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Social networks and early resource mobilisation by science-based firms

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Abstract: This paper addresses the way entrepreneurs' social networks affect the opportunity identification and the access and mobilization of resources in a science-based field – biotechnology - facilitating the founding of new firms. Adopting an analytical framework that combines contributions from the technological entrepreneurship and the social network literature we propose that: (i) entrepreneurs' social networks are critical to access the wide range of resources required for firm creation; (ii) different networks configurations (in terms of composition and structure) are associated with the access and mobilisation of different types of resources.

The paper presents a methodology that combines several methods usually applied separately and which permits to assemble a vast array of data capturing the origin, nature and contents of the relationships through which key resources and competences flow into the new firm. A central aspect of this methodology is the reconstruction of the firm social networks, encompassing the mapping of the personal networks of the entrepreneurial team, built along their academic and professional trajectories (potential networks); and the identification of the members of these networks who were *mobilised* by the firms during the formation process, as well as the new relationships, informal or formal, intentionally build already having the new firm as a goal (mobilisation networks). Different “mobilisation networks” are reconstructed, according to the nature of the inputs being searched: network of opportunity and access (tangible resources, such as capital, human resources and facilities); network of innovation (scientific and technological knowledge); network of power and influence (credibility and mediation into relevant sources). The structure and composition of these networks are then analysed and compared, using social network analysis methods, with a view to assess whether the nature of different types of resources is associated with different networks configurations.

This methodology is applied to the most science-based sub-set of the Portuguese biotechnology industry – the molecular biology firms (23 firms and 61 entrepreneurs). In this paper we present preliminary results based on the analysis of four cases that enabled us to test the viability and robustness of the methodology and to evaluate its effectiveness in answering to your research questions. The results are therefore still exploratory, being focused on regularities that could be identified and that might reflect modes of behaviour that are shared by this category of firms. They confirm that entrepreneurs, in their search for key resources, select only some of the members of networks derived from their previous trajectories, but also add new members, purposefully chosen because they fulfil some important function in the new firm. In addition, the comparison of the composition and structure of different “mobilisation networks”, provides some confirmation that access to different resources entail different types of actors and relations, thus being associated with different network configurations. But it also uncovers the presence of “multiplex ties” that provide access to more than one type of resource, as well as the central role of some type of actors, associated with the entrepreneurs trajectory.

1. Introduction

New entrepreneurial firms played a key role at the outset of biotechnology industry and remain critical actors in the process of knowledge creation and transformation into market value (Ebers and Powell, 2007). However, the transformation of a technological opportunity into a marketable technology, product or service and its commercialisation, can be a complex process, requiring the combination of a variety of technological and non-technological competences and resources. Thus, success in firm formation is determined, not only by the entrepreneurs' capacity to identify an opportunity, but also by their ability to mobilise these resources and competences. The entrepreneurship literature defends that firm creation is a social process and that entrepreneurs' social networks - built along their academic, professional and personal life - have an important role in this mobilisation process (Walker, et al 1997). Our argument is that different types of networks may be required to mobilise different types of resources and that, therefore, entrepreneurial teams with diverse backgrounds and experiences - which result in networks with distinct compositions and structures - will face different resource access problems and will develop different strategies to mobilise the set of actors who can assist in their solution.

These differences concern on one hand the ease of access to specific resources. In the case of science-based firms, knowledge resources are generally easier to access than business-related resources, because knowledge networks are likely to be more developed than business networks (Ensley and Hmieleski, 2005). But dissimilarities in terms of backgrounds and personal experiences may still exist, with impact upon entrepreneurs' ability to encompass the whole range of needed resources (Mangematin et al, 2002). The differences also concern the mode of access to resources. In fact the channels used to gain access to specific assets, and the strategies deployed to mobilise the actors that can support that access, can vary strongly, being influenced by the composition and also by the structure of the entrepreneurs' social networks (Powell et al, 1996). In conducting these processes entrepreneurs will rely on their existing ties, but will also strive to build new relationships with actors they regard as key for the firm (Lin, 1999). The members of the existing network can also be instrumental at that level, assisting in the identification of such actors and acting as mediators or credibilisers (Moensted, 2007).

Considering the above, the main research question examined in this paper is: how do entrepreneurs' social networks affect the opportunity identification and the access and mobilisation of resources in a science-based field, facilitating the founding of new firms? To address this question we reconstruct the social networks of a set of biotechnology entrepreneurial teams, and assess the way these networks were mobilised to solve key problems in the process of firm formation and early development: a) opportunity identification and exploration through the acquisition of tangible resources (capital, human, physical); b) acquisition of scientific and technological knowledge; c) achieving credibility and obtaining mediation to critical sources.

2. Analytical framework

In order to investigate the role of scientific entrepreneurs' social capital in the process of firm creation and growth, we combine literature on social networks and literature on technological entrepreneurship.

2.1 The influence of social networks on entrepreneurship

Recent research has shown the importance of the entrepreneurs' social capital in the access to several tangible and intangible resources, needed for the formation and growth of new firms (Greve & Salaff, 2003; Singh, 2000). Entrepreneurship is described as a social process, embedded in social structures and thus, in order to fully understand the nature of the entrepreneurial process, it is necessary to take into consideration the social networks built by the entrepreneurs along their academic, professional and personal life, as well as the ways entrepreneurs mobilise them to achieve their goals (Johannisson, 1998; Murray, 2004).

Several kinds of resources are important in the entrepreneurial process (Brush et al. 2001). In the case of science-based entrepreneurship, key resources include: scientific and technological knowledge; capital; human resources; reputation and credibility; information about markets, financing,

regulatory processes, intellectual property; counselling in these same fields (Mangematin et al, 2002; Chesbrough and Rosenbloom, 2002; Mustar et al, 2006). Given the high uncertainty (technology and market) often confronted by these firms and the level and nature of their resource requirements, social networks are presented as playing a particularly important role during their formation and early development (Yli-Renko et al, 2001).

Castilla et al. (2000) define social network as a set of nodes or actors (persons or organizations) connected by a social relationship (or tie) of a specified type. Network configurations can differ, according to type of actors and the type of relations they encompass. Relations can be characterised by the type of interaction (e.g. formal vs. informal), the intensity of the tie and the content of the relation (e.g. the type of resource(s) that circulate through it).

It is argued that different network configurations will be associated with the access and mobilisation of different types of resources. Differences in network configuration can be introduced by the nature of the resource or by the stage of firm in the entrepreneurial process (Casson & Giusta, 2007; Elfring & Hulsink, 2003; Hite & Hesterly, 2001; Larson & Starr, 1993). In this research we will focus on the nature of resources, since we are only considering the early entrepreneurial stages. For this purpose, we consider the network types mentioned by Castilla et al. (2000): networks of access and opportunity (related to opportunity identification and exploration and obtaining tangible resources); networks of power and influence; and networks of production and innovation (where knowledge is the main resource that circulates).

2.2 The impact of network characteristics on resource mobilisation

Network characterization, as conducted in the social network literature, usually involves three aspects: the *position* occupied by different actors in the network, the network *structure* and the *tie content*. Regarding network position, it is considered that different positions, usually measured by network centrality measures, offer different opportunities to access the relevant sources of resources (Powell et al, 1996).

Network structure is frequently analysed using density measures. There is some debate over the effects of different network configurations, i.e. more densely embedded or “closed” networks with many strong ties (Coleman, 1988), vs. more “open” networks with many weak ties (Granovetter, 1973) and structural holes (Burt, 1992). Some authors suggest that firm creation will require a mix of strong and weak ties (Uzzi, 1997), the former enabling the exchange of fine-grained information and tacit knowledge, trust-based governance, and resource cooptation (Ahuja, 2000; Gulati, 1998), the latter providing access to novel (non redundant) information (Burt, 1992).

Tie content concerns the substance of the relation. In the case of firm creation such content are the resources and the activities performed to access and mobilise them. The concept of multiplex ties was introduced to take into account the fact that the same tie can be used to access more than one type of resource (Degenne e Forsé, 1994), but this theoretical concept has rarely been applied at an empirical level. In this research, we use the concept of multiplexity as a basis to understand what type of network(s) – involving different types of actors and/or relations and/or structures - are more appropriate for obtaining different resources/ combinations of resources.

An additional dimension is the mode of construction of the network. Here we can distinguish between intentional and non-intentional networks. The former are purposefully created to achieve a given goal – as Lin’s (1999) “instrumental actions related with contact resources”, or Hite & Hesterly (2001) “calculative networks”. The latter are by-products of the activity or trajectory of the actor and do not have a particular motivation behind them – the case of Lin’s (1999) “expressive actions related with accessible resources”, or the “identity-based networks” proposed by Hite & Hesterly (2001).

Finally, it is also relevant to take into consideration the debates about proximity and its impact upon access to key resources and competences (Feldman, 1994). While accepting that geographical proximity is an important facilitator in the establishment and mobilisation of key relations, it can be argued that it is a necessary but not sufficient condition. Indeed, recent contributions propose other modes of proximity (social, organizational, technological) (Boschma, 2005), that can also be instrumental in accessing scarce or specialised resources and whose operation can take place at a distance (Breschi and Lissoni, 2001). However, distant relations can be more difficult to build and to

maintain (Bathelt et al, 2004) and therefore there may be limits of the number of such relations that young small firms are able to manage. The conditions on which access to resources and competences can take place at a distance, and the role played by social networks in this process are particularly relevant for countries or regions that are peripheral to the major concentrations of knowledge and business in emerging/advanced fields (Fontes, 2005; Gilding, 2008).

3. Methodology

Building on the contributions of the entrepreneurship and social network literature described above, we developed a methodology to analyse the role of social networks on the creation of the new firm that enables us to identify the key networks, uncover the way they were built and achieve an understanding of the contribution of different types of ties to the identification of an opportunity and to the mobilisation of a set of resources critical for the formation of a science-based firm.

A central aspect of this research was the (re)construction of the firm social networks, encompassing both the entrepreneurial personal networks, built along their academic and professional trajectories, and the intentional networks purposefully built along the formation period. This reconstruction raised several methodological challenges. The ways we addressed those challenges are presented in this section, covering data collection, network (re)construction methods and network measures.

The methodology was applied to the most science-based subset of the Portuguese biotechnology industry: the molecular biology companies, involving 23 companies and a total of 61 entrepreneurs. This group of firms belongs to the younger generation of biotechnology firms (80% were created from 2003 onwards) and their activities concentrate in the health sector, with a predominance of clinical applications. All the firms were created by entrepreneurs originating from universities or research organisations; but several teams also included non-academic individuals with managerial competences and/or industrial experience. The teams were mostly composed of young entrepreneurs (although some also involved one senior researcher) and in almost all firms there was at least one individual with some type of international background.

3.1 Data collection

Data about the biotechnology firms and about their entrepreneurs was collected using a novel combination of complementary methods, involving both documentary information and in-depth face-to-face interviews with the founders. The former included: the Curriculum Vitae (CV) of the entrepreneurs, publication and patent data, published data about formal collaborative projects and information on firms' formation histories. The interviews, conducted in 2008, were based on a semi-structured questionnaire that focused on the entrepreneurs' personal networks and their importance for the creation process. They elicited systematic and fine grained information about the people who were important during the formation period (defined as the pre-start-up period and the first three years), including the origin of the relationships and the type, nature and relevance of their respective contributions. They also gathered data on firm activities, strategy and performance.

3.2 Network (re)construction

The (re)construction of social networks took several steps. The first one was the identification of ego-centred networks at personal (entrepreneur) level – the “trajectory networks”. It involved the (re)construction of the academic and professional paths of all members of the founding team, in order to identify the organisations where they had developed training or professional activities, and thus where personal relationships might have been established (Burton et al, 2002). It combined methods usually applied independently (e.g. Balconi et al, 2004; Casper, 2007; Dietz et al, 2000; Murray, 2004): CV, project, patent and bibliometric analysis¹.

The next step was to (re)construct the networks at firm level. We combined, for each firm, the personal networks of all the members of the founding team, based on the assumption that when firms are being created their social networks are the sum of those of their entrepreneurs (Hite and Hesterly, 2001). Since we were now adopting an organisational perspective, a correspondence was made

¹ The data obtained from bibliometric analysis (co-authors) will only be included in a subsequent stage of the research.

between individuals and the respective organisation(s). The resulting networks were labelled “potential networks”.

The final step was to build the networks that were effectively *mobilised* by the entrepreneurs during the creation and early development of the firm. For this purpose, we used the information, elicited through the interviews, about the actors described as important to identify the opportunity and to obtain the critical resources, and about their contributions. This information was combined with data on formal relationships established by the firm up to its third year of activity.

The information was collected for different types of activities, enabling us to reconstruct the three “mobilisation networks” suggested by Castilla et al. (2000). The *network of access and opportunity* is composed of all the actors/relationships used to identify the opportunity and to access and acquire the tangible resources (capital, human resources and facilities) necessary to explore it. The *network of innovation* includes actors/relationships used to obtain scientific and technological knowledge. The *network of power and influence* is related with the process of achieving credibility and/or using well positioned and influential individuals as mediators in granting access to critical actors that are not part of the potential network and could not be mobilised without proper references.

3.4 Network analysis

A detailed analysis of the composition and structure of the potential and mobilisation networks was conducted using the methods of Social Network Analysis (Wasserman and Faust, 1994) and supported by the UCINET software. Network characterisation involves determining the actors’ *position*, the network *structure* and the *tie content*. Given the nature of the networks being analysed at this stage (ego-networks with only direct ties) we only calculated measures to characterize the networks in terms of structure and content, which are described below:

- Network size:
 - Total number of actors in a network.
 - Total number of ties in a network.
 - Mean (nodal) degree: mean of the number of nodes adjacent to each ego, that gives the mean “activity” of the network (Wasserman & Faust, 1994)
- Network density:
 - Network density (Wasserman & Faust, 1994): ratio between the number of ties that are present in the network and the maximum ties possible
 - Average strength of connection between actors (Burt, 2000): ratio between the sum of all ties considering the respective strength and the total number of ties
- Actor composition:
 - Importance of each type of actor present in the network - other biotechnology firms, firms from other sectors, venture capital firms, universities and research centres, science & technology parks, professional and trade associations - measured through the respective proportion in the total number of ties
- Spatial distribution:
 - Weight of local/regional; national non-local and international relations, measured through the share of relations in each location, for each network.

4. Preliminary results

In this section we present some preliminary results of the application of the methodology described above, based on the analysis of four firms out of our sample of 23 molecular biology companies². This preliminary analysis, was based on cases expected to display substantially different characteristics and enabled us to test the viability and robustness of the methodology, to fine-tune some of the methods and to evaluate its effectiveness in answering to your research question. The results are therefore still exploratory, being particularly focused on regularities that could be identified on the

² While data was already collected and organised for the whole sample, the actual network building and network analysis is still on-going for the remaining companies.

composition and structure of the networks and that might reflect modes of behaviour shared by this category of firms.

For each firm we built four networks - the “potential network” and the three “mobilisation networks”: access and opportunity, innovation, power and influence – and computed the networks measures described above. In order to assess whether the nature of different types of resources had implications for network configuration, we examined the composition and structure of the three different “mobilisation networks” – that is, networks that are effectively used by the firms in their search for resources – and compared them among themselves and also with the “potential networks”.

The analysis of the network representations and respective measures was expected to provide some preliminary insights regarding the following questions:

- What types of actors are present in each mobilisation network?
- What types of network configurations (in terms of frequency, intensity, distance, nature) predominate in each mobilization network?
- What types of resources circulate between different types of actors and what is the importance of multiplex ties?

4.1 What types of actors are present in each mobilization network?

The data obtained for the cases analysed, show that the entrepreneurs mobilise only a sub-set of the relations in their potential network, but, at the same time, build intentional relations with new actors, particularly to access some types of resources.

As would be expected, potential and mobilisation networks are different. The former are largely dominated by actors from universities and research centres, reflecting the academic trajectory of a substantial proportion of the entrepreneurs. Mobilisation networks tend to be more diversified, reflecting the additional requirements of transforming a technological knowledge into a product or service and commercialising it. This is particularly visible in the network of access and opportunity, which includes several new actors, namely related with access to capital (venture capital firms) and facilities (science and technology parks), that were not present in the potential networks.

A more detailed analysis of the actor composition of each mobilisation network, shows that innovation networks are dominated by universities, which is in line with the nature of biotechnology firms' knowledge base (particularly in early stages). Those networks are built around some key organisations, already present in the potential network, with which firms maintain strong relations. But, innovation networks tend to be more diversified than potential networks, also integrating other firms (biotech and non biotech). Interestingly, universities also emerge as important actors in access and opportunity and in power and influence networks. In the first case, former academic colleges or professors are instrumental in opportunity identification and early decision making process, as well as in access to human resources and facilities. Regarding power and influence, university actors enhance firms' credibility and mediate their access to people/organisations that later become part of the other mobilisation networks.

4.2 What type of networks configurations predominate?

When we observe network configurations in terms of density and tie strength, we conclude that, as expected, for each firm, different mobilisation networks have distinct configurations. Innovation networks, which are based on knowledge flows, tend to have small average density and small average tie strength. This may be explained by the distributed nature of S&T knowledge that leads firms to interacting with a large number of organisations, but possibly only maintaining strong relations with a few of them. Conversely networks associated with opportunity identification and exploration and access to tangible resources seem to have higher levels of density and average tie strength, which suggests that these networks may be associated with higher levels of trust (Ahuja, 2000).

Regarding the spatial distribution of the networks, the data shows that, in all firms, the most intense relations tend to be with local/regional and national actors. But while all firms have international actors in their potential networks (reflecting the international mobility of their funders), these play different

roles. One firm did not mobilise any international relations, while another mobilised exclusively from the potential network and into the innovation network. The remaining firms had international actors in all mobilisation networks, some of whom were new intentional relations. This variety of results can be related with the nature of the international background and/or with the type of activities that may require different inputs from international actors. The greater complexity of distant relationships (particularly new ones) may also be determinant. A closer analysis of this type of ties and their association with firms' activities (e.g. type of markets, stage development technology, local availability of resources) may provide additional insights.

4.3 What is the importance of multiplex ties?

All firms display multiplex ties, that is, ties in which the same actor belongs to more than one mobilisation network, being associated with access to more than one type of resource. Universities emerge as the prime actors in multiplex relations. In all cases there is at least one university whose ties are mobilised to access the three types of resources: information to identify and explore the opportunity, tangible assets, knowledge and influence. These strong multiplex ties originate from the entrepreneurs trajectory and thus involve actors that are likely to have higher levels of social, organisational and cognitive proximity with the entrepreneurs.

Additionally, there seems to be an inverse relation between the size of the potential network and the number of multiplex ties. This means that firms that interact with a small number of actors use these relations in a more intense way, to access a diversity of resources. So we can detect two possible strategies: some firms choose to extend the number of actors, with whom they develop less intense and less multiplex relations; other firms choose to have smaller networks, with more intense and multiplex relations.

5. Discussion and implications

The main research question addressed in this paper concerns the way entrepreneurs' social networks affect the opportunity identification and the access and mobilisation of resources in a science-based field – biotechnology - facilitating the founding of new firms. We adopted an analytical framework combining contributions from the technological entrepreneurship and the social network literature and proposed: i) that entrepreneurs social networks, both associated with their academic and professional trajectories and intentionally build having the firm as a goal, are critical to access the wide range of resources required to successfully create a new firm; ii) that different network configurations are associated with the access and mobilization of different types of resources.

We developed a methodology that combines several methods usually applied separately and which permits to assemble of a vast array of data capturing the nature and contents of a wide range of relationships and the multiplicity of mechanisms through which the several resources flow into the new firms. This methodology was applied to a sub-set of the Portuguese biotechnology industry – the molecular biology firms, encompassing 23 companies and a total of 61 entrepreneurs.

In this paper we presented some preliminary results based on the network analysis of four firms out of our sample of 23, which was conducted in order to test the viability, robustness and effectiveness of the methodology. The small number of cases prevents a comparison between firms that would allow discovering differences and/or patterns along some dimensions, so they focus on some regularities of behaviour. At this level, they confirm some of our expectations and provide some insights into important features of the firms' networks, which will be further explored in subsequent analysis, covering the larger sample.

Our approach permitted to (re)construct the social networks of the entrepreneurial team and to uncover the ways these networks were mobilised in the search for resources and competences, during firm formation. It namely confirmed that, along this process, entrepreneurs select only some of the members of networks that result from their academic and professional trajectory, but add *new* members, purposefully chosen because they fulfil some important function in the new firm.

The research also entailed the analysis and comparison of the structure and composition of different "mobilisation networks": access and opportunity (access to tangible resources); innovation (access to

scientific and technological knowledge); power and influence (achieving credibility and obtaining intermediation). The analysis confirmed that access to different resources requires different types of actors and relations, thus being associated with different network configurations. But it also uncovered the presence of “multiplex ties” that are present in different mobilisation networks, as well as the central role of some network actors.

Globally, it can be concluded that this approach, by considering simultaneously a variety of resources and actors/relationships (which is rarely the case in this type of research), can contribute to a better understanding of the roles played by social networks on entrepreneurship, adding to on-going theoretical and methodological debates on this field. At this stage, the main contribution regards the development of a methodology that enables a comprehensive investigation of the networking behaviour of science-based entrepreneurs in their search for resources for firm formation and early development, and an assessment of the characteristics of the networks that support the access to different types of resources. The results of its application to the case of biotechnology entrepreneurs in Portugal, although still exploratory, already provide some indications concerning the formation and strategic use of these social networks. The promising results obtained so far, lead us to expect that the analysis of the remaining cases in our sample and the more in-depth exploration of the very rich data obtained, which is underway, will offer us important insights into the process of network mobilisation for biotechnology firm formation and early development. They are also expected to provide evidence regarding the network configurations that are more effective in the access to key resources in countries/regions that are peripheral to the major concentrations of biotechnology knowledge and business, contributing the still scarce research on this type of contexts.

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