. and Antweiler, W. (2002). Venture Capital Syndication: Improved Venture Selection versus the Value-Added Hypothesis. *Journal of Economics and Management Strategy*, 11 (3), 423-452.

Brander, J. A., Egan, E. J. and Hellman, T. F. (2008). Government Sponsored versus Private Venture Capital: Canadian Evidence. International Differences in Entrepreneurship. University of Chicago Press

Brav, A. and Gompers, P. (2003). The role of lock-ups in initial public offerings. *Review of Financial Studies.* 16, 1-29.

Burtis, P. R. (2006). Creating Cleantech Clusters: 2006 update. www.nrdc.org

Bygrave, W. (1987). Syndicated investments by venture capital firms: A networking perspective. *Journal of Business Venturing*, 2, 139-154.

Bygrave, W. and J. A. Timmons. 1992. Venture Capital at the Crossroads. Boston, Mass.: Harvard Business School

Camp, S. M., and D. L. Sexton. 1992. "Trends in Venture Capital Investment: Implications for High-Technology Firms." Journal of Small Business Management, 30 (3): 11–20.

Casamatta, C. and Haritchabalet, C. (2007). Experience, screening and syndication in venture capital investments. *Journal of Financial Intermediation*. 16 (3), 368–398.

Christopher, A. (2001). VC and the Law: Potential Legal Hurdles Involved in Funding the Next Big Thing. *Venture Capital Journal*. 43-45.

Cleantech Group. (2011). *Global Clean Technology Venture Investments Rises in 1Q 2011 as Investors Focus on Larger Late-stage Deals*. [Internet], Cleantech Group. Available from: <http://www.cleantech.com/2011/06/05/global-clean-technology-venture-investment-rises-in-1q-2011-as-investors-focus-on-larger-late-stage-deals/> [Accessed 7 May 2012]

Cleantech Group. (2012). *What is Cleantech? Clean is more than green*. [Internet], Cleantech Group. Available from: <http://www.cleantech.com/about-cleantech-group/what-is-cleantech/> [Accessed 7 May 2012]

Cumming, D. (2006). Adverse selection and capital structure: Evidence from venture capital. *Entrepreneurship Theory and Practice*, 30, 155-183.

De Vries, G. and Block, J. H. (2010). Venture Capital Syndication in Times of Economi Crisis. *Venture Capital*. 13 (3), 195-213.

Deloitte and NVCA (2010). *Global Trends in Venture Capital: Outlook for the Future*. [Internet], Deloitte and NVCA. Available from: <https://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/TMT/dttl_tmt_GlobalTrendVC2010.pdf> [Accessed 7 May 2012]

Deloitte and NVCA. (2010). *Global Trends in Venture Capital: Outlook for the Future*. [Internet], Deloitte and NVCA. Available from:

<http://admin.bvca.co.uk/library/documents/2010GTVC_slidepack.pdf> [Accessed 7 May 2012]

Dembe, A. and Boden, L. (2000). Moral Hazard: A Question of Morality? *New Solutions*, 10 (3), 257-279.

Fellers, C. R. (2001). Making an Exit: VCs Examine their Options. *Venture Capital Journal.* 40-42.

Freed, J. and Stevens, M. (2011). Nothing Ventured: The Crisis in Clean Tech investment. Clean Energy Innovation, report.

Fried, V. H. and Hisrich, R. D. (1995). The venture capitalist: a relationship investor. *California Management Review.* 37 (2), 101-113.

Gans, J. and Stern, S. (2003), When Does Funding Research by Smaller Firms Bear Fruit?: Evidence from the SBIR Program.

Gentry, W. M., and Hubbard, R. G. (2002). Tax Policy and Entry into Entrepreneurship. *American Economic Review.* 90, 283-287.

Ghosh, S. and Nanda, R. (2010). Venture Capital Investment in the Clean Energy Sector. Working Paper 11-020

Gompers, P. (1995). Optimal Investment, Monitoring and Staging of Venture Capital. *Journal of Finance.* 50(5), 1461-1489.

Gompers, P. and Lerner, J. (1998). Venture Capital Distributions: Short-Run and Long-Run Reactions. *Journal of Finance.* 53, 2161-2183.

Gompers, P. and Lerner, J. (1998). What Drives Venture Capital Fundraising? *Brooking Papers on Economic Activity – Macroeconomics.* 149-192.

Gompers, P. and Lerner, J. (2000a). Money chasing deals? The impact of fund inflows on private equity valuations. *Journal of Financial Economics*. 55, 281-325.

Gompers, P. and Lerner, J. (2000b). The Determinants of Corporate Venture Capital Success: organizational structure, incentives and complementarities. University of Chicago Press.

Gompers, P. and Lerner, J. (2001). The Venture Capital Revolution. *The Journal of Economic Perspectives.* 15(2), 145-168.

Gompers, P. and Lerner, J. (2004). *The Venture Capital Cycle*. Cambridge: MIT Press.

Gorman, M. and Sahlman,W. A. (1989). What do Venture Capitalists Do? *Journal of Business Venturing.* 4, 231-248.

Guller, I. and Guillen, M. F. (2010). Institutions and the Internationalization of U.S. Venture Capital firms. *Journal of International Business Studies.* 41, 185-205.

Hall, B. and Lerner, J. (2010). The financing of R&D and Innovation. NBER Working Paper 15325.

Hellman and Puri, (2002). Venture Capital and the Professionalization of Start-Up Firms: Empirical Evidence. *The Journal of Finance.* 57, 169-197.

Hochberg, Y., Ljungqvist, A. and Lu, Y. (2007). Whom You Know Matters: Venture Capital Networks and Investment Performance. *The Journal of Finance,* 62 (1), 251-301.

Hsu, D. (2004). What Do Entrepreneurs Pay For Venture Capital Affiliation? *The Journal of Finance.* 59(4), 1805-1844.

Ibrahim, D. M. (2012). The New Exit in Venture Capital. *Vanderbilt Law Review*. 65.

IEA. (2007). IEA Energy Policies Review: The European Union 2008. International Energy Agency, OECD, Paris.

Jeng, L. A. and Wells, P. C. (2000). The determinants of venture capital funding: evidence across countries. *Journal of Corporate Finance.* 6 (3), 241-289.

Jankins, J. and Mansur, S. (2010). Crossing the Valley of Death: Solutions to the next generation clean energy project financing gap. Bloomberg New Energy Finance, June 2010.

Jenkins, J. and Mansur, S. (2011). *Bridging the Clean Energy Valleys of Death. Breakthrough Institute.* [Internet]. Available from: <http://thebreakthrough.org/blog/Valleys_of_Death.pdf> [Accessed 9 May 2012]

Jenkins, J., Muro, M., Nordhaus, T., Shellenberger, M., Tawney, L. and Trembath, A. (2012). Beyond Boom & Bust. Breakthrough Institute, Brookings Institution and World Resources Institute.

Jenkins, J., Swezey, D. and Borofsky, Y. (2010). *Where Good Technologies Come From. Case studies in American Innovation Breakthrough Institute*. [Internet], AIBI.

Available from:
<http://thebreakthrough.org/blog/Case%20Studies%20in%20American%20Innovation%20report.pdf> [Accessed 9 May 2012]

Kaplan, S., Schoar, A. (2004). Private Equity Performance: Returns, Persistence and Capital Flows. *The Journal of Finance*. 60 (4), 1791-1823.

Kaplan, S. N. and Strömberg, P. (2003). Financial Contracting Theory Meets the Real World: An Empirical Analysis of Venture Capital Contracts. *Review of Economic Studies.* 70, 281-315.

Kaplan, S. N. and Strömberg, P. (2004). Characteristics, Contracts, and Actions: Evidence from Venture Capitalist Analyses. *The Journal of Finance.* 59(5), 2173-2206.

Klausner, M. and Litvak, K. (2001). What Economists Have Taught us about Venture Capital Contracting. Stanfor Law School Working Paper

Lerner, J. (1994). Venture capitalists and the decision to go public. *Journal of Financial Economics.* 35, 293-316.

Lerner, J. (1994 b). The Syndication of Venture Capital Investments. *Financial Management*, 23 (3), 16-27.

Lerner, J. (1995). Venture Capitalists and the Oversight of Private Firms. *Journal of Finance*. 50, 301-318.

Lerner, J. (1999). The government as venture capitalist: The long-run effects of the SBIR program. *Journal of Business.* 72, 285-318.

Lilles, P. (1977). Sustaining the Venture Capital firm. Cambridge. Management analysis centre.

Ljungqvist, A. and Wilhelm, W.J. (2003). IPO pricing in the dot-com bubble. *Journal of Finance.* 58(2), 723-752.

Megginson, W. (2004). Towards a global model of venture capita? *Journal of Applied Corporate Finance.* 16(1), 89-107.

O'Shea, M. (1996). Government Programs for Venture Capital. OECD Working Group on Innovation and Technology Policy.

OECD. (2010). Public procurement programmes for small firms –SBIR-type programmes. OECD Innovation Policy Platform.

Office of the Press Secretary. (2010). President Obama Sets Greenhouse Gas Emission Reduction Target for Federal Operations. The White House. Retrieved May 9, 2012 from http://www.whitehouse.gov/the-press-office/president-obama-sets-greenhouse-gas-emissions-reduction-target-federal-operations

Repullo, R. and Suarez, J. (2004). Venture Capital Finance: A Security Design Aprroach. *Review of Finance.* 8, 75-108.

Sahlman, W. A. (1990). The structure and governance of venture-capital organizations. *Journal of Financial Economics.* 27, 473-521.

Sahlman, W. A. (1990). The Structure and Governance of Venture-Capital Organizations. *Journal of Financial Economics.* 27, 473-521.

Sapienza, H. J. (1992). When do venture capitalists add value? *Journal of Business Venturing.* 7, 9-27.

Seppä, T. and Jääskeläinen, M. (2003). Syndication and the efficiency of venture capital firms. In Seppä, T. (2003). Essays on the Valuation and Syndication of Venture Capital Investments. 113-146. Helsinki University of Tehcnology Institute of Strategy and International Business, Doctoral Dissertation 2003/1.

Sorensen, M. (2007). Learning by Investing: Evidence from Venture Capital. *SIFR Research Report Series* 53, Institute for Financial Research.

Stack, J. (2007). *Cleantech Venture Capital: how public policy has stimulated private investment.* [Internet], Cleantech Venture Network report. Available from: <http://www.forseo.eu/fileadmin/media/forseo/docs/Cleantech-Venture-Network-Report.pdf> [Accessed 12 May 2012]

Stancill, J. McNeill. (1986). How Much Money Does Your New Venture Need? *Harward Business Review.* 122-139.

Tan, X. (2009). *An Emerging Revolution: Clean Technology Research, Development and Innovation in China*. [Internet], World Resource Institute. Available from: <http://pdf.wri.org/working_papers/an_emerging_revolution.pdf> [Accessed 9 May 2012]

Teppo, T. and Wüstenhagen, R. (2006). Do venture capitalists really invest in good industries? Risk-return perceptions and path dependence in the emerging European energy. VC market *International Journal of Technology.* 34 (1-2), 63-87.

Thomson Reuters and NVCA. (2011). *Venture-Backed IPO Market Activity Continues to Improve in Q2 2011*. [Internet]. Available from: <*http://thomsonreuters.com/content/financial/pdf/491304/2011_07_01_ipo_market_activity*> [Accessed 2 May 2012]

Tian, X. (2011). The Role of Venture Capital Syndication in Value Creation for Entrepreneurial Firms. *Review of Finance,* 15 (3).

Tykvova, T. (2005). Who chooses whom? Syndication, skills and reputation. ZEW Discussion Paper, 00-62.

United Nations Framework Convention on Climate Change (UNFCCC). (2011). *Kyoto Protocol*, *UNFCCC*, [Internet] Available from: <http://unfccc.int/kyoto_protocol/items/3145.php> [Accessed 12 May 2012]

Wallsten, S. (1998). Rethinking the Small Business Innovation Research Program. In: L. Branscomb and J. Kelle (eds), *Investing in Innovation*. MIT Press, Cambridge (MA).

Wallsten, S. (2000). The Effects of Government-Industry R&D Programmes on Private R&D: The Case of the Small Business Innovation Research Program. *Rand Journal of Economics*. 31 (1).

Welch, I. (1989). Seasoned offerings, imitation costs, and the underpricing of initial public offerings. *Journal of Finance.* 44, 421-449.

Wright, M. and Lockett, A. (2003). The Structure and Management of Alliances: Syndication in the Venture Capital Industry. *Journal of Management Studies.* 40 (8), 2073-2102.

Zider, B. (1998). How venture capital works. *Harvard Business Review* 76(6), 131-139.

Appendices

Appendix I. VC Actor Types table

VC actor type	Up from
VC Firm	Private equity firm
Angel VC	Angel group and Individuals
Corporate VC	Corporate Private Equity/Venture
Financial institution VC	Bank affiliate; Endowment, Foundation or Pension Fund; Insurance firm affiliate
Government VC	Government affiliated program; Incubator/Development program; SBIC; University program
Other VCs	Investment management firm; Non-private equity; Service provider; Private equity advisor or fund of funds; Other

Appendix II. Correlation table

Variables	*1*	*2*	*3*	*4*	*5*	*6*	VIFs[1]
1. Cleantech							
2. Government participation	0.019*						1.01
3. VC experience	0.028*	-0.069*					1.60
4. Syndicated	-0.004	-0.001	0.404*				1.23
5. Start-up age	-0.004	-0.044*	-0.032*	-0.071*			1.21
6. VC age	-0.004	-0.054*	0.492*	0.087*	0.065*		1.36
7. Round number	-0.042*	-0.074*	0.063*	0.053*	0.399*	0.101*	1.21

Notes: 36,229 observations of 12,730 start-ups. Data source: VentureXpert database.
* Significance level $p \leq 0.01$
[1] For start-up age, VC age and VC experience, the VIF factors and correlation coefficients relate to their logged values.

Appendix III. Number of rounds and its percentage change year over year in each of the sectors mentioned (U.S. based start-ups rounds only)

	Cleantech		Biotech		Computer software and services		Internet specific		Medical/ Health	
Year	no. of rounds	percentage change	no. of rounds	percentage change	no. of rounds	percentage change	no. of rounds	percentage change	no. of rounds	percentage change
2002	58	---	284	---	1.002	---	725	---	452	---
2003	71	22%	325	14%	954	-5%	550	-24%	478	6%
2004	99	39%	331	2%	998	5%	536	-3%	516	8%
2005	105	6%	372	12%	959	-4%	609	14%	523	1%
2006	203	93%	402	8%	1.028	7%	811	33%	618	18%

2007	308	52%	480	19%	1.065	4%	958	18%	693	12%
2008	356	16%	482	1%	1.123	5%	1.091	14%	711	3%
2009	289	-19%	474	-2%	792	-29%	811	-26%	616	-13%
2010	362	25%	565	19%	968	22%	977	20%	739	20%
2011*	335	-7%	396	-30%	814	-16%	877	-10%	512	-31%
Total	2.185		4.111		9.703		7.945		5.858	
Avg**	206		413		988		785		594	

Source: VentureXpert database. *2011 deal numbers are without 4Q; **shows average of all years excluding 2011

Appendix IV. Monetary value of rounds in millions and its percentage change year over year in each of the sectors mentioned (U.S. based start-ups deals only)

	Cleantech		Biotech		Computer software and services		Internet specific		Medical/ Health	
Year	value of rounds	percentage change	value of ronds	percentage change	value of rounds	percentage change	value of rounds	percentage change	value of rounds	percentage change
2002	331	---	2.615	---	5.294	---	4.880	---	4.240	---
2003	901	172%	2.863	10%	5.119	-3%	3.129	-36%	3.706	-13%
2004	2.668	196%	2.812	-2%	6.626	29%	3.285	5%	6.183	67%
2005	1.010	-62%	3.201	14%	5.205	-21%	5.009	52%	5.050	-18%
2006	4.836	379%	3.745	17%	9.728	87%	5.095	2%	5.712	13%
2007	3.780	-22%	4.985	33%	5.871	-40%	6.039	19%	6.545	15%
2008	5.208	38%	4.114	-17%	5.856	0%	9.640	60%	6.999	7%
2009	3.772	-28%	3.606	-12%	3.523	-40%	5.075	-47%	3.946	-44%
2010	6.494	72%	3.445	-4%	5.404	53%	6.668	31%	4.354	10%
2011*	3.682	-43%	3.305	-4%	5.841	8%	9.073	36%	10.805	148%

Source: VentureXpert database. *2011 deal values are without 4Q

Appendix V.

Investment ratio tables

A 1 Cleantech investment ratios

Year	Number of rounds	Value(mil) of rounds	Value-to-rounds ratio	Average
2002	58	331	5,71	
2003	71	901	12,69	15,12
2004	99	2.668	26,95	

2008	356	5.208	14,63	
2009	289	3.772	13,05	15,21
2010	362	6.494	17,94	

A 2 Internet specific investments ratios

Year	Number of rounds	Value(mil) of rounds	Value-to-rounds ratio	Average
2002	725	4.880	6,73	6,18
2003	550	3.129	5,69	

2004	536	3.285	6,13	
	---	---	---	
2008	1.091	9.640	8,84	
2009	811	5.075	6,26	7,31
2010	977	6.668	6,82	

A 3 Biotechnology, Computer & Software, Medical and Health investments average ratios

Year	Number of rounds	Value(mil) of rounds	Value-to-rounds ratio	Average
2002	579	4.050	6,99	
2003	586	3.896	6,65	7,37
2004	615	5.207	8,47	
	---	---	---	
2008	772	5.656	7,33	
2009	627	3.692	5,88	6,34
2010	757	4.401	5,81	