



**FACULTEIT ECONOMIE
EN BEDRIJFSKUNDE**

TWEEKERKENSTRAAT 2

B-9000 GENT

Tel. : 32 - (0)9 - 264.34.61

Fax. : 32 - (0)9 - 264.35.92

WORKING PAPER

**(NO) PATENT, NO CASH?
A RISK PERCEPTION PERSPECTIVE ON INVESTMENT
MANAGERS' ATTITUDES TOWARDS PATENTS ¹**

Mirjam Knockaert²

Annelore Huyghe³

Bart Clarysse⁴

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² Ghent University & University of Oslo, Tweekerkenstraat 2, 9000 Gent, Mirjam.knockaert@ugent.be

³ Ghent University, Tweekerkenstraat 2, 9000 Gent, annelore.huyghe@ugent.be

⁴ Ghent University, Tweekerkenstraat 2, 9000 Gent and Imperial college Londen; b.clarysse@imperial.ac.uk

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ABSTRACT

Employing a risk perception perspective, this paper studies the link between the investment manager's human capital and his or her attitude towards the appropriability regime in the business proposal, and more specifically whether or not the technology is patent protected. Even though many researchers acknowledge the benefits related to patenting, agency theory suggests that patents may enlarge agency risk and may therefore result in VCs refraining from investing in proposals commercializing patented technology. We find that task-specific human capital, operationalized as the number of years experience as investment manager, positively affects the attitude towards patents. We find that some elements of general human capital, namely consulting experience, financial experience and entrepreneurial experience affect the attitude towards patents.

Keywords: venture capital, selection behaviour, appropriability, human capital, risk perception

1. INTRODUCTION

Many studies have emphasized the importance of VC (venture capital) financing for early stage high tech companies. By raising substantial amounts of financing, these companies have better chances of building the critical mass necessary to bridge the liabilities of newness and smallness (Lee et al., 2001; Romanelli, 1989; Schoonhoven et al., 1990). It is however also acknowledged that raising VC financing is not easy, given the stringent criteria VCs use during the screening, selection and due diligence process. Typically less than 1% of the business plans submitted to VCs get funded (Gompers and Lerner, 1999). Before deciding to invest, VC investors engage in information collection in order to screen out ex ante unprofitable projects and bad entrepreneurs (Kaplan and Strömberg, 2001). As such, investors try to limit the costs caused by information asymmetries (Amit et al., 1998), and arising from adverse selection and moral hazard, which have typically been referred to as agency costs (Jensen and Meckling, 1976).

Subsequently, many researchers have commented on the selection criteria that VCs use in order to limit agency costs and maximize investment returns. Typical criteria that VCs base their investment selection decision on include the human capital of the entrepreneur and the entrepreneurial team (Keeley and Roure, 1989; MacMillan et al., 1985; Shepherd and Zacharakis, 1999; Tyebjee and Bruno, 1984), the characteristics of the industry (Hisrich and Jankowitz, 1990; Hutt and Thomas, 1985), the characteristics of the product and service (Macmillan et al., 1985) and financial characteristics (Macmillan et al., 1985). Even though many authors have described the screening criteria that VCs use, few attempts have been made to identify under which circumstances criteria matter less or more. This is surprising,

given the importance of understanding the drivers of selection behavior to many stakeholders in the entrepreneurial process, including venture capitalists, entrepreneurs and policy makers.

In order to provide understanding of the drivers of VC selection behavior, we focus on one specific subgroup of the VC industry, namely early stage high tech VCs, and specifically analyze the importance of an essential characteristic of early stage high tech firms, namely the appropriability regime. Appropriability refers to the degree to which a firm captures the value created when it introduces inventions (Ceccagnoli, 2009; Teece, 1986). Strategies to increase appropriability include secrecy, patent protection, being first to the market and ownership of complementary marketing and manufacturing assets (Cohen et al., 2000; Levin et al., 1987). Winter (2006) subsequently differentiates between appropriability associated with the protection of the information itself (which can be assured through the “ideal” patent) and aspects that are entwined with the context of use of the invention. The focus of our study is on the first, as such defining the appropriability regime as the extent to which the technology is patent protected. Our focus on the early stage high tech VC industry is inspired by the fact that early stage investing is different from late stage investing (Elango et al., 1995; Sapienza et al., 1994), while, at the same time, high tech investing is different from low tech investing (Lockett et al., 2002; Murray and Lott, 1995). Further, even though many authors have commented on the importance of appropriability as a selection criterion (Kakati, 2003; MacMillan et al., 1987; Tyebjee and Bruno, 1984), we know little about the drivers of the attitude of VCs towards appropriability. The literature suggests that the VC’s attitude towards appropriability is not unambiguous, therefore warranting further research.

Indeed, the received literature provides indications of both arguments in advantage and disadvantage of selecting business proposals exhibiting high levels of appropriability.

On the one hand, many authors emphasize the potential benefits of businesses built upon patents, indicating that the presence of patents is an indicator for innovative potential (Baum and Silverman, 2004), may help firms to sustainably differentiate themselves from competition (Cohen et al., 2000; Mann, 2005; Teece, 1986) and may help to create value and to gain competitive advantage (Audretsch et al., 2006; Lee et al., 2001; McCann, 1991). Previous research has identified a positive relationship between patents and evolution in firms' performance indicators including market value and sales or profits (Comanor and Scherer, 1969; Ernst, 1995, 2001; Griliches, 1990; Narin et al., 1987; Scherer, 1965). Furthermore, intellectual property protection helps companies to appropriate the returns from R&D investments and facilitates technology commercialization (Cohen et al., 2000; Dechenaux et al., 2008; Levin et al., 1987). Formal intellectual property rights such as patents were further shown to play a central role in the design of an efficient market for ideas, with Gans and Stern (2010) emphasizing that patent protection can transform intangible ideas into assets which can be easily traded and understood. As a result, intellectual property rights make idea selling safe as they protect against imitation or replication and impede expropriation threats (Gans and Stern, 2003, 2010). Patents may especially be important for start-ups and their investors as they represent a marketable asset in case the firm aims to sell out later (Levin et al., 1987). The importance of patents has further been acknowledged in the VC literature. Several studies found that firms with a larger number of patents have a higher likelihood of attracting VC financing (Baum and Silverman, 2004; Engel and Keilbach, 2007; Hellman and Puri, 2000) and that VC investors rely on intellectual property rights as quality signals when trying to assess potential portfolio companies (Baum and Silverman, 2004; Hsu and Ziedonis, 2008) and when distinguishing high-quality firms from low-quality firms (Long, 2002).

On the other hand, researchers have indicated that strong appropriability regimes may result in higher levels of information asymmetry and agency risks, causing VCs to refrain from investing in ventures with high appropriability (Mahoney, 2005). Intangible assets such as intellectual property rights are associated with greater agency costs (Gompers, 1995; Gompers and Lerner, 2001). Since the information revealed through patents is “noisy”, evaluation costs of interpreting patent signals can be high (Hsu and Ziedonis, 2008). As noted by Svensson (2007), patents are characterized by high costs and no incomes during the early phases, and by high uncertainty and unpredictability about future returns. Furthermore, entrepreneurs are more closely involved and typically possess more knowledge about the patent protection than potential investors. Long (2002) finally also acknowledges the ambiguity of patent signals, indicating that they can increase informational asymmetries and agency risks.

Following the merits and demerits that have been associated with high appropriability regimes, we argue that a contingency approach will be appropriate when studying the VC’s attitude towards appropriability during the screening and selection phase. In what follows, we argue that the VC’s attitude towards patents will be contingent on the VC’s risk perceptions. Dimov and Shepherd (2005) argue that perceptions of risk, return, opportunities, and threats are central to the decision making of investment managers in VC firms. Moreover, Tyebjee and Bruno (1984) argued that the VCs’ investment decisions could be predicted from their perceptions of risk and return. According to Sitkin and Pablo (1992), one key factor contributing to risk perception is problem domain familiarity, indicating that there is less perceived risk in familiar domains than in unfamiliar ones. Dimov and Shepherd (2005) subsequently argue that one of the key ingredients for assessing risk, return, opportunities and threats is relevant knowledge. Therefore, it seems natural that risk perception depends on the

investment manager's human capital. This paper aims at providing further understanding of the human capital characteristics that have a positive or negative impact on the investment manager's attitude towards high appropriability regimes. In order to do so, we use a conjoint methodology and assess the utility derived by the investment manager from patents in the business proposal. As such, we gain insights into how useful appropriability is to VC investment managers during the selection process. In what follows, we first present our theoretical framework, followed by a description of the methodology used. We then present our results, and end with conclusions, implications and directions for future research.

2. THEORETICAL FRAMEWORK

2.1. Agency theory and the role of appropriability

Venture capitalists typically operate in environments where asymmetric information is significant (Amit et al., 1998). There are two major forms of informational asymmetry. The first, sometimes referred to as "hidden information", occurs when one party to a transaction is aware of relevant information that is not known to the other party (Amit et al., 1998). Entrepreneurs are likely to possess greater information about their venture than VCs who may find it difficult to access this information even with extensive due diligence. The market may subsequently become crowded by inferior projects because investors find it hard to distinguish between low-quality and high-quality projects. This phenomenon is called "adverse selection" and is especially a concern when investing in high tech industries as it is more complex to understand and value a start-up's new or untested technology, intellectual property and future potential (Mason, 2009). The second, often described as "hidden action", may occur when one party to the transaction cannot observe relevant actions taken by the other party (Amit et al., 1998). For instance, the entrepreneur provides unobservable (or at least unverifiable) effort that

is important to the entrepreneurial venture's performance (de Bettignies and Brander, 2007). By reducing effort, the entrepreneur reduces the probability of success and hence the efficiency of the employed capital (Bergemann and Hege, 1998). Alternatively, the entrepreneur can "shirk" and decide to (partially) withhold the investment and divert the capital to his or her private ends. Although the entrepreneur can autonomously take certain decisions, part of the costs resulting from these decisions will be borne by the remaining shareholders (Jensen and Meckling, 1976). This problem leads to "moral hazard": the informed party has an incentive to act out of self interest, even if such actions impose high costs on the other party (Amit et al., 1998). These information asymmetries may thus lead to agency conflicts (Gompers, 1995).

Agency conflicts and costs may be especially important in high tech companies, where investors usually cannot evaluate the technology and have difficulties in assessing the commercial implications of strategic choices (Carpenter and Petersen, 2002; Cumming 2006; Knockaert et al. 2006). Consequently, the search and transaction costs associated with the identification of interesting investment projects and the assessment of their technical and commercial potential may be large for early stage high tech VCs (Kaplan and Strömberg, 2001; Svensson, 2007). The ownership of patents by the potential portfolio company may further increase information asymmetry and may therefore give rise to agency problems. According to Mahoney (2005), intangible assets such as patents are more difficult to value and assess and may thus exacerbate the problem of optimizing the agent's (in this case the entrepreneur's) ownership of the firm's assets. Patzelt et al. (2009) argue that technological risks are substantial in the case of early stage high tech ventures given that they have not developed a viable technical prototype yet, and that future development of their technology may be difficult to project. Further, whereas patents are a typical form of explicit knowledge (Hong, 2008), there is often a considerable body of knowledge that is not captured in the

patent; the tacit component (Knockaert et al., 2011). Tacit knowledge is acquired by and stored within individuals, in this case the inventor/entrepreneur and is embedded in a social and cultural context (Nonaka and Takeuchi, 1995; Osterloh and Frey, 2000). Therefore, successful commercialization of inventions captured by patents may require significant involvement by the inventor or considerable interaction between the inventors and parties commercializing the patent (Knockaert et al., 2011; Zucker et al., 2002). As such, it may enlarge information asymmetries between entrepreneur and investor and increase the risk of the venture due to a high dependence on the inventor/entrepreneur. Therefore, VCs may only invest in firms holding patents in case they dispose over capabilities that mitigate these agency risks. In what follows, we apply a risk perception perspective and argue how the VC's human capital will affect his or her risk perception towards firms commercializing patented inventions and subsequently the utility they derive from patents during the screening and selection phase.

2.2. A risk perception perspective

Central to the decision making of investment managers in VC firms are perceptions of risk, return, opportunities and threats (Dimov and Shepherd, 2005; Fiet, 1995; Wright et al., 2002). Indeed, of the many different perceptions that constitute the cognitive models of managers, risk perceptions appear particularly relevant for strategic decisions (March and Shapira, 1987). Perceptions of people depend, in part, on observable demographic characteristics, particularly education and experience (Carpenter et al., 2004; Hambrick and Mason, 1984; Patzelt et al., 2009). Education and experience constitute an individual's human capital (Becker, 1975). Dimov and Shepherd (2005) have, in a VC context, distinguished between general and specific human capital, based on whether or not the VC's human capital in a particular domain provides skills that can be directly used in the selection or monitoring

of portfolio companies. As such, general human capital relates to the overall education and practical experience of the investment executive which are useful across a wide range of occupational alternatives, while specific human capital concerns the education and experience that is only applicable in a particular activity or context (Becker, 1975; Dimov and Shepherd, 2005; Gimeno et al., 1997), in this case the high tech VC context. Furthermore, consistent with Zarutskie (2010), specific human capital can be split up into industry-specific human capital and task-specific human capital. In what follows, we elaborate on these three types of human capital, their impact on risk perception, and subsequently the relationship with the usefulness or utility that VCs derive from patents during the screening and selection process.

Industry-specific human capital

In line with Knockaert et al. (2010a) and Patzelt et al. (2009), we argue that industry-specific human capital in the case of early stage high tech ventures will relate to either a technical education (in science and/or engineering) or experience in a technical function. According to Patzelt et al. (2009), a decision made by a VC manager with a technical background will particularly be informed by his or her perceptions of technological risk, but less by perceptions of market and agency risks. Moreover, individuals tend to focus their attention on aspects of their environment where they have prior knowledge (Levinthal and March, 1993). Accordingly, we expect that VC investment managers who are more familiar with high-tech domains will attach more importance to and acknowledge the value of a protected technology. People disposing over this industry-specific human capital will have substantial knowledge of technologies and will find it easier to assess the risks related to future technological development. They may further be more aware of the current state of the technology, enabling them to assess the extent to which the technology is promising. Having more technical knowledge may be particularly valuable for VC investment managers when

selecting their portfolio companies, and especially in high tech industries for which having an understanding of the underlying product or technology is essential (Walske and Zacharakis, 2009; Zarutskie, 2010). Therefore, technical human capital may help reducing information asymmetries initiated by IP protection and may decrease the perception of risk related to business proposals that are built upon patented inventions. As such, patents will be more useful in the due diligence to investment managers possessing industry-specific human capital, as the information held by patents is more likely to be comprehended by them and to lower their risk perceptions. Therefore, we offer the following hypothesis:

H1: Industry-specific human capital will positively affect the investment manager's attitude towards patents

Task-specific human capital

In line with Zarutskie (2010), task-specific human capital in this study refers to prior VC investment management experience. Former research has shown that the experience of VC investment managers has a significant impact on the evaluation of business proposals. Bonner (1990) for instance shows that task-specific knowledge has an influence on both the selection and weighing of attributes in the VC decision-making process. Shepherd et al. (2003) suggest that decision makers experienced in a given task may develop and utilize superior decision processes relative to those with no or less experience. VC investment managers with more task-specific knowledge may, as a result of their prior interactions, have built a network of experts to call upon to estimate the value of patents, or may have developed own knowledge on how to assess patents. Consequently, experienced VC investment managers may face a lower cost of sourcing information useful for evaluating patents, and as such possess an advantage when deriving informational content revealed by patents (Hsu and

Ziedonis, 2008). As a result, task-specific human capital enables investment managers to identify true investment opportunities more easily (Walske and Zacharakis, 2009) and to mitigate the potential agency risks related to patents. Consequently, we argue that, in the case of higher levels of task-specific human capital, prior experience and domain familiarity will result in lower perceived risk (Sitkin and Pablo, 1992), and in investment managers valuing patents as useful elements in a business proposal. This leads to the following hypothesis:

H2: Task-specific human capital will positively affect the investment manager's attitude towards patents

General human capital

General human capital consequently refers to human capital that is unrelated to knowledge or experience in high tech domains or investment management. Following the definitions of Dimov and Shepherd (2005) and the classification of Knockaert et al. (2010a), general human capital corresponds with education in humanities, experience in finance (excluding investment management experience), consulting or management and entrepreneurial experience. Patzelt et al. (2009) indicate that neither an education in management or entrepreneurial experience is likely to inform investment managers' perceptions of technological risks. As such, people disposing over high levels of general human capital cannot use this human capital to mitigate agency risks linked to the technicality of the business proposal and its patent(s). Therefore, investment managers with a high level of general human capital will experience high levels of risk perception when faced with patents, which they cannot offset by utilizing their previous experience or education. Consequently, we hypothesize that higher levels of investment manager general human capital will not lead to reduced perceived risk of business proposals based upon patented technologies and that

subsequently the investment manager will derive less usefulness or utility from patents in the business proposal. This leads to the following hypothesis:

H3: General human capital will negatively affect the investment manager's attitude towards patents

3. METHODOLOGY

3.1. Sample and data collection

The research setting is the population of early stage high tech venture capital investors in seven European regions. We decided to focus on seven regions in Europe that had high R&D intensity and venture capital presence, which includes Cambridge/London (UK), Ile de France (France), Flanders (Belgium), North Holland (The Netherlands), Bavaria (Germany), Stockholm (Sweden) and Helsinki (Finland). It is well-established that the location of both high tech companies and VCs that fund these companies is highly clustered in a handful of regions (Powell et al. 2002). We further focused on VCs drawn from multiple European regions in order to increase the generalizability of the findings compared to studies that focus on a single region or country.

In order to identify early stage high tech VCs, we started with constructing a list of venture capital funds that focus their investments on early stage high tech companies. For this purpose, we could have used the member list of the European Private Equity and Venture Capital Association (EVCA). Yet, this would have resulted in a sample biased towards larger private venture capital firms. We created our own sample frame, combining data from EVCA, multiple regional venture capital associations, and information obtained through contacts with academics who had specific regional expertise and contacts. We excluded funds that had not

made more than 10 investments in early stage high tech ventures (to ensure that we focus on active investors in early stage high tech companies) and funds that had not existed for more than one year (and for which investment managers may not have made a representative number of investment decisions). This resulted in a set of 220 venture capital funds investing in early stage and high tech ventures across the seven regions.

We wanted to have a balanced representation of early stage high tech VCs operating in different funds. Hence, the sample of venture capital funds was stratified into different groups or subpopulations according to the size of the funds and their institutional investors. We selected 68 venture capital funds of which 11 from Cambridge/London, 10 from Ile de France, 8 from Flanders, 11 from North Holland, 10 from Bavaria, 11 from Stockholm and finally 7 from Helsinki. With respect to fund size the sample includes 33 small funds, 21 large funds and 14 mega funds⁵. With respect to the type of funds the sample includes 6 private equity arms of banks, 9 public funds, 12 public/private partnerships and the others are private funds. We selected one investment manager per VC fund given that data collection required considerable time and effort from VCs.

Data were collected over the period 2003-2004. Interviews with investment managers were carried out, each taking on average 90 minutes. Interviews first focused on the characteristics of the venture capital firm and the investment manager. Information already obtained from other secondary sources, including trade directories and websites was verified at this stage of the interview. Data on the venture capital fund include, amongst others, fund size, origin of the fund, year of establishment, industry focus, geographical focus and the number of investments made in early stage high tech companies. Data on the investment manager includes his/her education and experience. The latter was verified using social network sites such as LinkedIn.

⁵ Venture funds having a fund size between 100 million Euro and 250 million Euro are considered to be large funds for venture investments. Mega funds are those funds having a size of more than 250 million Euro, small funds have less than 100 million Euro under management (EVCA definition)

In the second part of the interview, we used a conjoint methodology to assess the investment manager's attitude towards patents in the selection process. To date, the most commonly used methods for studying investment selection are post hoc methodologies and verbal protocol analysis. The post-hoc method has however been criticized since interviewees are poor at introspection (Shepherd and Zacharakis, 1999), are motivated to bias the results in a post hoc rationalization (March and Feldman, 1981), and have limited capacity to recall what has happened (Fischhoff, 1982). Further, the subjectivity of the analysis when using verbal protocol analysis has been questioned by Riquelme and Rickards (1992). As such, we follow Shepherd and Zacharakis (1999)'s recommendation to employ a conjoint methodology when studying VC selection behavior. We refer to Knockaert et al. (2010b) for a detailed description of the conjoint methodology used. Concretely, a first stage consisted of identifying, based on the literature and interviews, those criteria that matter to investment managers during the selection process, resulting in twelve different attributes, of which patent protection was one. Other attributes were the team, entrepreneur, contact with the entrepreneur, uniqueness of the product, market acceptance, general purpose technology, location, size and growth of the targeted market, time to break-even and return on investment. The second stage of the analysis was to use the twelve attributes to construct a range of possible events that would form the basis of fictitious business proposals. In line with the conjoint analysis philosophy, and consistent with Muzyka et al. (1996), potential events were matched to the different attributes. For instance, in the case of the attribute "patent protection", there are two potential events: no patent protection or patent protection. These possible events associated with the twelve attributes were then combined into "business proposals" (or profiles). A fractional factorial design using Addelman's basic plans (Addelman, 1962) for designing an orthogonal main effects plan was chosen, resulting in 27 business proposals that were presented to the respondents (VC investment managers). The 27

proposals were printed on cards that were used during the interviews. Respondents were asked to judge the proposals on a five-point Likert scale (from 1= bad investment opportunity I would certainly not invest; to 5= major investment opportunity, large chance of investing). Using a conjoint analysis these responses were then translated into utility scores (or usefulness) for each attribute. Utility represents an individual's subjective preference judgment representing the holistic value or worth of a specific object (Hair et al., 2010). In this study, the object of interest is patent protection of the business proposal's technology.

Our research was designed to avoid common methods bias (CMB). Podsakoff et al. (2003) advocate the use of procedural remedies related to the questionnaire design first. They suggest that obtaining data on the dependent and independent variables from different sources is the most effective remedy. Alternatively, CMB can be minimized by obtaining data from different contexts (e.g. phone and mail questionnaires). We ensured methodological separation of measurement of the predictor and criterion variables (Podsakoff et al., 2003) by using different data collection methodologies (conjoint analysis and open-ended questions). Further, statement ambiguity was reduced by pre-testing the survey (Tourangeau et al., 2000) and triangulation from archival sources was conducted (Parkhe, 1993). As a robustness test we also carried out a Harman One-Factor test (Podsakoff et al., 2003). CMB is assumed to exist if (1) a single factor emerges from unrotated factor solutions; or (2) a first factor explains the majority of the variance in the variables (Podsakoff & Organ, 1986). Analysis on our data produced five components, explaining 68% of the variance with the first component explaining 20% of the variance. Consequently, there is limited evidence to suggest the results are affected by common method bias.

3.2. Measures

3.2.1. Dependent variable

Utility of patent protection. In order to assess the attitude of the VC towards patents, we used the utility score for patent protection derived from the conjoint methodology as a dependent variable. We preferred using utility scores over importance scores, which can be derived from utility scores, and which give an insight into how important the criterion is in the final decision. This is because importance scores do not allow differentiating between negative and positive utilities, or, put in other words, VCs for which patents have a negative impact on the chances of investment versus VCs for which patents are seen as assets contributing to a favorable decision. The average utility score in the sample is 0.18, with a minimum of -0.39 and a maximum of 0.94. 13 VCs indicated that patent protection has a negative utility, therefore negatively affecting the chances of a positive investment decision, whereas 54 VCs indicate that patent protection positively affects their investment decision. As such, we find confirmation of the ambiguity related to the role of patent protection in the selection process.

3.2.2. Independent variables

Industry-specific human capital. Industry-specific human capital is operationalized as the extent to which the investment executive possesses human capital related to technology. More specifically, we included two variables in the analysis: experience in a technical function and technical education. The former measures how many years of experience the investment manager has with high technology, by means of a PhD or a research position at a university or other research institute. Only a minority of the sample, or 11 investment executives, has *technical experience*. The investment managers in the sample have on average 1.09 years of

technical experience, ranging between 0 to 20 years. Consistent with Dimov and Shepherd (2005), the second variable, called *technical education*, takes the form of a dummy and is coded one when the investment manager has obtained a bachelor or master degree in mathematics, natural sciences or engineering. 52.9% of the investment managers in the sample, or 36 investment managers, have a technical education.

Task-specific human capital. In line with Zarutskie (2010), we define task-specific human capital as the number of years experience in VC investment management. Naturally, all of the investment managers held this type of experience. The average experience was 4.86 years and the variable ranged between 1 and 17 years.

General human capital. General human capital refers to the overall background and experience of the investment executives, in particular human capital not related to high tech industries or VC investment management. In line with prior research (Knockaert et al., 2010a) and following the definitions by Dimov and Shepherd (2005), 5 variables are utilized and classified as general human capital. *Financial experience* is measured as the number of years the investment managers worked in commercial, investment and merchant banking prior to joining the VC industry. The majority of the sample (89.7%) has financial experience. The investment managers interviewed have on average 6.89 years of financial experience, with a range from 0 to 35 years. The second indicator of general human capital, *consulting experience*, reflects the number of years an investment manager has worked for a company providing consulting services. In the sample of this study, 19 respondents have experience as consultant. The average of the variable is 1.03 years. *Entrepreneurial experience* measures how many years the investment managers have previously been involved as entrepreneur or founder of a new venture, which is on average 1.15 years for the sample. 15 of the 68

interviewed investment executives have entrepreneurial experience. Next, Dimov and Shepherd (2005) labeled law industry experience as a general human capital variable. However, only one investment manager in the sample had worked for a law firm in the past. As 30 interviewed executives have prior experience as manager in the industry, it was more relevant to include *management experience* as additional variable. The variable is measured as the number of years experience in general management, which is on average 4.04 years for the sample and has a range from 0 to 24 years. Finally, *education in humanities* reflects all MBA degrees as well as degrees in art or social sciences (excluding economics) and takes the form of a dummy variable. 46 out of 68 investment managers have had such an education.

3.2.3. Control variables

Percentage public capital. Given that previous research indicated that a fund's financial sources may affect the investment manager's selection behavior (e.g. Knockaert et al., 2010a; Mayer et al., 2005), we controlled for the percentage public capital in the fund. 47 out of 68 VC funds are entirely privately funded, 9 are completely funded by public means, whereas the other 12 funds received some public funding (ranging from 15% to 70%). The funds in our sample on average received 20.21% of their capital from public sources.

VC fund size. Since previous research has found that capital managed may affect the VC firm's investment strategy (Gupta and Sapienza, 1992; Hall and Tu, 2003), we control for VC fund size by measuring the capital under management. The smallest fund manages 0.9 million Euro, whereas the largest fund has a size of 4,400 million Euro. The average fund size is 269 million euro.

VC firm age. We control for the VC firm age, measured as the number of years since founding of the VC firm, given that prior research has indicated that firm age may affect the VC's investment selection activity (Dimov and Murray, 2008; Hall and Tu, 2003). The age of the VC firms in our sample varied between 1 and 58 years, with an average of 8.06 years.

ICT dummy. Sectoral differences may affect the VC's selection behavior. Because many authors indicate that protect ability of technology is relatively unimportant in the ICT sector because of the difficulty to protect software (Mann and Sager, 2007; Gans et al., 2008), we include a dummy variable, indicating whether or not the VC fund invests in ICT. 85.3% of the respondents indicated that the VC fund invests in ICT.

Biotech dummy. While the appropriability and uniqueness of the technology may be less important to investors in ICT, it may be of great importance in case of biotech investing (Baeyens et al., 2006). Therefore, a dummy variable is included to control for whether or not the VC fund invests in portfolio companies active in the biotechnology sector. 57.4 % of the VC investment managers indicated that their fund invests in biotech proposals.

Table 1 offers descriptive statistics and correlations.

<<<Insert Table 1 about here>>>

4. RESULTS

The results of the multivariate analyses focusing on the association between the investment manager's human capital and the utility of patent protection, using hierarchical regression analysis are presented in Table 2. Given that all correlations are below 0.60, and the variance inflation factors are below 3.00 (maximum value of 2.03), we may assume that multicollinearity is not an issue here (Hair et al., 2010).

<<<Insert Table 2 about here>>>

We gradually develop more complex models. The base model, only including the control variables is statistically significant, with an adjusted R^2 of 20.1%. Significant coefficients were found for the percentage of public capital (beta=.24, $p<.05$), fund size (beta=.25, $p<.05$) and an ICT investment focus (beta=-.46, $p<.001$). We separately add the independent variables capturing industry-specific (model 2), task-specific (model 3) and general human capital (model 4). When including all our independent variables and control variables, the model improved significantly (adjusted R^2 of 36.1%). We limit our discussion of the results to the full model (model 5). The effects previously found in the control model remain stable, with percentage of public capital and fund size positively affecting the attitude towards patents and ICT focus negatively affecting this attitude. Further, we do not find industry-specific human capital to affect the utility of patent protection significantly. Therefore, we do **not** find **support** for **hypothesis 1**. We do find task-specific human capital to positively affect the usefulness of patent protection to investment managers (beta= .22, $p<.10$). Consequently, we can conclude that **hypothesis 2** is **supported**. Finally, we find that two of the general human capital variables relate significantly negatively to the utility of patent protection. This is the case for financial experience (beta= -.29, $p<.05$) and

entrepreneurial experience ($\beta = -.30, p < .05$). We do not find management experience or education in humanities to have any statistically significant impact. Contrary to our expectations consulting experience has a significantly positive coefficient ($\beta = .26, p < .05$) and positively affects the investment manager's preference for patents. Therefore, we find that **hypothesis 3 is partially supported**. While we further tested for potential moderation effects between the variables used, no significant results were found.

Given that Shepherd et al. (2003) demonstrated that inexperienced VCs as well as highly experienced VCs make decisions in less reliable or effective ways than moderately experienced VCs, we also tested for the existence of such curvilinear relationship between experience and the importance attached to protection ability in the VC investment decision. Therefore, squared terms of the human capital variables were added to the full model. No indication of a curvilinear relationship was found. A possible explanation for this finding is the relatively young and emerging nature of the European VC market (Bottazzi and Da Rin, 2002; Martin et al., 2002). Shepherd et al. (2003) showed that greater experience in the VC task is beneficial to the quality of VC decision making, but only up to a specific point, followed by a decline in decision effectiveness and that this optimal level of VC experience is about 14 years. In the sample of this study, investment managers had on average only 4.86 years of experience in the VC industry. Moreover, only 4 out of 68 respondents had more than 14 years experience as investment manager, which might justify the absence of a curvilinear relationship.

Further, it has been acknowledged that criteria that VCs declare to use may not correspond to their in-use investment criteria. Shepherd (1999) indicated that there may be a gap between the investment manager's espoused and in use decision policies, which is, according to Zacharakis and Meyer (1998) to be attributed to a lack of insight into their

intuitive decision making process, especially when noise causes information overload. Therefore, we deemed it necessary to test whether the respondents in this research, deriving high utilities from patent protection, would also show an investment pattern in favor of patents. Therefore, we contacted each investment manager who participated in this research again in 2005, and asked them to provide a list of their portfolio companies. Given that some investment managers had left the VC firm, the VC firm had ceased to exist, or did not want to participate in this second round, we did not receive answers from all 68 investment managers, but from 36, resulting in a list of 171 portfolio companies. For these companies, we traced whether or not they held patents using the European database Espacenet. Based upon this information, we created a variable for each investment manager, measuring the percentage of portfolio companies holding patents. The percentage of portfolio companies holding patents correlated significantly with the utility scores for patent protection (correlation of .21, $p < .10$). As such, we find some indication that the results of the conjoint analysis are in line with the in use selection behavior of the investment managers.

5. DISCUSSION, IMPLICATIONS AND DIRECTIONS FOR FUTURE RESEARCH

5.1. Discussion

This study aimed at providing a better understanding of the VC's attitude towards patents during the screening and selection process. Even though ownership of patents has been found to entail a number of benefits for firms, it increases at the same time the information asymmetry between investor and entrepreneur, increasing the risk of agency problems. We indeed show that, whereas some VCs favor patents during the selection process and as such consider patents to be useful and value-contributing assets, for other VCs patents have a negative utility, thus affecting the outcome of the investment selection process

negatively. Using a risk perception perspective and building on a framework of how different types of human capital could affect the VC's attitude towards patenting, this research found that task-specific human capital positively, and general human capital negatively affected the VC's interest in patents.

First, when VCs build more experience in the VC industry, they tend to favor patents more. This can be explained by the fact that investment managers with more experience may have built a network of experts to call upon to assess the value of patents, or may have built own knowledge on how to assess and value patents.

Second, some types of general human capital tend to negatively affect the VC's interest in patents. This may be caused by the fact that a general education, for instance an MBA or general experience, provides investment managers with knowledge about markets in different industries, without providing detailed knowledge in a technological domain or informing investment manager's perceptions on technological risks (Patzelt et al., 2009). As such, this type of human capital provides little indication on how to value or understand patents, which are technical in nature. We do find that one of the aspects of general human capital, namely consulting experience positively affects the attitude towards patents. A possible explanation for the unexpected positive relationship between consulting experience and the attitude towards patents is the fact that there exists a broad range of types of consulting on the market, such as consulting in management, strategy, engineering, human resources, corporate finance, marketing or IT. It could be that certain types of consulting experience lead to more favorable attitudes towards patents whereas others do not. Alternatively, investment managers with consulting experience may have experienced in practice the positive impact of patents, which relate to innovative potential, competitive advantage and value creation, amongst others.

Surprisingly, we do not find any significant relationship between industry-specific human capital, such as a technical education or technical experience and the VC's attitude towards patents. This may be caused by the fact that not all technical education types pay attention to the role and assessment of patents. Indeed, Jabade et al. (2008) and Fishman (2010) call for an integration of knowledge on intellectual property protection in the curricula of technical studies. Further, patents may be very domain-specific, with people with a technical background in for instance life sciences finding it hard to analyze or assess a patent in other technical domains.

5.2. Practical and theoretical implications

First, for entrepreneurs, this research provides an indication of which investment managers may be in favor of patents, and which may value it negatively. Our study may be helpful for entrepreneurs in identifying those investment managers who may value the fact that their technology is patent protected. Given that most of the human capital characteristics that we used in this research are readily available from CVs that are posted on the VC's website, entrepreneurs may increase their chances of raising investments by carefully analyzing the investment manager's profile. In the case of investment managers possessing mainly general human capital it may be beneficial to emphasize the less technical elements of the business plan, such as team and financial aspects.

Second, for VC firms, our findings indicate how the human capital of the investment managers they recruit may affect selection behavior, and consequently the investment portfolio that the firm builds. As such, VC recruitment policy could take into account the findings of our research, and identify those investment manager profiles that are most likely to match the optimal portfolio for a specific VC firm. From the perspective of investment managers in VC firms, the results of this study allow them to understand how their education

an experience impact their investment decisions, which may help them to improve their decision making.

Third, our research has implications for policy makers who have been supporting the VC industry. This is especially the case for the early stage high tech industry, given the equity gap that has been identified in this stage (Dimov and Murray, 2008). Governments have therefore taken a number of initiatives to support the VC industry (Wright et al., 2006 for an overview), with a main objective to promote technological renewal and employment. As a consequence, public shareholders in high tech VC funds may mainly focus on creating technological renewal or economic development (Hood, 2000) and expect the investment managers appointed by these funds to take a similar objective. Our research shows which investment managers are most likely to select those proposals that score high on technical complexity and appropriability, which may be relevant to policy makers and public investors in VC funds.

Finally, this study makes a number of contributions to the literature. First, whereas extant research has studied VC selection criteria and behavior, less attention has been given to understanding the drivers of VC selection behavior. We contribute to the VC literature by shedding light on the determinants of VC investment policies, hereby focusing specifically on one aspect of the business proposal, namely patent protection and the link between the VC's human capital and the utility he or she derives from patented technologies. As such, we respond to a recent call by Patzelt et al. (2009) to study the link between educational level and functional background of VC top management team members and their decision policies. Second, this paper contributes to the entrepreneurship and innovation management literatures which have so far acknowledged and studied the benefits of patents, while ignoring the potential downside of patent ownership, induced by potential agency risks and costs. As such, we show that the role of patents is ambiguous and ownership of patents may not always be

viewed positively by the firm's stakeholders, and call for future studies to take into account this ambiguity. Finally, this paper responds to recent calls for no longer viewing the venture capital industry as a homogeneous industry, but for distinguishing between the specific nature of subsections of that industry. Indeed, Dimov and Shepherd (2005) argue that types of human capital beneficial in conducting pre-and post-investment activities with high-tech portfolio companies might be less beneficial or even detrimental in conducting these activities with low-tech portfolio companies. As such, this paper adds to previous research (e.g. Patzelt et al., 2009) that has referred to the importance of taking a risk perception perspective when studying VC's decisions and decision making, but that has considered the VC industry as a whole.

5.3. Limitations and directions for future research

Despite the contributions of this research, it has a number of limitations, which lead to future research directions. First, our research did not allow distinguishing between patents held by the owner/entrepreneur and the firm. Audretsch et al. (2009) found the distribution of ownership to affect equity distribution. Further research could analyze the extent to which distribution of ownership of intellectual property could affect VC selection behavior. Second, this study was cross sectional in nature, therefore capturing the investment manager's utility derived from patents at a certain moment in time. Longitudinal analysis could indicate to which extent the investment manager's attitude remains stable over time, or could indicate whether specific events or experience with portfolio companies change the investment manager's investment preferences. Third, investment decisions may be partially determined by whether or not the VC firm typically syndicates with other firms. Collaborating with a syndicate partner disposing over larger levels of industry-specific or task-specific human capital may affect the investment manager's risk perception, in turn affecting selection

behavior. Given that many venture capital deals are syndicated (Bygrave, 1987), future research may integrate the investment manager's and syndicate partners' human capital. Finally, our study assessed the utility of patents observed by one individual investment manager per fund. Due to the relatively high effort and time that was required from investment managers to participate in the interview and the conjoint exercise, we were limited to selecting one investment manager per fund. Given that investment decisions are often taken by a team of investment managers (Dimov and Shepherd, 2005; Patzelt et al., 2009), it may be relevant to study the extent to which other team members may affect the individual investment manager's perception towards specific business proposals and eventually affect the financing decision.

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Table 1: Descriptive statistics and correlation table

	Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Independent variables												
(1) Technical experience	1.09	3.31	1.00									
(2) Investment manager experience	4.86	3.84	-0.10	1.00								
(3) Financial experience	6.89	6.77	-0.19	0.51**	1.00							
(4) Consulting experience	1.03	2.22	0.03	-0.23	-0.25*	1.00						
(5) Entrepreneurial experience	1.15	3.00	0.50**	0.06	-0.04	-0.06	1.00					
(6) Management experience	4.04	6.35	0.30**	-0.04	-0.28*	0.04	0.05	1.00				
Control variables												
(7) % public capital	20.21	35.37	0.09	0.10	0.36**	-0.07	0.20	0.05	1.00			
(8) VC fund size	269.04	654.25	0.10	-0.09	0.10	-0.05	-0.11	-0.07	-0.16	1.00		
(9) VC fund age	8.06	9.45	-0.15	0.26*	0.21	-0.08	-0.10	-0.10	0.05	0.41**	1.00	
Dependent variable												
(10) Utility of patent protection	0.184	0.246	0.16	0.00	-0.20	0.21	-0.18	0.08	0.15	0.18	0.10	1.00

Pearson correlations level of significance (two-tailed): * p<0.05, ** p<0.01, n=68

Table 2: Results of hierarchical OLS regression analysis

Dependent variable: utility of patent protection	Model 1	Model 2	Model 3	Model 4	Model 5
Independent variables					
<i>Industry-specific human capital</i>					
Technical experience		-0.002			0.162
Technical education		0.215*			0.106
<i>Task-specific human capital</i>					
Investment manager experience			-0.009		0.216*
<i>General human capital</i>					
Financial experience				-0.219*	-0.286**
Consulting experience				0.249**	0.264**
Entrepreneurial experience				-0.176	-0.299**
Management experience				-0.080	-0.144
Education in humanities				-0.175*	-0.064
Control variables					
% public capital	0.238**	0.276**	0.239**	0.396****	0.421****
Fund size	0.246**	0.208*	0.244*	0.214*	0.225*
Fund age	0.054	0.062	0.057	0.085	0.053
ICT	-0.456****	-0.475****	-0.457****	-0.477****	-0.460****
Biotech	0.001	-0.030	0.001	-0.039	-0.077
Constant	0.382****	0.343***	0.385****	0.497****	0.390****
Model					
F-statistic	4.380***	3.732***	3.593***	4.464****	3.907****
R-squared	0.261	0.303	0.261	0.439	0.485
Adjusted R-squared	0.201	0.222	0.188	0.341	0.361
R-squared change ^a		0.042	0.000	0.178***	0.224***

Standardized regression coefficients are displayed in the table

Levels of significance: * $p < 0.10$, ** $p < 0.05$; *** $p < 0.01$; **** $p < 0.001$; $n=68$

^a Change of R-squared compared to model 1 with control variables