The Emergence of Iintermediary Organizations: A Network-based Approach to the Design of Innovation Policies

Please cite as: Caloffi, Annalisa, Rossi, Federica and Russo, Margherita (2015) 'The emergence of intermediary organizations: a network-based approach to the design of innovation policies' in Cairney, P. and R. Geyer (eds.) *Handbook on Complexity and Public Policy*, Cheltenham: Edward Elgar.

The emergence of intermediary organizations: A network-based approach to the design of innovation policies

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ha formattato: Inglese (Regno Unito)

ha formattato: Italiano (Italia)

Policies for innovation networks and the emergence of intermediary organizations

The importance of networking among heterogeneous organizations as a source of innovation is increasingly acknowledged within the scientific community. Some contributions (Nooteboom, 2000; Powell and Grodal, 2004) stress that the creative recombination of heterogeneous knowledge is an important source of innovation; others (Lane and Maxfield, 1997; Lane, 2009) focus on generative relationships characterized by heterogenous competences, mutual and aligned directedness in contexts of joint action, as drivers of innovation processes; while yet others (Spence, 1984; Katz, 1986) suggest that networks foster innovation through the production and internalisation of spillovers within the group of participants. In line with this growing consensus, policymakers increasingly implement interventions in support of networks among either small and large firms, or firms and universities, explicitly aimed at promoting innovation through joint R&D, knowledge transfer or technology diffusion. Nonetheless, our understanding of what network configurations most contribute to innovation, or indeed whether networks lead to innovation, and precisely how they do so, is still limited (Cunningham and Ramlogan, 2012).

Greater understanding of what factors support the formation of innovation networks and their successful performance would help policymakers improve the design of policy interventions. In their recent review of the literature on the effectiveness of innovation policies, Cunningham and Ramlogan (2012) propose several elements that contribute to the success of innovation networks: strong network management and leadership, coupled with transparent and efficient administrative processes; established connections and relationships, which can drive the formation of new networks; the ability of network participants to actively manage their relationships, which often depends upon prior experience and network management competencies. The networks' objectives are more easily achieved when the policy instruments facilitate network formation and development, for example by supporting various types of intermediary organisations that create ties across different organizations.

Several studies have acknowledged that the success of policies in support of innovation networks depends on the involvement of intermediary organizations (Bessant and Rush, 1995; Hargadon and Sutton, 1997; Cantner et al., 2011; Kauffeld-Monz and Fritsch, 2013): their role suggests that the production of knowledge spillovers is not necessarily a spontaneous process, nor their absorption is automatic. This is particularly true for policies aimed at micro and small firms: here, the presence of intermediaries may facilitate the exchange of knowledge and competencies among agents (such as small firms, large firms and universities) that have different languages, organizational cultures, decision-making horizons, systems of incentives and objectives (Howells, 2006; Russo and Rossi, 2009).

Therefore, improving our understanding of which organizations are more likely to play intermediary roles in the context of innovation networks carries useful policy implications. Such knowledge can be used to identify the most appropriate organizations to involve in the policy interventions, and to set up more successful networks by promoting collaborations with the most appropriate intermediaries.

But identifying who network intermediaries are is not straightforward, as the identity of the organizations that play this role is likely to vary according to the network's characteristics. Indeed, intermediaries are usually best identified on the basis of their behaviour in the network, rather than a priori on the basis of their "mission" or economic activity. In this chapter we aim to identify intermediaries according to their relational positioning within networks of relationships, as an emergent result of the involvement of organizations in multiple networks. We adopt therefore a complexity approach to understanding social organization, according to which micro-level interactions among individual agents give rise to emergent meso-level structures whose behaviour in turn influences the actions of individuals by providing constraints and opportunities for action (Dopfer et al., 2004; Lane, 2009).

In particular, we use Social Network Analysis (SNA) to map the micro-level interactions and detect the meso-level structures (such as network communities) whose presence affects the behaviour of individuals. Complexity approaches to the study of social organizations and SNA do not coincide, nor they imply one another. However, all studies that use SNA must epistemologically recognize the role played by the structure of inter-individual interactions in constraining individual behaviour. When used in the analysis of complex social systems, SNA can provide useful tools to empirically identify higher-order structures emerging from the micro-level interactions among individual agents.

We claim, as described in greater detail in the following sections, that the meso-level network structure affords agent the opportunity to act as intermediaries, either by bridging structural holes in the network or by connecting different network communities. To identify these "bridging organizations", or intermediaries, we experiment with two different measures developed in SNA: the brokerage index and a measure of intercohesion, respectively. We argue that the different measures identify different types of intermediary positions, which are linked to different ways to manage flows of knowledge within the network and hence to different roles in the innovation process.

The chapter is structured as follows. In section 2, we review some of the literature on innovation intermediaries and we discuss how knowledge flows within networks, introducing two network measures that can be used to identify organizations that play intermediary roles. We also discuss how different measures may identify intermediaries that perform different functions in the network. To support our arguments, we perform an exploratory analysis on an original empirical dataset of participants in policy-funded innovation networks. In section 3, we describe some of the main features of our dataset and our empirical strategy. In section 4, we present our empirical results, aimed at identifying different types of intermediaries and analysing their features. In section 5, we derive some conclusions and implications for policy.

Identifying intermediaries in innovation networks

The features of intermediaries

In recent years, numerous strands of research[1] have highlighted the important role played in innovation processes by organizations that facilitate connections between other organizations that are engaged in the invention, development and production of new products, processes and services. These connecting organizations have been identified with a variety of terms, such as “intermediaries”, “knowledge (or technology, or innovation) brokers”, “bricoleurs”, “boundary organizations”, “superstructure organizations”, “innovation bridges”, and others (Howells, 2006). Intermediaries enable the formation of appropriate partnerships, facilitate the realization of innovation projects and even support the appropriate dissemination and implementation of their results.

In the context of policies for innovation networks, greater awareness of which organizations can act as intermediaries, and of the roles of different intermediaries, could help policymakers design more targeted interventions, and potential beneficiaries to set up more successful networks. Within a comprehensive review of the literature on innovation intermediaries, Howells (2006) suggests that – while it is not yet possible to identify a specific body of literature on innovation intermediaries (exploring their functioning, organization, performance and theoretical rationales) – a consensus has emerged around a few general themes.

First, the functions of innovation intermediaries extend beyond the roles of “information clearinghouses” and “matchmakers” between potential collaborators. Intermediaries often engage in long-term collaborations with other organizations, which sometimes lead to further innovation processes, to new relationships, and to new services. The functions of intermediaries have therefore been found to be many and diverse, including:

a) facilitating relationships between organizations, by identifying potential partners for innovation projects (Shohert and Prevezer, 1996) and helping to compensate firms that have a poor advice network and lack connections to socially distant organizations (McEvily and Zaheer, 1999);

b) acting as “superstructure” organizations that provide collective goods to their members and facilitate and coordinate information flows between them (Lynn et al., 1996; Russo and Whitford, 2009);

c) supporting innovation processes by helping package the technology to be transferred between firms (Watkins and Horley, 1986), selecting suppliers to make components for the technology (Watkins and Horley, 1986), adapting technological solutions available on the market to the needs of individual users (Stankiewicz, 1995), and acting as knowledge repositories, able to provide solutions that are new combinations of existing ideas (Hargadon and Sutton, 1997).

Second, intermediaries do not always operate in a simple one-to-one basis, but they are increasingly involved in more complex relationships, such as many-to-one-to-one, one-to-one-to-many, many-to-one-to-many, or even many-to-many-to-many collaborations. For example, Provan & Human (1999) contrast two different examples of innovation intermediaries, one of which engaged in one-to-one relationships with the members of its networks, while the other engaged in many-to-many interactions, being primarily involved in stimulating collective discussions and interactions among network members. Similarly, Russo and Whitford (2009) describe how both types of relational behaviours were adopted by the same intermediary organization, which provided both one-to-one services to its members as well as opportunities for simultaneous interactions between several members (these different activities are described by the authors respectively as "switch" and "space" functions). Although these functions were provided by the same organization, they involved different parts of the organization and responded to different revenue generation models[2].

However, our understanding of which organizations are best suited to play these roles in innovation networks, and whether there are different types of intermediaries each with different roles and specificities, is still limited. When analysing organizations that play an intermediary role in innovation processes, one important question is how to identify them. The literature often conflates intermediaries with service providers, because providing services is one of the most important tasks of intermediaries (Shohert and Prevezer, 1996). However, this is not always the case. For example, it is well known from studies of industrial clusters that the role of "knowledge gatekeepers" (Allen, 1997), absorbing external knowledge, translating it and transmitting it to other organizations within the cluster – this way performing an important intermediary function in the cluster's innovation processes – is very often played by large leading firms (Morrison, 2008). Moreover, the organizations that perform intermediary functions may be different in different economic sectors, in different areas, or even in different innovation networks. Therefore, it is not possible to simply identify certain types of organizations that should "naturally" play the role of intermediaries based, for example, on their stated economic activity or mission. A more exploratory approach is needed, with the objective to detect what are the organizations that actually mediate relationships between other organizations in a specific context. In this chapter, we exploit information about relationships within an innovation network, in order to identify, using methodologies based on SNA, who are the actors that occupy positions in the network that allow them to mediate between other actors, or groups of actors: we assume that the position of an actor within a network of relationships is likely to influence the functions that it performs. This is not an unrealistic assumption given that numerous studies have demonstrated that an organization's network position affects its opportunities for shared learning, knowledge transfer, and information exchange (Burt, 1992; Provan and Human, 1999; Nooteboom et al., 2005) and hence its success in developing innovations (Nooteboom 2000; Tsai, 2001; Graf and Kruger, 2011).

SNA provides a powerful analytical tool to highlight features of innovation networks in general, and of intermediaries within such networks in particular, and it has flourished in the last few years (Fritsch and Kauffeld-Monz, 2007; Gilsing et al., 2008). This approach requires the analyst to possess precise and comprehensive data about the relationships among the participants in innovation processes, so as to be able to construct a fairly reliable network of the relationships between them. However, the analysis focuses on the presence of relationships and not on the quality and nature of these relationships. This prevents us from developing rich analyses of how relationships evolve, carrying different functionalities and leading the participants to explore new directions. These aspects have been investigated through different methodologies such as ethnography and case study research (see for example Hargadon and Sutton, 1999; Morrison, 2008; Parolin, 2010).

Brokers and intercohesive agents

An organization's positioning within a network of relationships strongly affects its ability to manage and control communications within that network, and consequently the exchange of information and knowledge among network participants. How such inter-organizational knowledge flows are structured shapes the way in which production and innovation processes are distributed between organizations. Consequently, there is a link between an organization's positioning within the network and the extent and nature of its contribution to innovation processes.

In his seminal contribution, Burt (1992) suggested that a node that spans a structural hole in a network – that is, a node that creates a bridge between two otherwise non-connected parts of that network – enjoys the opportunity to broker the flow of information between people, and to control the projects that bring together people from opposite sides of the hole. People on either side of the structural hole have access to different flows of information; hence, the node that bridges the structural hole (an actor that can be termed a "broker") creates a connection that allows the transmission of non-redundant knowledge between the two sides. According to Burt (1992), a broker can enjoy numerous benefits from its network position. First, the broker can learn early on about activities in different groups, therefore it can spread new ideas and behaviours; second, as it has many diverse contacts, it is more likely to be included in the discussion of new opportunities; third, the more diverse its range of contacts, the more it is attractive for other actors who want to become part of its network; finally, it has the opportunity to control the flow of communication between other actors and hence can exploit this power to its own advantage[3].

According to McEvily and Zaheer (1999) actors that occupy a broker position – that is, actors that are at the centre of a network of non-overlapping ties – can exploit access to non-redundant knowledge which allows them to build better competitive capabilities. Compared with actors who are only connected to one side of the structural hole, brokers have better knowledge of their environment and can gain access to a wider spectrum of information and knowledge. The more cohesive a network is (that is, the greater the connectedness among nodes), the fewer the structural holes and the fewer the opportunities for brokerage. Combining the analysis on agents' position in a network and agents' basic features, Gould and Fernandez (1989) propose a finer distinction between different types of brokerage positions according to the nature of the actors that are connected through the broker.

The identification of bridging positions in a network may also come as a result of analyses aimed at discovering the emergence of meaningful communities, that is network sub-groups populated by agents that are more intensively connected to each other than to the rest of the larger network. Stark and Vedres (2009) use the term "intercohesive nodes" to identify intermediaries that are embedded in different communities at the same time. Differently from the ideal-typical broker, which provides bridges between actors that are not directly connected to each other, intercohesive nodes bridge communities of actors, some of which may be connected to each other. While brokers may mediate between different communities, but do not belong to any of them, intercohesive nodes are insiders to multiple social groups[4].

Intermediary positions and innovative contexts

Following the line of enquiry that we have developed so far, we explore wether agents that occupy broker or intercohesive positions in a network can play different intermediary roles in distributed innovation processes involving several organizations and can be linked to different forms of learning and innovation. Some studies suggest that different intermediaries may support different learning dynamics within the networks.

In their analysis of the impact of network embeddedness on firm novelty creation and absorption, Gilsing et al. (2008) discuss the relation between agents' position in a network, exploitation or exploration learning dynamics and agents' cognitive distance. Assuming that exploitation processes most often occur when environmental conditions are stable, while exploration processes strongly characterise agents' activity in turbulent contexts, the authors recall that the literature on innovation networks has often shown that networking among similar agents is beneficial for knowledge exploitation processes (Nooteboom, 1999; Nooteboom et al., 2005). In fact, partners that have similar technlogical knowledge, expertise, and beliefs, are able to understand each other quickly and easily learn from others. This easy and fast dissemination of information and knowledge is most appropriate for an effective implementation of exploitation processes (Gilsing, 2005). On the contrary, what matters most for the realization of exploration processes is a certain degree of cognitive distance between the agents: distant agents bring different pieces of knowledge within the network, which can be recombined in new and original ways (Nooteboom et al., 2005).

Taking a structural perspective, and drawing on Burt's (1992) concept of structural holes and brokerage positions, Gilsing et al. (2008) observe that brokers are more likely to be in a good position to engage in knowledge exploration processes. Assuming that agents engage in homophilous behaviour – this is, they tend to form ties with similar others (McPherson et al., 2001) – and, therefore, that similar agents are likely to be part of the same group, the authors argue that brokers, who are connected to different groups of partners, are in a position to recombine different knowledge and then engage in exploration processes.

Intercohesive agents, instead, belong to multiple cohesive subgroups at the same time. By the same homophily assumption, overlapping cohesive subgroups, that share many connections, are likely to be formed by similar agents. As a consequence, intercohesive agents will play a role in coordinating similar agents. In light of the contribution of Gilsing et al. (2008), this type of agent is more likely to be found in stable contexts, where it can best exert its role in knowledge exploitation processes. If these arguments hold, we can hypothesize that different intermediaries support the implementation of different types of learning and innovation processes, which take place in different contexts. We expect to find that brokers more often engage in turbulent contexts, where learning processes are mainly explorative; while intercohesive positions are more often occupied by organizations that engage in learning processes that are mainly exploitative, as happens in the case of stable contexts.

In the following sections we will perform an exploratory analysis to understand whether brokers and intercohesive agents actually have these characteristics. Our empirical analysis concerns the implementation of a regional policy intervention to support innovation in small firms. The involvement of intermediaries with knowledge diffusion and knowledge recombination capabilities can be particularly important when policies are aimed at small businesses, whose internal knowledge and skills, and ability to participate in innovation projects, are limited.

Data and methodology

The dataset

The empirical analysis focuses on a set of innovation networks set up thanks to funds competitively allocated by the Tuscany Region (Italy). In 2002, the regional government launched a set of policy initiatives designed to support joint innovation projects performed by networks of heterogeneous economic actors, with the ultimate objective to promote non-transitory forms of collaboration among the small and medium-sized firms (henceforth: SMEs), the universities and the research centres based in the region[5].

These policy initiatives were funded through two main European Regional Development Funds (ERDF) funding schemes: the Single Programming Document (SPD) 2000-2006 and the Regional Programmes of Innovative Actions ('Innovazione Tecnologica in Toscana' 2001-2004 - hereafter RPIA-ITT-2002 - and 'Virtual Enterprises' 2006-2007 - hereafter RPIA-VINCI-2006)[6]. The programmes were implemented between 2002 and 2008.

Within these funding schemes, the regional government launched nine calls for innovation projects to be realized by networks of cooperating organizations. Some of these programmes allowed agents to participate in only one project per programme, while others allowed multiple participations. In what follows we will consider only the five programmes that admitted simultaneous multiple participations (the RPIA-ITT-2002 programme, and four waves of the SPD programme measure 1.71 implemented in 2004, 2005, 2007 and 2008) because it is precisely within this type of programmes that we can see the emergence of intermediaries such as brokers and intercohesive nodes, mediating the relationships among agents participating in different projects.

Overall, 1,362 different organizations were involved in these five programmes, submitting 225 project proposals. Out of these, 141 projects (62.7%) were granted funding. In what follows we will consider organizations participating in funded and/or non-funded projects. Their main characteristics are listed in the following Table 1.

Table 19.1. Participating organizations by type

Type of organization	Participating organizations		Funds received (000€)	
	n.	**%**	**n.**	**%**
Enterprises	860	63.1	12300.0	35.0
Universities & research centres	116	8.5	7316.8	20.8
Private research companies	23	1.7	537.6	1.5
Innovation centres	37	2.7	6191.9	17.6
Private service providers	76	5.6	3784.5	10.8
Associations	97	7.1	2738.0	7.8
Chamber of Commerce	11	0.8	802.2	2.3
Local governments	92	6.8	691.7	2.0
Other public bodies	50	3.7	815.4	2.3
Total	**1362**	**100.0**	**35178.0**	**100.0**

Note to Table 1: The table shows the number of organizations that have taken part, both in funded and non-funded project proposals, in the observed policy programmes. Given that these programmes allowed multiple participations, some of the 1,362 participants have been involved in more than one project.

The characteristics of the networks, including the nature of the organizations involved, were often shaped by the tender requirements, which, especially in the early stages of the policy period, imposed numerous constraints on the composition of the admissible networks (Rossi et al., 2013). Some tenders explicitly mandated the involvement of certain types of knowledge-intensive business service providers (KIBS) that should have played the role of intermediaries: namely, innovation centres (usually public or public-private agencies) and private business services providers. The presence of some KIBS (be they public, private, or mixed) was advocated in order to introduce some interfaces between the manufacturing SMEs – particularly those operating in low-tech sectors – and private, academic and government research organisations[7]. Besides their interface role, the KIBS (together with a broader set of agents) were also supposed to act as catalysts for knowledge dissemination, and to reach out to SMEs.

The programmes mostly encouraged the implementation of process innovations, and targeted a mix of sectors and technologies. Thanks to the information we have collected in previous analyses and evaluations of these programmes, we have identified two main types of projects: those focusing on technological environments characterized by relative stability, and those focusing on technological environments characterized by a fast rate of change. The former include all those projects involving low and medium-low tech sectors, or focusing on the diffusion of well-established technologies (53 projects, or 24%), while the latter include projects involving high or medium-high technology sectors (115 projects, or 51%)[8]. 57 projects (25%) could not be classified based on the available information.

Empirical strategy

Our objective is to explore the extent to which some organizations have played intermediary roles in mediating the relationships between other organizations involved in the policy programmes, and to ascertain whether different types of intermediary positions in the programme networks are occupied by organizations with different characteristics and that operate in different technological environments, suggesting that different learning dynamics are taking place.

In order to identify broker and intercohesive positions and to examine their characteristics, we have analysed the set of participants and projects by means of SNA.

First, we have considered the set of relationships activated in each of the observed programmes and we have constructed five two-mode networks (one for each programme), where each organization is connected to the project(s) in which it participates. Second, the five two-mode networks have been transformed into as many one-mode undirected networks in which the participating organizations are connected to each other through co-membership in innovation projects. The organizations participating in more than one project create connections between the other organizations participating in these projects. Then, we have focused on two different types of intermediary positions, as identified by means of two different SNA measures: brokers and intercohesive nodes.

In SNA terms, a broker is a “go-between” for pairs of other agents that are not connected directly to one another. If A, B, C are three agents and A and C are not linked without the intermediation of B, B is a broker. For the analysis of brokers, we refer to the normalized brokerage index that is implemented in the Ucinet software (Borgatti et al., 1999). Considering a node’s immediate neighbourhood (all nodes to which the node is directly connected), the normalized brokerage index is the ratio between the pairs of nodes that are not connected to each other, and the overall number of pairs of nodes in that node’s neighbourhood. An agent is considered as a broker when its normalized brokerage index is greater than zero.

Given the structure of our data, where agents are connected through their co-participation to the same innovative projects, we note that brokers are agents that participate in more than one project at the same time (in the same programme), and hence bridge different project partnerships. Hence the interesting policy question is whether this type of agent can be an important veichle for the exchange and the absorption of knowledge among different innovation projects.

In order to detect intercohesive nodes, we have used the clique percolation algorithm developed by Palla et al. (2004), included in the CFinder software, which aims to find meaningful network subgroups. The algorithm identifies communities as groups of adjacent k-cliques (where a k-clique is a set of nodes each of which is connected to at least other k nodes): two k-cliques are adjacent if they have k-1 vertices in common. The idea underlying such communities is that, for a social group to be cohesive, it is not necessary for all members of the group to interact with all others (as in a k-clique) but there can be cohesion even if some actors interact with only k-1 others. We have identified all the communities in the network that are formed as groups of adjacent k-cliques, with k varying depending on the policy programme considered[9]. An intercohesive agent is then identified as an agent that belongs to two or more communities. Even intercohesive agents perform a bridging role among different projects. In fact, the communities they connect are formed by groups of agents that are more intensely connected among each other than with the rest of the network (in our case, the network is the policy programme).

The following Table 2 shows the distribution of nodes according to whether they have positive normalized brokerage index (they are brokers) and whether they belong to more than one community (they are intercohesive), in at least one of the five programmes considered. In particular: 69 nodes are brokers in at least one of the five programmes, but never intercohesive (see the column "Pure brokers (B)" in Table 2) and 197 nodes are intercohesive in at least one of the five programmes, (see the column "Intercohesive agents (I)" in Table 2)[10] .

Table 19.2. Number of brokers and intercohesive nodes by type of agent

Nature	Brokers (B)	Intercohesive agents (I)	Total intermediaries (B+I)	Total agents
Enterprises	28	61	89	860
Universities & research centres	3	30	33	116
Private research companies	2	5	7	23
Service centres	3	16	19	37
Service providers	8	13	21	76
Associations	11	27	38	97
Chamber of Commerce	0	9	9	11
Local governments	12	28	40	92
Other public bodies	2	8	10	50
Total	**69**	**197**	**266**	**1,362**

Note to Table 2: Brokers and intercohesive nodes are calculated on the basis of the individual programme. "Brokers" include agents that are brokers in at least one of the observed programmes, but never intercohesive, while "Intercohesive agents" belong to more than one community at the same time in at least one of the five programmes. The third column reports the sum of Brokers and Intercohesive agents, which is the total number of intermediaries. The last column reports the total number of agents involved in the 5 observed programmes.

After we have identified brokers and intercohesive agents, we have defined a number of variables illustrating their features.

In order to describe the type of technological environment in which the agent is embedded, we have used the information on the technological field of the projects in which the agent participates (see the previous section). Then we have defined the variable *turbo_pct* measuring the share of the agent's projects which focus on technological environments characterized by a fast rate of change, and the variable *stable_pct* measuring the share of the agent's projects which focus on relatively stable technological environments. This variable, as well as the others we have defined, are described in the following Table 3.

We have tried to specify a model that helps us to account for the possible sample selection bias due to the fact that intermediaries in general (either brokers or intercohesive nodes) could have a number of features that distinguish them from the whole population[11]; this needs to be accounted for when modeling an agent's likelihood to be a broker as opposed to an intercohesive node, so as to remove the influence of characteristics that are typical of intermediaries in general, rather than of specific types of intermediaries. Therefore, in order to identify the brokers' characteristics, we estimate a probit model with sample selection (Heckman two-stage probit) on the 1,362 agents. In the first stage, we estimate the probability that an agent is an intermediary (*either* broker or intercohesive) or not *(neither* broker nor intercohesive), using 1,362 observations. In the second stage we estimate the probability that an agent is a broker or an intercohesive agent, using 266 observations. The analysis is very exploratory, and focuses on the behaviour and on the characteristics of agents within the policy programmes[12]. In the main equation, we seek to determine what is the probability that an agent is a broker (rather than an intercohesive node) given a set of characteristics of the agent (nature) and of the projects (be they funded or not) in which it is involved (turbulent or stable technological environment, average project duration, share of projects that are funded). In the selection equation, we consider a number of variables that could influence whether the agent becomes an intermediary, namely its nature, the number and technological features of projects in which it participates, and the other features that we have included in the main equation (average project duration, share of projects that are funded).

Table 19.3. Basic descriptive statistics of agents' characteristics

Variable	Description	Total population N obs=1,362		Intermediaries N obs=266	
		Mean	St.Dev	Mean	St.Dev
Intermediary	(S) Dependent variable in the selection equation. Dummy variable equal to 1 when the agent is an intermediary (broker or intercohesive) and 0 otherwise.	0.195	0.397	1.000	0.000
Broker	(M) Dependent variable in the main equation. Dummy variable equal to 1 when the agent is a broker and 0 when it is an intercohesive node. The agent is a broker when the brokerage index, as calculated by the software Ucinet, is >0, and the agent is not an	0.051	0.219	0.259	0.439

	intercohesive node.				
N_projects	(S) Total number of projects (be they funded or not) participated by the agent. The variable is calculated based on the nine policy programmes issued in 2000-2006 (see Caloffi et al., 2012), not only on the five programmes that admitted multiple participation.	2.093	2.491	5.342	4.108
Turbo_pct	Share of projects participated by the agent, which focused on technological environments characterized by a fast rate of change. The variable is calculated on the total number of projects, funded and not funded, in all programmes, in which the agent participated.	0.270	0.407	0.223	0.257
Stable_pct	Share of projects participated by the agent, which focus on relatively stable technological environments. The variable is calculated on the total number of projects, funded and not funded, in all programmes, in which the agent participated.	0.510	0.446	0.555	0.315
Share_fin	Share of projects participated by the agent, which were funded.	0.665	0.418	0.661	0.277
Avg_dur	Average duration of the project, expressed in days (non funded projects had a duration of zero days)	342.977	226.836	441.400	151.142
Enterprise	Dummy variable equal to 1 when the agent is an enterprise and 0 otherwise	0.631	0.483	0.335	0.473
University - research centre	Dummy variable equal to 1 when the agent is a university or research centre and 0 otherwise	0.085	0.279	0.124	0.330
Private research company	Dummy variable equal to 1 when the agent is a private research company and 0 otherwise	0.017	0.129	0.026	0.160
Innovation centre	Dummy variable equal to 1 when the agent is an innovation centre and 0 otherwise	0.027	0.163	0.071	0.258
Private service provider	Dummy variable equal to 1 when the agent is a private service provider and 0 otherwise	0.056	0.230	0.079	0.270
Association	Dummy variable equal to 1 when the agent is an association and 0 otherwise	0.071	0.257	0.143	0.351
Chamber of Commerce	Dummy variable equal to 1 when the agent is a chamber of commerce and 0 otherwise	0.008	0.090	0.034	0.181
Local government	Dummy variable equal to 1 when the agent is a local government and 0 otherwise	0.068	0.251	0.150	0.358
Other	Dummy variable equal to 1 when the agent is a public body or another type of agent not included in the previous classes, and 0 otherwise	0.037	0.188	0.038	0.191
Medium	Dummy variable equal to 1 when the agent is a medium-sized firm and 0 otherwise	0.012	0.108	0.008	0.087

Small	Dummy variable equal to 1 when the agent is a small-sized firm and 0 otherwise	0.051	0.221	0.038	0.191
Micro	Dummy variable equal to 1 when the agent is a micro-sized firm and 0 otherwise	0.181	0.385	0.109	0.312

Note to Table 3: (S) identifies the variables that are included in the selection equation only. (M) identifies the variables that are included in the main equation. All the other variables (except for *other*, that we have displayed only for clarity) are included both in the selection and in the main equation.

Empirical results

The following Table 4 displays the main results of the Heckman probit model that we have estimated.

Table 19.4. Regression results

VARIABLES	(1) Broker	(2) Intermediary
N_projects		**1.032*** **
		(0.068)
Turbo_pct	**0.783+**	**0.434***
	(0.477)	(0.262)
Stable_pct	0.149	**0.441***
	(0.410)	(0.242)
Share_fin	0.145	**-1.089*** **
	(0.391)	(0.261)
Avg_dur	0.000	**0.002*** **
	(0.001)	(0.000)
Enterprise	0.528	0.385
	(0.478)	(0.337)
University- Research centre	-0.502	-0.268
	(0.547)	(0.406)
Private research company	0.696	0.694
	(0.701)	(0.557)
Innovation Centre	0.762	0.034
	(0.535)	(0.392)
Private Service provider	-0.002	-0.090
	(0.564)	(0.479)
Association	0.503	**0.630***
	(0.494)	(0.380)
Chamber of Commerce	-5.637	0.386
	(19,985)	(0.665)
Local Government	0.486	**1.003*** **
	(0.492)	(0.373)
Medium	-9.921	-0.216
	(0.000)	(0.181)
Small	-6.422	**-3.837*** **
	(34,436)	(0.425)
Micro	**-0.488+**	-0.216
	(0.297)	(0.181)
Constant	**-1.614*** **	**-3.837*** **
	(0.584)	(0.425)
Athrho		**0.575*** **
		(0.189)
Observations	266	1,362

Note to Table 4: Number of obs: 1,362 in the selection equation and 266 in the main equation; Standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1, +p<0.15.
LR test of indep. eqns. (rho = 0): chi2(1) = 11.88 Prob > chi2 = 0.0006

Our hypothesis that broker positions are more often occupied by organizations that engage in turbulent contexts and that intercohesive agents are more often found in stable environments, finds support in the data. In fact, as we can see from Table 4, the variable *turbo_pct* is positive and (weakly) significant for brokers. Intermediaries in general seem to be more likely than non–intermediaries to be engaged in turbulent contexts, but this depends on brokers in particular. In fact, the increase in probability attributed to a one-unit increase in the variable *turbo_pct* is larger for brokers (0.783) than for intermediaries in general (0.434). Given that the latter are the sum of brokers and intercohesive agents, this means that the contribution from the intercohesive agents is lower than the contribution from the brokers.

As for the agents' nature, we find that intermediaries in general are more likely to be (local) associations and local governments. These agents participated in the observed projects less frequently than others, but when they did, they mobilized their local communities.

Besides associations and local governments, no other agents have a significant probability to be intermediaries. Hence, service providers (e.g. innovation and technology transfer centres, a business development service centres, private service providers) do not preferentially play an intermediary role. This may be explained by two main factors. First, performing an intermediary role in innovative projects must require the mobilisation of a number of technological and scientific knowledge and skills that service providers do not always have. Second, intermediaries may be important in the preliminary stages leading up to a project, for example in the screening phase of the call for tenders and in the writing of proposals, rather than in the implementation phase: once the project has been funded and it is implemented, they play a role in providing support to the individual firm, rather than in coordinating the whole partnership. Hence, intermediary roles are played by a large variety of agents, varying from project to project.

Intermediaries are also involved in longer projects and less likely to receive public funds. Becoming an intermediary, as well as actually playing an intermediary role, can take some time, in order to get to know the various types of agents, create connections among them and maintaining such connections. Therefore, we can understand why the impact of the variable *avg_dur*, although very small, is positive. Intermediaries are agents participating in many project proposals (even simultaneously): this is why the incidence of failures (projects that are not selected for funding), may be higher than that of other types of actors who play no role as intermediaries.

Conclusions

Our analysis has tried to identify what are the peculiar features of intermediaries in the context of innovation policy programmes. Several studies (Bessant and Rush, 1995; Hargadon and Sutton, 1997; Cantner et al., 2011; Kauffeld-Monz and Fritsch, 2013) have acknowledged that intermediary organizations support the formation and successful management of innovation networks. However, their features and the role they play in practice are still under-investigated.

The exploratory analysis presented here takes a step in this direction. Focusing on a set of policy programmes that allowed organizations to participate in more than one project, thus creating bridges between projects, we have tried to identify *ex post* what are the main features of different types of intermediaries based on an analysis of their positions within networks of relationships. We have observed that brokers and intercohesive agents have different features. The former – linking agents that are not connected among each other – are more likely to be found in technologically turbulent environments, while the latter – bridging cohesive communities of network agents – operate in more stable contexts. Drawing on the analysis of Gilsing et al. (2008) we could presume that brokers play a more incisive role than intercohesive agents in knowledge exploration processes, while intercohesive agents are more likely than brokers to engage in knowledge exploitation processes.

Intermediaries in general are more likely to be local governments or local associations. However, besides this, it is not possible to clearly identify organizations that, by nature, are more likely to be either brokers or intercohesive agents: different innovation networks may require different organizations to mediate relationships between the other participants. This finding calls for further research into what types of knowledge and competencies are needed in order to (effectively) facilitate and manage different types of innovation networks.

Notes

[1] Howells (2006) identifies four main sources: "(a) literature on technology transfer and diffusion; (b) more general innovation research on the role and management of such activities and the firms supplying them; (c) the systems of innovation literature; and (d) research into service organizations and more specifically Knowledge Intensive Business Services (KIBS) firms" (Howells, 2006: 716).

[2] In particular, "switch" services were priced on a mark-up–on-cost basis, while "space" services were included in the annual association fee paid by members. The latter type of services indirectly stimulated the interaction among the members of the organization and enhanced their demand for additional switch services.

[3] A classic study on the exploitation of a brokering position to maintain political power is the work by by Padgett and Ansell (1993) on Cosimo de Medici. The authors have shown how the main sponsor of the Italian and European Renaissance gained his power thanks to a strategy aimed at creating links between different élites (through business relationships or marriages), and then exploited this position in his favour, playing an intermediary role between different groups.

[4] However, it is important to keep in mind that there is no antinomy between the two definitions, since they relate to different aspects. We will come back to this issue in the empirical section.

[5] Similar initiatives eliciting the growth of self-organised co-operation networks in research and development have been promoted in other European regions (Eickelpasch and Fritsch, 2005).

[6] The empirical research was carried out over an extended time span, starting from 2004, since the authors had participated in the monitoring and analysis of three specific regional programmes implemented during this period, namely the RPIA-ITT (see Russo and Rossi, 2009a), the RPIA-VINCI, and the SPD line 1.7.1, 2005-2006 (see Bellandi and Caloffi, 2010).

[7] In some cases the call for tender explicitly required the presence of a minimum number of service centres (a particular kind of KIBS), while in other cases the tender simply responded to the general objective to promote "networks among enterprises, research centres and universities, innovation centres and other public and private organisations" for innovation and innovation-diffusion purposes.

[8] Projects in biotech, geothermal energy, optoelectronics, nanotech, new materials and multiple technologies have been classified as belonging to turbulent environments, while projects in ICT applications to traditional sectors, mechanics and organic chemistry have been included in the group of projects in stable enviroments.

[9] The value of k should be determined on the basis of the peculiar features of the network under observation. Since our networks are made up of projects in which everyone is connected to everyone, it is very likely that the algorithm identifies exactly these groups of agents (projects) as communities. To identify meaningful subgroups that are not a mere duplication of projects, for each programme we have chosen k equal to the size (number of participants) of the smallest project in that programme, minus 1. In this way, we are sure to find sub-groups that do not coincide with the projects.

[10] When an agent is both broker and intercohesive, we have classified it as intercohesive, because we are interested in observing the differences between a "typical" broker – which mediates amongs organisations that are not linked – and other types of intermediary positions which are more similar to that represented by the intercohesive agents. All intercohesive agents also have positive brokerage index; however, in all five programmes, their brokerage index is on average lower than that of the pure brokers.

[11] For instance, intermediaries in general could be more likely to operate in turbulent environments or to have a homophilous environment than the non-intermediaries. Therefore, this feature should not be considered as typical of either brokers or intercohesive nodes.

[12] Obviously, being an intermediary can be influenced by a number of events happening outside of the policy framework. Therefore, our analysis is partial. However, we take this as a first attempt to identify a number of features that can be typical of the different types of intermediaries.

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