What networks to support innovation? Evidence from a regional policy framework

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Abstract

We explore how the implementation of a set of policy programmes over a period of six years induced some "emergent" learning effects which had not originally been envisaged by policymakers. This way, we show how policy evaluation can be used not only to assess the expected impact of policy interventions but also to discover their unexpected behavioural effects, and therefore provides an important instrument to guide the design of future interventions.

Keywords

Policy evaluation, social network analysis, behavioural effects, policy design

JEL classification: D85, H43, L14, L52, O32

1. Introduction

Complexity-based approaches to innovation have emphasized the role of interactions among heterogeneous agents as key sources of innovation [1] highlighting the elements of such interactions that are associated with greater likelihood to generate innovations and to foster long-lasting relationships giving rise to innovation cascades. In management theory, it has been recognized that, as technologies become more complex and economic environments more uncertain, firms increasingly rely upon external sources of knowledge for their innovation processes, leading their innovation activities to become more open and distributed [2]. Firms' ability to access knowledge through interactions with other organizations, including universities, is increasingly recognized as a source of competitive advantage.

Hence, the ability to effectively access external knowledge through networking is a very important competence for firms wishing to innovate successfully. However, not all organizations are equally able to engage in effective networking. Small firms, for example, may find it difficult to distract resources from their main activities in order to engage in the search for external partners, to interact with organizations that are cognitively very distant (like universities or large multinational corporations) and even to identify the appropriate social channels through which contacts with potential partners could be made.

While policies directed at improving the education of the workforce may increase the networking capabilities of organizations in the long term (it has been shown that a

higher share of highly qualified personnel increases an organization's absorptive capacity and hence its ability to search for and absorb external knowledge) another more immediate approach could be to encourage organizations to gain experience in networking with external partners by promoting the set up of innovation networks.

Policies fostering inter-organizational collaborations have been undertaken for a very long time (in Europe, at least since the launch of the first collaborative research programmes in the 1980s) but usually their stated objective is to promote joint R&D or technology transfer – promoting participants' networking skills is only incidental. Only a few programmes in the EU have had networking per se as a specific objective, and even these promote the formation of networks, not the strengthening of the participants' ability to network with others.

This points to the need to investigate what instruments can be used to strengthen organizations' networking skills. In this paper we explore whether policies sponsoring the formation of innovation networks may have as a significant "emergent effect" the strengthening of the participants' networking abilities, and if so which characteristics of these policies may be particularly conducive to enhancing networking skills. We do this thanks to the empirical analysis of a set of nine policy programmes in support of innovation networks implemented in the same region (Tuscany) between 2002 and 2008. The time dimension allows us to investigate whether agents' repeated participation to these policies enhances their ability to form "better" innovation networks. This approach fits with the recent debate in policy analysis on the need to investigate whether policies have "behavioural effects" in terms of stimulating learning processes on the part of the participants [3-4].

2. What makes a "good" innovation network?

By not only promoting the set up of innovation networks but also by imposing constraints on their characteristics, the policymaker may facilitate learning processes within and between the networks and thus to stimulate to a greater or lesser extent the development of the participants' networking capabilities. In our empirical analysis, we focus on three types of policy constraints which could promote learning and which were actually present in some of the policy interventions that we investigated.

1. Heterogeneity. By requiring the networks to include a certain degree of heterogeneity, the policymaker may facilitate learning processes thanks to which organizations improve their ability to interact with diverse organizations and hence to form heterogeneous networks in the future. The experience of engaging in and managing relationships with agents characterized by different cognitive frames and modes of operation is likely not only to facilitate the emergence of novelty [1, 5], but also to teach organizations how to improve their ways of interacting with others.

2. Stability. Stable relationships are important in order to promote knowledge spillovers and innovation diffusion to agents who are cognitively very distant and hence may need more time and repeated interactions in order to "absorb" external knowledge. The policymaker may facilitate the consolidation of stable relationships by providing continuity in the policy framework. In fact, participants to policy-supported innovation networks have highlighted that the different time scales at which innovation processes and innovation policy interventions unfold (the former develop along a much longer time scale than the latter) can be problematic [6].

3. Intermediaries. The policymaker may want to ensure that networks include new participants, even in the presence of a stable core, in order to avoid "lock in" into communities of stable collaborators which can lead to undesirable effects like closure to outsiders, inward-looking attitudes, dependence on a partner, and the emergence of lobbying behaviour. The involvement of innovation intermediaries might provide support to achieve this aim. Intermediaries are organizations that play a mediating role in innovation processes, facilitating connections between other organizations that are engaged in the invention, development and production of new products, processes and services. They ensure interaction and communication among heterogeneous participants, which differ in language, systems of incentives and objectives, etc. [7].

In the policy practice, it can be very difficult to find a balance between fostering efficient and effective teamwork (allowing the time to create mutual understanding and routines) and favouring the creation of ruptures and novelty. The tension between temporary and stable relationships could be solved by considering the specific objectives of the network: that is, networks that explicitly prioritize innovation diffusion processes or the absorption of spillovers resulting from established innovations may be more effective when built around relatively stable communities of innovators that include either small and large firms or enterprises and universities; while networks aimed at the production of radical innovations may be more effective when new relationships play a prominent role.

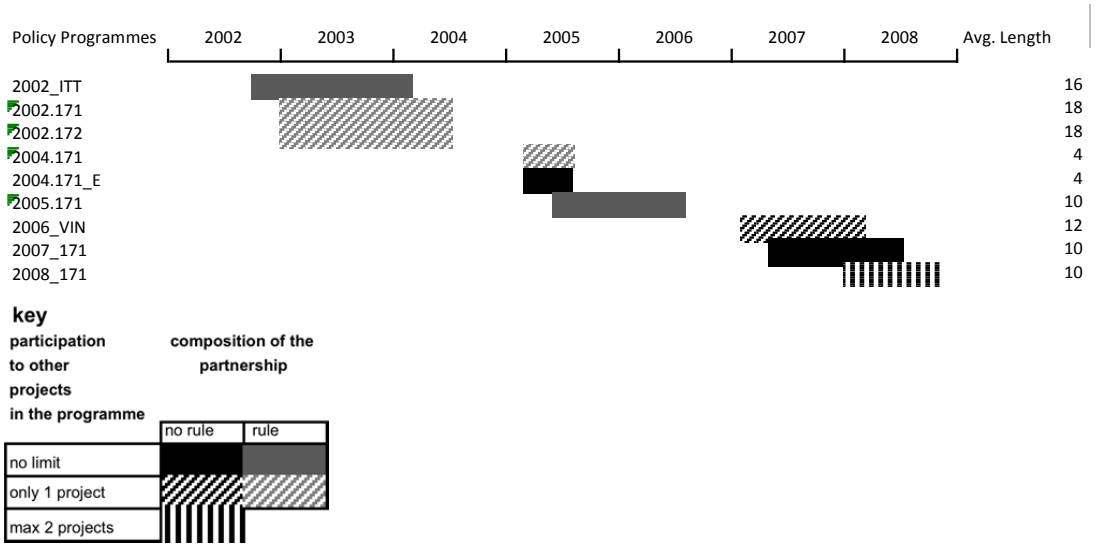
3. The regional policy programmes

In the programming period 2000-2006, Tuscany's regional government promoted nine consecutive programmes aimed at supporting innovative projects carried out by networks of heterogeneous economic agents. The set of policy programmes can be divided into two major periods. The first period, which included the majority of programmes and participants, ran from 2002 to 2005 (the last projects were completed towards the end of 2006). It included six programmes (2002_ITT, 2002_171, 2002_172, 2004_171, 2004_171E, 2005_171). In the vision of policymakers, these programmes would have led to the development and strengthening of innovation clusters made of SMEs and large companies working together with innovation service providers and other agents supporting innovation. Strongly inspired by the regional innovation system framework (which was dominant in the European innovation strategies of the time) the regional policy maker considered the emergence of such clusters as the first step towards the formation of Tuscany's innovation system. These programmes were characterized by the imposition of numerous constraints - on the size and composition of the partnership and on the number of projects in which each organization could participate, as shown in the figure below.

The second period started in 2006, and ended with the last intervention implemented in 2008. It included three programmes (2006_VIN, 2007_171 and 2008_171). The policymaker's goal was to consolidate the networks formed in the previous period[1]. No constraints were present in this period. This allows us to test, in our empirical analysis, whether the policy constraints imposed in the first period had some impact on the participants' learning processes influencing the development of their networking abilities in the second period.

[1] Interestingly, these interventions had not been planned at the beginning of the programming period. Rather the region was able to procure additional funds that enabled it to implement a further RPIA and two more waves of the SPD line supporting innovation networks (programme 171).

Figure 1. The time profile and rules of the different programmes



Note to figure 1: The first column displays the nine policy programmes considered. The Regional Programmes of Innovative Action are identified with the following labels: 2002_ITT (Regional Programme of Innovative Action issued in 2002, whose acronym was ITT – Tuscany Technological Innovation) and 2006_VIN (acronym: Virtual INnovation and Cooperative Integration, issued in 2006). The different calls of the two lines 1.7.1 and 1.7.2 included in the Single Programming Document are identified with the name of the line and of the reference year, as identified by the administrative documents we have analysed.

Overall, the nine programmes were assigned almost € 37 million, representing around 40% of the total funds spent on innovation policies, and sponsored 168 projects. The total number of different organizations involved in the nine programmes was 1127, a subset of which (348) took part in more than one project. We classified the organizations involved in the programmes into nine categories: firms (60.3% of all organizations involved[2]), business service providers (7.6%); private research companies (2%); local business associations (7.5%); universities and other public research providers; service centres (generally publicly funded or funded via public-private partnerships; 3%); chambers of commerce (1%); local governments (6.8%); and other public bodies (3.5%).

The various programmes addressed a set of technology/industry targets. A large share of funds was devoted to ICT and multimedia (48.2%), with the objective to widen their adoption in traditional industries and SMEs. Projects in opto-electronics, an important competence network in the region, received 16.4% of funds. The third targeted area, projects in mechanics, received 7.5% of funds. The remaining technological fields included organic chemistry (5%), biotech (4%), and others (new materials, nanotechnologies and a combination of the previously mentioned technologies).

[2] In terms of economic activity (based on Nace Rev. 1.1 codes) and size, the largest share of participating enterprises were manufacturing companies (68%): of these, 21.8% were micro and small firms in the traditional industries of the region (marble production and carving, textiles, mechanics, jewellery), while the remaining share were micro firms in the service sector (Nace Rev. 1.1:72). The latter were an active group, with 1.8 projects per agent on average. The share of participanting enterprises varied in the different programmes, ranging from a minimum of 37.1% in programme 172_2002 to a maximum of 100% in the smallest programme (171_2004).

4. Assessing learning effects/1: the heterogeneity of project networks

We assessed the heterogeneity of each project by measuring the diversity of the types of participants (using the reciprocal of the Herfindahl index computed on the shares of participants belonging to each of nine categories outlined earlier). The average heterogeneity index is not too dissimilar across different programmes. The only exception is the RPIA programme launched in 2006, which had lower average heterogeneity and low dispersion of these values around the mean. Remarkably, in the first period, there was very little difference in the mean and dispersion of the heterogeneity index between the five programmes that imposed a minimum heterogeneity constraint and the programme that that did not; nor there was lower average heterogeneity in the second period, when no constraints were imposed. We also find that greater project size was associated with greater heterogeneity, and that project networks funded within programmes where a minimum heterogeneity constraint was present were generally much larger than those funded within programmes without such constraint, and very often much larger than the minimum size required to fulfil the heterogeneity constraint. A possible explanation for this is that the imposition of a mandatory heterogeneity constraint forced projects coordinators to include organizations that were not strictly necessary to the project's success and required them to increase the network size to include all the desired participants; while the elimination of such constraints allowed the partnership to be designed according to the effective project requirements and to economise on the number of partners without necessarily reducing heterogeneity. This would therefore recommend caution in imposing arbitrary heterogeneity constraints without taking into account the actual partnership needs of the different projects.

Computing the heterogeneity index at the level of the entire programme, rather than at the level of individual project networks, provides a different outlook. The heterogeneity index in terms of participants' fluctuated around a stable trend, and programmes with a minimum heterogeneity constraint were no more heterogeneous than the others. Instead, the heterogeneity index in terms of participants' technology areas was increasing over time, indicating that the programmes progressively involved a wider range of technologically diverse organizations.

To detect the learning effects of the policy interventions on the organizations' networking abilities, we consider the 205 organizations that took part in projects in both periods, 2002-2005 and 2006-2008, and we test whether an organization's participation in policy interventions in the first period (and the features of that participation) had an impact on its ability to engage in heterogeneous partnerships in the second period.

We measure heterogeneity of an agent's networks in period 2002-2005 using the average of the heterogeneity index of all the project networks that the organization was involved during that period (*avgdiversity_20068*). We then regress this variable on a set of variables that capture the involvement of the agent in previous and current policy programmes:

- *p2002ITT, p2002171, p2002172, p2004171, p2004171E*: set of five dummy variables capturing which policy programmes the organization was involved in during period 2002-2005;
- *avgdiversity_20025*: average heterogeneity index of the projects the organization was involved in during period 2002-2005;

- *avgfunding_20025*: average funding obtained by the organization in projects during period 2002-2005;
- *avgpctSC_20025*: average share of partners that were service centres in the projects the organization was involved in during period 2002-2005;
- *avgp_20025*: average number of partners in the projects the organization was involved in during period 2002-2005;
- *avgfunding_20068*: average funding obtained by the organization in projects during period 2006-2008;
- *avgpctSC_20068*: average share of partners that were service centres in the projects the organization was involved in during period 2006-2008;
- *avgp_20068*: average number of partners in the projects the organization was involved in during period 2006-2008;

We also consider a set of control variables capturing the type of agent, its size and the share of projects it engaged in in each technological area. We use OLS with robust standard errors to control for possible correlation among the errors[3]. Due to some missing observations, the overall number of observations is 197.

Table 1. Regression explaining average heterogeneity of organization's networks in 2006-2008

dependent variable	*avgdiversity_20068*		
Number of obs	197		
	Coefficient	**Robust standard error**	**Sign.**
p2002ITT	-0.007	0.089	
p2002171	-0.391	0.230	*
p2002172	0.080	0.221	
p2004171	0.318	0.222	
p2004171E	0.448	0.225	**
p2005171	-0.088	0.039	**
avgdiversity_20025	0.122	0.103	
avgfunding_20025	0.000	0.000	
avgpctSC_20025	-3.289	1.773	*
avgp_20025	0.004	0.018	
avgfunding_20068	0.000	0.000	*
avgpctSC_20068	0.110	0.072	
avgp_20068	0.094	0.024	***
_cons	3.040	0.592	***

Note: * 0.1, ** 0.01 *** 0.001. F(31, 165): 7.51, Prob > F: 0.0000, R-squared: 0.4229, Root MSE: .94736

These result suggest that the constraints imposed by the policy did not have the expected impact on the participants' behaviour. In fact, participation in two of the programmes with minimum heterogeneity constraints (171_2002 and 171_2005) had a significantly negative effect on the heterogeneity of networks in the second period, while participation in the only programme *without* a minimum heterogeneity constraint (2004_171E) had a significantly *positive* effect. This may suggest (negative) policy learning: as the imposition of a minimum heterogeneity constraint forced organizations to form partnerships that were larger and more heterogeneous than was necessary, this negative experience may have led these organizations to limit the heterogeneity of their later partnerships in order to avoid inefficiencies. Hence, the constraint was not effective, maybe because the type of heterogeneity devised by the policymaker did not match the actual needs of the participants. Vice versa,

[3] To check whether the "learning effects" induced by the policy were effectively due to the policy participation rather than to joint participation to other projects, we experimented with including a dummy variable equal to 1 if the organization had already collaborated with another participant in the policy programmes but outside of the set of regional policies, in both regressions. The inclusion of this variable reduced the number of observations to 182 due to missing values, did not change the sign and significance of the coefficients, and was itself not significant. Hence we did not include it in the final analysis.

participation in a programme where no such constraint was present seemed to have encouraged partners to experiment with more heterogeneous networks in the second period.

A greater share of relationships with the types of agents that the policymaker had envisaged could play the role of innovation intermediaries, the service centres, has a significantly *negative* effect on heterogeneity in the second period. As service centres are generally focused on specific technological areas, this may indicate that relationships with service centres did not encourage the encounter with organizations in different fields but rather only promoted relationships within the same area. This is not to say that service centres were not instrumental in facilitating relationships, but rather they did not seem to promote the ability of organizations to form relationships with heterogeneous partners (at least in the very aggregate terms we have measured it).

Greater average funding and larger networks in the second period were associated with greater heterogeneity in the same period. This suggests that the organizations that have the resources to obtain and manage more funds and to engage in larger projects also have better networking competences that enable them to organize heterogeneous partnerships.

5. Assessing learning effects/2: the stability of relationships

By definition, the first programme included participants and relationships that were new to the programme. Then, as time went by, there was a progressive increase in the number of agents that have already benefited from these policies. Nonetheless, continuous participation (that is, having been continuously active in all the previous programmes) and relatively stable participation (that is, having been present in at least one of the previous programmes) were associated with new relationships among new and old participants, as the share of new relationships remained high across all programmes; in particular, it remained constant and near 100% in the first period, while it declined (non monotonically) in the second period, remaining however above 80%.

This is consistent with the general policy objectives which, as we discussed earlier, were focused on the construction of new networks in the first period and on the consolidation of existing relationships in the second period.

We also find that the programmes that attracted the largest share of new participants were (besides the first) those which required project networks to have a minimum number of participants (172_2002 and 171_2005). Therefore, one of the effects of the presence of a high minimum number of participants was the involvement of a large number of agents that were new to the policy. On the contrary, broadening the range of target sectors/technology areas – as implemented in the programmes after 2004 – did not appear to have the same effect.

Our results show that around 86% of the total number of relationships was repeated over at least two years. Very often, such relationships developed between firms, between firms and universities, or between firms and service providers (service centres or private business service providers) indicating that repeated relationships developed among organizations that have a common research or technological focus.

We then test whether an organization's participation in policy interventions in the first period (and the features of that participation) had an impact on its ability to engage in stable partnerships in the second period, by regressing the stability of links in 2006-2008 (measured as the percentage of relationships of each agent in 2006-2008 which already existed in 2002-2005, *Pctrepeated20068*) on the same regressors and control variables as in the regression used to study heterogeneity. We consider the set of 205 agents that participated in projects in the two periods and we run a OLS regression with robust standard errors. Due to some missing observations, the overall number of observations is 197.

Table 2. Regression explaining stability of relationships of participants in 2006-2008

Dependent variable	*Pctrepeated20068*		
Number of obs	197		
	Coefficient	**Robust standard error**	**Sign.**
p2002ITT	0.025	0.032	
p2002171	0.220	0.099	**
p2002172	-0.004	0.058	
p2004171	0.100	0.072	
p2004171E	0.035	0.055	
p2005171	0.069	0.017	***
avgdiversity_20025	0.034	0.028	
avgfunding_20025	0.000	0.000	
avgpctSC_20025	0.103	0.466	
avgp_20025	0.001	0.004	
avgfunding_20068	0.000	0.000	
avgpctSC_20068	0.022	0.025	
avgp_20068	0.015	0.007	**
_cons	0.042	0.172	

Note: * 0.1, ** 0.01 *** 0.001. F(31, 165): 9.20, Prob > F: 0.000, R-squared: 0.4853, Root MSE: 0.24836

Participation in the two programmes that provided funds only to projects that had a minimum number of participants (172_2002 and 171_2005) had a significantly positive effect on the stability of relationship in the subsequent period. We have already noted how this constraint seems to have encouraged the involvement of new participants in the programme; this result seems to suggest that these participants have also gone on to form relationships that were repeated in the second period. There was a positive effect of average number of partners in 2006-2008 on the stability of an organization's relationships in the same period, suggesting that organizations building larger networks relied to a greater extent on partners they had already collaborated with. This may be explained on the basis of the need to be able to rely on trusted partners with whom communication and knowledge exchange are easier, when managing the complexities of larger networks.

When considering the control variables (not shown), we find that local governments tend to have a greater share of stable relationships, and hence do not appear as playing a role of brokers of new relationships in the networks. Organizations involved in projects in certain technological areas, especially those can be characterized as "high tech", are less likely to have a greater share of stable partnerships. This provides some (weak) support for our suggestion that projects that entail greater technological complexity and that may have the potential for more radical innovation aim for greater novelty in the partnership's composition.

6. Conclusions

In this paper we have shown, using some simple econometric tools, how the imposition of constraints on network formation in the context of policy interventions

supporting innovation networks may have some learning effects, stimulating the participants' ability to form heterogeneous and stable partnerships, although not always in the direction envisaged by the policymaker. This analysis represents one step in a wider research programme focused on the exploration of innovative analytical tools in order to investigate the behavioural effects of policy interventions, which involves the use of qualitative research, econometric analysis and static and dynamic social network analysis.

References

1. Lane, D.A. and R. Maxfield (1997) 'Foresight Complexity and Strategy', in: W.B. Arthur, S. Durlauf and D.A. Lane (eds.), The economy as an evolving complex system II. Redwood City, CA: Addison Wesley.
2. Chesbrough, H. (2003) Open Innovation: The New Imperative for Creating and Profiting from Technology. Boston: Harvard Business School Press.
3. Autio, E., Kanninen, S. and Gustaffson, R. (2008). First- and second-order additionality and learning outcomes in collaborative R&D programs, Research Policy, 37(1): 59-76.
4. Clarysse, B., Wright, M. and Mustar, P. (2009). Behavioural additionality of R&D subsidies: A learning perspective. Research Policy 38: 1517-1533.
5. Nooteboom, B. (2000). Learning by Interaction: Absorptive Capacity, Cognitive Distance and Governance. Journal of Management and Governance, 4(1-2): 69-92.
6. Russo, M. and Rossi, F. (2009). Cooperation Partnerships and Innovation. A Complex System Perspective to the Design, Management and Evaluation of an EU Regional Innovation Policy Programme, Evaluation, 15 (1): 75–100.
7. Howells, J. (2006), Intermediation and the role of intermediaires in innovation. Research Policy, 35: 715-728.