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Entrepreneurial finance and technology transfer

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Abstract Scholars in technology transfer come from a variety of different backgrounds and employ different theoretical and methodological assumptions. Such multidisciplinary approach has fertilized the evolution of a florid technology transfer literature, with insights from entrepreneurship, economics, and management. This paper brings the perspective of entrepreneurial finance into the realm of technology transfer, and identifies emerging topics that can complement our understanding of some aspects of technology transfer, especially with regard to supply-side public policies. This article introduces the rationale for the special issue dedicated to entrepreneurial finance and technology transfer. We summarize the main topics and themes covered by a selection of papers presented at the annual conference of the Technology Transfer Society in 2013, and suggest areas for future research.

Keywords Entrepreneurial finance · Technology transfer · IPOs · M&As · Crowdfunding · VC · GVC

JEL Classification G30

1 Introduction

The field of technology transfer research is unique in its multidisciplinary approach. The many research issues raised by technology transfer can be fruitfully addressed from a variety of disciplinary and methodological perspectives. It therefore provides an abundance

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of research opportunities. Coherently, recent special issues of the Journal of Technology Transfer strengthened the connections among researchers in entrepreneurship, economics, management, psychology, organization, sociology, language, and other areas (Audretsch et al. 2014a, b; Breznitz and Feldman 2012). The Journal of Technology Transfer has recently published a few papers (Bonardo et al. 2010; Cattaneo et al.2014; Croce et al. 2014; Lehmann et al. 2012) that bring the perspective of entrepreneurial finance, which deals with investment and financing decisions that stakeholders might confront in an entrepreneurial venture (Bertoni et al. 2014), into the realm of technology transfer. Other studies have also contributed to open this dialogue (Audretsch and Link 2012a; Bonardo et al. 2012; Meoli et al. 2013). The present issue is a further step along this road.

We start with a parallelism with entrepreneurship, that finance scholars historically considered as a separate field. The implicit idea was that the issues in entrepreneurial finance are different from those faced by public corporations so as to limit the applicability of traditional finance theory. On the one hand, entrepreneurial finance primarily refers to early stage financing mechanisms, often supplied by the entrepreneur's personal network as a consequence of her inability to fully access the public market. On the other hand, corporate finance literature tends to focus on publicly traded firms as the main unit of analysis. However, the evolution of both the real economy and academic research has made clear that this is no longer the case. Financial scholars have indeed recognized that agency problems and information asymmetries, that are the basis of corporate finance and financial economics, are actually the two fundamental issues in entrepreneurial finance. In the entrepreneurial setting, information asymmetry is particularly pronounced due to the difficulty faced by entrepreneurs in conveying the quality of their new ventures to firm outsiders, resulting in potentially severe agency issues. The difference mainly rests on the contractual solutions adopted to prevent these issues, as their relevance is actually higher among entrepreneurial ventures than in large, established corporations. This recognition leads to a plethora of studies on entrepreneurial finance issues, such as Initial Public Offerings and Venture Capitalists, that are grounded both in financial economics and in entrepreneurship (Kerr et al. 2014; Levis and Vismara 2013; Vismara et al. 2012).

Similarly, research in finance has more recently started to focus on issues that are core to technology transfer scholars, such as technology transfer offices, science parks, incubators, and accelerators. From a financial perspective, all these devices imply demand for capital. Coherently, scholars have also focused on the design of demand-side public interventions, to identify better allocation criteria for public funds with the aim of fostering entrepreneurship and regional development. Much less efforts have been devoted to supply-side policies. This is the focus of the present special issue, dealing with broad policy issues with regard to the direct or indirect provision of finance to both technology entrepreneurship and higher education systems (Audretsch and Link 2012b). To exemplify, two papers in this special issue address the rationale for public intervention in the Venture Capital industry, while other two deal with subsidies and financing mechanisms of universities.

Policy makers consider supply-side programs as an important part of a broader economic development strategy, useful to address the problems of financing gaps by intervening in multiple areas (Gicheva and Link 2013; Link et al. 2014). Since several aspects affect their efficacy, policy interventions must be approached from a multidisciplinary perspective. The aim of this special issue is thus to foster the scientific debate on these topics by bringing them to the attention of technology transfer scholars, that are characterized by a broad and diversified background. We hope that the resulting collection of papers will provide a foundation for the accumulation of knowledge on this topic and bring

Table 1 Summary of articles in this special issue on entrepreneurial finance and technology transfer

Authors	Sample and data	Summary of findings
Finance and technology entrepreneurship		
Colombo, Cumming, and Vismara	Review of 61 papers on GVCs	Governments around the world have set up GVC funds, and are increasingly doing so, with the aims of fostering the development of a private venture capital industry and to alleviate the equity capital gap of young innovative firms. This paper discusses the rationale and the appropriateness of these programs, documents the evolution and compares the effects of the different types of governmental support
Cumming and Johan	Australian VC data, 1990–2012	Australian government subsidized funds have facilitated employment, R&D, patents, time to IPO, and market capitalization relative to private VC funds and non-VC backed companies
Finance and universities		
Fisch, Block, and Sandner	Patents filed by 155 leading Chinese universities, 1991–2009	Two types of subsidy program (cost reimbursement subsidy and research excellence subsidy) lead to a growth in patent applications (quantity). Only the subsidy aimed at promoting research excellence at university level is an important determinant of patent citation (quality)
Cattaneo, Meoli, and Signori	Productivity of 75 Italian universities, 1999–2011	The introduction of competitive funding mechanisms in higher education increases research productivity, in particular for more legitimized universities
Universities and technology entrepreneurship		
Guerrero, Urbano and Fayolle	Impact on regional competitiveness of 102 European universities	The entrepreneurial activity generated by university students have a positive impact on regional competitiveness
Brescia, Colombo, and Landoni	Knowledge Transfer Offices of the best 200 ranked world universities	The best universities, in terms of citations of their research, mostly adopted the internal model of organization of their Knowledge Transfer Office. For these universities, it is less useful to involve external people and organizations in the management of the knowledge transfer activities
Azagra-Caro and Consoli	600,000 patents from the EU27 states, 1990–2007	The quality of the national innovation system has a positive effect on knowledge flows and that a national bias towards applied research and development (R&D) exists

new scholars in this promising intersection of research fields. Ultimately, we aim to contribute to set the ground for the design of more effective public policy measures in this area.

On November 8–9, 2013, the Cisalpino Institute for Comparative Studies in Europe (CCSE) hosted the annual conference of the Technology Transfer Society. Professionals from academia, research institutes, and the business world from 27 countries gathered in the i.lab scientific park in Bergamo, Italy. There were over 100 submissions to the conference, of which the best 64 papers were presented. These papers employed a variety of methodologies, including qualitative methods, interview-based techniques, regression analyses of survey data, and sophisticated econometric analyses of archival data. Different units of analysis were employed, such as the individual invention, the university, firms, or industries. In addition, we were fortunate to host the keynote speeches by David B. Audretsch, Massimo G. Colombo, Douglas J. Cumming, Manuel Trajtenberg, and Charles W. Wessner. A collection of papers and thoughts presented at this conference is summarized in this issue. More information about the conference and the Technology Transfer Society is available at www.cisalpino.eu/t2s.

This special issue contains seven papers in addition to this introductory essay. This article introduces the rationale for the special issue, summarizes the main themes covered by the papers presented and suggests areas for further research. At the end of this introductory editorial, we discuss related future research questions. In particular, we identify some factors that the technology transfer literature could derive from the evolution of the research in finance.

2 Entrepreneurial finance, technology entrepreneurship, and universities

The keywords of this special issue are finance, university, and technology entrepreneurship. The first two papers of this issue deal with the relationship between finance and technology entrepreneurship. The next two papers are dedicated to the financing mechanisms of university and higher education systems. The final three papers connect universities and technology entrepreneurship. Table 1 summarizes the sample, data sources, and contributions of these studies.

2.1 Finance and technology entrepreneurship

In their study "Governmental venture capital (GVC) for innovative young firms", (Colombo et al. 2014) provide a definition and taxonomy of GVC funds and discuss their appropriateness. The creation of these funds is primarily meant to correct supply-side failures in domestic VC markets, mostly due to adverse selection, moral hazard, and agency problems. Thus, a justification for a public engagement in VC programs stems from the aim to avoid market failure in the provision of entrepreneurial finance. However, while this can be theoretically justified, it might be counterproductive for three main reasons. First, there could be a selection problem, with GVC managers being unable to select good investments, or distorted by political interests. Second, there could be a treatment problem, with GVC managers being ineffective in monitoring, nurturing, and mentoring investee companies. Third, there could be a crowding-out problem, with public intervention displacing private investments.

Drawing from 61 recent papers, the authors present empirical evidence from around the world. In contrast with a lack of success in some countries, there have been successful

GVC initiatives, such as the Australian Innovation Investment Fund (IIF). With this regards, the paper by Cumming and Johan (2014) studies the "Venture's Economic Impact in Australia". They empirically compare the contributions of VC and private equity backed firms, including those backed by government subsidized IIFs. Before the IIF Program was introduced in 1997, early stage capital was close to nonexistent or scant in Australia. Since that time, they find that IIF and VC investments have played an important role in investing and supporting firms that would otherwise not exist. VC- and IIF-backed firms contribute indeed disproportionately to R&D and patents.

2.2 Finance and universities

A second set of papers is dedicated to the financing of higher education systems. Fisch et al. (2014) paper "Chinese university patents: Quantity, quality, and the role of subsidy programs" investigates the role of subsidy programs with regard to university patenting. Governments frequently introduce initiatives to stimulate university patenting, such as subsidy programs or patent-friendly regulatory changes. In the United States, the Bayh-Dole Act was introduced in 1980. Subsequently, most European countries introduced similar regulations to promote university patenting. Even though these regulations are often described as stimulators of university patenting, their effects are heterogeneous between countries and not entirely clear in their direction. Using a dataset of university patents by 155 leading Chinese universities from 1991 to 2009, Fisch, Block, and Sandner show that university patents witnessed rapid growth in terms of quantity while patent quality did not increase to a similar degree. A subsidy program meant to promote research excellence at selected universities is a significant driver of patent quantity and quality. In contrast, a regional subsidy program that decreases the costs of patent applications seems to primarily enhance patent quantity, but not patent quality. They conclude that innovation policies aiming to stimulate impactful innovation by universities should focus on increasing university R&D and to a lower extent on decreasing the costs of university patenting.

The paper "Performance-based funding and university research productivity: the moderating effect of university legitimacy" by Cattaneo et al. (2014) investigates the change in research productivity experienced by Italian universities following the introduction of the first Performance-based Research Funding System (PRFS) in 2003. In general, the introduction of competitive funding mechanisms in higher education is found to increase research productivity. However, using a sample of 75 Italian universities observed during the period 1999–2011, the authors find that the diversity within higher education systems leads universities to respond in substantially different ways to the adoption of competitive funding criteria. In particular, the legitimacy of universities, defined as their level of recognition based on the adherence to socially accepted norms and expectations, is crucial in shaping their reaction in a positive way. The introduction of PRFS leads indeed to an increase in research productivity which is significantly more pronounced among more legitimate universities.

2.3 Universities and technology entrepreneurship

After investigating the relationship between finance and technology entrepreneurship and between finance and universities, the third set of papers close the circle by focusing on the link between universities and technology entrepreneurship. In their "Entrepreneurial Activity and Regional Competitiveness: Evidence from European Entrepreneurial

Universities" paper, (Guerrero et al. 2014) contribute to the vast literature on the relationship between entrepreneurial activity and regional competitiveness. While previous studies have documented the role played by university in fostering economic development (e.g. Audretsch 2014; Audretsch et al. 2012a), the present study focusses on the entrepreneurial activity generated by university students. At a country/regional level of analysis, this paper is to explore the impact of universities' entrepreneurial activity on regional competitiveness. By adopting the institutional economics and endogenous growth approaches, the authors develop a conceptual framework that is then tested in a structural equation model using data from 102 universities located in 56 NUTS II of 12 European countries. Results provide evidence about the influence of universities' entrepreneurial activities on their regional competitiveness.

Brescia et al. 2014 examine the structure of the Knowledge Transfer Offices of the world top 200 universities in their paper entitled "Organizational structures of Knowledge Transfer Offices: an analysis of the world top-ranked universities". They document the presence of three organizational models (internal, external and mixed models), and six different configurations of these models. The most diffused model is the internal model, especially in the United States. The adoption of an organizational model does not depend on the age or size of the Knowledge Transfer Office. The best universities, in terms of citations of their research, mostly adopted the Internal model. This may suggest that, for those universities with the best research outputs, it is less useful to separate research activities from knowledge transfer activities, or to involve external people and organizations in the management of the knowledge transfer activities.

Finally, the "National knowledge flows, R&D structure and the moderating role of public–private cooperation" paper, by Azagra-Caro and Consoli (2014), investigates the influence of country-specific factors on knowledge flows. The study uses a sample of 600,000 patents from the EU27 member states in the years 1990–2007 to assess knowledge flows with backward citations as the dependent variable. While existing studies are focused on forward citations, typically used to gauge the technological impact of an invention, backward citations are used as an indicator of the pool of knowledge underpinning the patented invention. More specifically, the authors show, among other things, that the quality of the national innovation system has a positive effect on knowledge flows, and that a national bias towards applied research and development (R&D) exists.

3 Research directions

To conclude, we discuss the insights that the research in technology transfer can gain from the finance literature. First, we start from the comparative approach that characterizes the CCSE that hosted the 2013 conference of the Technology Transfer Society, to which this special issue is dedicated. In Europe, there is an ongoing trend toward a concentration of political decisions at the top of the European Union, which reduces the leeway of national governments and politics. The importance of each country's regions is therefore increasing as global competition is ultimately about regional competition (Audretsch et al. 2012b). The CCSE tries to cope with this dynamics. To improve regional competitiveness and growth, decision-makers in politics, economics and administration should be aware of how and why regions differ in their institutional arrangements, performance and endowments. The guiding mission is to study the performance of markets and institutions in different countries and regions, as well as their interrelation within the context of a global economy. Ultimately, the intent is to learn from each other.

Globalization and regionalization, antecedents within the ongoing process of the increasing interrelation of markets, politics and society, have led to a greater awareness of the importance of the international dimension of research in entrepreneurship and technology transfer. Theories and practices developed in a single institutional setting do not necessarily hold across countries, regions, and cultures. Nevertheless, at the moment, international research represents a modest, though growing, part of the empirical research in technology transfer. We hope that a larger number of comparative studies will emerge in this field. Relatedly, we believe that reproducibility of results is vital to building a cumulative body of thought that is reliable. The need for replication is not only embedded in the probabilistic logic of estimating statistical significance, but is also essential to progress accumulating 'truth value' through a Darwinian notion of the survival of the fittest applied to theories. We therefore encourage technology transfer scholars to attempt to replicate original results in independent datasets.

Scholars in technology transfer come from a variety of different backgrounds, rely on different theories and employ different methods. Like in every scientific field, because of the intricacy of making contributions, scholars continuously reevaluate the state of methodological practice. From the finance literature, we can draw an example of how different assumptions and methodologies contribute to the understanding of a single issue. Eugene F. Fama, Lars Peter Hansen and Robert J. Shiller were awarded the 2013 Nobel Prizes in Economic Sciences "for their empirical analysis of asset prices". While Fama's main contribution is the market efficiency hypothesis, Shiller's has stimulated the emergence of a new research field, namely, behavioral finance, which borrows from psychology to improve understanding of asset prices. In his keynote speech at 2014 conference of the European Finance Association, Shiller humorously summarizes the difference between his and Fama's perspectives by saying that "We agree much more than you think. There is a different rhetoric that we have. I tend to mention psychologists and sociologists often. Eugene Fama never wants quoted a psychologist or a sociologist. It's a different world view, but I think we largely agree on the facts". We believe that, as in the case of finance, very different approaches can coexist.

Finally, we focus our last paragraph on entrepreneurial finance. New ways to finance entrepreneurial ventures may emerge at the crossroads between private and public equity. Equity crowd funding has started making its way into entrepreneurial finance. This means that crowd funding platforms will need to cope with collective-action problems, since crowd-investors have neither the ability nor the incentive, due to the small size of the investments, to devote substantial resources to due diligence. The crowdfunding phenomenon is now spreading around the world, but academic research in this area, although rapidly growing, is still in its infancy. In addition to crowdfunding, a whole set of innovative financial instruments have recently emerged in order to support the creation and growth of science and technology based startups, such as startup accelerators, proof-of-concept centers, university-based seed funds, and IP-backed financial instruments. Although the diffusion of such types of gap funding schemes has increased in the United States and in Europe over the last decade, we still miss a comprehensive empirical assessment of the nature and output of such programs, as well as policy evaluation exercises adopting rigorous empirical methods. We believe that the study of these and other topics emerging in the field of entrepreneurial finance can complement our understanding of some aspects of technology transfer, which we hope will continue to flourish thanks to the pursuit of multidisciplinary approaches.

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