

Venture Capitalists, Technology Transfer and Academic Spin-outs: Attitudes, Involvement, Implications

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Abstract

Using an agency and human capital perspective, we examine which venture capital (VC) firm and investment manager related factors drive investment managers' attitudes towards academic spin-out investing. We use a unique hand-collected dataset involving 68 investment managers working at early stage VCs in Europe. We find that the attitude towards academic spin-out investing is positively affected by having public capital in the fund's capital and by investment managers who work more intensively with the entrepreneur in the post-investment phase. Human capital affects the attitude towards academic spin-out investing. Investment managers who had worked in an academic environment were more inclined to invest in academic spin-outs. General human capital largely did not affect investment managers' interest in academic spin-out investing, except that entrepreneurial experience negatively affected the attitude towards academic spin-outs and financial experience positively affected this attitude. We discuss research and policy implications.

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Introduction

The European Union (EU) has been confronted with a phenomenon commonly referred to as the knowledge paradox (EC 1994; Pavitt 2000). This paradox is illustrative of the high generation of knowledge within the EU, that has however not been translated into commercial applications. Therefore, the EU and national governments have taken a number of initiatives to increase the transfer of research to industry (Wright et al. 2006). One set of initiatives is directed towards the stimulation of technology transfer through the creation of academic spin-outs. Researchers have shown that, in several European countries, there has been a substantial increase in the number of academic spin-outs created (Wright et al. 2004; Moray and Clarysse 2005). This increased activity has spurred the attention of academic research in the domain (Clarysse et al. 2007b).

High tech start-ups (of which academic spin-outs are a subgroup) face the liabilities of smallness and newness. The liability of smallness arises because small firms are unable to buffer themselves from market contractions due to the lack of financial resources and managerial weaknesses (Kale and Ardit, 1998). The liability of newness arises as the new firm needs to establish stable exchange relationships with clients, creditors, suppliers and other organizations and is caused by the lack of reputation, social capital and tangible resources (Hannan and Freeman, 1977).

Many of the initiatives aimed at overcoming the constraints that high tech start-ups are faced with are financing-related initiatives. Indeed, the lack of funding for high tech ventures is often seen as the major reason why high tech companies in Europe find it difficult to get started and grow (Gill et al. 2002; Martin et al. 2002), in

comparison to US firms. High tech start-ups require substantial amounts of financing to get started, which causes internal financial resources to be insufficient or inappropriate (Oakey 1984; Westhead and Storey 1995; Berger and Udell 1998). Further, they are often deprived from attracting external debt finance, given that they possess little collateral, and external equity finance, given that investors face potential high agency costs. Murray and Lott (1995) and Lockett et al. (2002) show that Venture Capitalists (VCs) in Europe are reluctant to invest in high tech start-ups, even though they are seen as the primary source for inventive high-tech start-up companies (Gompers and Lerner 1999, 2001).

The specific nature of academic spin-outs may cause the lack of financing to be even more acute. Academic spin-outs are defined as new companies founded by employees of the university around a core technological innovation which had initially been developed at the university (Wright et al. 2006).

Academic spin-outs are a particular set of high tech companies. First, universities focus on radically new and disruptive technologies that may create new industries and refine existing markets (Mason and Harrison 2004; Gompers 1995) and tend to exploit technologies that are radical, tacit, early stage and general-purpose (Shane and Stuart 2002; Van de Velde et al. 2008). Therefore, their financial needs will be high and VC funding will probably be the most appropriate source of funding. At the same time, the technological developments on which the spin-out company is based are often legally protected, causing the start-up process to be more complex, and requiring technology transfer from the research institute to the spin-out companies. As Wright et al. (2006) highlight, this may give rise to frictions between the spin-out and the research institute, and these frictions may cause VCs to refrain from investing in academic spin-outs. Technology Transfer Offices (TTOs) have been

set up to support the management of intellectual property at universities and research institutes (Clarysse et al. 2005). As Wright et al. (2006) point out, the nature of individual universities' objectives, strategies and support for commercialization may affect the ability of VCs to negotiate an appropriate deal that would enable them to achieve their target rates of return. Second, academic entrepreneurial teams possess little commercial human capital (Wright et al. 2006; Vanaelst et al. 2006). Even though the founders or the TTO may encourage surrogate (external) entrepreneurs to assume a leadership role (Franklin et al. 2001), it is clear that team composition in academic spin-outs remains to a large extent homogeneous in terms of education, industry experience, functional expertise and skills (Ensley and Hmieleski, 2005) and lacking in competencies that need to be acquired to enable the venture to grow (Rasmussen, Mosey and Wright, 2009). Or, as Lockett et al. (2005) indicate, spin-outs typically face a "knowledge gap". Given the importance that VCs attach to the lead entrepreneur and the management team during the selection process (Tyebjee and Bruno 1984; MacMillan et al. 1985; 1987; Keeley and Roure 1989), it seems natural that academic spin-outs may face even higher impediments to attracting VC funding than other early stage high tech firms.

On the other hand, the observation of the equity gap has recently given rise to public initiatives aimed at bridging this gap. Some, but not all, of these initiatives were targeted at academic spin-outs and may have increased the supply of risk financing for this specific group of high tech start-ups (Wright et al. 2006; European Commission 2003). Since the mid-nineties in each of the countries under study, a Bayh-Dole type of Act has been introduced. These Acts not only changed the ownership of publicly financed research from individual professors to universities, but were also accompanied by a range of government measures to finance the

professionalization of TTOs that were expected to manage the property rights over these inventions (Clarysse et al., 2007b). The result was that in each of the countries under study, TTOs received substantial public funds to set up new activities. In Sweden, VINNOVA launched a number of university incubator programs of which Chalmers University in Göteborg is often considered to be the best case. In Germany, the Bio-Region and Exist programs subsidized a number of initiatives, in respectively biotechnology and ICT, which provided the necessary support to incubate academic spin-outs in a pre-seed stage. The Bio-M incubator in Munich resulted from these initial efforts. In other European countries similar initiatives were also taken.

Most of these initiatives have increased the supply of risk financing for academic spin-outs (Wright et al. 2006; European Commission 2003). University related pre-seed funds were set up as public private partnerships with local banks or venture capitalists. In the UK, the University Challenge Funds best represent these initiatives. Relatively small funds were set up to “further develop” the spin-outs and make them venture capital ready. As of today, Imperial Innovations has been the most successful of these funds, having invested in 74 spin-outs, being quoted on the LSE with a market cap of over £ 100 million. It can thus not be ignored that the changes in legislation in each of the countries have had a positive impact on availability of financing for academic spin-outs.

However, Clarysse et al. (2007b) have shown that this has also led to an important side effect. Each TTO has increased its focus on the Intellectual Property (IP) created within the university. The public-private partnership funds that were created following the changes in legislation therefore are often considered as a first step in the IP valuation of the new born spin-out. This means that in the first capital rounds, the pre-seed capital is used to match a relatively high pre-money valuation of

the technology. The inflation of IP importance has also affected the attitude of investment managers in these public private partnership funds, and even in the private follow-up funds. The protection of technology has now become an important negotiation element which universities try to commercialize, regardless of its impact on the subsequent performance of the academic spin-outs.

So far, little research has focused on the supply of venture capital for academic spin-outs and what drives this supply specifically. Wright et al. (2006) study the mismatch between the supply of and demand for spin-outs financing, but do not elaborate on the access of academic spin-outs to start-up financing or the drivers that affect the supply of VC financing to academic spin-outs. The specific nature of spin-out companies and their prospects for growth may have an impact on the supply of venture capital financing.

By studying a set of early stage VCs in Europe, this research aims at understanding which factors explain investment managers' attitudes towards academic spin-out investing. Understanding these factors is expected to have important implications for policy design as well as for the development of the literature concerning the behavior of VCs and the success of academic spin-outs. First, we provide a conceptual framework for understanding the drivers of VCs' attitudes towards academic spin-outs. By building on agency theory and human capital theory, we hypothesize that both the characteristics of the VC fund and the human capital of the investment manager may affect the attitude of the investment manager towards academic spin-out investing. Second, we provide an insight into the methodology used. Finally, we present and discuss the results and conclude by providing insights for practice and directions for further research.

Theory and hypotheses

Selection behavior by VCs has been of interest in the entrepreneurship and VC literature for some time. A first group of researchers has focused on how VCs select their portfolio companies and what criteria they base their decision on (Hall and Hofer 1993; McMillan et al. 1985; 1987; Muzyka et al. 1996). A second group of researchers has linked investment decisions and behavior to the goal orientation of VCs (Jovanovic and Szentes, 2007; Manigart et al., 2002). Jovanovic and Szentes (2007) for instance suggest that a high required return makes the VC impatient to start investing new funds and terminate existing non-performing investments. In a third stream, the VC literature has provided in-depth analyses of selection behavior. In this area, one group of researchers has focused on the impact of the investment manager's background and human capital on investment decisions (Dimov et al. 2007; Franke et al. 2006, 2008). Another group of researchers has analyzed the determinants of portfolio strategy of the VC firm, which is to a large extent a strategic decision taken by the top management team in VC firms (Dimov et al. 2007). Strategic decisions include the decision to focus portfolios on a specific investment stage (Elango et al. 1995; Manigart et al. 2002), to build portfolios that are diversified across industries or that focus on specific industries (Knockaert et al. 2006; Gupta and Sapienza 1992), or to build portfolios that are geographically spread (Gupta and Sapienza 1992). These decisions were found to be highly dependent on fund characteristics, such as public vs. private funds, fund size etc.

So far, little research has integrated both VC fund characteristics and human capital characteristics when studying investment decisions. We argue that, in order to fully understand the drivers of the investment manager's interest in academic spin-

outs and subsequently investment behavior with respect to spin-out investing, it is necessary to include both factors in the analysis. In what follows, we build a conceptual model to analyze the impact of VC firm characteristics and human capital characteristics on the investment manager's attitude towards academic spin-out investing. In order to do so, in what follows we build on agency theory and human capital theory.

Agency theory and attitudes towards academic spin-out investing

Given the lack of collateral and the risk connected to early stage high tech investments (Di Giacomo 2004; Lerner 1999), debt finance is not believed to be an appropriate source of financing for academic spin-outs. Neither is angel financing, given the limited amounts of funding that these financial parties provide, and given that angels are generally unfamiliar with high level science and engineering research. Mason and Harrison (2004) show that business angel investments may not be appropriate in the case of university based intellectual property. Therefore, VCs are often viewed as the primary source for inventive high-tech start-up companies (Gompers and Lerner 1999, 2001). Many researchers have pointed out that venture capital is a form of financial intermediation that is particularly well suited to support the creation and growth of early stage high tech companies (Hellmann and Puri 2000, 2002; Kortum and Lerner 2000). Research (Murray and Lott 1995; Lockett et al. 2002) has however shown that VCs may be reluctant to invest in early stage high tech business proposals. This reluctance can be explained from an agency theory perspective. Venture capitalists typically operate in situations 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, by virtue of being intimately involved in their venture, are likely to possess greater information about it than are VCs who may find it difficult to access this information even with extensive due diligence. The market may subsequently become crowded by low-quality projects because investors find it hard to distinguish between bad-quality and low-quality projects. This phenomenon is called “adverse selection”. 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 (Cumming 2006; Knockaert et al. 2006). The VC literature suggests that there are two ways to offset these agency risks. First, VCs may develop abilities in selecting entrepreneurial projects, which decrease the chance of encountering

adverse selection and moral hazard problems caused by information asymmetries (Amit et al. 1998). Before making an investment, VCs carefully scrutinize the founders and their business concepts (Fried and Hisrich 1994). Second, VCs may engage in extensive monitoring and follow-up on investments made, in order to minimize potential agency costs. With significant equity blockholding, VCs have the incentive to become active in decision control (Wright and Robbie 1998), which includes exerting costly effort to improve outcomes (Kaplan and Strömberg 2001).

Even though VCs may develop specific abilities in selecting entrepreneurial projects, evidence shows that VCs will be in favor of projects that have minimal information asymmetries (Lockett et al. 2002), which often causes high tech start-ups to be deprived of funding. This problem is even more pertinent for academic spin-outs, for which specific technological and human capital resource configurations cause potential agency costs to be higher. The lack of funding for early stage high tech companies and academic spin-outs has typically been referred to as “the equity gap” (Murray 1999). Governments have considered this lack of funding for high tech start-ups as a market imperfection, which justifies public intervention (Di Giacomo 2004; Lerner 1999). Governments can rectify market imperfections that exist with respect to the provision of early stage high tech financing by using a large number of instruments, ranging from the establishment of public funds to providing financing to private funds, over refinancing and guarantee schemes to the provision of fiscal incentives and incubation schemes (Wright et al. 2006). Wright et al. (2006) provide an overview of measures that have been taken in order to help academic spin-outs attract funding. They identify the establishment of public VC funds, such as Twinning Growth Fund and Biopartner and public/private equity funds, such as the University Challenge Funds and Technologiebeteiligungsgesellschaft as examples of public risk

financing provided to academic spin-outs. Even though public instruments may not mitigate potential moral hazard and adverse selection problems, they may allow funds to share (or in the case of public funds to entirely take over) the agency risk and potential agency costs.

Therefore, we hypothesize that VC funds that receive public funding will have at least partially a mission to offset market imperfections and will have as a portfolio strategy to invest in companies that are faced with the equity gap, amongst other academic spin-outs. Therefore, we offer the following hypothesis:

H1: The availability of public funding in the VC firm's capital will positively affect the investment manager's attitude towards academic spin-out investing

Tyebjee and Bruno (1984) define post-investment activities as one type of activities VCs engage in. Post-investment behavior includes both monitoring and value-adding behavior (Knockaert et al. 2006). The VC rationale to engage in these activities is twofold. First, post-investment involvement is an alternative way to decrease the likelihood that moral hazard problems occur. Second, through their post-investment activities, VCs may add value to the venture. Entrepreneurs specialize in the development of knowledge about combining resources to exploit new opportunities (Kirzner 1973) and in the day-to-day development of new business activities (MacMillan et al. 1989), while VCs focus mainly on creating networks to reduce the cost of acquiring capital, to find customers and suppliers and to establish the venture's credibility (MacMillan et al. 1989; Lam 1991). The VC literature has shown great heterogeneity between VC funds in their post-investment behavior (Elango et al. 1995; Schefczyk and Gerpott 2001). Funds that follow up on their

investments intensively are called hands-on funds, whereas funds that mainly carry out monitoring activities in a non-intensive way are called hands-off funds (Sweeting and Wong 1997). It may be expected that funds that choose to play an active post-investment role are in a better position to invest in academic spin-outs. First, by closely monitoring these companies the agency risks and chance of potential moral hazard problems can be reduced, which is specifically relevant to academic spin-outs given the high level of information asymmetry. Second, research inspired by the competence-based perspective suggests that firms are bundles of unique, difficult to imitate capabilities, which are closely related to the knowledge and skills of the founders, and are the key driver of growth of New Technology Based Firms (Colombo and Grilli 2005). Academic spin-outs however are typically resource-poor (Clarysse et al. 2007a) and are faced with a “knowledge gap” (Lockett et al. 2005). Colombo and Grilli (2005) indicate that help to overcome this gap may be obtained from VCs who may use their managerial skills and network of contacts to assist entrepreneurs in domains where the latter lack autonomous expertise. Hands-on funds may be better placed to invest in academic spin-outs since these spin-outs are typically resource-poor (Clarysse et al. 2007a) and hands-on investors can bring much needed human and social capital resources. This involvement helps to protect the interest of the VC, to ameliorate the problems of information asymmetry and to add value to the venture (Sahlman 1990). Therefore, hands-on funds, which operate in close proximity with the entrepreneur in the competence space, may have a more positive attitude towards academic spin-outs investing. Therefore, we offer the following hypothesis:

H2: The closer the investment manager operates with the entrepreneur in the competence space, the more positive the investment manager's attitude towards academic spin-out investing

Human capital theory and attitudes towards investing in academic spin-outs

Both the “similar-to-me” hypothesis and self-efficacy theory indicate how human capital could affect selection behavior. First, we build on the “similar-to-me” hypothesis (Byrne 1971) to explain how the human capital of investment managers may influence their selection behavior. The effect has earlier been applied to venture capital by Franke et al. (2006), who studied a sample of 51 VCs, and who found that VCs tend to favor teams that are similar to themselves in type of training and professional experience. The similarity effect has been confined to psychology and hardly been incorporated into behavioral economics or management studies. According to the “similar-to-me” hypothesis (Byrne 1971), individuals rate other people more positively the more similar they are to themselves. A rationale for this hypothesis can be found in three different theoretical backgrounds, namely learning theory, self-categorization theory and social identity. According to learning theory, similarity is perceived as rewarding and dissimilarity works as a negative reinforcement (Lefkowitz 2000). Self-categorization theory implies that a person's self-concept is based on the social categories s/he puts themselves in and that each person strives for a positive self-identity (Jackson et al. 1991). According to social identity theory (Tajfel 1982), people strive to belong to a group as this leads to the positive feeling of social identity. Assignment to a specific group allows for in-group/out-group comparisons which are biased towards the own group. The impact of the “similar to me” hypothesis has been demonstrated in many management fields,

such as buyer-seller relationships (Lichtenthal and Tellefsen 2001) and employment selection interviews (Anderson and Shackleton 1990). Vanaelst et al. (2006) also find similarities in new team members that added to founder teams in spin-outs.

Second, self-efficacy theory suggests that people who think they can perform well at a task do better than those who think they will fail (Gist and Mitchell 1992). Thus, people perform activities and pick social environments they judge themselves capable of managing (Wood and Bandura 1989). This is in line with agency theory, suggesting that VCs will prefer projects where monitoring and selection costs are relatively low or where the costs of informational asymmetry are less severe (Amit et al. 1998). VCs may therefore prefer to invest in teams with similar human capital, and operating in similar domains, since they will feel more comfortable in assessing the uncertainty and risk of the venture, and subsequently the potential success and return of the investment. They may also feel more confident about their ability to add value when operating closely with the entrepreneur in a competence space they are familiar with.

Based on the similarity and self-efficacy effect, we could hypothesize that investment managers who have similar human capital to the academic founding team are more likely to be positive towards academic spin-out investing. Two key demographic characteristics, education and experience, underlie the concept of human capital (Becker 1975). Applying the human capital concept in a VC context, Dimov and Shepherd (2005) distinguished between general and specific human capital. General human capital refers to overall education and practical experience, while specific human capital refers to education and experience with a scope of an application limited to a particular activity or context (Becker 1975; Gimeno et al. 1997). In a VC context, Dimov and Shepherd define specific human capital as

education and experience that is directly related to the tasks of the VC. Bottazzi et al. (2008) explore the role of VC monitoring and its impact on portfolio firm performance among European VC firms in general. They find that VCs whose partners have prior business experience are significantly more active in investee firms, that VC experience of the firm's partners is not significant, while the influence of a science background for executives is weak. They also find a positive relationship between active VC monitoring and exit performance that is both statistically and economically significant.

In this study, we apply the concepts of specific and general human capital to academic spin-out investing. First, academic spin-outs tend to exploit technologies that are radically new and disruptive, and often early stage and general-purpose (Christensen 2003; Danneels 2004; Nelson 2001). Second, the human capital of academic founding teams has often been found to be very homogeneous in terms of education, industry experience, functional experience and skills (Ensley and Hmieleski 2005; Vanaelst et al. 2006), or, as Franklin et al. (2001) point out, often bring a strong commitment to the technology, but frequently lack business experience and knowledge. It is therefore clear that academic founding teams will to a large extent have both education and experience in high tech domains. Therefore, we define specific human capital as experience or education in high-tech domains. Specific human capital in this context is defined as technical education and experience in a high tech research environment. General human capital in this high-tech VC context is defined as education in humanities, and experience in finance, consulting or investment management. Building on the similarity and self-efficacy effects, we hypothesize that investment managers who possess specific human capital relating to academic spin-out investing will regard investment proposals from academic

entrepreneurs in a more positive way given that they have the same background, whereas the general human capital of investment managers will negatively affect the investment manager's attitude towards academic spin-out investing. Therefore, we offer the following hypotheses:

H3a: The higher the degree of specific human capital relating to spin-out activity, the more positive the investment manager's attitude towards academic spin-out investing

H3b: The higher the degree of general human capital, the less positive the investment manager's attitude towards academic spin-out investing

Research methodology

The sample and data collection

Given that none of the publicly available databases and information sources on VC activity in Europe, such as VentureEconomics or VentureOne provide sufficiently detailed information on the level we required, namely fund characteristics and investment management characteristics, and the VC's attitude towards academic spin-out investing, we constructed our own unique dataset of European early stage VCs and the academic spin-outs in which they invest.

A stratified sample of 68 VC investors was drawn from different regions across Europe. As our research focus focuses on early stage VC investors, we needed to obtain an international dataset because the number of potential respondents within any one country, outside of the US, would have been too small. We selected the seven regions across Europe that had the highest R&D intensity and venture capital presence. The seven regions were: Cambridge/London region (UK), Ile de France

(France), Flanders (Belgium), North Holland (the Netherlands), Bavaria (Germany), Stockholm region (Sweden), Helsinki region (Finland). In each region, we sought a representation of small and large funds with various degrees of public funding. A random sample based upon the most widespread available sample frame, i.e. the EVCA (European Venture Capital Association)-filings, would have resulted in a sample biased towards the larger private venture capital firms. Therefore, we created our own sample frame, collating the directory information from EVCA with those of the various regional venture capital associations and information obtained through contacts we had with academics specific regional expertise and contacts. This resulted in a population of 220 funds across the 7 regions. These were all funds that are investing in early stage. The sample frame was stratified into different groups or subpopulations according to the scale of the funds (small funds versus mega funds) and their institutional investors. In terms of scale, 33 funds were small, 21 were large and 14 were mega funds¹. With respect to institutional investors, 6 funds were private equity arms of banks, 9 funds were public funds, 12 were public/private partnerships and the others are private funds.

Interviews were conducted between January and December 2003. Each interview provided information on fund characteristics, investment manager's human capital and the attitude towards academic spin-outs.

¹ 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)

Measures

Dependent variable

The dependent variable took the form of a dummy (0/1), indicating whether or not the VC showed a positive attitude towards investing in academic spin-outs. Specifically, we asked the investment manager the following question: “Would you consider investing in academic spin-outs?”, and asked to respond with “yes” or “no”. 25 VCs indicated that they would not consider investing in academic spin-outs, 43 indicated that they would consider academic spin-out investment. We explicitly chose to measure the attitude by the investment manager, since we believed that measuring the actual event of spin-out investing may result in certain biases, for instance because the investment manager had never had the opportunity to invest in this type of companies. An attitude is a valuation of an object or a concept, i.e., to what extent an object or concept is judged as good or bad (Wiklund et al., 2003). Attitudes are considered to be important determinants of behavior, and research has shown that attitudes can predict behavior if certain conditions are met (Bagozzi and Warshaw, 1992; Kim and Hunter, 1993). Attitudes have been found to be moderately strong predictors of goal-directed behavior, indicating that the concept of attitude is relevant in our context. For validity reasons, however, we carry out a number of checks using the actual events (number of spin-out investments) and report on them in the results section.

Independent variables

Availability of public capital. We constructed a dummy variable to capture whether or not the fund is funded by public means. 22 funds had received some public

funding (ranging from 15 to 100%), whereas the other 46 funds were entirely privately funded.

Intensity of post-investment involvement. First, we measured the number of days per month the investment manager on average spends on post-investment activities per portfolio company. Our group of early stage investors spends on average 2.8 days per month (standard deviation of 2.6) per portfolio company on follow-up activities. The VC with the lowest involvement spends 2 hours per month, whereas the VC with the highest involvement spends up to 16 days per month per portfolio company. We then normalized the variable as follows:

Intensity of post-investment involvement = (days spent on post-investment involvement / average number of working days)*100, supposing an average number of working days of 20 days a month. The variable subsequently ranged from 1.25% to 80% spent on post-investment activities per portfolio company, with an average of 14%.

Human capital. Following several studies building on self-efficacy and similarity (Franke et al., 2006) and general and specific human capital (e.g. Shepherd et al., 2003; Colombo and Grilli, 2005; Bottazzi et al., 2008) we use the number of years of experience as human capital variables and distinguish between specific and human capital:

Specific human capital. To capture the extent to which the investment manager possesses human capital that relates to academic spin-out investing, we constructed two variables. The first measures how many years of academic experience the investment manager has through means of a PhD or a research position at a university or research institute (labeled “academic experience”). On average, the investment managers in our sample had 1 year of academic experience. The majority

of investment managers (58) had not had any academic experience. Following Dimov and Shepherd (2005), we defined a second variable which measures whether or not the investment manager has a science education (all bachelor and master degrees in mathematics, natural sciences and engineering), and takes the form of a dummy. 34 investment managers had a science education.

General human capital. In order to capture general human capital, i.e. human capital not related to academic spin-out investing specifically, 5 variables were created, also following the definitions by Dimov and Shepherd (2005). Financial experience is measured as the number of years of experience in commercial, investment, and merchant banking, as well as investment fund management, in both public and private markets. The investment managers interviewed had on average 6.89 years of financial experience. Consulting experience is measured as the number of years working for a company designated at providing consulting services, which is on average 1.03 years for the investment managers in the sample. Entrepreneurial experience reflected the number of years the investment managers had previously been involved in a new venture as entrepreneur or founder. In our sample, the average number of years of entrepreneurial experience is 1.15 years, with 15 investment managers having had this experience. In addition, we constructed a variable which we labeled “management experience”. The variable is measured as the number of years in general management, on average 4.04 years in our sample. This differs from Dimov and Shepherd (2005)’s definition of human capital. Whereas Dimov and Shepherd defined an extra variable that measured experience in the law industry, only one investment manager in our sample had such experience. On the other hand, 30 investment managers had experience as a manager in the industry, which made it more relevant to define “management experience” as an extra variable. Finally,

education in humanities and MBA reflects all MBA degrees and degrees in art and social sciences and is measured as a dummy variable. 46 of the 68 interviewed investment managers had this education.

Control variables

We control for the fund size of the VC. The smallest fund manages 0.9 million Euro, whereas the largest fund has a size of 4400 million Euro. The average fund size is 269 million Euros. Additionally, we control for whether or not the VC fund invests in biotech, ICT or industrial automation. This classification is based on the EVCA industry classification in 8 sectors², and in line with previous research (e.g. Knockaert et al., 2006). We then constructed three dummy variables, in line with the EVCA cluster classification: one for ICT (grouping communications, computer related and other electronics related), one for life sciences (including biotech and medical/health related) and one for industrial automation, indicating whether or not the fund invests in these clusters. 57% of the respondents indicated that their fund invests in life sciences, 85% indicated investing in ICT, and 31% is active in investing in industrial automation. 29% of the respondents indicated to invest in other sectors.

Results

Table 1 presents the descriptive statistics for the VCs that had a positive attitude towards academic spin-out investing and those that did not. We used the Mann-Whitney U test to test for differences between groups of spin-out investors and non-spin-out investors. We prefer this non-parametric alternative over the student's t-test, given that the distribution of the data is not normal, and given that this test is

² Communications, computer related, other electronics related, biotech, medical/health related, energy, chemicals and materials, industrial automation

considerably more efficient for distributions sufficiently far from normal and for sufficiently large sample sizes. Furthermore, the Mann-Whitney U test is more robust than the t-test (Conover, 1980). The groups differ on a number of characteristics. First, the academic spin-out investors are to a larger extent involved in post-investment activities, or are more hands-on than non-academic spin-out investors. Second, except for experience in consulting, which is higher in VCs that do not invest in academic spin-outs, the univariate analysis did not show any significant differences at the level of human capital.

<<insert Table 1 about here>>

In order to test our hypotheses, we used a binary logistic regression model. The correlation matrix for the variables included in the analysis is provided in Table 2. Correlations between variables were all below 0.6. In order to make sure that multicollinearity was not an issue, the collinearity statistics were calculated using the condition index and tolerance analysis. The condition index was below 30 (maximum value of 19), and the tolerance levels were all above .10, suggesting that multicollinearity was not an issue (see Hair et al, 1998).

<<insert Table 2 about here>>

The binary logistic regression model is presented in Table 3.

<<insert Table 3 about here>>

Hypothesis 1 states that the availability of public capital in the VC fund's capital would relate to a more positive attitude towards academic spin-outs than is the case for private VC funds. The regression analysis shows that VCs that have public capital in their fund capital are more interested in investing in academic spin-outs ($\beta = 2.41$; $p < 0.05$). Therefore hypothesis 1 is supported. Hypothesis 2 states that a higher intensity of post-investment involvement will lead to an increased interest in investing in academic spin-outs. The regression results show a significant positive impact of intensity of post-investment involvement on the attitude towards academic spin-out investing ($\beta = 0.25$; $p < 0.01$), providing support for hypothesis 2. Hypothesis 3 states that a higher degree of specific capital relating to academic spin-out investing will lead to a positive attitude towards academic spin-out investing, whereas general human capital was expected to negatively influence this attitude. The results for these hypotheses are mixed. First, we find that one of the measures of specific human capital, namely the amount of academic experience affects the attitude towards academic spin-outs in a positive way ($\beta = .54$, $p > .05$). On the other hand, we do not find that people who have had a technical education are more inclined to invest in these spin-out ventures. Second, we find that investment managers who have gained a more extensive experience as entrepreneurs are less inclined to invest in academic spin-outs ($\beta = -.38$; $p < .10$). Third, we find that financial experience positively affects the attitude towards academic spin-out investing ($\beta = .26$; $p < .05$). Other general human capital did not seem to affect the investment manager's attitude towards academic spin-out investing. In summary, the results relating to human capital suggest that human capital affects the attitudes towards academic spin-outs to some extent, and we therefore conclude that we find partial support for hypothesis 3. Given that the coefficients cannot to be interpreted as direct effects, we calculated

partial effects at the average for each of the variables, following Greene (2003). The results indicated that a 1 percentage point higher involvement in post-investment results in an increase in the chance of positive spin-out investment attitude by 0.7 percentage points. At the human capital level, we found academic experience to have the largest effect, with the chance of a positive attitude increasing by 1.5 percentage points per extra year of academic experience, compared to 0.8 percentage points per extra year of financial experience, and decreasing by 1.1 percentage points per year of entrepreneurial experience. Having received any public capital increased the chances of a positive attitude by 2.6 percentage points. Additionally, we tested for the existence of a curvilinear relationship between experience and attitude towards academic spin-out investing, by adding the squared terms of the human capital variables to the model. We did not find any indication of curvilinearity. This may be due to the relatively young nature of most of the European VC industry (Martin et al., 2002). Shepherd et al. (2003) for instance found a curvilinear relationship between experience in the VC task and decision performance, with an optimal VC experience of 14 years. The respondents in our sample however had on average 6.9 years of financial experience, of which 4.85 years as venture capitalist. Only 4 respondents had more than 14 years experience in the VC industry. Finally, we tested for the complementarity of different types of skills / experience, but did not find any significant interaction effects between human capital variables. Neither did we find any significant interaction effects between human capital and other independent variables.

Finally, we extend our analysis to provide validity checks. Our main focus has explicitly been to analyze investment managers' attitudes towards academic spin-outs investing, in contrast to their actual investment behavior. The rationale behind this

choice was that investment managers may be willing to consider academic spin-out investing, but may not have done so far for a number of reasons that lie beyond the scope of our research, for instance the fact that no such potential deal had been presented to them so far. However, for validity reasons, we also analyzed actual spin-out investments. While we finalized our interviews with investment managers at the end of 2003, we contacted them again in mid-2004 and asked for a list of portfolio companies for which they had been engaged in selection and follow-up. This resulted in a list of 172 portfolio companies provided by 35 investment managers. Using secondary information sources, we identified 42 portfolio companies as academic spin-outs, indicating that 16 VCs had invested in academic spin-outs before. This additional data allowed us to check that investment managers who had invested in academic spin-outs had also indicated interest in academic spin-out investing. This was the case for all 16 VCs. We also found that, whereas 19 investment managers had not invested in academic spin-outs before, 8 of them were interested in investing in these companies, therefore indicating the usefulness of our dependent variable. We carried out univariate analyses similar to those reported in Table 1, and found that investment managers who had invested in academic spin-outs before exhibited a significantly higher intensity of post-investment involvement compared to those who had not invested in academic spin-outs before ($p < .05$), which is in line with the results found when using our dependent variable.

Discussion and Conclusions

Using a unique hand collected dataset of European VC firms, this paper has examined the VC firm and investment manager related factors that drive the VC's attitude towards academic spin-out investing. Our findings highlight a number of

important aspects. First, we show that VC funds that have received at least some public capital show a more positive attitude towards academic spin-out investing. This indicates that public funds tend to invest in those areas for which they were established, namely the areas where the equity gap is most acute. Even though public funding cannot mitigate moral hazard and adverse selection problems, it is used for sharing or offsetting agency risks and costs with private investors. Second, the results show that funds that operate closely with the entrepreneur in the competence space have a more positive attitude towards academic spin-out investing. Our third set of results shows that the human capital of the investment manager partially differentiates the academic spin-out investors from the funds that do not consider academic spin-outs: spin-out investors tend to have a higher degree of academic experience and tend to have less entrepreneurial experience. This points to a similarity and self-efficacy effect: investment managers who have been in academia tend to have a more positive attitude towards academic founders, who tend to have similar human capital as theirs. From a self-efficacy perspective, investment managers may feel more confident in their selection and value-adding abilities in relation to entrepreneurs with similar backgrounds, starting up ventures in domains they feel comfortable with. This finding indicates therefore that on the one hand, investment managers who invest in academic spin-outs may be in the right position to understand the difficulties spin-outs face. They tend to understand the specific university culture that is often different from a commercial environment (Wright et al. 2006), which may help for instance during negotiations with the research institute during technology transfer negotiations. On the other hand, this finding also indicates that spin-out investors are not likely to possess human capital that is complementary to the academic founders. However, given that academic spin-outs are typically resource-poor and are dependent on their

environment for the attraction of resources (Blau 1964; Pfeffer and Salancik 1978), it seems unlikely that VCs will be able to bring in the necessary human capital, especially commercial experience. This is in line with research by Clarysse et al. (2007a) indicating that in VC backed ventures, boards tend to be complementary to the (mainly technical) founding team.

Further research

Our research points to a number of directions for further research. First, we show that VC behavior is both determined by human capital and fund characteristics and calls for an integration of both types of characteristics in further research into VC behavior. Second, even though the analysis of the actual investments in academic spin-outs by the investment managers interviewed indicated that investment managers who had a positive attitude towards academic spin-out investing tended to put their intentions into practice, further research could study the number of actual academic spin-outs invested in by the investment manager, by applying a longitudinal design, and following up on the investment manager, irrespective of the fund he or she works for and the career changes that occur.

Third, our focus here was on behavior from the perspective of VCs and we did not examine the nature of the intensity of involvement of VCs in the academic spin-outs or of the outturns from these investments. Qualitative evidence from spin-outs indicates that there is some heterogeneity in the ways in which VCs are able to add value to portfolio companies (Wright et al., 2004). Further analysis could usefully examine the role of VCs in these respects from the spin-out firm perspective.

Fourth, and relatedly, since we have shown that specific types of VCs (publicly funded, with investment managers who have specific human capital) are

interested in investing in academic spin-outs, this research suggests a need for increased attention to VC behavior in the context of academic spin-outs. Little is known about how VCs interact with academic entrepreneurs in the competence space, how and if they add value and how their presence affects board composition and contribution.

Given the amount of seed and pre-seed capital which is invested in various spin-outs (Wright et al., 2006), one would expect that there is at least an *a priori* growth expectation at start-up. International presence and investments right after start-up seem to be a major driver of growth (Autio et al., 2000), not only internationally but also domestically. However, young start-ups that internationalize are very vulnerable as they do not have any experience in international markets. Although they might learn a lot from having international exposure, they will also make a lot of mistakes due to a lack of experience. Partnerships with both venture capitalists and customers that are co-located with the start-up but nevertheless have international experience might be a way to substitute for the lack of experiential learning within the company. We know little about how these relationships work and the challenges involved.

Fifth, our analysis has focused on the decision to invest in academic spin-outs but has not considered the returns to that decision emanating from the realization of VC investments through strategic sales, IPOs or secondary buyouts. Little is known also about how spin-outs prepare for exit even if they are pursuing a strategy that is exit focused. An important aspect of preparing a firm for exit via IPO is the development of boards of directors and related control systems. Spin-outs in high tech sectors typically need to develop both an executive board and a scientific advisory board. Some firms are much more skilled at developing and using boards in ways that

give them advantages over their rivals (Barney, Wright and Ketchen, 2001). TMTs may not have knowledge or abilities to understand changing competitive landscape and specific challenges of industry and markets. Weak boards may mean little internal pressure to change and at the same time send a negative signal to potential investors. Boards in spin-outs may be more effective when skilled directors have been recruited to help the firm fully realize its potential for generating economic rents, rather than simply to monitor the accountability of managers (Zahra, Filatotchev and Wright, 2009). TTOs and venture capital investors may play an important role in appointing non-executive directors with experience in developing and listing high-tech firms onto the spin-out board whose role is to help academics to develop effective management and control systems, i.e professionalize management. Further research is needed on this aspect of the role of VCs.

A further major exit issue for both VCs and academic entrepreneurs is that, when acquiring young technology-based firms, investors are confronted with tremendous uncertainty about the quality of the target. Young technology-based ventures must convince investors of their quality and can do so by providing information that signals the firm's legitimacy (Higgins & Gulati, 2006) or credibility (Vohora et al., 2004). Young academic spin-outs can build legitimacy by entering into relationships with reputable partners. Both VC investors and strategic partners of the academic spin-outs contribute to the firm's legitimacy and increase the likelihood of being acquired and the acquisition price. Preliminary work using a sample of 296 young technology-based firms based in the UK shows that the experience of the lead investor in strategic sales is a crucial driver of the likelihood of being acquired (Bobelyn, Clarysse and Wright, 2009). The development of legitimacy through signalling via symbolic actions such as press releases about the recruitment of board

and management team members as well as innovative breakthroughs and successful trials is also important and VC firms have a role to play here (Clarysse, Bruneel and Wright, 2009).

Finally, we have not considered the investment behaviour of VCs in subsequent funding rounds. Important issues concern the extent to which first round VCs are able to add value to spin-outs that will enable second round funding to be obtained. Different types of first round funders may be better placed than others to do this. A further issue concerns the extent to which public sector VCs, perhaps with more limited funding, are able to attract private sector VCs with whom to syndicate in subsequent rounds.

Implications for policy and practice

Our research has a number of implications for policy makers, entrepreneurs and VCs. First, in respect of policy makers, the European Commission has observed the existence of a so-called knowledge paradox in Europe, indicating that too little knowledge is converted into commercial products and processes (OECD 2002). The main focus of the EC is therefore on facilitating technology transfer and dissemination of knowledge. Academic spin-out establishment is one potential way to bridge the gap between research and industry (Wright et al. 2008b). Our research indicates that the market imperfection that arises for early stage high tech companies is even more acute for academic spin-outs, with not all VCs that invest in early stage deals willing to consider academic spin-out investing. Further, it indicates that publicly funded funds have carried out their investment policy in line with the expectations of government: the funds are to a large extent used for making the investments they were launched for, namely bridging the equity gap for those companies that face market failures.

However, this research also holds a number of caveats for policy makers. The results show that the human capital of the VCs that invest in academic spin-outs is to a large extent similar to that of the founding team of these spin-outs.

Therefore, our research also suggests that, even though publicly funded VCs are positive towards spin-out investing, they may not be in the best position to help academic spin-outs overcome their resource dependency and add value to the venture. Governments could remedy this shortcoming by providing more funds to public fund management, that should allow them to attract people from industry or who have previously started and developed a successful business or who have worked previously in investment banking.

Second, for academic entrepreneurs, our research provides an insight into which VCs may be interested in investing in their spin-out venture. This research indicates that mainly publicly funded VCs may be willing to invest in academic spin-outs, and that those VCs that do invest will take a hands-on approach following investment. Therefore, this also requires that the academic entrepreneur is sufficiently open to accepting high involvement by the VC, which often may result in a loss of control and autonomy by the entrepreneur (Clarysse et al. 2007a). In addition, this research indicates that for academic entrepreneurs, it may be useful to identify the investment manager within the VC firm who may have the most positive attitude towards spin-out investing. This person should be quite easily identifiable, since investment managers frequently publish their CV on websites, and will mention for instance a PhD title and areas of prior experience.

Third, academic entrepreneurs also need to be able to signal the quality of their ventures if they are to attract external investors. Academic entrepreneurs in spin-outs seeking VC investment therefore need to develop a leveraging competency that

enables them build on their initial resources (Rasmussen et al., 2009). Academic entrepreneurs can obtain this leveraging competency from a variety of sources including actors both internal and external to the university, such as recruiting team members with commercial experience.

Fourth, not all academic entrepreneurs are neophytes. Habitual academic entrepreneurs with prior business ownership experience are likely to have broader networks and are more effective in developing network ties to gain equity finance Mosey and Wright (2007). Conversely, less experienced nascent and novice academic entrepreneurs are likely to encounter disconnects (sometimes referred to as *structural holes*) between their scientific research networks and networks to the external investor community. Universities and departments within universities may need to consider developing policies to encourage more experienced academic entrepreneurs to help facilitate access to venture capital.

Fifth, there may be a need for universities to recruit and develop individuals who can act as intermediaries or boundary spanners between the university scientist and providers of finance where there are shortcomings in the networks of TTOs. Schemes such as the Medici Fellowship Scheme in the UK, which involve the inculcation of skills relating to marketing, finance, opportunity identification etc. to individuals who typically are post-docs with a science background suggests that these can have a positive impact. For such policy interventions to be effective there is a need to provide sustained support rather than short term schemes and to establish defined career paths for these non-conventional fellows (Wright et al., 2008a).

Sixth, for VCs and investment managers, this research confirms that investment managers suffer from a similarity and self-efficacy bias in decision taking.

It would therefore be advisable to make sure that people with different backgrounds analyze business proposals.

Seventh, there is a need for greater development of linkages between VCs and universities. Few universities have developed in-depth links with venture capital firms and few venture capital firms have developed links with more than one university. There is a need to develop these relationships in order to overcome the problems that universities fail to present proposals for the funding of spin-offs that are investor ready and that universities' decision-making processes are often not conducive to the time-scales required by VCs (Wright et al., 2006).

Finally, there may need to be policy development of mechanisms to help ensure continued VC investing beyond initial investment rounds for ventures that are at very early stages of development. One approach to this shortfall is via an experimental model of relationship building currently underway within the UK. Investment funds have been created on the premise that they have first refusal on IP emanating from a portfolio of different UK university faculties. They argue that by bundling together IP from a number of cutting edge departments they can build a venture capital backed firm with a higher potential growth profile than any single University could manage by operating in isolation. One such fund has a high profile management team including experienced VC investors and academic entrepreneurs and they have realised a number of significant value public offerings within the field of biochemistry.

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Table 1: Univariate statistics for attitude towards academic spin-out investing (Mann-Whitney U test)

	Academic spin-out investors	Non-Academic spin-out investors
Intensity of post-investment involvement***	16.75 (14.70)	8.68 (5.23)
Specific human capital		
Academic experience (number of years)	1.57 (4.01)	0.28 (1.21)
General human capital		
Financial experience (number of years)	8.01 (7.81)	5.00 (2.97)
Consulting experience (number of years)*	0.95 (2.32)	1.16 (2.10)
Management experience (number of years)	4.38 (6.21)	3.48 (6.67)
Entrepreneurial experience (number of years)	1.30 (3.43)	0.88 (2.09)
Number	43	25

Levels of significance for differences between groups: * $p < .10$; ** $p < .05$; *** $p < .01$; **** $p < .001$; n=68

Table 2: Correlation matrix

	Mean (s.d.)	1	2	3	4	5	6	7
(1) Intensity of post-investment involvement	14.15 (12.97)	1	.03	.09	.00	-.13	-.07	-.17
(2) Academic experience	1.09 (3.31)		1	-.19	.03	.30*	.50*	.10
(3) Financial experience	6.89 (6.77)			1	-.25*	-.28*	-.04	.10
(4) Consulting experience	1.03 (2.22)				1	.04	-.06	-.05
(5) Management experience	4.04 (6.35)					1	.05	-.07
(6) Entrepreneurial experience	1.15 (3.00)						1	-.11
(7) Fund size	269.04 (654.25)							1

Pearson correlations level of significance: * $p < .05$; n=68

Table 3: Binary logistic regression

	Academic spin-out investor (0/1)
Independent variables	
Public capital in fund capital (0/1)	2.41** (1.16)
Intensity of post-investment involvement	0.25*** (0.10)
Specific human capital	
Academic experience	0.54** (0.23)
Technical education	-2.18 (2.26)
General human capital	
Financial experience	0.26** (0.13)
Consulting experience	0.27 (0.24)
Management experience	0.10 (0.06)
Entrepreneurial experience	-0.38* (0.22)
Business administration education	-.66 (2.20)
Control variables	
Fund size	0.00 (0.00)
Life Sciences	-1.18 (1.02)
ICT	3.23* (1.73)
Industrial Automation	-2.02* (1.20)
Constant Term	-5.73
Nagelkerke R ²	0.55

Levels of significance: * p< .10; ** p<.05; *** p<.01; **** p<.001; n=68