Venture Capital and Innovation

The role of Venture Capital Reputation in the Innovative Performance of an Enterprise.

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Title Page.

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Abstract. *The intent of this paper is to describe the relationship between Venture Capital (VC) Reputation and Innovation in enterprises. The contribution of Reputation to the successfulness of Venture Capital Involvement is of interest. First we will discuss the existing literature on this topic, and compare different methods and results. Using this information, we will propose a set of independent variables used to measure Venture Capital Reputation. In addition, we will explain how Innovation can be captured. To answer our main question we will perform a regression in order to draw conclusions on the strength of the relationship.*

1. Introduction.

Innovation has always been an important part of our society; especially the last two hundred year technological innovation has taken a flight. Innovation in the early 1800's has helped to pull our modern society out of the Malthusian trap and since then steadily improved our wealth. Innovation is an expensive process, and funding has always been a vital importance (O'Sullivan, 2005). Since long Venture Capital is seen as an important channel for supporting Innovation (Kortum and Lerner, 2010). Leading Innovative companies like Apple, Microsoft, Google, Dell and Intel all received Venture Capital (Gompers and Lerner, 1999).

VC capital, unlike conventional sources of funding, tends to invest early in the Innovation process (Smith 2006). This in itself makes it foster innovation (see 2.3). Since there is an extensive amount of literature on the link between Innovation and Venture Capital, the decision was made to specify and to focus on the non-financial part of Venture Capital. VC firms traditionally have a large network and have management capabilities which young companies often lack.

Many authors, of whom Josh Lerner is the best known, have investigated the relationship between Venture Capital Investment and Innovation, and found that VC backed companies tend to have higher Innovative performance compared to non-VC backed companies (Kortum and Lerner 1998,2000). Other authors like Nahata, did extensive research on the relationship between Venture Capital Reputation and the success of the companies they invested in. They found that more reputable VC firms were more successful in creating value through their Portfolio Company investments (Nahata, 2007), (Hochberg 2007).

The specific relationship between Venture Capital Reputation and Innovation has not been the subject of any research yet. In order to draw conclusions on the proposed relationship this paper tries to answer the following sub-questions:

Subq1: How can we measure VC reputation?

Subq2: How is innovation quantified and measured?

Subq3: To what extend does VC reputation influence Innovation in the companies they invest in?

In chapter two, the existing literature on Venture Capital Reputation, Innovation and the link between these two will be investigated. This chapter will answer the first two sub-questions and give an insight in the variables needed to conduct the empirical research.

In chapter three we will extensively explain the proposed Venture Capital Reputation, Innovation, and Control variables. In addition, we will discuss the regression analysis. Chapter four will summarize and draw conclusions.

2. Literature review

2.1 Venture Capital

Venture Capital (VC) investment is a form of private equity that is used to fund high growth potential enterprises. Although VC dates back to 1946, between 1946 and 1977 the flow of money into new venture funds never exceeded a few hundred million dollars annually (Kortum and Lerner, 2000). As we shown in figure 1 (appendix 1), the total amount of VC increased dramatically in the late 70's and early 80's. An important factor in this increase is 1979 "prudent men" amendment, which allowed pension funds to invest a larger part of their money in high-risk assets like Venture Capital (Lerner, 2002). After a small period of stagnation and decrease, venture capital takes a flight in the late 90's to peak just before the burst of the Silicon Valley internet bubble in 2001. After the peak in 2000, VC investment saw a dramatic decline in 2001 (Lerner, 2002) only to recover rapidly in the past 10 years. Howells (2005) makes the connection between the success of VC and the success of Silicon Valley as Innovation hot-spot. As there is a high concentration of VC firms and Innovation in that cluster.

Already in 1931 the Macmillen report (1931) find the existence of a so called "equity gap" which describes the difficulties of small firms to source risk capital. An OECD (2005) report on innovation describes VC as the link between start-ups and institutional capital. In figure two, Rorke et al. (1991) describe an investment curve in which Venture Capital closes the gap between personal savings & bootstrapping and an IPO. In accordance to figure 2, Smith (2010) distinguishes formal and informal investors. Informal investors are often business angels that "have no visible market in which they operate or directories that list them" (Mason and Harrison, 1996, 1997).

Venture Capital firms manage pools of capital that they borrow from institutional investors (Christofidis and Debande, 2001). They use this money to invest in start-up companies in order to make a gain when this company Exit's with an acquisition or an IPO. Lerner (1994) argues that Venture Capital firms have an important role in bringing companies public. Venture Capital is a most commonly used by young start-up firms. These firms typically have high uncertainty and few tangible assets, and therefore find it difficult to source capital from traditional financial institutes in order start new projects (Gompert and Lerner, 1998). Timmons (2009) states in his book about new Venture creation that successful entrepreneurs become Venture Capitalist themselves in order to invest in the next generation of entrepreneurs. They often use the entrepreneurial knowledge to help the start-up companies they invest in.

Gorman and Sahlman (1989) argue that the involvement of Venture Capital firms extends beyond that of traditional financial institutions. While traditional institutions tend to focus on providing information, Venture Capital actively influences strategic decision making in sales, marketing, and human resource management (Hellmann and Puri, 1999). Hellmann and Puri also find that companies that have been funded through VC are likely to professionalize faster. VC firms support internal organizational change that is needed in a growing company. Start-up companies that are growing and become more complex need talented employees. Venture Capital firms can play an important role in attracting those high potential employees (Hellmann and Puri, 1999).

We can conclude that Venture Capital can have a large impact on their portfolio companies. Their involvement influences decision making in the company and provides the network to source high potential employees.

2.2 Venture Capital reputation.

As mentioned before the impact of VC on a company is not solely a financial one. VC firms tend to commit to a company; Kortum and Lerner (2002) state that VC firms are active in advising, directing and sometimes even managing the companies they invest in. Hellmann and Puri (1991) found that VC-backed companies are likelier to replace their founder by an outside CEO. As mentioned above, successful entrepreneurs tend to become Venture Capitalist themselves; their entrepreneurial experience can add value to start-up companies (Timmons, 2009). Reputation is an important factor in how successful Venture Capital firms are in adding value to and professionalizing their portfolio companies. When concerning growth and survival, Portfolio Companies rely to a great extend on the advisory they receive from Venture Capital firms (Khrisnan et al, 2011)

Nahata (2007) states that the Reputation of potential financial services providers is an important factor in the cost- benefit analyses of companies interested in raising capital. Sorensen (2007) finds that companies funded by experienced VC firms have a higher tendency to go public. Gompers and Lerner (1999) state that an IPO (going public) is the most successful access a VC can have. In that light experienced VC firms with higher reputation tend to be more successful.

Sirri and Tufano (1993) and Chevalier and Ellison (1995) argue that past performance of a VC firm is an important factor of their ability to attract new investors. Lerner (1994) concludes that well established VC firms are successful in bringing companies public near market peaks. Bringing a company to the market in a peak means that the entrepreneur and the VC firm is able to sell its share in the company for a relatively high price. In addition, Gomper (1996) finds that younger VC firms try to accelerate their reputation building by taking their portfolio companies public sooner. Here we see a distinction between the behavior of relatively young VC firms, and the more experienced ones. The more value a VC firm manages to create by investing in start-up firms and bringing them public, the more visibility they will create. Doing this continuously has a cumulative effect on the VC firm's reputation (Krishnan et al, 2006). Young VC firms might be too eager to create a reputation and bring their Portfolio Companies public prematurely.

Hochberg Ljungqvist, and Lu (2007) argue that companies that have a large connectedness with other participants in the industry have a better access to information and potential investments. Sahlman (1991) describes the positive relationship between VC reputation and network orientation. Large et al. (2007) state: "Venture Capitalists bring a network of contacts with experienced infrastructure providers". In that light, we can conclude that VC connectedness positively correlates with amount of exposure Portfolio Companies have to "experienced infrastructure providers". These infrastructure providers help to mature the company because of advisory about strategy, management, and finance (Kortum and Lerner, 2002). We see a positive correlation between the networking capabilities of a VC company and the performance of its portfolio. So the better a VC firm's networking capabilities are, the better it can help its portfolio companies. It is clear that connectedness is part of VC's reputation. Sorensen (2007) captures this by stating that more reputable VC firms add more value to the companies they invest in than less reputable VC firms.

Not only is VC reputation important for the companies they invest in, they also require reputation for being a long-term player in the financial market. Since this market is highly network orientated, reputation is needed to attract potential investors and create work-relations with stakeholders like lawyers, pension funds, and auditors (Sahlman, 1990). We can conclude that the amount of "network orientation" is an important factor in the reputation of a VC firm. Hochberg et al. (2007) refers to this as "VC connectedness".

Most studies focus on the relationship between Venture Capital Reputation and investment success. We can make use of their quantification of Venture Capital Reputation in order to investigate potential VC Reputation Variables.

Nahata (2008) quantifies Venture Capital Reputation using an accumulation of the dollar value of all companies a VC firm has taken public as a measure for VC reputation. In addition, he uses the share of the aggregate investment a VC has in its industry as a reputation measure. He finds that a higher share reflects a better reputation. Gompers (1996) uses VC experience variables such as age, cumulative aggregate investment, and number of investment rounds to measure VC reputation. A common measure of VC reputation, used by Krishnan et al (2011), and Megginson et al (1991), is IPO Market share. This measure depicts the share of successful IPO's of a VC company compared to other VC firms. Nahata (2008) uses a similar measurement and finds that a higher IPO market share positively relates to the probability of a future IPO.

Since we have only limited time and limited resources, we will propose variables that can be found in ThomsonOne financial database. Chapter three will give more elaboration on this. We quantify Venture Capital reputation by: Age of the VC firms, Total Amount of Equity invested in VC deals, and Industry focus.

2.3 Innovation

Rogers (1995) describes innovation as "an idea, practice or object that is perceived as new by an individual or other unit of adaptation". Most authors agree that Innovation is more than an idea, DTI (2005) states that "Innovation is the successful exploitation of ideas". According to Smith (2006),

Innovation has three phases; Invention, Commercialization and Diffusion. Invention is associated with the creative idea whereas Commercialization and Diffusion are associated with the "successful exploitation" of these creative ideas.

Literature distinguishes two different types of Innovation; Incremental Innovation and Radical Innovation. Radical Innovation is based on relatively new technology (Govindarajan et al, 2004) whereas Incremental Innovation involves modest changes Christiansen (1997) describes it as "a change that builds on a firm's expertise in component technology within an established architecture" Radical innovation is rather risky compared to Incremental innovation which is based on extending existing product lines and platforms (Ali et al, 1993).

Innovation can occur in large R&D facilities like those of Xerox and AT&T, but also other sources became increasingly important since the 2nd half of the 20th century. Innovation can occur in other areas in the company like Marketing and Production. Also Innovation occurs outside the company through interaction with clients and customer organizations (Manuel, 2007). Von Hippel (2005) calls this the "democratization" of Innovation.

Sood and Tellis (2009) argue that the higher return on investment occurs in the development stage of a product (innovation). In order to protect Intellectual Property and secure future profitability, patents are vital in this stage of the Innovation cycle. Most authors find that patenting is a way to measure innovation. The more patent application a company does, the more innovative the company is.

Lerner (2011) captures innovation in one of his latest works on private equity and Innovation by counting the amount of patents of companies that had at least one successful patent application in the three years before the arrival of PE. He argues that "old economy" firms have a greater reliance on trade secrets and branding. Lerner (2011) distinguishes 3 different features regarding patenting: the quality, size, and structure of the Patent portfolio. Quality is measured by counting the amount of times the patent is cited in other patent applications in the rest of the calendar year and the 3 years after the patent grant. The size is measured by the amount of patents a company has applied for, and the Structure is a measurement for the different types of patents a company holds in its portfolio.

We do not have access to the same databases as Lerner has, nor do we have the amount of time and resources to do such an extensive research. We will quantify Innovation as the amount of patents a company applies for after the arrival of Venture Capital.

2.4 Research and Development (R&D)

Innovation can occur through individual insights: "a flash of genius" (Smith, 2010), this is usually the case with small start-up companies. A major source of innovation for more established firms is Research and Development. Research and Development is one of the key input factors of Innovation. Lerner (2000) finds that R&D expenditure and Innovation are to a great extend substitutable.

R&D is hard to finance in a competitive economic environment. The output of Innovation is the knowledge on how to make goods and services. This output is difficult to keep secret and it cannot be

precluded that other firm make use of this knowledge. Given this information, R&D investment classically tends to have a low return on equity (Hall, 2009). A prisoner's dilemma occurs in which every player is reluctant to invest.

To counter this problem, governments have implemented Intellectual Property Right (IPR), an R&D tax benefits. Also, companies counter this problem by setting up joint R&D facilities. In spite of these measures, it is for small start-up companies in their early stage difficult to source capital from external sources (Grant, 2010). They will need to finance his invention with private capital.

Investment in R&D is for more than 50% needed for the wages of highly educated scientist and technicians (Hall, 2009). The output of their labor is knowledge on which future revenue is based. This knowledge is an intangible asset and can suddenly disappear when employees are fired or decide to leave the company. This makes a R&D investment a risky one.

Lerner (2000) controls for the amount of R&D spending when investigating the connection between Venture Capital and Innovation. He investigates whether companies funded by Venture Capital have more Innovative output (patents) in comparison to non-VC financed companies while having the same amount of R&D spending. He finds that companies backed by VC capital have more Innovative output with the same amount of R&D spending.

Since it is not possible for us to get the information on R&D spending of the companies we are investigating, most of them are still privately held companies, we will not control for the R&D spending when investigating the relationship between VC reputation and Innovation. We assume that controlling for the total amount of Equity invested in a company will make sure our results are not biased due to different R&D spending. We need to assume that companies in the investigated industry spend around the same proportion of their equity in R&D.

2.5 Innovation and Venture Capital Reputation

The main focus of this paper is to find the relationship between Venture Capital Reputation and innovation. There is an extensive base of literature on the topic of VC and Innovation, yet there are little to no publications on VC reputation and Innovation. We will propose relationships that will be subject of investigation in chapter 3.

Figure two gives an overview of the cash flow in an innovation process. This shows us that Venture Capital arrives as seed capital, long before the company has a positive cash flow. This initial seed capital is often provided by angel-investors. Later on when the company is further in the innovative process and can show a working prototype, institutional Venture Capital arrives. Because VC arrives in a relatively early stage of the company, it can to a large extend influence the strategic decision making and in that light also the innovative performance (Grant,2010). We propose a positive relationship between VC reputation and the ability to influence strategic decision making in a Portfolio Company in such a way that more Innovation occurs.

Large companies tend to focus on incremental Innovation, which is more certain. Since risk is relatively low, these large companies are financed by large institutional investors through debt and share equity (Lerner, 1994). Small start-up companies tend to focus on radical Innovation and have a large innovative potential. Since their risk is relatively high, they tend to attract Venture Capital. VC firms provide the necessary means so that the innovative potential is transformed into real Innovation (Large et al, 2007). The fact that a company has managed to attract a certain VC company with a certain reputation may be a signal for other investors that the company is worthy to invest in. When addressing signaling, Venture Capital reputation is an important facet of the credibility of the signaling. The more reputable a VC firm is, the more its Portfolio Companies will be able to attract additional capital to invest in Innovation.

Innovation is much more than an invention. It is the successful exploitation of these ideas. The Venture Capital firms can help transform invention into innovation; they provide "a network of experienced infrastructure providers" to help the company with commercializing and diffusing their product (Large, 2007). The VC firm provides managerial capabilities needed in a growing company. In addition, they might be able to source capable employees. Again we see the importance of VC reputation. Dobloug (2008) argues that Venture Capital accelerates growth and secures long term successfulness of a company. Companies might experience more help in the diffusing and commercialization from experienced VC firms than they do from less experienced VC firms.

In order to secure long term successfulness, companies need to protect their competitive advantage. One of the most common way of doing this is by patenting. Lerner and Gomper (1998) find that Venture Capital activity increases the patenting rate in given industries. In addition, the patents they produce are more valuable. Lerner and Gomper (1998 and 2000) conclude that VC backed companies are more innovative compared to their non-VC backed rivals. More experienced VC companies might be more aware of the necessity of protecting innovations. Krishnan (2011) argues that more reputable VC firms contribute to a better Corporate Governance in their Portfolio Companies. Short (2002) finds that effective Corporate Governance is an important driver for innovation. We can conclude that VC Reputation and Innovation positively relate.

Hellman and Puri (1999) argue that innovative companies are more likely to attract Venture Capital than companies that rely on imitation. Venture Capital firms tend to invest in innovative firms because they assume them to have a significant growth potential hence a larger growth potential (Engel and Keilbach, 2007). Most authors suggest a causality problem here. They argue that it could be that Innovative firms select Venture Capital as their source of financing and vice versa. In this light, VC financed firms might be more innovative than non VC financed firms, but this is not caused by the VC firm. Lerner (2000) acknowledges this causality problem but proves that Venture Capital Activity and Innovation still has a significantly positive relationship. Scherer (1990) finds that young firms tend to be more innovative than older firms. We will need to control for the age of the Portfolio Company.

Another difficulty in measuring Innovation is that, as Kortum and Lerner (2000) suggest, VC companies tend to have a higher degree of patenting then their non VC financed rivals simply because they need to disclose their technology. So in this case, more patenting does not necessarily mean more Innovation.

Kortum and Lerner (2000) account for this by including patent citation as a measure for successfulness of a patent.

We have seen that many authors find a positive relationship between VC Reputation and profitability Nahata (2007) Hochberg (2007). Leiponen (2000) finds that innovation is a key driver for profitability, provided that companies have the right complementary competencies. He defines those competencies as knowledge on how to apply new knowledge. In this light we can argue that because more reputable VC firms tend to spur profitability, and Innovation is a key driver for profitability, VC reputation has a positive influence on Innovation. This can be explained by arguing that more reputable VC firms are better at providing complementary competencies to their portfolio companies.

In the next chapter we will give more elaboration on the proposed variables and we will investigate whether the proposed relationship between VC reputation and Innovation will hold.

3. Data and methodology

3.1 Introduction

In the literature review we have seen several measures for VC reputation and Innovation, which is the main focus of my paper. I have also revealed several variables that can influence VC Reputation and Innovation. These variables will be the control variables. In most existing papers, a comparison is made between companies which received VC and companies that did not. For example Khrishnan et al (2011) find that companies that receive VC have a better post IPO performance than companies that don't. Kortum and Lerner (2000) find that the impact of VC on patenting relative to one dollar of R&D is 3.1. We will investigate what the effect of VC reputation is within a set of companies that are VC backed. Does a variation in VC reputation lead to a variation in Patent applications?

The dataset will consist of Venture Capital deals done by U.S. VC firms in the U.S in the Online Software Industry. We have chosen the time span 1st of January 2005 to 1st of January 2008. We will count all the patent applications after the arrival of VC, also the ones applied for after 2007. This way we account for the lag between the arrival of VC and the visibility of Innovation. We will only look at first round investments, this way previous Venture Capital Investment does not influence our results.

The following filters have been applied in ThomsonOne

- Internet software industry
- 1st of January 2005 - 1st of January 2008
- US VC firms/US Portfolio Companies
- Venture Capital investment

This gives a total of **877** investments.

The following filters have been applied after data source from ThomsonOne

- First round investments
- Largest VC firm according to Total Estimated Equity Invested

This leaves us with **126** investments for which we investigated the amount of Patent Applications of the Portfolio Company.

After removing investments with information on one or more variables missing, we have **99** investments left to perform the regression.

Figure three and four will provide information on the selected investments before we account for missing information.

We have identified several control variables that may influence the Independent and Dependent variables. We used the 2 year dummy variables to account for differences in Macro-economical environment. We do not account for changes in Intellectual Property (IP) law.

The following Innovation production function will be used:

Y = B0 + B1**X1(AGE)** + B2**X2(TEEI)** + B3**X3(EXP)** + B4**X4(EAE)** + B5**X5(OVC)** + B6**X6(AAF)** + B7**X7(TF)** + B8**D1(2005)** + B9**D2(2006)**

3.2 Venture Capital Reputation variables.

In this research I will investigate the relationship of the independent reputation variables with the dependent variable Y. The independent variables also include the control variables.

We differentiate three different variables that measure Venture Capital Reputation. Which are used by the majority of the authors in existing literature when addressing VC Reputation

Our first variable is a variable that most authors use when measuring reputation. According to Gompers (1996), Krishnan (2011) and Nahata (2008), Age of the VC Company is an important measurement for Reputation because it has a positive relationship with experience. Many authors find that VC companies with high experience seem to have better capabilities in increasing the profitability of their portfolio companies. The fact that a firm already exists for a large period of time is seen as an indication for its past success, and is expected to have a higher future success probability. Also, a VC firm with more experience has a bigger network and better managerial capabilities (Nahata, 2008).

The second variable I use is based on Lerner's (1994) and Gompers (1996) cumulative aggregate investment. Both authors find a positive relationship between cumulative aggregate investment and reputation. An explanation for this can be found in the fact that more cumulative investments means higher network orientation. The relationship between network orientation and reputation is explained in the literature review. It can also be concluded that VC firms with a large amount of aggregate investment are seen as trustworthy by institutional investors that provide a part of the working capital. Larger does not always mean better, flexibility is an important capability that large companies tend to

lack. Cumming (2006) finds a negative relationship between VC firm size and assistance to their Portfolio Companies and also the performance of the Portfolio Companies. Lerner and Gomers, and Cummings seem to contradict each other here since reputation has proven to have positive relationship on performance (Nahata, 2008). Lerner and Gompers argue that firm size improves reputation and therefore performance while Cumming argues the contrary. Nieponen (2000) proves that profitability is highly dependent on Innovation, and in that sense we are going to research the relationship between firm size and Innovation and if this is in accordance to Lerner and Gompers findings or Cummings findings. We will depict firm size by Total Estimated Equity Invested, which is sourced from the ThomsonOne Venture Capital database.

The third VC reputation variable depicts the industry focus of a Venture Capital firm and is sourced from Nahata's (2008) "VC's share of aggregate investment in the VC industry". Nahata finds a positive relationship between VC's share of aggregate investment in VC industry and industry knowledge. The VC will know better the pitfalls and opportunities in a given industry. Nahata (2008) argues that this results in better investment success of the VC firm. We suggest that VC firms with superior industry knowledge will be more capable of supporting innovation in their portfolio companies. We will try to find a relationship between the share of total deals a certain VC firm has and the Innovation of the Portfolio Company.

In this research we will only include first round Venture Capital investments. This way previous investments that have been done before the investigated time span (2005-2008) will not influence Y. Since companies often have multiple investors, we look at the AGE, TEEI and TNCI of the biggest company measured by highest TEEI. This method helps to rule out problems with double data. For the EXP variable, we will include later round investments because previous later round investments influence the Reputation for later first round investments.

X1(AGE): This variable will be sources from the variable "Firm's founding year" in ThomsonOne. This number can take any positive value. It is assumed that a higher age contributes to a higher reputation.

X2(TEEI): Total Estimated Equity invested is the total amount of Equity the VC firm has invested in companies. It is assumed that TEEI is a measure for the scale of a company, the bigger the scale, the higher its reputation.

X3(EXP): The total amount of deals a VC firm had within in the online Software Industry. This reflects the industry concentration. It is assumed that a higher industry concentration means more industry knowledge and a better reputation. We will count how many times a certain VC firm has invested in a company in the online Software Industry in the time span 2005-2008. We choose a relatively small time frame because we assume that the Online Software industry is subject to fast change. Also, time constraint problems played a role.

Figure five and six give an overview of the VC reputation data.

3.3 Control Variables

The control variables are independent variables which we assume also influence the dependent variable. We use these variables to say something about the degree the VC reputation variables influence the Innovation compared to other influences.

The first variable will control for the amount of equity the biggest VC firm invests in its Portfolio Company. Regardless of the reputation of the VC, a bigger investment tends to result in a higher scale and more patent applications.

The second variable will control for the existence of multiple VC investors in a company. More VC firms that participate in the investment suggest a larger network and more managerial capabilities the portfolio company can make use of. This can influence the amount of patent application regardless of the reputation of those VC investors.

The third variable will control for the difference in age of the Portfolio Company. As mentioned above, Scherer (1990) finds that younger firms are more innovative than older firms. A relatively older company might have superior innovative capabilities regardless of the Reputation of the Venture Capital Firm.

Last variable we will control for is the total funding to date. Other forms and amounts of funding might influence the Innovative capabilities of a portfolio company regardless of the Reputation of the Venture Capital investor.

X4(EAE): Equity Amount Estimated. This is the amount of Equity the biggest first round VC firms has invested in the company.

X5(OVC): Other Venture Capital. This variable measures the amount of VC firms that participate in the first round investment in the Portfolio Company.

X6(AAF): Age at Financing: the age of the company when it first receives VC. This age will be measured in months.

X7 (TF): Total funding to date. The total amount of funding the company has received can influence Y.

D1 (2005): Dummy variable for the year 2005. Every VC transaction completed in 2005 receives a 1

D2 (2006): Dummy variable for the year 2006. Every VC transaction completed in 2006 receives a 1

Other variables that might influence Y are Company Profitability, Amount of Employees, and IPO date. Unfortunately, this information is not available for my dataset.

3.4 Dependent variable:

Our dependent variable will measure Innovation.

Innovation can be measured by accumulation of the amount of new/improved products a company brings to the market (Grand, 2010). This is not very practical and we see that most authors choose for a different approach. The industry we research is a relatively new industry and therefore is not part of the "old economy" in which trade secrets and branding are central Innovation captives. In the online software industry, Intellectual Property Right (IPR) is a captive for Innovation (Kortum and Lerner 2002). Kortum and Lerner (2002) use the amount of patent applications as variables to measure IPR activity and Innovation.

Lerner (2011) uses the Harvard Business School (HBS) patent database which is based on the United States Patent and Trademark Office (USPTO). This database accounts for the USPTO's misspellings and inconsistencies. Some authors like Criscuolo et al. (2005) and Lerner (2011) account for the successfulness of the patents by using patent citation as an indicator. This way, they account for the probability that companies feel pressured by the VC firm to file an extensive amount of patent applications even though they have not become more Innovative. This goes beyond the scope of this thesis.

Since we cannot get access to the HBS patent database we will match the investment data sourced from ThomsonOne with the patent application information publicly available in the United States Patent and Trademark Office (USPTO). We will account for patent application that is filed after the arrival of the first round of Venture Capital investment.

Y(P): Amount of patents after arrival of VC. This information is sourced from USPTO

Figure 7 gives an overview of the amount of patents that have been applied for after the arrival of Venture Capital. We differentiate between the years they first received Venture Capital.

3.5 Outcome of regression

Before we will perform the regression we first investigate the correlation matrix to determine if it is useful to include all the proposed independent variables. A high correlation between two variables suggests they describe the same relationship with the independent variable. In appendix 1 you will find the correlation matrix. It shows that the correlation between X2(TEEI) and X3(EXP) is relatively high (0.802). This means that X2 and X3 are to a relatively high degree substitutable. This can be explained by the fact that firms high on Total Estimated Equity Invested tend to have a large part of the amount of investments deal and vice versa. We decide to include both variables because X3(EXP) tells something about the amount of VC deals within the investigated industry, while X2 (TEEI) only tells us something about the overall size of the VC firm regardless of the industry. In other words, X3(EXP) is our only industry experience indicator. We will continue using all the proposed variables.

In order to make a distinction between the Venture Capital Reputation Variables and the variables we want to control for, we have used a hierarchical multiple regression. This means that we can make a

distinction between the models with and without control variables. We first investigate the model summary and the ANOVA of the regression produced by SPSS.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,344[a]	,118	,091	5,172
2	,466[b]	,218	,138	5,034

a. Predictors: (Constant), X3(EXP), X1(AGE), X2(TEEI) Millions USD

b. Predictors: (Constant), X3(EXP), X1(AGE), X2(TEEI) Millions USD, Dum_2005, X4 (EAA) Million USD, X6(AAF) Months, X7(TF) Million USD, Dum_2006, X5(OVC)

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	341,354	3	113,785	4,253	,007[a]
	Residual	2541,333	95	26,751		
	Total	2882,687	98			
2	Regression	627,277	9	69,697	2,750	,007[b]
	Residual	2255,410	89	25,342		
	Total	2882,687	98			

The second R tells us that the correlation of all the independent variables (including the control) and the dependent variable is 0.466. Given the rule of thumb that any correlation between 0.4 and 0.6 is a moderate relationship, we can conclude that there is a moderate relationship between the dependent variable and the independent variables in our research.

The first R shows the correlation between the independent Venture Capital Reputation variables and the dependent variable is 0.344. So if we do not include the control variables, the VC reputation accounts for 34.4% of the variation in patent application. If we look at the R square, this percentage drops to 21.8%.

The significance level of 0.007 in the ANOVA table is less than 0.05 (5% variation), we can conclude that the 0 hypothesis (there is no relationship between the dependent and the independent variables) can be rejected. So as suggested in the theory, the independent variables explain the dependent variable.

By including the control variables, the model has increased its R square by 0.100 We see that the significance does not change.

We will now look at the relationship of the each independent variable to the dependent variable by investigating the Coefficient summary.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,787	1,078		1,657	,101
	X1(AGE)	-,002	,043	-,004	-,038	,970
	X2(TEEI) Millions USD	,000	,000	,389	2,377	,019
	X3(EXP)	-,018	,057	-,057	-,314	,754
2	(Constant)	,263	1,614		,163	,871
	X1(AGE)	,002	,043	,006	,051	,959
	X2(TEEI) Millions USD	9,972E-5	,000	,309	1,910	,059
	X3(EXP)	-,029	,060	-,090	-,478	,634
	X4 (EAA) Million USD	,143	,146	,112	,979	,330
	X5(OVC)	,693	,591	,133	1,171	,245
	X6(AAF) Months	-,018	,023	-,080	-,794	,430
	X7(TF) Million USD	,047	,028	,176	1,645	,104
	Dum_2005	-1,697	1,287	-,145	-1,319	,191
	Dum_2006	-,260	1,260	-,023	-,206	,837

a. Dependent Variable: Y:Patents

We see that in model 1, where we exclude the control variables, the only variable that is significant is X2 (sig <0.05). This means that this variable has a direct relationship with the amount of patent application. The fact that the B is so low can be explained by noting that the TEEI is a rather large number while the amount of patents is a small number. When the TEEI increases with 1 million USD than the amount of patents will increase with only a small fraction of that.

We see that X6(AAF) has a negative relationship with patenting. This is in accordance with Sherer's (2000) findings that young firms are more innovative. We also see a negative relationship between AGE and EXP, and Patenting. This not in accordance to our proposed relationship. We have to note that both variables are not significant.

When we look at the dummy variables we can see that in relationship to 2007 the amount of patent applications of firms which received VC in 2005 and 2006 was lower (ceteris paribus). This suggests that the macro-environmental conditions for patent application were better in 2007 compared to 2005 and 2006 .

4. Summary, Conclusion and Recommendations.

We have analyzed an extensive amount of literature on Venture Capital Reputation and its positive relationship with the success of the Portfolio Company. We have also seen the positive relationship between Venture Capital and Innovation that has been proven by many authors. We have learned that Innovation is a main driver for success in a company and have therefore suggested a positive relationship between VC reputation and Innovation. After proposing our own variables while taking into account the limited resources available we were able to source all the data needed to perform a regression. We found that our independent variables significantly explained the variation in patent application. When we analyze the differences in R square of the two models (with and without control variables) we can conclude that VC Reputation explains the variation in Y relatively well. We have to acknowledge that we cannot we cannot draw a conclusion on what the impact of VC reputation is on patenting relative to a dollar of R&D like Kortum and Lerner (2000) do this. We can however conclude that within all the factors that draw up VC involvement, reputation is relatively important when it comes to explaining the variation in patenting. In particular, the firm size (X2 TEEI) seems to be a good predictor.

We would recommend further research on this topic with more investment data in order to get a better significance. In addition, it would be useful to also take into account the successfulness of a patent (e.g. citation, company performance). We would suggest using the HBS patent database instead of the USPTO one which is full of errors. Also, a more elaborate Industry focus variable will be necessary. The one we used does not capture the importance well enough.

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Appendix 1: Figures

Figure 1: Venture Capital investment throughout the years. Sourced from Kortum and Lerner (2000)

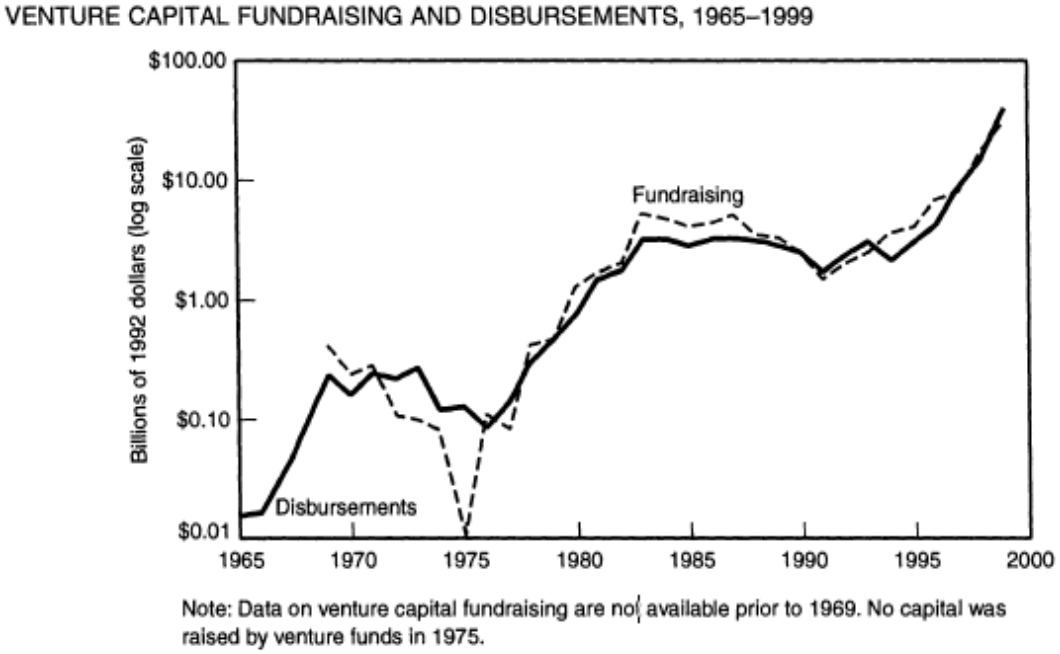


Figure 2: Innovation cash flow. Sourced from Rorke et al. (1994).

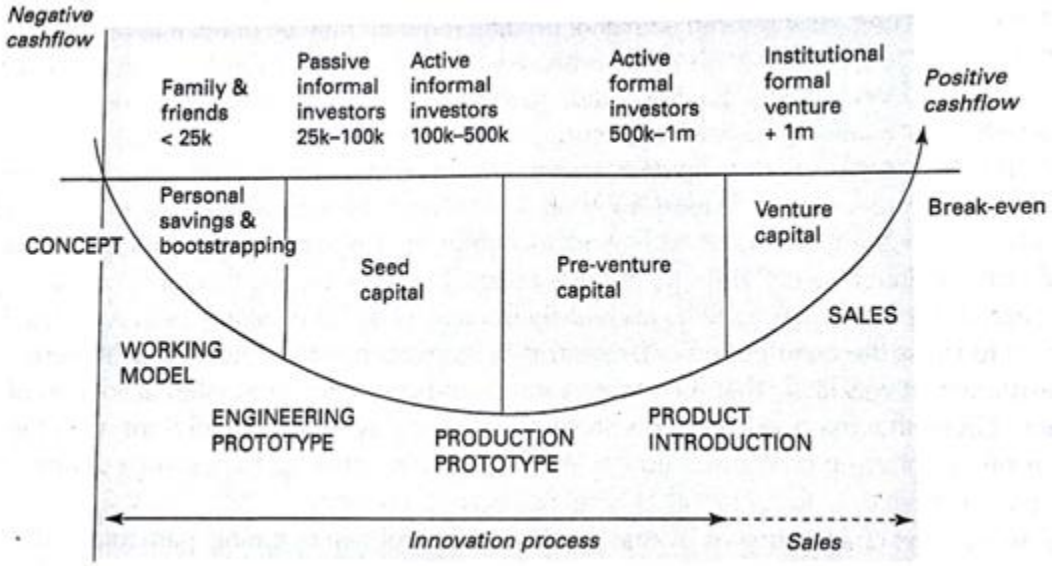


Figure 3: Investment quantity per year.

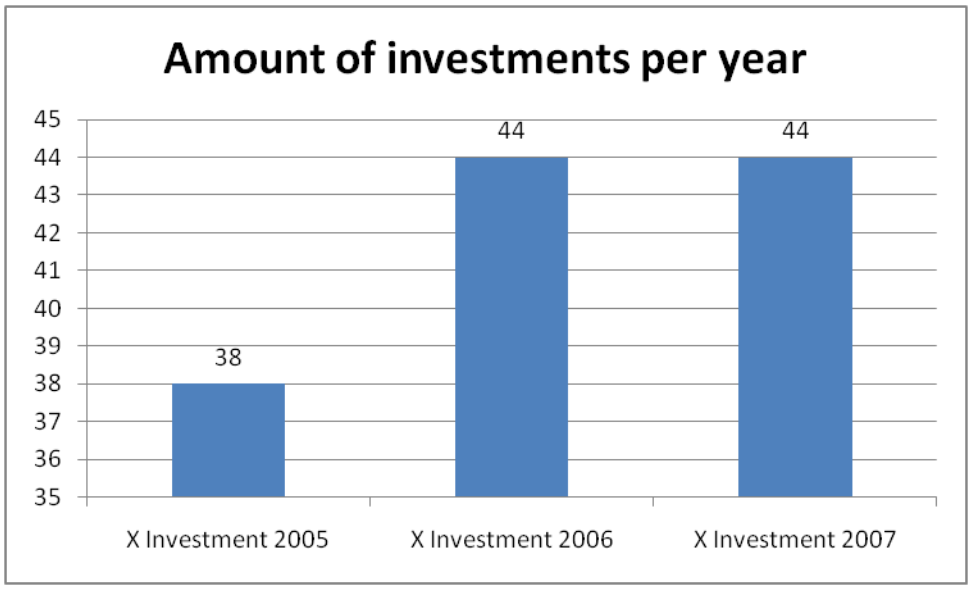


Figure 4: Equity Invested per year.

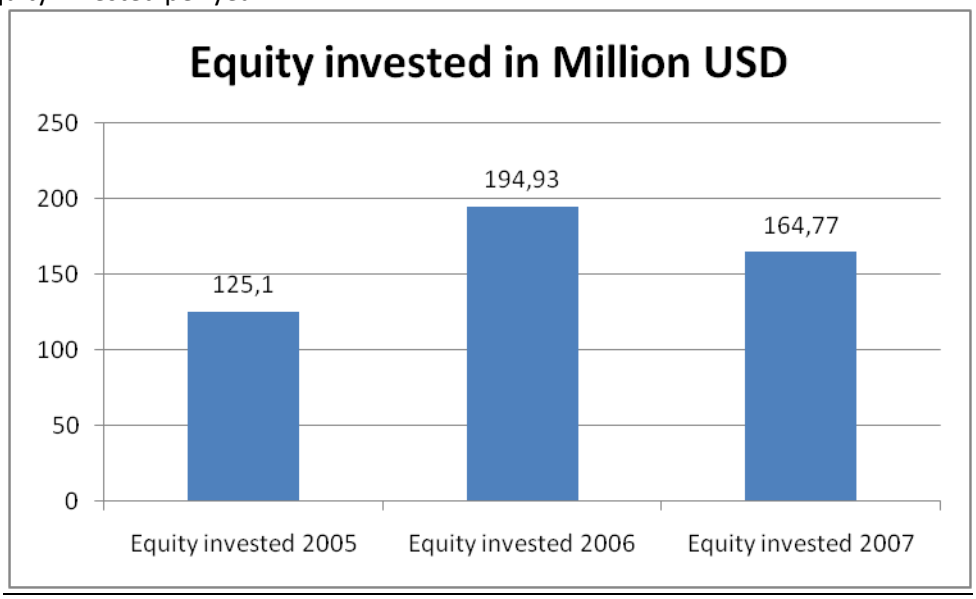


Figure 5: Age and experience information.

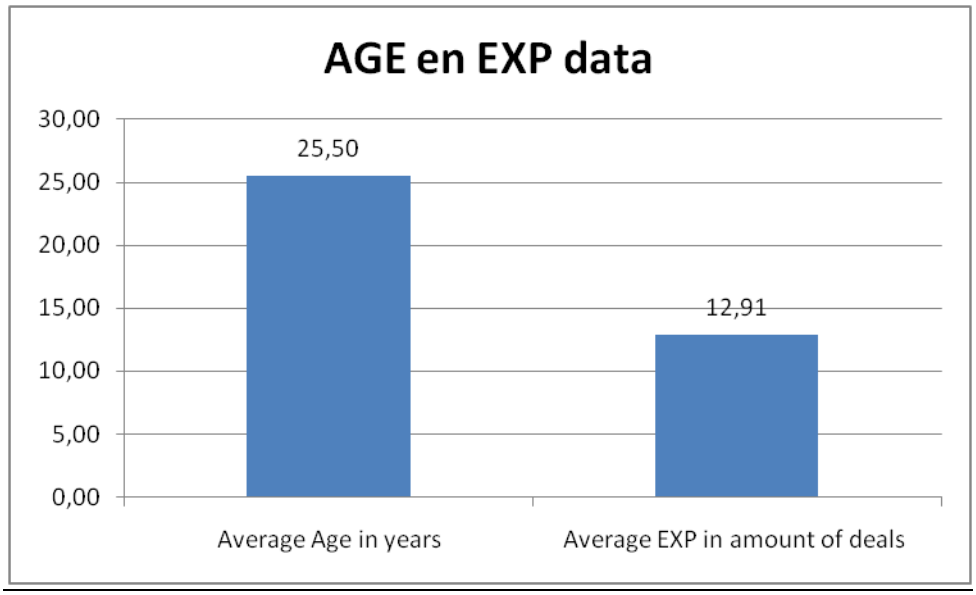


Figure 6: Average size of VC firms per year.

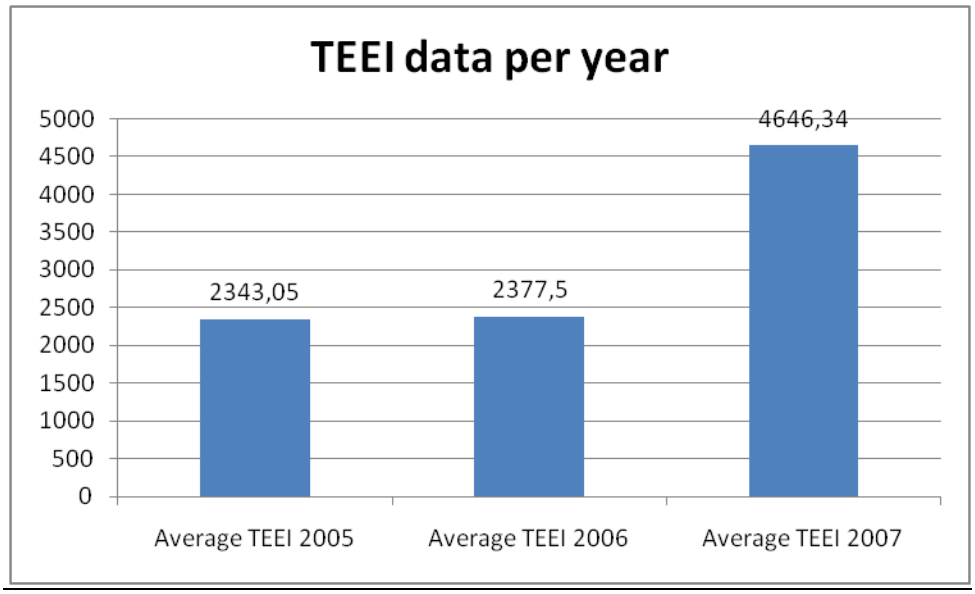
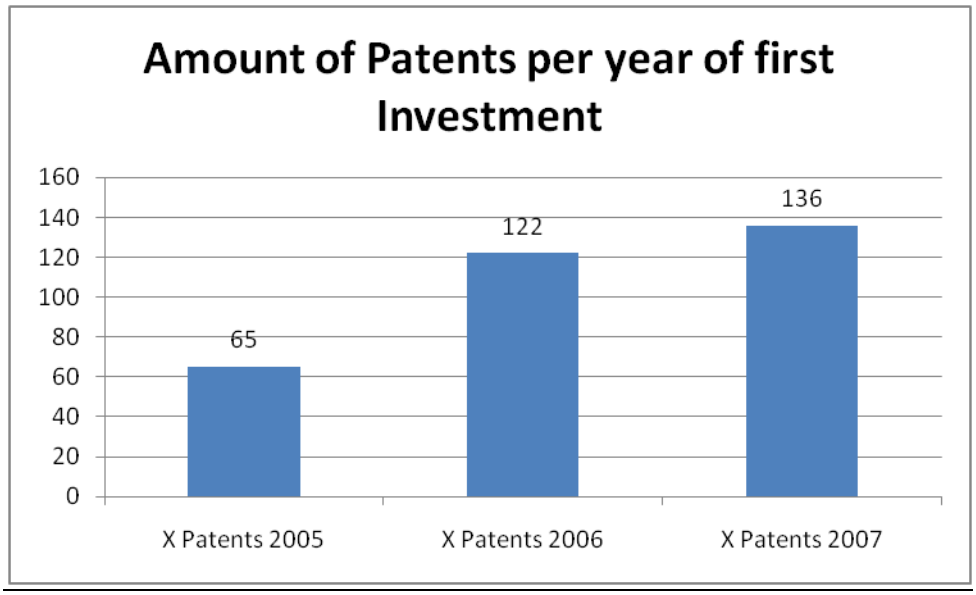


Figure 7: Information on Patent application per year of first VC investement.



Appendix 2: Correlation Matrix

		Y:Patents	X1(AGE)	X2(TEEI) Millions USD	X3(EXP)	X4 (EAA) Million USD	X5(OVC)	X6(AAF) Months	X7(TF) Million USD	Dum_2005	Dum_2006
Pearson Correlation	Y:Patents	1,000	,092	,342	,253	,213	,296	-,071	,274	-,120	,021
	X1(AGE)	,092	1,000	,323	,514	,098	,184	,139	,041	,017	-,157
	X2(TEEI) Millions USD	,342	,323	1,000	,802	,039	,400	-,094	,159	-,050	-,133
	X3(EXP)	,253	,514	,802	1,000	-,038	,451	-,086	,137	-,008	-,184
	X4 (EAA) Million USD	,213	,098	,039	-,038	1,000	,266	,294	,361	-,093	,154
	X5(OVC)	,296	,184	,400	,451	,266	1,000	-,027	,309	,062	-,041
	X6(AAF) Months	-,071	,139	-,094	-,086	,294	-,027	1,000	-,020	-,024	-,003
	X7(TF) Million USD	,274	,041	,159	,137	,361	,309	-,020	1,000	,164	-,056
	Dum_2005	-,120	,017	-,050	-,008	-,093	,062	-,024	,164	1,000	-,466
	Dum_2006	,021	-,157	-,133	-,184	,154	-,041	-,003	-,056	-,466	1,000
Sig. (1-tailed)	Y:Patents	.	,182	,000	,006	,017	,001	,241	,003	,119	,418
	X1(AGE)	,182	.	,001	,000	,166	,034	,085	,342	,432	,060
	X2(TEEI) Millions USD	,000	,001	.	,000	,350	,000	,178	,058	,313	,095
	X3(EXP)	,006	,000	,000	.	,354	,000	,199	,088	,468	,034
	X4 (EAA) Million USD	,017	,166	,350	,354	.	,004	,002	,000	,180	,065
	X5(OVC)	,001	,034	,000	,000	,004	.	,394	,001	,273	,343
	X6(AAF) Months	,241	,085	,178	,199	,002	,394	.	,422	,407	,488
	X7(TF) Million USD	,003	,342	,058	,088	,000	,001	,422	.	,052	,290
	Dum_2005	,119	,432	,313	,468	,180	,273	,407	,052	.	,000
	Dum_2006	,418	,060	,095	,034	,065	,343	,488	,290	,000	.
N	Y:Patents	99	99	99	99	99	99	99	99	99	99
	X1(AGE)	99	99	99	99	99	99	99	99	99	99
	X2(TEEI) Millions USD	99	99	99	99	99	99	99	99	99	99
	X3(EXP)	99	99	99	99	99	99	99	99	99	99
	X4 (EAA) Million USD	99	99	99	99	99	99	99	99	99	99
	X5(OVC)	99	99	99	99	99	99	99	99	99	99
	X6(AAF) Months	99	99	99	99	99	99	99	99	99	99
	X7(TF) Million USD	99	99	99	99	99	99	99	99	99	99
	Dum_2005	99	99	99	99	99	99	99	99	99	99
	Dum_2006	99	99	99	99	99	99	99	99	99	99