FROM THE LAB TO THE STOCK MARKET?

AN ANALYSIS OF UNIVERSITY-ORIENTED SEED FUNDS IN EUROPE

Abstract

This work investigates financial mechanisms of academic entrepreneurship focusing on the role of university and PRO-oriented seed funds (i.e. USFs), namely private-equity VC funds with an explicit mission to make investments in academic spin-offs. In this work, we first offer an overview on USFs highlighting heterogeneity and main characteristics. Second, through data (drawn from Thomson One) on a total of 1353 companies we provide empirical evidence showing how USF-backed companies perform in the market with respect to non USF-backed companies. Empirical evidence suggests that USF-backed companies perform better in terms of staging and syndication, but worse in terms f exit and acquisition. Finally, results also suggest that within the group of USF-backed companies, the one that can attract more investors are the ones financed by USFs that collaborate with a unique university.

Keywords: technology transfers, academic spin-offs, university seed funds, funding gap

Jel Codes: G24; O33, O39

Introduction

In Europe, over the last decade several actors have invested significant resources towards the creation of a considerable array of knowledge transfer activities available to universities and public research organizations (PROs) for the commercialization of their technologies.

University-generated inventions are typically embryonic in nature and often at the frontier of scientific advancements (Colyvas et al., 2002; Jensen and Thursby, 2001), thus involving considerable risks associated with their validation, industrialization and commercialization. As a consequence, also sophisticated investors such as Venture Capitalists (VCs) might be reluctant to invest in this type of companies due to the elevated transaction costs, significant asymmetric information with the early stage ventures and high risks pertaining to the uncertainty of the project outcomes (Murray, 2007; Murray et al., 1998). This situation is likely to generate a *funding gap*, a lack of adequate private funding sources to support technology transfer activities and academic spin-offs (ASOs), which also characterizes more advanced and risk-oriented investors such as VC firms or business angels (Lockett and Wright, 2008).

To address such critical issue, which might severely limit the success of technology transfer activities, in many countries national governments and regional authorities have implemented public policy measures to provide financial support or stimulate VCs' interest in ASOs (Brander et al., 2008; Clarysse et al., 2007; Myers, 1984; Murray, 1998; Wright et al., 2006; Knockaert et al. 2010). Similarly, universities and PROs are increasingly partnering with diverse investors to create innovative financial instruments, such as university seed funds, proof of concept funds, incubators (Rasmussen and Sørheim 2012).

In this context, an important topic that needs a deep investigation is how financial investors can contribute in supporting technology transfer activities and how the public intervention can act as a catalyst to accelerate this process. With our work, we try to address

this issue by focusing on the role played by University Seed Funds (USFs), defined as seed and early stage VC funds that have an explicit mission to make equity investments in ASOs with the aim to support technology transfer and the commercialization of university and public research results. More precisely, the aim of this work is threefold. First, we precisely define USFs and we map them across European countries in order to have a comprehensive overview of the degree of diffusion of this financial mechanism. Second, we conduct some empirical analyses in order to assess the impact of USFs on their supported ASOs. As in previous research on the performance of VC funds (i.e. Lerner, 1999; Cumming, 2006; Cumming et al. 2008), we focus on the level of analysis of portfolio companies and measure their success in terms of exit performance (i.e. likelihood to reach an IPO or a trade sale) and ability to attract further funding through staging and syndication processes and in comparison to a control group of new ventures backed by other VC funds. Finally, given the high level of heterogeneity of USFs, not only across countries, but also within the same country, we investigate whether the success rate of the investee companies is influenced by some specific characteristics of the USFs, such as the type of affiliation (i.e. to a single university or to multiple universities) or the investment strategies (i.e. investment focus on specific regions or specific technological fields) or the size of the fund.

We perform our analyses through a final sample of 73 USFs and a control group of 209 other seed funds (i.e. non-USFs) developed over the period 1980-2012. Our dataset also contains information on 1,353 portfolio companies, among which 598 are USF-backed, while 764 are non USF-backed. Our results indicate that USF-backed companies are less likely of obtaining a positive exit than non USF-backed companies, in particular for what concern a potential acquisition. On the contrary, they seem to be more able to attract further financing through staging and syndication. When we move to investigate the USFs' characteristics that mainly impact on their performance, we find that when there is only one university (not zero

or a consortium of universities) in sponsoring the USF the level of syndication is higher. Finally, a better performance is registered when the funds are big and when they have a technological or regional focus in their investments.

Summarizing, we provide different contributions to the existing literature. First, existing studies on USFs are limited in number, focus (the U.S. and the U.K.) and are generally based on case studies (Lerner, 2005; Nightingale et al. 2009). Our work, instead, will refer to a cross-national European sample in order to perform detailed econometric analyses. Second, previous studies have not taken into account the heterogeneity that characterizes this type of instruments, and whether and how it can affect their success. USFs, in fact, may differ in terms of type of affiliation (i.e. single university vs. multiple universities), level of integration with the academic institution (i.e. fully-integrated fund, partnership-based funds, market-based funds), supporting institutions (i.e. universities, governments, regional authorities, foundations), structuring and investment strategies (i.e. investment focus on single universities/regions/technological fields), governance structure and management teams. Finally, we take into account such differences in order to more carefully assess their impact, particularly in terms of growth and success rates of portfolio companies.

The rest of the paper is organized as follows. The next session provides a review of the literature with the aim to explain the importance of the available sources of funding for technology transfer activities in presence of a funding gap and analyze USFs as a specific mechanism to address the funding gap. The second section describes the sample and the data sources, together with the results of the mapping process of USFs across Europe, and the ones of econometric analyses. Finally, we discuss our findings and suggest future lines of research.

BACKGROUND LITERATURE

Financing technology transfer activities: critical issues and existing evidence

Over the past thirty years, the attention toward the transfer to the market of technological knowledge developed within universities has dramatically increased and it has come to be considered as a natural stage in the evolution of the modern university, which takes economic development as one of its goals (generally labelled as "third mission"), in addition to the more traditional mandates of education and research (D'Este and Perkmann, 2011; Rothaermel et al., 2007; Van Looy et al., 2011). A wide and constantly increasing stream of research in economics and management has extensively recognized the relevance of technology transfer activities for innovation development and economic growth (Hulsink et al., 2008; Mustar, 2002; Wright and Filatotchev, 2008). Several works have analyzed, for instance, the size and evolution of technology transfer activities (OECD, 2008), the impact of legislation reforms governing university technology transfer (Baldini et al., 2006; Geuna and Rossi, 2011; Mowery and Sampat, 2005), the organizational structures, incentive systems and capabilities required to enhance the commercialization of university research (Conti and Gaule, 2011; Wright et al. 2006), the different channels through which university-generated knowledge diffuses to the industry and society, such as patents and licensing (Jensen and Thursby, 2001; Mowery et al., 2002; Powers and Mcdougall, 2005), new firms creation (Nerkar and Shane, 2003; Markman et al., 2005) or collaborative R&D projects (Nerkar and Shane, 2003; Markman et al., 2005).

However, an aspect which has been still relatively neglected in the literature regards the involvement of financial investors in technology transfer and the types of financial instruments that can be leveraged to ease the establishment of technology transfer activities. The literature on innovation financing, indeed, has largely ignored the issues related to technology transfer, with the exception of a limited number of studies which have assessed

the provision of equity capital by VC firms to ASOs (Shane and Stuart, 2002; Wright et al., 2006; Munari and Toschi, 2010). It is well-known, for instance, that new technology-based firms, especially those operating in seed and early-stages, typically face significant constraints in accessing equity financing by VC firms, due to high level of risk and information asymmetries (Lockett et al., 2002; Munari and Toschi, 2011). This type of funding gap can be particularly significant for ASOs, (Shane, 2004; Wright et al., 2006), for several reasons.

Tassey (2005) discussed the "risk spike" occurring when a project moves from basic scientific research into technology research. In this phase, the technical and market risks are extremely high. As a consequence, the scale and cost of the due diligence process by investors may be disproportionately high when investing in ASOs. This situation arises from the exceptional information demands involved, as a consequence of the newness and complexity of both the technology and the markets for the commercialization of the related products. The basic and embryonic nature of the technology developed by ASOs requires also a deep scientific understanding for evaluating business proposals that often investors do not have (Wright et al., 2006). In the case of ASOs, this exacerbates the problems of information asymmetries in the relationship between the venture and the external investors (Lockett et al., 2002; Salmenkaita and Salo, 2002). In the same vein, the typical composition of the entrepreneurial team of ASOs could create some problems in attracting VC investors. Since academic start-ups emerge in a non-commercial and non-competitive environment as that of a university or research institution, the maj,or part of such start-ups is generally not "investor ready" (Rasmussen and Sorheim, 2012). The strong research orientation and the lack of commercial experience of the academic founding team, critical for introducing new technologies into the market, could discourage VCs in investing in such a type of ventures (Lockett et al. 2002; Moray and Clarysse, 2005; Hsu, 2007). To sum up, the barriers and challenges identified above are likely to create an important funding gap between the new

ventures stemming from university labs and the potential investors supporting their development, that needs to be addressed by external actors with the explicit aim to increase the success rate for technology transfer and commercialisation, thereby increasing the economic and social impact (Rasmussen and Rice, 2012).

To address the funding gap issue, different technology transfer mechanisms have been implemented in numerous countries, often with the support of public policies, such as proof-of-concept programs (Audretsch and Lehmann, 2005; Rasmussen, 2008; Rasmussen and Rice, 2012), science parks (Löfsten and Lindelöf 2002; Siegel et al. 2003; Phan et al. 2005), incubators (Mian 1996; Colombo and Delmastro 2002; Soetanto and Jack 2011). Among them, we devote specific attention to university seed funds, whose mission is to provide financial support to ASOs in order to facilitate the development of university technologies and unfold their potential for commercialization.

University seed funds as a response to the funding gap

University seed funds (USFs) can be defined as seed and early stage VC funds that have a deliberate and explicit mission to make equity investments in ASOs to support technology transfer and the commercialization of university and public research results. The first pioneering experiences of this type of instruments can be traced back to the United States, where according to Lerner (2005), the very birth of the VC industry had its roots in the American Research and Development (ARD) fund, designed to focus on technology-based spinouts from the Massachusetts Institute of Technology. Several other similar initiatives followed (Lerner, 2005), and a recent report estimates that in 2011 there were over nearly 70 research universities in the United States which had established internal gap funding programs, in addition to several State-based technology and start-up funding programs which

partnered with local universities in order to support technology transfer activities (Johnson, 2011).

As far as Europe is concerned, Wright et al. (2006) provide several examples of university seed funds established in different countries, distinguishing between 100% publicly owned funds (e.g. Twinning Growth Fund and Biopartner in the Netherlands; the Danish Growth Fund in Denmark; Fond de Co-investissiment des Jeunes in France; Sitra fund in Finland), and public-private partnerships (e.g. the University Challenge Funds in the UK; the University Seed Funds in Belgium). The University Challenge Fund (UCF) Program of the United Kingdom is probably one of the first examples of program in Europe based on the establishment of a pool of seed capital funds to encourage the exploitation of scientific discoveries in universities (Mustar and Wright, 2010; Wright et al., 2008). The funds of the program were established in 1998 by the Department of Trade and Industry (DTI), Wellcome Trust, Gatsby and Host University, with the objective of fostering a spirit of entrepreneurship and providing universities with access to seed funds to take projects from the lab bench out into the commercial world. The program was composed of 19 USFs and provided early-stage funding to create university spin-out companies with an initial funding of £45 millions which went into the scheme in 1999 and a second round of funding of £15 millions in 2001. Now, the program is closed and it has enabled 57 universities to access funds to support 172 early-stage business proposals derived from research (DTI website).

In a similar vein, other countries have promoted the establishment of USFs with a specific mission to support university start-ups and promote technology transfer, such as Belgium (Wright et al., 2008), France (Mustard and Wright, 2010), Norway (Rasmussen and Rice, 2012), Italy (Clarysse et al., 2007), Canada (Rasmussen, 2008) and Sweden (Jacob et al., 2003).

Despite the importance that USFs can have for the achievement of the third mission by universities, they still represent a relatively new and surely under researched phenomenon in the academic literature on entrepreneurship and technology transfer. Most of existing studies on this issue are just base of anecdotal evidence or on the analysis of few case studies. Based on the analysis of case studies and empirical evidence from pioneering USFs in the United States, such as Boston University's venture capital subsidiary or the ARCH initiative of the University of Chicago, Lerner (2009) points out the risks of establishing this type of instruments by academic institutions or governments, such as crowding out independent VCs, generating a limited deal-flow or backing unsustainable companies.

In a similar vein, Jacob et al. (2003) analyze the Swedish context through the experience of the Chalmers University of Technology, with the establishment in 1999 of Innovationskapital as a venture capital company partly owned by Chalmers, in order to provide a bottom-up view of the transformation from a traditional to an entrepreneurial university. The main issues describing the difficulties in creating the entrepreneurial university can be summarized in this work in terms of organization of the infrastructure and integration of the entrepreneurship function with the primary tasks of research and education.

Rasmussen (2008) reviews the Canadian support structure at the federal level by describing the most important initiatives related to the building of capabilities and commercialization culture at the research institutions and the initiatives to support the commercialization of university research with a particular focus on the experience of the University of British Columbia. The main factors highlighted for the success of a bottom-up approach supporting research commercialization projects are the provision of direct resources for commercialization projects or for developing professional expertise in technology transfer in the university sector, the encouragement of innovation in project design, and the development of a tight cooperation between commercializing organizations.

At a broader level of analysis, Rasmussen and Rice (2012) examine the Norwegian context in order to develop an understanding of the different initiatives developed at the government level for supporting the commercialization of university research and develop insights into how they are being implemented. Also in this case the main factors for a successful government support aimed at enhancing university technology transfer are provided: extending academic research into development, extending the role of commercial actors and investors and supporting the development and engagement of intermediators.

The only two quantitative studies centered on the analysis of university seed funds, to our knowledge, are represented by a work by Nightingale et al. (2010) on the experience of UCFs and other hybrid funds in the UK and by a recent working paper by Croce et al. (2013) on a sample of USFs in the United States and in Europe. The report by Nightingale et al. (2010) analyzes 782 companies backed by 6 public-private VC schemes in the United Kingdom - including the UCF scheme - and compares them with an untreated, matched control group of other new ventures. The findings from the econometric analyses show that these schemes have had a positive impact on firm performance, when compared to the matched control sample, but the size of their impact remains modest. The recipients of UCF funding, as compared to other public/private funding schemes, seem to be characterized in this study by a higher likelihood to be acquired, a higher likelihood to fail, and a lower average number of follow-on funding rounds obtained.

The study of Croce et al. (2013) analyzes 26 USFs, 15 of which registered in EU and 11 registered in the United States, using data from Thomson One. They focus on “pure” USFs, defined as funds directly managed by the focal universities that invest (or co-invest with other investors) in the equity capital of portfolio companies. This study provides an useful exercise for understanding which universities tend to set-up USFs, which are their investment characteristics in terms of target industries and investment stages of portfolio

companies, which types of co-investors are involved in the deals, and which are the factors impacting on the USFs' final performances. However, it refers to a strict definition of USF, based on data collected from a single source. It does not take into consideration the high level of heterogeneity characterizing this type of financial mechanisms along a series of dimensions, such as the type of affiliation, the pursued goals, the investment focus and the internal structure of the fund.

More research is thus needed in this emerging and important area, in order to better understand how to design and implement this type of financing instruments, and improve their success rates. This topic is particularly relevant not only at the light of the problems faced by ASOs in accessing VC financing, due to information asymmetry and uncertainty related issues (as discussed in the previous sections), but also for the challenges associated with the development of a effective supporting structure to the commercialization of early-stage technologies developed within the university. The proliferation of funds dedicated to investing in new firms spawned from these institutions with the vision to generate more wealth for the university has to take into consideration also the challenges that these university-affiliated funds have to face. As discussed in Lerner (2005), the experience of the ARCH Venture Partners in the United States is a good example to highlight some of the issues associated with these efforts, such as the presence of a political interference that can undermine the effort, the existence of regulations that can severely restrict researchers' involvement with start-ups and the inability of the programs to recruit and retain the best talent in terms of fund management. With these problems in mind, academic research should pay particularly attention on the design and structure of the USFs and the context in which they have to be developed.

In these lines, we intend to contribute to the existing literature in different ways. First, we aim to make a comprehensive mapping of the USFs landscape in Europe, leveraging on

different data sources. This task is particularly complex for the lack of a precise definition and unique label to identify these funds. However, providing a comprehensive overview of the landscape in terms of USFs across Europe represents an important starting point for deriving policy suggestions for supporting the technology transfer process. Second, we recognize the existence of a strong heterogeneity that characterizes this type of tools and we take it into consideration in our empirical investigation. For instance, as suggested in the literature review and confirmed by our data, "pure" USFs, where universities promote their own funds, represent only a minor part of the European landscape. Different configurations of seed funds, characterized by various linkages with universities and investment strategies also exist. Our intent is therefore first that of identifying relevant structural dimensions for the design and implementation of university seed funds, and then to analyze whether and how these different dimensions impact on the success rates of the investee companies. We thus try to understand in more depth which specific factors are critical in determining the success of these funds, by taking as the level of analysis that of portfolio companies. We investigate the performance of portfolio companies by looking at three different dimensions: their final exit in terms of IPO or M&A; their ability to attract additional funding through a greater number of investment rounds (i.e. staging) and through a greater involvement of other investors (i.e. syndication).

Finally, we intend to assess these measures of performance for USFs along two distinctive directions. On the one hand, we are interested in understanding if the level of effectiveness of the USFs is different as compared to other seed funds (which do not have a specific mission towards investing in academic spin-offs and promoting technology transfer). On the other hand, in the specific case of USFS, we intend to empirically investigate which design dimensions more deeply impact on the success rates of investee companies, focusing on some specific dimension which emerge from our mapping exercise, such as the size of the fund, the affiliation to one or more universities, the presence of an exclusive investment focus

(or not) on academic spin-offs, on a specific regional area or a technological sector, as we detail in the next sections.

METHODOLOGY

Data sources and Sample

The first challenge of our research was that of identifying USFs established in different European countries. In order to do that, we adopted a broad definition of university seed funds, as those seed and early stage funds that have a deliberate and explicit mission to make equity investments in academic and PRO spin-offs so to support technology transfer and the commercialization of university and public research results. This definition thus contains four building blocks that define the nature of the university seed funds: a) a focus on new companies and on equity investments, and not on single projects, research teams, or patents (this helps to differentiate them from other instruments such as proof of concept fund, IP funds or other public grants); b) a deliberate and declared mission towards investing in university and PRO spin-offs and supporting the technology transfer process, so to distinguish these funds from other venture capital (early stage and seed) funds generically investing in high-tech new ventures; c) a focus on initial stages of investment (seed and early stages of a new company).

For what concerns the identification of university seed funds activated in Europe, we followed different steps. We started our data collection by using the Private Equity module of Thomson One database (formerly known as VentureXpert), by selecting only those funds resulting in the "venture capital" category (thus excluding buyouts) and included in the category "University Development Program". With this category, Thomson One classifies those programs established by a university/college to make private equity investments in spin-offs and start-ups. The Thomson One database has been extensively used in other studies on VC

and private equity (e.g. Croce et al 2013; Lerner 1995; Kaplan and Schoar 2005; Sørensen 2007) and its reliability has already been validated by previous studies (Gompers and Lerner 1999; Kaplan et al. 2002).

As a second step, we redefined and augmented our sample through a desk-research on the web, using a set of selected key-words[1]. We included in our sample only those venture capital funds declaring on their official website an explicit mission in supporting technology transfer from universities and PROs and invest (in the form of equity investment) in the seed phase of the company life-cycle. Finally, for some countries, we conducted additional direct phone interviews with experts on technology transfer issues and university-industry collaborations, asking them to nominate university seed funds available in the respective countries.

For all the additional USFs we were able to identify through web searches and interviews with experts, we then checked their presence on Thomson One so to collect data on the fund and their portfolio companies. In this way, we were able to identify 73 USFs established in XX European countries after 1980, and the related 598 USF-backed companies.

Finally, to compare USFs with other seed funds that do not have a specific mission of supporting academic spin-offs and technology transfer, we also constructed a control group of other seed funds (non-USFs) and their portfolio companies. To construct such control group, we selected from Thomson One those VC funds created after 1980 in the same European countries of USFs, and focused in the seed stages (naturally excluding the previously identified USFs). We then used Thomson One to retrieve data at the fund and the investee company level also for such funds.

Our final sample thus consists of a total of 281 VC funds, divided into 73 USF and a control group of 209 other seed funds (i.e. non -USF). Our dataset also contains information

[1] In our web-searches, we used key-words such as “university seed fund”, “university challenge fund”, “university accelerator fund”, “seed funds and academic spin-offs”, “seed fund and university”. We also used Google Translate in order to translate such key-words and conduct the web-search in the different European languages.

on a total of 1353 portfolio companies, among which 598 are USF-backed companies, while 764 are non USF-backed companies.

A first look at our sample: characteristics of university and PRO-oriented seed funds

The first, qualitative investigation of our data allows to highlight some interesting patterns which characterize USFs in Europe. It is immediate to notice the high heterogeneity, which exists among USFs. A first, important difference regards their governance. On the one hand, it is possible to identify USFs that have established a formal and tight link with universities or PROs, either because they are promoted by the university or the PRO itself, or because they have activated stable partnerships with them. On the other hand, it is possible to identify USFs which do not have such formal links, even though they declare a specific mission to sustain the technology transfer process in the form of academic spin-offs. In the latter case, for instance, are included *Portugal Ventures* (Portugal) or TTVenture (Italy), which are not directly affiliated to universities or PROs, nor declare partnerships with a specific university or PRO, although they declare an explicit purpose of making investments in academic and PROs spin-offs. In our sample, among about 60% of companies are in the portfolio of USF sponsored or collaborating with universities, while the remaining 40% are financed by USFs which do not declare such formal linkages.

For the former group, another difference relies on the number of the universities (or PROs) with which the USFs has a formal link, which ranges from the case of a single university to the case of a consortium of more universities. For instance, *Imperial Innovation Fund,* initially established in the United Kingdom under the University Challenge Fund measure, has been promoted by a single university, i.e. the Imperial College. However, under the same measure, some USFs have been sponsored by a consortium of universities rather than single universities. It is the case, for example, of *Iceni Seed Corn*, promoted by the collaboration of

the universities of East Anglia and of Essex and of British research organizations such as John Innes Centre, Sainsbury Laboratory, Institute of Food Research, and Plant Bioscience Ltd. Similarly, the *White Rose Technology Seed Fund* was affiliated and promoted by the universities of Leeds, York and Sheffield. Similar examples are present in Belgium or in the Netherlands, for instance. On the one hand, *Brussels I3 Fund NV* and *Sopartec SA* are two funds promoted respectively by Vrije Universiteit Brussel and by the Catholic University of Louvain. On the other hand, other USFs, such as *Thuja Capital* (the Netherlands), have behind a larger number of universities and research centres (e.g. of University of Utrecth and the Medical Centre of Utrecht). In addition, we also notice that USFs can be heterogeneous in terms of investment strategies. They could focus their investments in a limited number of specific technologies (i.e. biotech and pharma, or ICT), or, on the other hand, adopt a more general approach in terms of technology focuses. For example, the *Karonlinka Development Fund* in Sweden has an investment focus in the biotech and medical technologies. Or, *Innova 31* that aims to make investments in chemical, biotech, or telecommunications. In our data, about 43% of USFs declare a specific technological focus of their investments.

Finally, USFs can focus their investments in precise regions or restricted geographic areas, or, on the other hand, have a nationwide span of investments. For instance, some USF funds only finance start-ups in determined local areas, like *Genopole 1er* in the Ile-de-france, or *Unirisco* in the region of Galicia in Spain. In our sample, about 72% of USFs invest in fact at a regional level.

Table 1 reports some significant examples of European USFs, in order to highlight how they differ according to these dimensions.

Insert Table 1 about here

In our subsequent regression analyses we are thus interested to assess whether the abovementioned characteristics which differentiate USFs influence the ultimate success rate of the companies in which they invest. This is an important step from a policy perspective in order to understand in more depth how to optimally design and manage such instruments in order to foster firms' growth and technology transfer. In the next sections, we first detail the construction of our variables, and then present the results of our regression analyses.

Variables and Measures

Dependent Variables

Positive Exit. It is a dichotomous variable that takes the value equal to 1 if the investee company has exited through IPO or acquisition as of December 2012, and 0 if not (source: Thomson One).

Acquisition. It is a dichotomous variable that takes the value 1 for companies acquired as of December 2012, and 0 if not (source: Thomson One).

Staging. It is a count variable that indicates the number of rounds of VC funding obtained by each company as of December 2012 (source: Thomson One).

Syndication. It is a count variable that indicates, for each company, the total number of VC investors involved in the various financing rounds, as of December 2012 (source: Thomson One).

Explanatory Variables

USF-backed. It is a dichotomous that takes value 1 if the investee company has received financing from an USF fund, zero otherwise (source: Thomson One, web searches and interviews with experts).

University and PRO-promoted Fund. It is a dichotomous that takes value 1 if the investee company has received financing from an USF that is sponsored and promoted by one or more universities, and zero otherwise (source: web search of the fund websites).

No linkages with universities. It is a dummy equal to 1 if the company has received financing from an USF fund which did not declare any formal linkage with universities or PROs, 0 otherwise (source: web search of the fund websites).

Linkage with one university. It is a dummy equal to 1 if the company has received financing from an USF fund which declared a formal linkage with one university or PRO, 0 otherwise (source: web search of the fund websites).

Linkage with two universities. It is a dummy equal to 1 if the company has received financing from an USF fund which declared formal linkages with two universities or PROs, 0 otherwise (source: web search of the fund websites).

Linkage with three or more universities. It is a dummy equal to 1 if the company has received financing from an USF fund which declared formal linkages with three or more universities or PROs, 0 otherwise (source: web search of the fund websites).

Control Variables

We controlled for a series of variables at fund, company, and environmental level to reduce unobserved heterogeneity.

Company Industrial Sector. Categorical variable indicating the technological field of the companies along with the classification by Thomson One. It includes the following ten technological sectors: Medical and Health; Biotechnology; Communication and Media; Computer Hardware; Computer Software and Service; Internet Specific; Consumer Related; Industrial-Energy; Semiconductors and Other Electronics, and Other products (source: Thomson One).

Age Company. Numerical variable that indicates the age of the company, expressed in years, as of December 2012 (source: Thomson One).

Total Amount Received. Total amount of PE investment received by the company from different investors as of December 2012 (source: Thomson One).

Fund Size. It indicates the average value of fund size of the co-investors which funded the company (source: Thomson One).

Technology focused fund. It is a dummy that takes value 1 if the USF has an investment focus on a limited number of technological sectors (e.g. specialist fund), and 0 if not (e.g. generalist funds) (source: web search of the fund websites).

Regional focused fund. It is a dummy that takes value 1 if the USF has an investment focus on a determined geographical area (i.e. province or region), and 0 if not (source: web search of the fund websites).

Bubble years. It is a dichotomous variable that takes value 1 if the first VC investment obtained by the investee company occurred in 1999 or 2000 (source: Thomson One).

VC investments availability. For each company, it indicates the average amount of VC investments which occurred in the period 1980-2012 in each of EU countries (sources: Eurostat).

MSCI. It indicates Morgan Stanley Capital International Index equity return for the UK in the first round investment year (source: Datastream).

Table 2 lists all the variables included in the empirical analysis and their definitions; Table 3 contains their descriptive statistics; and Table 4 presents pairwise correlations.

Insert Tables 2, 3, and 4 about here

RESULTS

Econometric Estimations

We divide our analysis into two steps. In the first, we compare USF-backed companies with the control group of non USF-backed companies (results are reported in Table 5), while in the second we concentrate only on analyzing USF-backed companies and USF characteristics (Tables 6 and 7).

In Table 5 we present the estimated results of the model that distinguishes portfolio companies of USFs from other VC funds (i.e. control groups). To estimate consistently the probability of our dependent variables we choose two different models: we employed a logit model for binary-coded variables (i.e. positive exit, acquisition), while we estimated staging and syndication through a negative binomial and a poisson model. The first specification (5.1) in this table estimates the probability of a positive exit. The estimated results confirm that USF-backed companies are less likely of exiting positively from the market; the effect is statistically significant at a 1 percent level. The second specification 5.2 tests the same key covariate but on the probability of exiting the market through an acquisition. Similarly, the presence of USF as investor is negatively associated with the likelihood the company to be acquired. The effect is statistically significant at the 1 percent level. However, being USF-backed produces the opposite effect on the probability of syndication and staging. The estimated results of specifications 5.3 and 5.4 show that the presence of USFs is beneficial on the odds of syndication and staging, and these two effects are both statistically significant ($p<.01$).

Insert Table 5 about here

In Table 6 and 7 we run analysis on the subsample of USFs to investigate in details if some characteristics might affect the positive exit and the acquisition of an investee company, the

number of co-investor, and the maximum number of rounds financed. The main explanatory variable in table 6 indicates if the investee company is financed by a USF sponsored by universities or PROs. In the specifications 6.1 and 6.2 results suggest there is not any significant effect of our main independent variable on the probability that the firm will exit positively from the market or being acquired. Similarly, it is the effect on staging, while being financed by a fund promoted by universities or PROs has a positive and significant effect on the level of syndication (significant at 1% level).

Insert Table 6 about here

Finally, in table 7 we introduce a new explanatory to investigate if the number of linkages of a USF is significant on the portfolio company performance. We create four dummies and we test in the specification 7.2 if being promoted by zero universities (baseline case), by one single university, by a collaboration between two universities or being a larger consortium of universities sponsoring a USF. This variable has no significant effect on positive exit, acquisition, and staging as we observe in the specifications 7.1, 7.2, and 7.3. However, empirical evidence suggests that fund promoted by a single universities are the one that increase the probability of company's syndication ($p<.01$).

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Insert Table 7 about here

Discussion and conclusions

In this work, we contributed to define the concept of University Seed Funds, as important financial instruments that can help addressing the funding gap, which severely limits the growth prospects of university spin-offs and the effectiveness of technology transfer

from universities to the industry. We mapped the landscape of USFs available in Europe, by triangulating several data sources, such as commercial databases, web-searches and interviews with experts. Our analyses permits to identify several characteristics which differentiate the structure and investment strategies, such as the size of the funds, the existence of formal linkages with universities and PROs, the number of universities involved in the partnerships with the funds, the technological and geographical focus of investments. . In our regression analyses, we tried to understand if these characteristics do influence the success rates of investee companies, in terms of exit rates, staging and syndication patterns. We also compared the success rates of companies backed by USFs with a control group of companies backed by other seed funds from the same countries.

A first interesting finding emerging from our analyses relates to the positive and statistically significant impact of the size of the fund on the ultimate success rates of investee companies. It seems therefore that a minimum efficient scale is required for this type of instruments, and that excessive fragmentation of resources should be avoided in this area. A second interesting insight is related to the positive influence that the technological focus of investments has on the exit rates of investee companies. This seems to suggest that specialized competences are required by the management team of USFs, necessary for providing a real support to research institutions in their TT process. The case for the availability of specialized and deep competences in specific technological areas covered by the fund seem to emerge from such results, so to facilitate the selection of promising companies and provide value-added services to portfolio companies.

Less conclusive findings emerge with respect to the impact of a formalized link with universities and PROs. Our results in this sense are positive and significant only in the models considering syndication as a dependent variable, in particular in cases when a link with a single university is established. Such findings should be interpreted as a first step in the

investigation in the optimal design and ultimate impact of university seed funds, as a policy measure to address the funding gap and the promote technology transfer. Additional evidence is required in order to overcome the limits presented by the current study. First of all, it appears important to adopt more precise performance measure to assess the ultimate impact of such funds. An interesting extension of our work could be that to consider typical measure of turnover or employment growth, or profitability levels related to portfolio companies, in order to assess the influence of USF funding vis-à-vis funding obtained by other types of VC funds. An additional important research avenue would be that of conducting further in-depth cases-studies concerning university and PRO-oriented seed funds, in order to understand more in detail their design, organization, and management, in particular for what concern the type of relationships existing with university TTOs and research departments, and the support activities offered to university researchers.

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Table 1: Examples of USFs in Europe

Fund Name	Country	Linkages with unviersities	Universities involved	Investment Focus
Uni Venture Fund	AUSTRIA	No specific link		preference to invest in healthcare and biotech
Gemma Frisius KU Leuven NV	BELGIUM	University-promoted	KU Leuven	preference to invest in start-ups in the region of Leuven
Brussels I3 Fund NV	BELGIUM	University-promoted	Vrije Universiteit Brussel	Preference to invest in Brussel capital-region
Sopartec SA	BELGIUM	University ans PROs promoted	Catholic University of Louvain, clinique universitaire st-luc, Institut de Duve	preference to invest in life sciences, electronics, new materials,
Genopole 1er Jour	FRANCE	University-promoted	Université d'Evry Val-d'Essonne	preference to invest in biotechnologie in the Ile-de-France
TT Venture	ITALY	No specific link		preference to invest in clean techs, agro-food, life sciences, new materials
TTSeed	ITALY	No specific link		
Thuja Capital BV - Unspecified Fund	NETHERLANDS	University-promoted	University Medical Center Utrecht	preference to invest in medical life sciences
Portugal Venture	PORTUGAL	No specific link		preference to invest in Lisbon and Oporto areas
Innova31	SPAIN	University-promoted	Universitat Politecnica de Catalunya	preference to invest in telecommunication, information technology, biotechnology, internet, electronics, and chemical
Karolinska Development Fund	SWEDEN	University-promoted	Karolinska Institute	preference to invest in Biotechnology, and Medical technology
Iceni Seed Corn	UK	University and PROs-promoted	University of East Anglia/ University of Essex/ John Innes Centre/ Sainsbury Laboratory/ Institute of Food Research/ Plant Bioscience Ltd	
Imperial Innovation Fund	UK	University-promoted	Imperial College, London	preference to invest in high-tech and healthcare
White Rose Technology Seed Fund	UK	University-promoted	University of Leeds/ University of Sheffield/ University of York	

Table 2 Definitions of the Main Variables

Variable	Description
Exit	It is a dichotomous variable that takes the value equal to 1 if the investee company has exited through IPO or acquisition as of December 2012, 0 otherwise (source: Thomson One).
Acquisition	It is a dichotomous variable takes the value 1 for companies acquired as of December 2012, and 0 otherwise (source: Thomson One).
Staging	It is a categorical variable that indicated the maximum number of staged investment rounds in obtained by the company as of December 2012 (source: Thomson One).
Syndication	It is the number of syndicated investors for all of the financing rounds as of December 2012 (source: Thomson One).
USF-backed	It is a dichotomous that takes value 1 if the investee company has received financing from an USF, 0 otherwise (source: Thomson One and web search of the fund websites).
University and PRO-promoted Fund	It is a dichotomous that takes value 1 if the investee company has received financing from an USF that is sponsored and promoted by one or more universities, and zero otherwise (source: web search of the fund websites).
No linkages with universities	It is a dummy equal to 1 if no universities support the USF investing in the company, 0 otherwise (source: web search of the fund websites)
Linkage with one university	It is a dummy equal to 1 if only one university support the USF investing in the company, 0 otherwise (source: web search of the fund websites)
Linkages with two universities	It is a dummy equal to 1 if two universities collaborate to support the USF investing in the company, 0 otherwise (source: web search of the fund websites)
Linkages with three and more universities	It is a dummy equal to 1 if more than two universities join a consortium to support the USF investing in the company, 0 otherwise (source: web search of the fund websites)
Co-investors Fund Size	It indicates the average of fund size of co-investors in syndication (source: Thomson One).
Total Amount Received	Total amount of PE investment received by the company from different investors on December 2012 (source: Thomson One).
Company_age	Categorical variable that indicates the age of the company, expressed in years, on December 2012 (source: Thomson One).
Msci	It indicates Morgan Stanley Capital International Index equity return for the UK in the first round investment year (source: Datastream).
VC investments disposal	It indicates the average of VC capital investment resources over the period 1980-2012 in each of EU countries (sources: Eurostat).
Bubble	It is a dichotomous variable that takes value 1 if the first investment got by the investee company is in 1999 or 2000 (source: Thomson One).
Company Industrial Sector	Categorical variable indicating the technological field of the companies along with the classification by Thomson One. It includes the following ten technological sectors: Medical and Health; Biotechnology; Communication and Media; Computer Hardware; Computer Software and Service; Internet Specific; Consumer Related; Industrial-Energy; Semiconductors and Other Electronics, and Other products (source: Thomson One).
Technology focused fund	It is a dummy that takes value 1 if the mission of the USF is the one of investing in precise technological sectors (e.g. specialist fund), and 0 if not (e.g. generalist funds) (source: web search of the fund websites).
Regional focused fund	It is a dummy that takes value 1 if the mission of the USF is the one of investing in a determined geographical area (i.e. province or region), and 0 if not (source: web search of the fund websites).

Table 3. Descriptive Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
USF-backed	1353	0.435	0.496	0	1
Fund University-promoted	589	0.598	0.491	0	1
Exit	1353	0.149	0.356	0	1
Acquisition	1353	0.120	0.326	0	1
Staging	1353	1.842	1.442	1	8
Syndication	1353	1.483	1.077	1	8
Co-investors Fund Size	1353	95.094	661.612	0.033	22887.040
Total_Funding received by the company	1353	10.774	18.020	0.004	341.140
Company_age	1353	9.591	4.566	0	30
Msci	1353	-0.007	0.242	-0.658	0.299
VC_disposal	1353	0.054	0.022	0.004	0.108
Bubble	1353	0.162	0.368	0	1
Fund_TechFocused	589	0.430	0.495	0	1
Fund_GeoFocused	589	0.739	0.440	0	1
No linkage with universities	589	0.402	0.490	0	1
Linkges with one university	589	0.373	0.484	0	1
Linkages with two universities	589	0.039	0.436	0	1
Linkages with three or more universities	589	0.082	0.274	0	1
Sector: Biotechnology	1353	0.190	0.393	0	1
Sector: Communications and Media	1353	0.036	0.187	0	1
Sector: Computer Hardware	1353	0.049	0.215	0	1
Sector: Computer Software and Services	1353	0.159	0.366	0	1
Sector: Consumer Related	1353	0.035	0.185	0	1
Sector: Industrial/Energy	1353	0.088	0.283	0	1
Sector: Information Technology	1353	0.016	0.124	0	1
Sector: Internet Specific	1353	0.127	0.333	0	1
Sector: Medical/Health	1353	0.130	0.337	0	1
Sector: Life Science	1353	0.015	0.121	0	1
Sector: Non-High Technology	1353	0.007	0.086	0	1
Sector: Other Products	1353	0.052	0.222	0	1
Sector: Semiconductors	1353	0.096	0.295	0	1

Table 4. Correlation matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	USF-backed	1.000																	
2	University-promoted Fund	.	1.000																
3	No linkages with universities	.	-1.000	1.000															
4	Linkage with one university	.	0.634	-0.634	1.000														
5	Linkage with two universities	.	0.167	-0.167	-0.158	1.000													
6	Linkage with three or more universities	.	0.242	-0.242	-0.229	-0.060	1.000												
7	Positive exit	-0.134	0.015	-0.015	-0.009	0.019	-0.014	1.000											
8	Acquisition	-0.118	0.011	-0.011	0.005	0.004	-0.018	0.828	1.000										
9	Staging	0.117	0.068	-0.068	0.071	-0.005	-0.030	0.226	0.140	1.000									
10	Syndication	0.431	0.216	-0.216	0.246	-0.027	0.060	0.212	0.143	0.340	1.000								
11	Total Funding received	-0.052	0.088	-0.088	0.139	-0.018	-0.034	0.082	0.018	0.537	0.314	1.000							
12	Company age	-0.157	0.099	-0.099	0.009	0.039	-0.017	0.149	0.131	0.170	-0.019	0.093	1.000						
13	Co-investors fund size	-0.157	0.024	-0.024	-0.015	0.110	0.041	0.046	0.049	0.359	0.131	0.314	0.048	1.000					
14	Msci	0.050	-0.034	0.034	-0.024	0.062	-0.075	0.003	-0.001	0.099	-0.004	0.118	-0.026	0.047	1.000				
15	VC disposal	0.280	-0.057	0.057	-0.157	0.057	0.022	0.026	-0.011	0.003	-0.176	-0.064	-0.039	0.038	-0.038	1.000			
16	Industry of the company	-0.022	-0.020	0.020	0.021	0.000	-0.041	-0.088	-0.077	-0.032	0.007	-0.039	0.032	0.051	0.000	-0.072	1.000		
17	Technology Focused fund	.	0.001	-0.001	0.291	-0.178	-0.095	0.035	0.048	0.044	0.180	0.076	-0.075	-0.045	0.027	-0.393	0.033	1.000	
18	Regional focused fund	.	0.302	-0.302	0.085	0.122	0.078	0.003	0.019	-0.026	0.095	-0.033	-0.001	-0.036	0.076	0.139	0.035	0.080	1.000

Table 5. Empirical evidence between USF-backed companies and not

	Exit (5.1)	Acquisition (5.2)	Syndication (5.3)	Staging (5.4)
USF-backed	-0.708***	-0.697***	0.581***	0.119***
	(0.195)	(0.214)	(0.054)	(0.046)
Company_age	0.151***	0.132***	-0.009	0.026***
	(0.019)	(0.019)	(0.005)	(0.005)
Co-investors Fund Size	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Msci	0.121	0.496	-0.053	0.175**
	(0.355)	(0.398)	(0.094)	(0.087)
VC investments disposal	19.004***	18.655***	-2.418**	3.079***
	(4.026)	(4.339)	(1.129)	(0.988)
Bubble	-0.033	0.088	-0.034	-0.009
	(0.214)	(0.229)	(0.071)	(0.057)
Company industrial sector dummies	YES	YES	YES	YES
Constant	-4.139***	-4.190***	0.285***	0.302***
	(0.387)	(0.414)	(0.100)	(0.087)
Observations	1,353	1,353	1,353	1,353
log likelihood	-495.858	-437.839	-1694.937	-2112.950
chi-square	145.347	119.768	283.298	129.187

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6. Empirical evidence within USFs

	Exist (6.1)	Acquisition (6.2)	Syndication (6.3)	Staging (6.4)
University and PRO-promoted Fund	-0.159	-0.154	0.197***	0.036
	(0.332)	(0.364)	(0.074)	(0.068)
Company age	0.184***	0.167***	-0.010	0.035***
	(0.043)	(0.046)	(0.008)	(0.008)
Co-investors Fund Size	0.001	0.001*	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Msci	-0.174	-0.179	-0.068	0.199*
	(0.619)	(0.669)	(0.117)	(0.120)
VC investments disposal	9.568	1.077	-3.228**	2.322
	(8.195)	(8.822)	(1.643)	(1.594)
Bubble	0.098	0.216	-0.024	-0.035
	(0.500)	(0.537)	(0.117)	(0.109)
Technology focused fund	0.640*	0.699*	0.066	-0.110
	(0.333)	(0.367)	(0.081)	(0.072)
Regional focused fund	0.036	0.287	0.076	0.119*
	(0.363)	(0.420)	(0.072)	(0.069)
Company industrial sector dummies	YES	YES	YES	YES
Constant	-4.536***	-4.473***	0.725***	0.341**
	(0.840)	(0.897)	(0.162)	(0.160)
Observations	589	589	589	589
log likelihood	-163.197	-141.702	-893.785	-960.724
chi-square	36.214	28.612	104.845	106.662

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7 Empirical evidence within USFs

	Exit (7.1)	Acquisition (7.2)	Staging (7.3)	Syndication (7.4)
Linkage with one university	-0.194	-0.108	0.053	0.229***
	(0.315)	(0.350)	(0.069)	(0.079)
Linkages with two universities	0.403	0.334	-0.287	0.124
	(0.640)	(0.775)	(0.177)	(0.178)
Linkages with three or more universities	-0.071	-0.221	-0.073	0.132
	(0.560)	(0.653)	(0.117)	(0.100)
Company age	0.143***	0.129***	0.035***	-0.010
	(0.034)	(0.037)	(0.008)	(0.008)
Co-investors Fund Size	0.000	0.001*	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Msci	-0.170	-0.185	0.198*	-0.071
	(0.572)	(0.628)	(0.120)	(0.118)
VC investments disposal	9.702	2.146	2.018	-3.378**
	(7.648)	(8.430)	(1.593)	(1.649)
Bubble	0.121	0.242	-0.039	-0.024
	(0.448)	(0.490)	(0.110)	(0.117)
Regional focused fund	-0.060	0.178	-0.080	0.083
	(0.334)	(0.391)	(0.071)	(0.082)
Technology focused fund	0.631**	0.651*	0.078	0.049
	(0.315)	(0.354)	(0.070)	(0.077)
Company industrial sector dummies	YES	YES	YES	YES
Constant	-4.288***	-4.237***	0.383**	0.735***
	(0.765)	(0.832)	(0.158)	(0.162)
Observations	589	589	589	589
log likelihood	-168.437	-145.402	-958.663	-893.210
chi-square	38.670	30.655	110.784	105.994

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1