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

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Abstract

This study analyzes the effect of the 2008 financial crisis on the venture capital market. We show that the crisis is associated with a decrease in the number of initial funding rounds as well as with a decrease in the amount of funds raised in later funding rounds. The effects of the crisis differed across industries and were stronger in the US than in other countries. We suggest that the crisis has led to a severe ‘funding gap’ in the financing of technological development and innovation.

Keywords: Venture capital, financial crisis, innovation finance, entrepreneurial finance, recession

JEL classifications: L26, G24, O30

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

I. Introduction

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

This chapter deals with the effects of the crisis on the venture capital (hereafter, VC) market. Due to the strong links between the VC market and the financial markets in general, we expect a severe impact of the crisis on the VC market. VC is a very important source of funding for start-ups in innovative industries. VC is particularly important in the early phases of a firm's life, when it starts to develop innovative products and to commercialize its innovations (Gompers and Lerner, 2001; Jell et al., 2009; Zider, 1998). In this start-up phase, a firm does not have many other institutions to turn to raise money. VC fills a void here. The inherent risks of a start-up in that phase are generally not accepted by banks (Bruns and Fletcher, 2008). To avoid risks, banks often require tangible assets, which are usually not available with young, innovative firms. The stock market and public equity are also not accessible at this stage, as the size of the firm is still too small for an IPO to be considered. Consequently, if the crisis has led to a strong decrease in VC activity, a funding gap in the financing of technological development and innovation may have occurred or may continue to occur. This in turn may have negative effects on subsequent economic development and growth. Prior research has shown VC funding to have a strong positive impact on firm growth,

technological development, and the evolution of industries (Audretsch and Thurik, 2001; Bottazzi et al., 2002; Florida and Kenney, 1988; Keuschnigg, 2004; Kortum and Lerner, 2000; Timmons and Bygrave, 1986). For example, Kortum and Lerner (2000) find that an increase in an industry's VC activity leads to higher patent activity. It is estimated that VC is responsible for about 10% of US industrial innovation. Thus, if VC activity decreases – and patent application volumes with it – adverse long-term effects on the economy may occur.

B. The questions explored in this study

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

1. Is the crisis associated with a reduction in the total volume of VC funds invested? Is there a strong decrease in the number of VC deals? Had the crisis already had an impact on VC activity before September 2008 (the month in which the historical event of the Lehman Brothers crash occurred)?
2. Did the crisis lead to a reduction in the amount of funds raised per funding round? If so, what was the size of this decrease?
3. Concerning the effects of the crisis, is there a difference between early- and later-stage financing?
4. How do the effects of the crisis on VC compare across industries and countries (US vs. non-US)?

The remainder of this study is organized as follows: Section II describes the causes of the crisis and presents a timeline of the events associated with it. Section III summarizes the arguments for why the crisis may have affected the VC market. Section IV presents the empirical study, which is then discussed in Section V. Section VI discusses implications for start-ups and policy-makers and gives an outlook on further research.

II. The crisis: its causes and events

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

- *US housing bubble*: The years prior to the outbreak of the crisis were characterized by a strong increase in US housing prices. This housing bubble was related to increasing financial incentives for banks to engage in mortgage loans. The decrease in the federal funds rate from the year 2000 onwards coincided with larger profit margins for banks on mortgages. As a result, housing prices peaked in 2006; their value had roughly doubled over the preceding decade. This boom period in the housing market was most importantly characterized by a strong increase in the amount of high-risk or subprime mortgages, which are provided to borrowers with relatively low credit ratings.
- *Subprime crisis*: Between 2004 and 2007, the federal funds rate started to steadily increase again, rising from a one-percent level in 2004. This trend brought increasing expenses for borrowers holding adjustable-rate mortgages. The combination of an increasing federal funds rate with the growing share of (adjustable rate) subprime mortgages led to a severe increase in the number of homeowners defaulting on mortgage payments as well an increase in the number of foreclosures on properties. In August 2007, the first hedge funds crashed (e.g., Bear Stearns), holding large shares of mortgage derivatives. Lending behavior among banks also became affected by the subprime crisis. Increasing insecurity with regard to the credibility of other institutions made banks more reluctant to lend, leading to a tightening of their lending requirements.

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

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

- *August 2007*: Outbreak of subprime crisis (bankruptcy of Bear Stearns' in-house hedge fund).
- *December 2007*: Impact of subprime crisis starts to affect other asset areas. Aside from mortgage banks, a large number of financial institutions are affected.
- *March 2008*: Run on Bear Stearns, resulting from a period of increasing liquidity problems for banks.
- *January 2008 to July 2008*: With the decreasing value of CDOs, money begins shifting toward commodities. The commodity bubble reached its peak in July 2008.
- *September 2008*: Increasing liquidity problems result in the bankruptcy of Lehman Brothers and the governmental takeover of AIG, which suffered from downgraded credit ratings. Along with the credit freeze, this led to a strong downturn in stock prices.

III. Arguments for why the crisis may have affected the VC market

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

Decrease in the supply of money to VC funds: Due to the crisis, VC funds (operated by VC firms) had difficulties in finding investors. Investors in VC funds are typically pension funds, insurance companies, and large banks (Gompers and Lerner, 1998). Many of these institutions were themselves adversely affected by the crisis. Some of them went bankrupt (e.g., Lehman Brothers, Washington Mutual), (were) merged with other financial institutions to survive (e.g., Merrill Lynch) or received help from the government (e.g., AIG, Fannie Mae, Freddie Mac, Commerzbank, ABN AMRO). Most banks and insurance companies were forced to decrease the share of their investments in risky assets such as VC funds. Another argument concerns the exit channels for VC investments, which are *IPOs*, acquisitions, secondary sales, buybacks, and write-offs (Cumming and MacIntosh, 2003). Since the crisis had also affected the market for IPOs, VC firms faced severe exit challenges, which in turn also reduced the supply of money for VC funds.¹ Black and Gilson (1998), for example, argue that the amount of funds raised depends on a vibrant market for IPOs.

Decrease in the valuation of VC-backed start-ups: The crisis has clearly led to one of the deepest recessions in recent years. The US GDP decreased by 5.4% in the fourth quarter 2008 from the previous quarter (Q1 2009: -4.6%; Q2 2009: -0.8%).² The German economy (the largest European economy) decreased by 1.8% in the fourth quarter (Q1 2009: -3.4%; Q2 2009: +0.8%).³ In times of recession, VC-backed start-ups have problems generating sufficient revenues. End consumers and firms have less money to spend and may postpone purchases. This puts pressure on the start-ups' sales and leads to lower firm valuations. In addition, the start-ups' bankruptcy risks increase, and VC firms apply higher discount rates. To summarize, the recession followed by the

¹ See Ritter (2009) for detailed information about the market for IPOs in 2008 and 2009.

² See <http://www.bea.gov> (accessed January 9th, 2010).

³ See <http://www.destatis.de> (accessed January 9th, 2010).

crisis has led to lower valuations of VC-seeking start-ups, which also correspond to declines in stock prices on public equity markets.

IV. Empirical study

A. Measures and data

This section analyzes the effect of the crisis on VC activity across different industries and countries (US vs. non-US). The funding round will be our unit of analysis (i.e., the financing round in which start-ups raise money from one or multiple VC investors). We focus on two measures: (1) the number of funding rounds per month; (2) the amount of funds raised per funding round. Both measures will be calculated for the periods *before* and *during* the crisis.

Our data originates from the Thomson VentureXpert database (formerly known as Venture Economics), which has been widely used in the entrepreneurial financing literature (Bygrave, 1989; Sorenson and Stuart, 2001; Gompers and Lerner, 2004; Hochberg et al., 2007). This decision contrasts with those of Block and Sandner (2009), who used the database CrunchBase as a novel dataset.⁴ Compared to CrunchBase, VentureXpert goes further back in time and is thus the largest available database on private equity and VC investments. It is updated on a daily basis using mainly public sources to gather its information (Gompers and Lerner, 2004).

B. The VC market over the last two decades and the effect of the crisis

Figure 1 shows the number of annual funding rounds from 1987 to 2009. During the second half of the 1990s, the VC market began to grow strongly. Favorable conditions in the IPO market and the exits of less experienced VCs encouraged investors to allocate money toward VC funds (Gompers & Lerner, 2001). This increase steepened during the late 1990s as internet start-ups became favorable investment targets. The bursting of the internet bubble in the year 2000 led to a

⁴ See <http://www.crunchbase.com> (accessed January 11th, 2010).

strong decrease in the number of funding rounds, bringing the annual number of funding rounds back to the level of 1999. During the aftermath of the dot-com crash, venture capitalists remained active at a level of about 7,800 rounds per year. The effect of the crisis becomes visible during the final year of our sample, where the number of rounds decreased to about 3,800 for the year up until September 2009 (corresponding to an annual number of funding rounds of about 5,100). The effect of the 2008 crisis is thus sizeable and comparable to that of the dot-com crash in the year 2000.

[Insert Figure 1 here]

C. The VC market immediately before and during the crisis

Figure 2 shows the number of funding rounds from July 2007 to September 2009 on a quarterly basis. A downward slope is visible starting from the third quarter in 2008, departing from 2,157 funding rounds and leveling off at 1,246 in the first quarter of 2009 (i.e., a decrease of 42%). When looking at this period on a monthly basis (see Figure 3), we see that the VC market is rather fluctuant in its activity, making it difficult to determine the exact date the crisis started to have an effect on VC activity. The impact of the crisis somewhat stabilizes from January 2009 onwards, around a level of 400 funding rounds per month.

[Insert Figures 2 and 3 here]

To determine the date from which the crisis began to have an effect on VC activity, we need to take seasonal fluctuations into account. For example, throughout the five years preceding the crisis, the highest number of funding rounds always occurred in December and June, in contrast to the months of January and February, which often report the lowest amount of VC activity. Taking seasonal influences into account, Figure 4 compares the number of funding rounds for each month to the same time period in the previous year. This measure can be compared to the common meas-

ure of GDP growth, which is also not an absolute but a relative measure but compares the GDP of the current year with the GDP of the previous year. First, we see that the VC market was growing until April 2008. The turning point occurs in May 2008, when the VC volume began to decline. The VC market was thus already in decline when the crisis became monumentally publicly visible in September 2008 through the crash of Lehman Brothers.

[Insert Figure 4 here]

D. The effect of the crisis on VC activity across different industries

To measure the impact of the crisis, it is necessary to choose a date that determines the pre-crisis period and the crisis period. Many events associated with the crisis occurred in September 2008, when many financial institutions became visibly affected by the crisis. Among others, the investment bank Lehman Brothers went bankrupt on September 15, 2008. A sharp decline in stock prices followed in the beginning of October. However, from our analyses above, we can see that the VC market was already declining when the crisis became visible in September 2008. Accordingly, for our analyses regarding the effect of the crisis across industries, we choose two different cutoff points to determine the crisis and pre-crisis periods: (1) September 15, 2008, the date Lehman Brothers went bankrupt, and (2) July 1, 2008. During July 2008, the commodity futures had already had their peak, and a shift toward US treasuries and gold started (Orlowsky, 2008).

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

Table 1 shows the effect of the financial crisis across different industries. We analyze the period from January 2007 to September 2009 and use July 1, 2008, as a cutoff date to determine the crisis and pre-crisis periods. During that period, 14,355 funding rounds occurred. We distinguish between the effects of the crisis regarding the first and later funding rounds, a distinction which has been shown to make a great difference (Block and Sandner, 2009). In initial funding rounds, the funds raised provide initial money to start-ups. Second and later rounds equip start-up firms with additional funds so that they can continue with their development, marketing, or internationalization efforts.

[Insert Table 1 here]

Table 1 reports a drop in the number of funding rounds per month during the crisis. This decrease occurs within all industries and is larger for first rounds (-33.3%) than for later rounds (-17.7%). Especially in *Biotechnology* (-29.4%), *Internet* (-39.7%), and *Medical/Health Care* (-40.0%), we observe that VCs were more reluctant to provide first-round investments toward 'new' start-ups during the crisis than during the pre-crisis period. Within these industries, the percentage decrease in first-round investments is about four times larger than the decrease in later-round investments.

Table 1 also shows the median *amount of funds raised* per funding round. Using the median as an indicator robust to extreme values, a decrease is visible in the amount of funds raised during the crisis, especially within later funding rounds. The Wilcoxon rank-sum tests show that start-ups raise significantly lower funds within later funding rounds in *Internet*, *Medical/Health Care*, and *Computer Software and Service*. A significant decrease in the amount raised in first-round investments can only be observed in *Biotechnology*.

In summary, during the crisis, VC activity slowed down. The crisis affected the number of first-round investments to a greater extent than the number of second- and later-round investments.

Second, the amount of funds raised in each funding round decreased to a greater degree in later funding rounds than in first rounds.

Table 2 uses the crash of Lehman Brothers on September 15th 2008 as a cutoff date to determine the crisis and pre-crisis periods. Across all industries, the decrease in the number of funding rounds is stronger than in Table 1, where July 1, 2008, is used as a cutoff point. This is in line with our expectations, as Figures 3 and 4 have already indicated that the number of funding rounds declined strongly during the months after September 2008.

[Insert Table 2 here]

The findings regarding the *amount of funds raised* per funding round also became more pronounced. For example, in addition to the later funding round decreases in *Internet, Medical/Health Care*, and *Computer Software and Services*, we now also observe a decrease in the amount of funds in *Communications and Media* and *Other Products*.

E. The effect of the crisis on VC activity: US vs. non-US

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

Tables 3 and 4 compare the consequences of the crisis for start-ups located in the US to the consequences for those outside the US. Table 3 defines the beginning of the crisis as July 1, 2008. It shows that the decrease in the number of funding rounds per month is stronger within the US than outside the US. This difference is particularly strong for first-round investments (−42% in the US vs. −19% outside the US). The reductions in VC activity reported in Table 4, taking September 16, 2008, as the cutoff date, are similar. It seems that the VC market in the US has been more strongly affected by the financial crisis than the VC market outside the US. This finding is also supported by our second measure. The decrease in the amount of funds raised per funding round is significant for the VC market in the US but insignificant for the VC market outside the US.

[Insert Tables 3 and 4 here]

V. Summary of main findings and discussion

A. Summary of main findings

The main findings from our empirical study in Section IV are as follows:

- The crisis led to a decrease in the number of funding rounds. This decrease was generally stronger for the first funding round than for later funding rounds. The effect could be observed across all industries. It was highest in *Internet* (−46%) and lowest in *Industrial/Energy* (−18%).
- The amount of funds raised per funding round decreased. This decrease was generally stronger for later than for first funding rounds. In addition, the decrease in the amount of funds raised per funding round differed across industries. Significant decreases could be observed in *Internet*, *Medical/Health Care*, *Computer Software and Services*, *Computer Hardware*, *Communications and Media*, and *Other products*. The crisis did not show a statistically significant effect in *Biotechnology*, *Consumer-related*, *Industrial/Energy*, *Other Products*, and *Semiconductors/Other Electronics*.

- Finally, the slowdown of VC activity due to the crisis has been more severe in the US than outside the US. This applies to both the number of funding rounds and the amount of funds raised in each funding round.

B. *Discussion of the results*

Our results show that the crisis strongly impacted the VC market: the market is down in both the number of investment dollars and the number of deals (see Tables 1 and 2). Interestingly, this effect differed with regard to the stage of financing. The decrease in the number of deals can primarily be observed in first funding rounds, whereas the decrease in the number of investment dollars occurred in later funding rounds. How can these results be explained? The lower number of deals in the first founding round is most likely due to stricter investment criteria by VC firms. compared to the period before the crisis, the VC firms have less money to invest, are more critical about their VC investments, and tend to postpone their investments. Not surprisingly, they are less willing to take risks than they were before the crisis. Accordingly, start-ups that still receive VC funding are at later development stages and are, *ceteris paribus*, thus associated with lower risks (i.e., they might already have developed a prototype or established first customer contacts). Additionally, these entrepreneurs are in a different situation than they were before the crisis. If possible, they postpone their costly development and internationalization plans until the capital markets stabilize. Some entrepreneurs might even refrain from starting a company at all because they do not expect to obtain adequate financing. Entrepreneurs at early-stage companies might also consider alternative employment options. The situation is different for later-stage start-ups. These start-ups find themselves in a dilemma. Despite the lower valuations and the declining VC market, they still need later-stage funding to survive. In turn, the VC investors face the choice of either partly writing off their past investments or committing to providing fresh money in subsequent rounds of financing. Most likely, the VC investors will commit to new rounds of financing, but they are prone to lower the amount of funds they invest. These start-ups are in a weak negotiation position vis-à-vis

the VC firm(s). They need the VC capital to survive. In a nutshell, later-stage ventures find themselves in a kind of 'lock-in situation' and cannot avoid the lower valuation of their firm by VCs. Early-stage start-ups have more alternatives (including to not start the venture) and thus appear to be in a more comfortable and flexible position.

An alternative explanation for the drop in investment dollars is the following: an important difference between early- and later-stage ventures is associated with the unhealthy state of the IPO market. VC firms do not provide 'patient' capital. Instead, they intend to sell the firm in which they have invested after a few years. Conducting an IPO in a recession is not an attractive option. Following this logic, firms at later stages of the venture cycle become less attractive as investment targets, especially because the prospects of a revival of the IPO market in the short term are poor. Cumming et al. (2005) show that when exit markets are illiquid, VC investors invest proportionally more in early-stage projects. In turn, when exit markets are liquid, VCs invest more in later-stage ventures. Another explanation not related to valuation issues concerns the process of staging itself. The crisis and the greater uncertainty about the prospects for the economy might have increased the tendency of VCs to stage their investments. This tendency should be stronger with start-ups in later stages of the venture cycle, as the money at stake for the VCs is larger.

Our empirical study also shows that the crisis had a stronger effect on the VC market in the US than elsewhere. From a theoretical standpoint, this seems surprising. In a world of efficient financial markets (Fama, 1970), there should not exist any differences. VC money is not bound to borders and can flow to wherever the best start-ups are located. If the crisis led to an external shock in the supply of VC money, the effect on the amount of deals and investment dollars should be similar in every country. The fact that the effect of the crisis seems to differ across countries shows market imperfections, which can be explained by irrational economic behavior and psychological pitfalls (e.g., Akerlof and Shiller, 2009; Klodt, 2009). Examples of such behavior are the tendency to overestimate our own skills (Thaler, 2000), the tendency to pay less attention to information questioning our decisions than to information supporting our decisions (Brehm, 1956), and the

endowment effect (Kahnemann and Tversky, 1979; Knetsch, 1989). These types of irrational behavior may exist in both the VC market and the financial market in general. Our results suggest that imperfections in the VC market were greater in the US than in other countries. Accordingly, the effects of the crisis should also be greater in the US.

VI. Implications and further research

A. Implications

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

- *Implications for start-ups:* Our results show that start-ups that sought VC were affected by the crisis. Start-ups that had already received initial funding and wanted (or needed) to raise further funds faced a discount as a result of the crisis (the extent of this discount varied between industries and countries; see Tables 1 to 4). This discount was most likely a result of valuation changes by VC investors. One lesson of this crisis is that start-ups seeking later-stage financing should try to foresee such developments and adapt their business planning accordingly. Cutting costs or postponing expansion plans may be adequate reactions. In times of a financial and/or economic crisis, they will encounter difficulties in raising the funds required to further finance their product development, marketing, and internationalization efforts. Our results also show that the crisis led to a drop in the number of initial funding rounds. We suggest that VC firms became more selective as a reaction to the financial crisis. Or, in other words: start-ups that sought VC during the crisis had to fulfill stricter criteria during the crisis than before it. Entrepreneurs that seek initial funding should keep this in mind and think about alternative sources of funds, such as angel investors or bank loans (Cassar, 2004; Harrison and Mason, 2000). If there exist no alternatives to VC money (as is often the

case), entrepreneurs might consider changing the way they communicate to potential VC funders, e.g., they might adjust their business plans and stress that the chances of success of their particular start-up are rather immune to the development of a crisis. They might also consider playing down some risks associated with their start-up. An alternative strategy would be to look for some sort of bridge financing from sources other than VC money. Finally, our results show that the effect of the crisis on VC activity differed across industries and countries. Industry differences can be explained by the varying potential of business models in different areas; country differences can be explained by market imperfections caused by different degrees of irrational economic behavior and psychological pitfalls (Akerloff and Shiller, 2009; Klodt, 2009). Start-ups seeking VC should be aware of these imperfections in their business planning.

- *Implications for the evolution of innovative industries and technological development:* VC is an important means of funding for start-ups in innovative and technology-driven industries because it is the vehicle used to turn innovative ideas into products that can be sold to customers (Jell, Block, and Henkel, 2009; Zider, 1998). VC particularly matters when firms conduct R&D and start to commercialize their innovations, that is, when they develop their products, apply for patents, look for distribution partners, seek initial customers, conduct their internationalization strategies, or simply scale up their operations (Gompers and Lerner, 2001; Zider, 1998). VC firms not only provide financial means but also offer non-financial benefits such as management support and access to experts or existing business networks (Large and Muegge, 2008; Schefczyk and Gerpott, 2001). Florida and Kenney (1988, p. 119) see VC firms as “technological gatekeepers accelerating the process of technological change.” Thus, the VC market drying up can have long-lasting negative effects with regard to the evolution of innovative industries (Audretsch and Thurik, 2001; Bottazzi et al., 2002; Kortum and Lerner, 2000). Innovative start-ups might face illiquidity, and the speed of

commercialization of technological innovations might slow down. Ultimately, a country's or an industry's path of evolution can be adversely affected. Governments should be aware of these negative side-effects of the financial crisis, as they might determine their country's innovative capacity. Therefore, far, the policy responses to the crisis have been designed to avoid a credit crunch (Gern and Janssen, 2009; Sinn, 2009), that is, to avoid a collapse of the credit market for small and large firms. Our results regarding the effect of the crisis on the VC market suggest that this may not be enough: many innovative firms do not rely on debt but rather on VC as a source of financing. Avoiding a credit crunch helps established (small and large) firms in established industries rather than start-ups in innovative industries.

B. Further research

This is one of the first studies to empirically document and analyze the effects of a financial crisis on VC activity (Block and Sandner, 2009). VC has become an element vital to the current economy and an important source of funding for innovative start-ups (Gompers, 1994; Jell, Block, and Henkel, 2009). In this study, we show that a financial crisis can have a strong, exogenous impact on VC activity. Unlike the last slowdown of VC activities following the collapse of the New Economy bubble in the year 2000, the 2008 slowdown came more as an exogenous shock to the VC market. In the 2007-2009 crisis, what initiated the downturn of VC activity were not unrealistic expectations regarding the "omnipotence" of the Internet and the New Economy but instead problems in the financial sector. We suggest that such an exogenous shock can lead to a severe funding gap in the financing of innovation.

A number of questions are left unanswered and provide good opportunities for future research. How do start-ups receiving funding during the crisis differ from start-ups that received funding before the crisis? For example, are the former more successful, were they associated with lower bankruptcy risks, or did they simply communicate in a better way? How did the start-up

entrepreneurs react to the challenges of the crisis and the difficulties in the search for VC funding?⁵ For example, did they look for alternative sources of funding such as money from business angels, or did they postpone their expansion plans? Have the fiscal stimulus packages of the US and other governments had any effect on the VC market?⁶ What is the effect of the crisis on the performance of VC funds? Why has the impact on the clean-tech industry been weak compared to impacts on other industries? And ultimately, over a longer time period, did the decrease of VC activity due to financial markets have severe consequences for the real economy? For example, did the number of innovations slow down?

⁵ See Koellinger and Thurik (2009) for a discussion of entrepreneurship and the business cycle.

⁶ See Van Roye and Wesselbaum (2009) for a study of the effect of the fiscal stimulus packages.

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Table 1: The effect of the financial crisis on VC activity across industries (cut-off point: July 1st, 2008)

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

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

Table 2: The effect of the financial crisis on VC activity across industries (cut-off point: Sept 16th, 2008)

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

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

Table 3: The effect of the financial crisis on VC activity: US vs. non-US (cut-off point: July 1st, 2008)

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

Notes: * $p \leq 0.05$; ** $p \leq 0.01$; two-sided tests employed; **Data source:** VentureXpert (accessed November 11th, 2009); all industries are included.

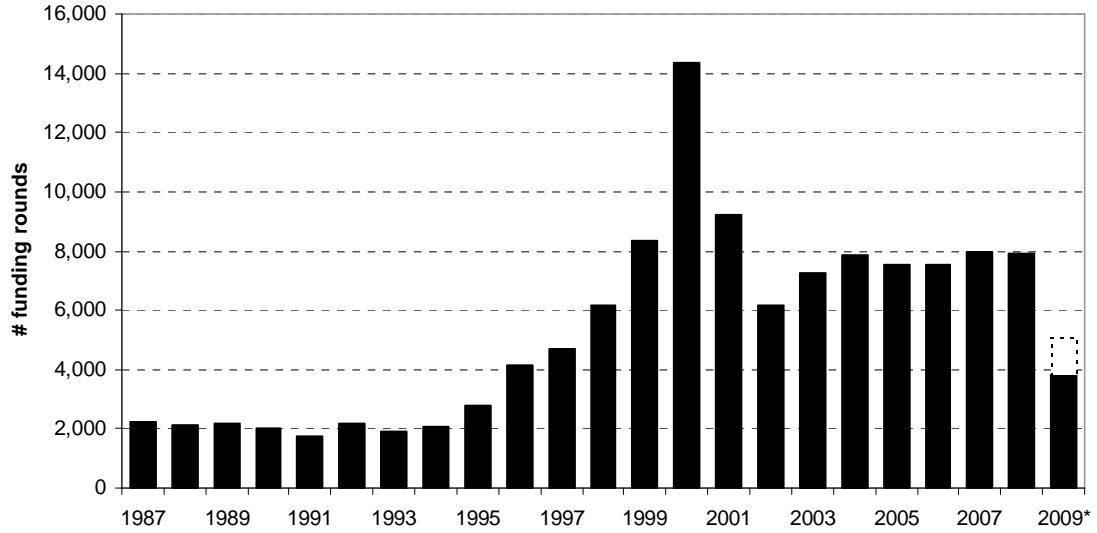
Table 4: The effect of the financial crisis on VC activity: US vs. non-US (cut-off point: Sept 16th, 2008)

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

Notes: * $p \leq 0.05$; ** $p \leq 0.01$; two-sided tests employed; **Data source:** VentureXpert (accessed November 11th, 2009); all industries are included.

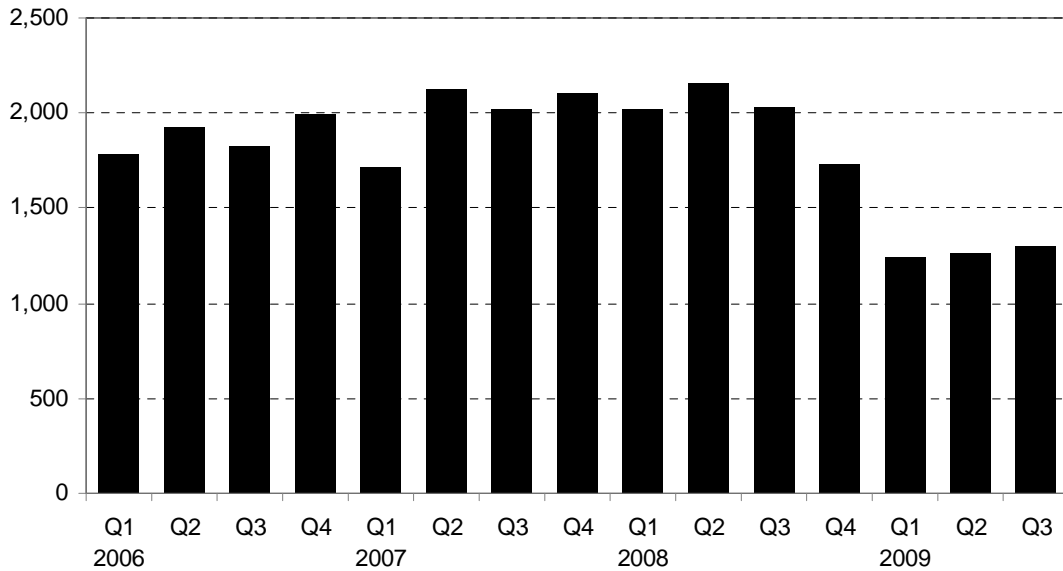
Figures

Figure 1: Number of funding rounds (from Jan. 1987 to Sept. 2009)



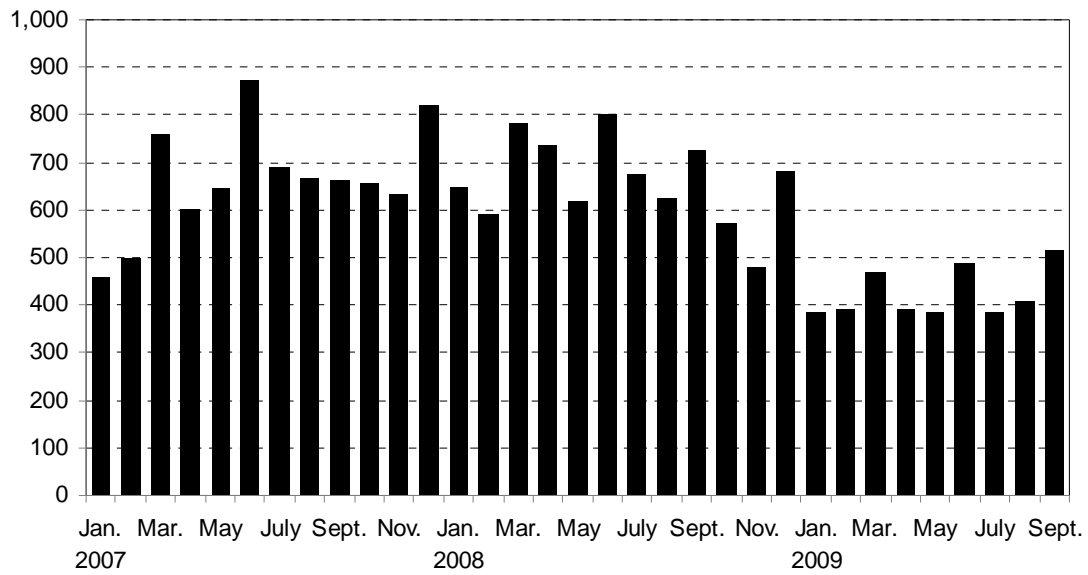
Source: VentureXpert (accessed November 11th, 2009); all industries and countries are included.
Note: *) The year 2009 only includes the months from January to September. The dotted line indicates the number of funding rounds proportionally scaled to the whole year ($3,817 / 3 * 4 = 5,090$)

Figure 2: Number of funding rounds (quarterly basis, from Q1 2006 to Q3 2009)



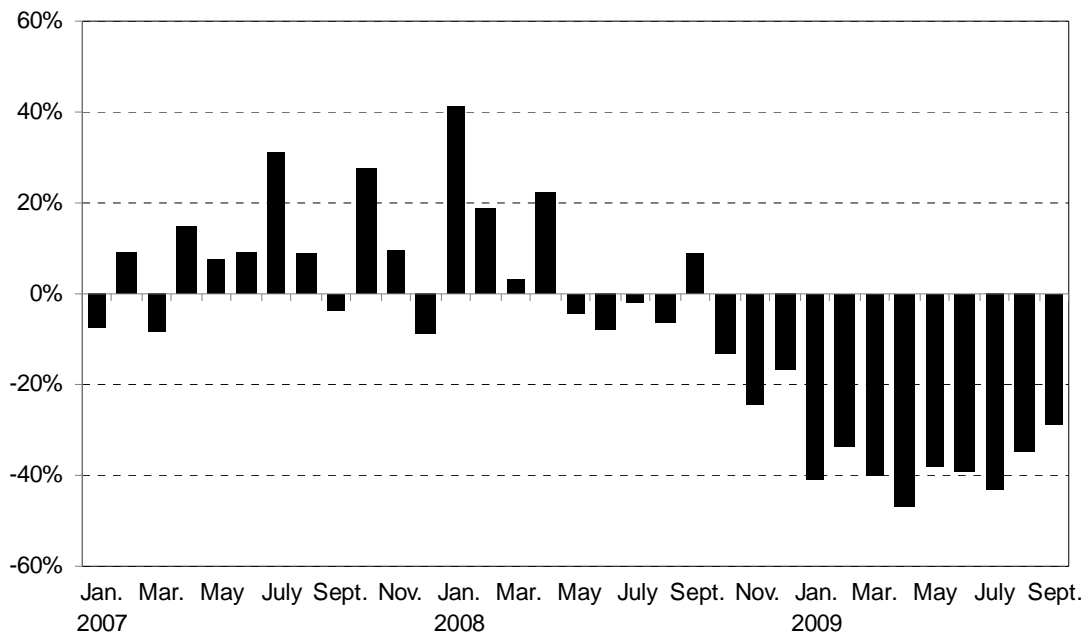
Source: VentureXpert (accessed November 11th, 2009); all industries and countries are included.

Figure 3: Number of funding rounds (monthly basis, from Jan 2007 to Sept 2009)



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

Figure 4: Change in the number of funding rounds (compared with previous year)



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