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The emergence of an innovation ecosystem in a low innovation region: Disrupting inertia by a young university

Elisa Villani, Christian Lechner

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Elisa Villani
University of Bologna

Christian Lechner
Free University of Bolzano

Abstract

Innovation ecosystems are characterised by a variety of complementary actors and relationships among them. Universities are considered a key player in innovation ecosystems for their ability of generating knowledge and qualified expertise for entrepreneurial innovation. While much attention has been paid to mature ecosystems characterised by cutting-edge technologies, the role of less established universities in less innovative regions, characterised by a lack of relationships, family-owned firms, difficult university-industry collaborations, but great potential, has remained very much underexplored. Based on a longitudinal case study of a young university in Italy, this paper aims at contributing to existing literature by looking at the role of the university in defining actors' positions and relationships in establishing an innovation ecosystem. In doing so, we contribute to existing literature in several ways. First, we highlight that the formation of an innovation ecosystem in a small area highly depends on the university's potential of disrupting established relationships, creating new ones and, thus, playing an active role in designing the ecosystem. Second, we provide a process-based view for understanding the establishment of an innovation ecosystem through the evolution of interactions, roles and activities. Finally, we describe the micro-dynamics characterising innovation ecosystem emergence and institutionalisation and we show that bottom-up approaches are possible as well.

Keywords: ecosystems; university; university-industry collaboration; innovation; longitudinal case study.

JEL codes: M10; 030.

Introduction

It has been widely recognized that the mode of knowledge creation, diffusion and use in contemporary society has changed dramatically (Gibbons et al., 1994). Whereas traditional knowledge was generated within disciplinary, primarily cognitive, contexts – according to the priorities and solutions identified by academic scientists – the 'new knowledge' is widely dispersed among many heterogeneous actors. It is only the interactions and exchanges between them that account for new knowledge generation, and therefore entrepreneurial innovation (Wright, 2014). Hence, innovation has been acknowledged as a non-linear and complex path because of the many interdependencies and interactions involved (Garud et al., 2013). As economic activity is embedded in social relationships (Granovetter, 1985), the notion of entrepreneurial innovation also needs to take into account the social and economic context in which this innovation occurs (Autio et al., 2014). Recent literature suggests that innovation systems may be better understood as regional ones, where the linkages among companies and with university and public institutions facilitate collective learning and increase the likelihood of innovation diffusion (Clarysse et al., 2014; Spigel and Harrison, 2018). As a result, geographical proximity to knowledge generators, such as universities, other public research organizations, firms with R&D departments, industry and non-governmental knowledge production entities, has a positive impact on innovative outcomes (Phelps et al., 2012). However, proximity is not magic and relationships between players determine the functioning of an innovation system.

Following this premise, the concept of innovation ecosystems (IES; singular IE) has begun to emerge in the last decade to explain innovation dynamics and processes. IES "refer to a loosely interconnected network of companies and other entities that coevolve capabilities around a shared set of technologies, knowledge, or skills, and work cooperatively and competitively to develop new products and services" (Nambisan and Baron, 2013, p. 1071). They are the hubs where people, culture and technology interact to stimulate invention and promote innovation across public and private sectors, and in a top-down, policy-driven and bottom-up entrepreneurial manner

(Carayannis and Campbell 2009; Thompson et al., 2018). Contextual characteristics matter and IES allow social actors to benefit from the localised knowledge that spill over from co-located players (D'Este et al., 2012). Technology transfer between universities and companies represents a prototypical example of a relationship capable to take advantage of physical proximity (Villani et al., 2017; Boschma, 2005), as it implies a bi-directional interaction where continuous learning and exchange processes are required (D'Este and Iammarino, 2010). Therefore, IES require, first, a variety of complementary players, and, second, sufficient relationships among actors.

Universities are considered one of the key actors in the production of this externality for two main reasons: a) because of their traditional function of providing qualified personnel to local firms and public organizations, and b) because university-industry collaborations have been acknowledged to be positively correlated with innovation outcomes (Mercan and Goktas, 2011). This is why being located in a geographical area where leading universities and public research institutions are present has been recognized as a big advantage for companies and innovative start-ups (Clarysse et al., 2014). At the same time, universities in Italy have been commonly criticised for their lack of inter-connectedness with other institutions. An increasing number of studies look at firm's performance and entrepreneurship in IES, but take a firm-level perspective (Nambisan and Baron, 2013; Adner and Kapoor, 2010). For example, previous literature has paid attention to the mechanisms through which firms create competitive advantage in ecosystems and to the value creation dynamics within this complex social and economic context (Borgh et al., 2012; Lechner and Leyronas, 2012; Clarysse et al., 2014).

The strength of university-industry relationships is an important dimension of an IE, but the outcomes they produce have a different impact depending also on the support mechanisms that a local context may provide. It has been shown that the level of financial development, the presence of specific entrepreneurial support services, and the industrial composition of a particular context can generate different business opportunities (Munari et al., 2016; Giuri et al., 2014; Fini et al., 2009). The instruments and policies put in place by universities to support innovation in a territory

can vary much, depending on their experience, the resources made available, the phase of intervention, and the type of activities promoted (Sanchez-Barrioluengo, 2014).

Although universities have been acknowledged as key players in accelerating innovation making in IES, the specific role they have in these ecosystems has been largely overlooked (Cesaroni and Piccaluga, 2016). The role of the university in an IES needs to be understood at the systems level and therefore depends on how the university impacts the cultural, material and social factors that characterise the IES (Spigel, 2017). While the university is potentially a place that provides material resources to an IES in terms of knowledge, it is less clear how the university contributes to the culture and function of the IES' regional networks. The impact and thus the role of the university highly depends on the role played by other actors in the ecosystem. Described as an "interconnected network of companies and other entities" (Nambisan and Baron, 2013, p. 1071), the ecosystem can be intended as a bounded area defined by specific actors' positions and relationships. Existing literature considers these two dimensions as already established, possibly changing over time (Adner and Kapoor, 2010; Autio et al., 2014), but it does not consider the case where they have to be defined and the role that universities can have in this respect. While there is evidence that a series of industry clusters have been emerging around universities with a high reputation in correlated specific domains (Tötdling, 1994; Powell and Owen-Smith, 1998), we do not know how universities contribute to the creation of an IE in the geographical area they are settled in and, more specifically, which specific activities and processes of knowledge and technology transfer they can initiate to this particular purpose (Thompson et al., 2018).

While much attention has been paid to highly innovative contexts characterised by cutting-edge technologies (such as the Silicon Valley) (Kenney et al., 2014), the role of less established universities in those isolated and less innovative regions, characterised by family-owned firms, difficult university-industry collaborations, but great potential, has remained very much underexplored (De Massis et al., 2015). Given the important role of universities in the generation of knowledge and qualified expertise for entrepreneurial innovation (Clarysse et al., 2014), this study

wants to contribute to existing literature by looking at the role of the university in defining actors' positions and relationships in establishing an IE. We aim at answering the following research question: *Which activities does a young university implement to promote the emergence of an innovation ecosystem in a region characterised by low innovation but high employment, and how does this affect the whole system?*

Based on a longitudinal case study, we look at the system of activities adopted by a young university in its effort to disseminate knowledge, build external relationships and, in general, manifest its academic engagement for navigating the emergence of an IE through better defining the position of actors in the system and, even more importantly, adopting a grass-root marketing approach for the creation of those relevant relationships in this evolutionary process. The study highlights the system of activities adopted by the University in this initial phase for better identifying the kind of resources, goals and key priorities for setting up the specific mechanisms of value creation and appropriation for establishing an IE. While outcomes are difficult to assess since they occur only in the long run and since concurrent developments cannot be isolated from the university-ecosystem relationship, outcome evaluation has been done through exploring perceptions of the stakeholders in the IE.

From a theoretical standpoint we contribute to existing literature in several ways. First, we generate new insights into the role of the university for the generation of an IE. More specifically, we show that the university may play a key role in disrupting the status quo of a local context, promoting the development of new relationships, as well as the consolidation of the existing ones, and driving the whole process of the emergence of an IE across different phases characterised by different evolutionary processes. In this respect, we answer to the call to take into account a university perspective, instead of an entrepreneurial one, in better understanding IE formation and functioning (Cesaroni and Piccaluga, 2016). Second, we add evidence to the relational and temporal micro-dynamics characterising IE emergence and institutionalisation (Thompson et al., 2018; Spigel and Harrison, 2018). Against the common argument that adopts an exogenous and top-down

focus for ecosystems generation, we show that bottom-up approaches are possible as well. We highlight an endogenous process through which initial interactions among a few individuals become diffused over time, attracting additional people, until the relationships get institutionalised. Accordingly, the development of an IE heavily relies on the commitment of some believers devoting effort to this activity. This, in turn, makes a contribution to the importance of micro-social interactions as a resource for and catalyst to ecosystem creation (Thompson et al., 2018). Third, with our longitudinal study we provide a three-steps process model by explaining the relationships between stages and the evolutionary dynamics characterising the passage from one stage to the next one. The adoption of a process-based view seems to be very much appropriate for better understanding complex phenomena like the establishment of an IE where multiple actors are involved (Spigel and Harrison, 2018). Other minor contributions are also reported at the end of the paper in the discussion section.

Innovation ecosystems and the role of universities

The notion of ecosystems originally appeared in ecology, where it describes the association between a set of living organisms and their environment. In management literature, different types of ecosystems are analysed: business ecosystems (Teece, 2007; Pierce, 2009); knowledge ecosystems (Almeida and Kogut, 1999; Whittington et al., 2009); entrepreneurial ecosystems (Voelker, 2012; Thompson et al., 2018; Spigel and Harrison, 2018); and IES (Adner and Kapoor, 2010; Nambisan and Baron, 2013). Thinking in terms of ecosystems enables scholars to highlight the importance of the collective action emanating from the actors themselves, an aspect that seems essential for the development of innovation. Indeed, the concept of innovation has evolved toward a social network perspective (Ritala, 2012) that has stressed the importance of the convergence of different kinds of knowledge that are retained by a multitude of different actors and not available in any single firm (Hidalgo and Albors, 2008). Cohen and Levinthal (1990) argued, for instance, that innovative performance is highly influenced by the ability to find and exploit external knowledge. Chesbrough (2006) highlighted that the more a firm remains focused internally, the greater its

likelihood of losing out on innovation opportunities. Adner (2006) considered collaboration with clients, suppliers, and even competitors as a key determinant of firms' innovativeness. IES truly correspond to a set of interconnected actors (i.e., firms, universities, financing institutions, policy makers) and the multitude of relationships established by them that concur to foster innovation and innovative culture within a local environment (Oh et al., 2016; Nambisan and Baron, 2013).

However, two main weaknesses exist in existing literature on IES. First, the ecosystem is mostly considered either in its mature phase or during its transformation, meaning that – independently from the complexity of its structure – each player is considered as already having its given space in the ecosystem and some defined connections that could eventually change during time. Thus, some actors may hold more important positions than others in terms of value creation (Iansiti and Levien, 2004), but the ecosystem is usually treated as already established. This is the case of the A380 super-jumbo passenger aircraft where the IE did not comprise only Airbus as the core innovator, but also its upstream suppliers and its downstream buyers, all of which have a specific role in the ecosystem (Adner and Kapoor, 2010). This is also the case of Apple's iPhone ecosystem, Google's Android ecosystem, and the Linux open source community (Nambisan and Baron, 2013; Rohrbeck et al., 2009). Accordingly, the case of emerging IES remains very much overlooked in existing literature, especially for what concerns those small and medium size areas where many universities are located in many countries, like Italy (Lazzeroni and Piccaluga, 2015), and where the process of legitimacy acquisition on the side of network actors has not been really initiated and completed (Lechner and Dowling, 2003). Second, the role of universities in IES has received very little attention, although there is wide recognition of the huge impact that knowledge, technologies and resources transferred from universities to the local territories have on industrial upgrading and innovation activities (Giunta et al., 2016). Most of the papers dealing with regional innovation systems take the point of view of entrepreneurial firms, or ecosystem leaders (Nambisan and Baron, 2013), to analyse how contextual influences affect entrepreneurial innovation (Autio et al., 2014; Clarysse et al., 2014). Whether the role of universities in already established ecosystems

is quite well understood and is concerned mainly with providing qualified labour for entrepreneurial organizations (Mercan and Göktas, 2011) – as in the case of Apple ecosystem – it becomes less evident how universities can contribute to the area they are settled in for becoming more engaged with the regional and local industrial communities and, in turn, navigate the emergence of an IE (Camuffo and Grandinetti, 2011). This becomes even less clear if we move the attention from U.S.-like contexts to less vibrant realities mainly populated by family-owned SMEs (De Massis et al., 2015).

That means that current research on IES considers the number and variety of actors as given, the spaces taken by specific but complementary actors as defined and the interrelationships between the actors as established and somehow developed over time. Successful IES score high on the number and variety of complementary actors and the network of relationships is sufficiently dense (Mack and Meyer, 2016). Unsuccessful IES lack these characteristics (Mack and Meyer, 2016; Spigel and Harrison, 2018). However, what moves an IES, especially those at their beginnings, towards a success trajectory remains a largely unanswered question.

Accordingly, in this paper we want to address these weaknesses by answering the following research question: *Which activities does a young university implement to promote the emergence of an innovation ecosystem in a region characterised by low innovation but high employment, and how does this affect the whole system?*

The setting

Our case concerns a young university settled in South Tyrol. The context in which this 20-year old university (hereafter referred to as University) is situated consists almost exclusively of family firms that are poorly engaged in innovation-related activities.

Such a context is usually characterised by a lack of relations between different stakeholders, which also leads to a lack of reciprocal legitimacy-granting. Legitimacy can be understood as the community's perception that an actor's actions will be acceptable and useful for the community (Suchman, 1995). The capacity for an actor to interact with other members of the entrepreneurial

ecosystem depends on the actor's acknowledged legitimacy within the ecosystem (Battilana et al., 2009). It has been advocated that understanding the sources of legitimacy (Deephouse and Suchman, 2008), legitimation processes (Greenwood et al., 2002), and the consequences of legitimacy (Deephouse and Suchman, 2008; Meyer and Rowan, 1977), offers the potential to advance research into ecosystem dynamics. Figure 1 shows that R&D expenditure of private firms and total R&D spending in Bolzano are well below the national average, while unemployment figures are the lowest in the country.

Insert Figure 1 around here

This case setting is somewhat extreme as, on one hand, there is little tradition for innovation activities and, on the other hand, given the high employment level, there is little incentive to engage in more proactive innovation behaviour. So, whether the region might have the material resources for innovation activities, the other elements for an IES, namely innovation culture and networks, appear as underdeveloped.

Methods and data

Research design and case selection

With the aim of providing a better understanding on the role of universities on the emergence of an IE in a small region that is far from the more vibrant high-tech clusters, we used an inductive, longitudinal and ethnographic field-based case study, which is judged as appropriate for grounded theory building (Glaser and Strauss, 2017; Eisenhardt 1989). Whereas a single case study limits somehow the generalisability of the findings, it also provides a great opportunity to really go in-depth in understanding the phenomenon of interest, especially when it aims at describing how a process dynamic unfolds. This methodology was particularly suitable for the purpose of our study for a series of different reasons: (a) it enabled us to closely investigate the different stages of a very complex phenomenon; (b) it was absolutely suitable for our purpose of building theory about an

unaddressed problem that deserves more attention from extant literature; (c) the focus on a single case was much more helpful compared to other possible research designs considering that we were interested in the temporal dimension of the phenomenon and its evolution over a long period of time (Langley, 1999). Since our objective was theory elaboration and extension (Eisenhardt, 1989), we did not define any theoretical concepts or assumptions at the very beginning of the study, but we repeatedly returned to the literature after each round of data collection in order to establish a connection between the findings and existing theory on IES.

The case under investigation was chosen for three main reasons: (a) the case proved to be such a 'revelatory, extreme case' (Yin, 2003; Eisenhardt, 1989) for the observation of theoretical issues connected to the role of universities in IES located in provincial, low-tech, and low-innovative areas; (b) the authors were personally in charge to follow the process initiated by the University for the establishment of an IE in the South Tyrol region. Accordingly, they have access to all the relevant information and data and can be considered among the most informed people on the activities initiated by the University in this respect; and (c) the selection of the case was perfectly in line with the idea of investigating a process of IES emergence from its very beginning, since at the time we started our study nothing existed in terms of structurally organized technology transfer and innovation activities in that regional area.

In order to improve the validity of our study, we adopted some strategies commonly used in longitudinal qualitative research. First, we triangulated data coming from different sources: individual interviews and focus groups; documents; and personal observation of the processes and activities taking place from 2014 to 2018 (Eisenhardt , 1989; Yin, 2003). Second, we collected data at different stages of the process in order to avoid retrospective bias and other possible respondents' bias by comparing the answers at each stage and among different stages.

Data collection

Data collection started in November 2014 with a focus on a specific project labelled "*Knowledge Transfer Platform*" (hereinafter KTP, Platform) – submitted to a competitive selection by one of the

authors and finally financed – which was intended to initiate technology transfer activities between the University and the local environment. The process of data collection followed three interconnected and recurring steps, and came to an end at the beginning of 2018. In the first step, we gathered information in order to have a deep knowledge of the history of the University, its activities, evolution and vision, as well as of the local context in which it operates. It was at this stage that we tried to better understand its internal functioning at a general level, and to detect possible relations with external stakeholders. In the second step, the focus was much more at the individual level, and we collected data both from internal and external key informants. In this case, our interest was essentially devoted to identifying the specific mechanisms at play within the University with respect to technology transfer activities, and to discover existing research-oriented collaborations with external partners or even nascent contacts. In the final step, we made an effort in gathering data at the group level with the aim of observing the interactions between different points of view and catching norms and practices governing the internal functioning of Faculties and external opinions by industrial and administrative representatives.

We relied on five different data sources in order to get reliable and objective information (Lincoln and Guba, 1985): 1) documentary external and internal data about technology transfer processes and ongoing collaborations from 2013 to 2018; 2) semi-structured interviews during the period 2014-2018; 3) focus group sessions mainly with internal stakeholders; 4) field observations by both researchers in the period November 2014 to February 2018; 5) written feedback from relevant stakeholders collected at the beginning of 2018. We ended up with more than 400 pages of material, including archival data and notes from field observations, 77 interviews with internal and external people, 15 focus groups, and 25 written feedbacks from internal and external stakeholders. All interviews were recorded and transcribed. The duration of the interviews ranged from 30 to 60 minutes. Most of the informants were interviewed more than once during the period of investigation, both to get clarifications and look for changing opinions and practices. We followed an interview protocol that was adapted to the characteristics of different informants and adjusted

according to emerging theoretical constructs (Patton, 2002). The general and open approach adopted at the very beginning was more and more customised during the process to take into account changing conditions and to progressively identify and include all the people actually involved in technology transfer activities. Instead, focus groups were designed in a way to have people from the same research area and/or the same sector together, with the aim to better grasp the specific ideas they had about technology transfer and innovation enhancement. This approach was very helpful in complementing and validating our understanding on the information received from individual interviews. As another source of information, we also relied on the hundreds of informal meetings and talks with people personally or indirectly involved with knowledge transfer and innovation issues. Finally, we also collected written feedback from internal and external players involved at different levels in the many activities developed during this four-year process. At this stage the questions were mainly related to investigating how the University affected the establishment of contacts with previously unknown partners, the beginning of new collaborations and future expectations about the role of the University within the territory.

Therefore, a combination of different perspectives towards the role of the Free University of Bolzano in navigating a local IE was utilized in order to ensure the reliability and validity of the research. Table I provides details on our data sources.

Insert Table I around here

Data analysis

Consistent with the objective of identifying the process leading to the emergence of an IE from the point of view of the University, two analyses were critical: the construction of the issue's history as depicted in activities, actions, and events from 2014 into 2018, and the use of theme analysis to explain the change in people's behaviours and approaches over time. Both analyses emerged from an identifiable set of steps.

Temporarily bracketing approach. We applied a *temporarily bracketing strategy* (Langley, 1999) in order to decompose the huge amount of longitudinal data into successive adjacent periods characterised by stable activities and linear patterns within each period, and by discontinuity and change from one period to another. This type of analysis was quite helpful in our case for identifying key temporal blocks, each of them characterised by a specific approach towards innovation activities and technology transfer issues. This was useful in making sense of the change in the activities carried out at the university level and at the context level, but also in making sense of the different behaviours and actions observed in this evolutionary process by the diverse stakeholders. At the end of this analysis we were able to identify three main temporal phases. In the first phase, "*resources audit and shaping minds*", in the period 2014-2015, we found a small group of people inside the University trying to sensitise the academic community to an innovation culture and to promote the importance of collaborations with enterprises so as to increase the economic and social impact of the research performed. We identified a second phase, "*standardising and connecting*", that evolved throughout 2016 and reported a shift in the approach used by the University at the central level, which became more directly and institutionally involved in those activities envisaging a connection with the external environment both in terms of particular joint research projects, but also with respect to more practical initiatives. The last phase, "*emergence of an innovation ecosystem*", was initiated in 2017 and is still in progress. The approach adopted by external relevant players in the environment towards technology transfer issues and the opinion they had about the skills and competences inside the University changed significantly. This was the phase where the push-based approach characterising the second phase started to transform in a combination of push- and pull-based systems and in the establishment of an IE.

Grounded theory approach. Following common practice in qualitative management research (Strauss and Corbin, 1990), we coded interviews and documents inductively with the aim of identifying important relationships between data, emerging themes and the existing literature. In particular, we used the grounded theory approach to identify the changing approach towards

technology transfer activities, on one hand, on the part of the University and, on the other hand, by the external partners. While the objectives of the first strategy was to individuate different phases within the whole process of the emergence of an IE, and differentiate them according to the different activities being initiated by the different players, the purpose of this strategy was to focus on the evolving, changing behaviours of those players and connect them to the different phases identified with the temporarily bracketing approach. Therefore, whereas in the first step we focused on the activities carried on by different players at different levels, in this second step of analysis we focused more on actors' attitudes and behaviours that explain better the pattern of historical interpretation over time. We applied a grounded theory strategy to all three temporal phases and, again following standard practice, we conducted the data analysis in each phase in a number of stages.

The analysis always began with an open coding process in which we tried to construct general categories. Following Corley and Gioia (2004), we often used in-vivo or first order codes (Glaser and Strauss, 2017) drawn from the lexicon used by the respondents or an evocative phrase when no in-vivo code was available. This open coding was refined over time, as we read and reread the transcripts, creating new, more precise codes and adjusting the existing ones. Through a comparative analysis of the text, the objective of the second phase was to give the same code to events, acts or happenings that share common characteristics. These codes were identified as first-order codes. We then proceeded from raw data and first-order codes to second-order categories. The second-order categories or theoretical themes differentiate from first-order codes, as they are positioned at a higher level and are more relevant from a theoretical point of view. Accordingly, we worked back and forth with the existing literature during this process to help us to clarify and extend our analysis. In sum, we proceeded from "organizational categories" (Maxwell, 2008), which represent the broad subjects around which we organised our interviews/meetings, to substantive categories that constitute the first, descriptive segmentation of data, and, finally, to an abstract framework for outlining conclusions. We used tables to organise the data (Miles and

Huberman, 1994) in order to facilitate the analysis during the identification of patterns and to minimize the likelihood of making a mistake in translating information. Moreover, throughout the analysis we triangulated interviews with archival documents so as to avoid possible bias during data analysis and to ensure a deeper understanding and reliability of results (Maxwell, 2008).

Thus, the application of a grounded theory approach for the analysis of the first phase, 2014-2015, followed all these steps mentioned above and was specifically intended at understanding the opinions and ideas of different internal and external stakeholders with respect to technology transfer issues at the time when we started our analysis. This starting point was absolutely crucial for catching subsequent changes. The second-order codes linked to this phase are "*individualistic approach*" and "*customized practices avoiding centralized control*". Taking advantage of the fact that this approach permits the constitution of comparative units of analysis for the exploration and replication of theoretical ideas, the same steps of analysis also were applied to the second and third temporal phases. The purpose of each of these two phases was to identify the potential changes in actors' behaviours and approaches with respect to the immediately antecedent period. In both cases we were able to define second-order themes. Whereas "*soliciting standardized rules*" and "*aiming for increasing external contacts*" characterised the second phase, 2016, "*replicating university's approach in external environment*", "*consolidating third mission activities*" and "*diffusing and strengthening an innovation culture*" depicted the third phase started in 2017. The resulting data structure is presented in Table II.

Insert Table II about here

Findings

University's actions and behaviours in the establishment of an innovation ecosystem

Although we present the different phases as separated one from another, they are very much interrelated and sometimes merged into each other. The path that we present below should be

thought of as an evolving history of interpretations, actions and behaviours, which offers important insights into the process initiated by the University for navigating the emergence of an IE in the South Tyrol region.

The three temporal periods are described in terms of two main components: *key actions undertaken* and *behaviours*. The key events and actions of each phase represent the most important elements for comprehending how the University interpreted the issue of technology transfer and innovation at each point in time and, consequently, the approach adopted in this respect. We avoid making a causal inference between actions and behaviours, since this would imply a systematic connection between the two and the causal path was not always very clear in terms of what caused what. However, we also wanted to observe the change in stakeholders' behaviours, in order to strengthen the process evolution and better identify the different phases. Our final objective was to provide a relatively complete description of how actions and behaviours coevolved over time, leading to the creation of an IE.

First period, 2014-2015: Resources audit and shaping minds

Key actions undertaken

2014 started with the application made by one of the authors for funding a three-year project intended to create a "*Knowledge Transfer Platform*", whose objective was to establish technology transfer competences at the University level and start a dialogue between the University and the external environment. This should be considered as the very first attempt to include technology transfer into the strategic plan of the University. The project was finally founded and a team of 5 people, including the two authors, was in charge of it. The team basically acted as an independent unit, almost completely detached from the University's central administration. At that point, the team divided itself into two sub-groups, the first one responsible for dealing with people inside the University, and the second one in charge of establishing some external connections, both with enterprises and institutional organisations. As a result, two main activities were initiated towards both directions: *individual interviews* and *focus groups*.

Individual interviews were organised around common topics, such as previous experience in university-industry collaborations, involvement in technology transfer activities and application of research results to the entrepreneurial context. The main purposes of this initiative was, on one hand, to acquire knowledge on the specific skills and capabilities at the individual level for the different research groups working in the five Faculties (i.e., Engineering, Economics and Management, Design, Informatics, and Education) and, on the other hand, to understand particular technology and innovation needs by the side of the external partners operating in the external context. While two people of the Knowledge Transfer Platform team carried out 43 interviews with academics, the other two people took care of the interviews with some entrepreneurs and institutional players, such as the President of the Chambers of Commerce, the Regional Innovation Office, the Regional Technology Incubator and some other people dealing with innovation issues at the Province level. 34 interviews were finally carried out with external stakeholders (i.e., entrepreneurs and representatives of local institutions). A huge amount of work was necessary for identifying those people to be included in this first step. From an internal point of view, we took advantage of a program used by internal staff for uploading research activities and projects. An accurate scanning process allowed identifying those projects having a higher impact on society and, therefore, potentially reaching greater interest from outside. The process took a couple of months, and the 43 academics involved in these projects were identified as the most interesting interlocutors at this stage. As for the interviews with external players, the KTP team started from the general topics identified with the previous step and, accordingly, tried to look for those enterprises operating in the same sector. In this respect, we mainly relied on information owned by the Chamber of Commerce.

It is worth noting that the KTP team did not receive any form of support from the University – as an institutional player – at this stage. This meant that it had to motivate people to participate in this initiative individually, by sponsoring the Platform as a special and innovative mechanism for helping the enactment of third mission activities. In this respect, the answer that the team received

from an academic researcher when he was contacted for scheduling an appointment is quite interesting:

> *The activities you're planning are very interesting, but I was wondering whether the University has any sort of interest in what you're doing.*

Focus groups represented the second activity developed by the KTP team. Whereas individual interviews were intended to collect individual experiences and points of view about past collaborations with enterprises and the attitude towards the possibility of initiating future technology transfer projects, the focus groups were mainly driven by the idea of fostering innovative thinking through the comparison of similar experiences and expertise. The KTP team actually tried to exploit the common technological knowledge present in the different research groups in order to stimulate discussion and brainstorming. The final purpose was that of enhancing awareness and commitment in an open way towards technology transfer issues and university-industry collaborations that were never treated at the University level in a systematic way. The 15 focus groups were organized in four different Faculties – Engineering, Economics and Management, Design, and Informatics – and they involved from 4 to a maximum of 7 people. The KTP team selected the groups, paying attention to their fields of expertise in order to make sure that the people included in each focus group were all from the same research area. This was a very important condition at that time, as the purpose was to mix more and less experienced researchers with respect to external collaborations, without making the level of communication among them too difficult. The KTP was in charge of coordinating the meetings. Each focus group started with a brief presentation made by each participant about previous experiences in research projects with external partners, and immediately after an open discussion on related issues was stimulated by the two people of the Platform team attending the meeting. Examples of some topics treated are the following: visual communication and design in city areas, climate and ecosystems change, mountain technologies, private finance and social housing, etc. Also, in this case the KTP did not receive any form of support from the University, although central administration was informed

about the activities undertaken. A similar activity was also carried out with external players.

Behaviours

The widespread set of activities initiated by the KTP in this 2014-2015 phase were of great importance in capturing opinions and behaviours on the part of internal researchers and external players about knowledge and technology transfer. What we observed was an attitude of clear detachment from the topic and strong scepticism towards the real benefits that such collaborations would have brought in terms of intrinsic and extrinsic rewards. A full professor during an interview at the beginning of 2015 said:

> *How can I convince my post-docs and junior researchers that starting research projects in collaboration with enterprises is a rewarding idea? I had some experiences of external partnership, but none of them really successful. At the moment, my interest in the region is just because it provides those natural resources that allow me doing my research on the mountains and publishing. External actors, being them enterprises or institutions, are not very interesting at this point…*

This represented a common point of view reported by researchers inside the University. More specifically, the authors observed a general tendency of avoiding collaborations with external partners, which were not directed by personal relations. Two aspects were highlighted as the main reasons for adopting this behaviour: a) lack of administrative support at the University level (i.e., an associate professor participating in a focus group in mid-2015 stated: "*I would have dozen interesting collaborations waiting to be started. But, if I follow all the administrative stuffs required for getting the documents ready and the collaboration started, I stop doing research. Honestly, this is a very huge barrier in this University*"); and b) lack of a university culture incentivizing and recognising the importance of these activities (i.e., a professor interviewed by the Platform team in 2014 said: "*technology transfer is not really a strategic issue inside the University; we neither have internal legislation in this respect, nor we have a structured office taking care of these activities. Why I should devote effort to technology transfer?*").

The same critical attitude was observed by other players in the region as well, but from a

different perspective. Institutional organizations, like the Chamber of Commerce, and entrepreneurs stressed the absence of cooperation with the University and the poor presence of the University within the local environment. Basically, there was a significant detachment between the entrepreneurial activities developed in the territory and the research activities carried on by academics. In 2015, the owner of an important family enterprise noted:

> *The University is very young but we expected much more in terms of collaborations and joint activities. Indeed, most of the students – after their graduation – look for a job in the region and it would be very useful for both parties to start a dialogue for improving the fit of profiles and analyse innovative cooperation paths.*

Summing up, this phase was characterised, on one hand, by the absence of a strategic vision on technology transfer issues as well as by a lack of any administrative support on the part of the University, and, on the other hand, by strong scepticism and mistrust by internal and external players towards possible joint collaborations. These behaviours were reinforced even more by the fact that a clear idea on the different possibilities for undertaking technology transfer and innovation activities was missing at all levels.

Second period, 2016: Standardizing and connecting

In 2016 some relevant changes occurred both in terms of activities promoted at the University level and in terms of stakeholders' behaviours with respect to technology transfer aiming at increasing innovation impact. These changes were substantially due to an increased awareness of the importance of technology transfer as a strategic aspect for making the role of the University more determinant and acknowledged by other institutional and entrepreneurial players in the region. Accordingly, the change could be attributed mainly to the recognition that technology transfer activities extend far beyond a general theoretical idea.

The activities carried out by the KTP team in 2014 and 2015 represented an important antecedent factor fostering the subsequent evolution of activities performed in this second phase. The most important evidence, at that stage, was the shift from an approach through which

technology transfer was promoted by a few individuals, to an approach very much centred on considering technology transfer as a strategic dimension of the University's mission.

Key actions undertaken

In this second phase, the effort put in place by University central administration in the adoption of a more informed method for dealing with technology transfer issues and for managing relationships with external stakeholders was immediately evident. The turning point actually could be identified at the beginning of 2016, when the President and the Rector of the University asked for a meeting with the Knowledge Transfer Platform team in order to discuss the activities they had organised and future developments in this respect. Based on the information that the KTP provided with respect to (a) the criticisms raised by the researchers within the university, (b) the points of view of external partners, and (c) the multitude of resources available internally and exploitable for enhancing the innovative potential and the impact of the University in the region, the University undertook an important legitimisation process at the institutional level. Several actions were initiated, and we describe the most important two - the *design of a legal framework for technology transfer* and the *organization of several matching events* – as follows.

The *legal framework* was intended to provide standardised guidelines for intellectual property (IPR) rights and also to provide for the creation of spin-off companies originated from academic inventions. The mandate for the completion of this framework was given to the Platform, under the supervision of the general manager of the University and the head of the central Research Office. For the first time the University was personally and formally involved in the implementation of actions addressed for the establishment and diffusion of a technology transfer culture. The IPR regulation was developed in a 6-month period through a complex process of repeated meetings with the general manager, external advice from experts in the field, and consultation with parties interested in the output. It was a highly inclusive process in which different levels within the University were involved at different stages. At one point, for example, expert advise was needed on specific technical aspects related to the establishment of different committees in charge of

following the IPR registration process. It was decided to have the point of view of one of the main experts in Italy on this issue, and three people went to visit him in Bologna. The central level of the University pushed very much to have a person from the central administration participating in the meeting; this was a clear sign of the new approach undertaken by the University for technology transfer matters. Even the Rector was involved in revising the document, with the aim of improving some specific aspects strictly related to the specific academic context. In 6 months the KTP team, together with employees at the University's central administration, were able to develop a formal document for IPR guidelines, get it approved by the University Council and have it ready for application. The commitment of the administrative level was significantly important in making this step.

Matching events were the second type of action stimulating greater openness towards technology transfer activities at the University level. The idea underlying these events was that of gathering together academics, entrepreneurs and representatives of local institutions for the purpose of fostering a discussion on topics of common interest. Four different matching events were organised on renewable energy, big data and data science, wine and the wine business and publishing. Each followed the same format, with 5-7 researchers selected from different faculties, 5-8 external partners, and a professional moderator. Four hours were devoted to each matching event, with a first session organised around a brief presentation from each participant, a second part managed by the moderator and centred on finding the most innovative thoughts, approaches and strategies for dealing with the topic under investigation, and a third session in which different round tables were arranged to make academic researchers and external stakeholders interact more closely. These events were intended to diffuse a twofold message: on one hand, the University wanted to push academic researchers towards a more open approach, aiming at initiating third mission activities that were fully supported by a University strategic vision at this stage; and on the other hand, the University also wished to communicate to entrepreneurs and local institutions its intention to be more present in the region for joint activities.

As for the legal framework, in this case the University central administration also acted as a key player in the organisation and promotion of the events. The joint work with the Knowledge Platform team was very helpful in ensuring the success of the matching events. The opening of each event was made by the Rector in person, who highlighted the importance of improving university-industry collaborations and of making technology transfer the most promising means for enhancing innovation in South Tyrol. Three of the matching events were attended also by the University General Manager. The commitment manifested from the highest administrative level of the University had a strong influence on the diffusion of a technology transfer mindset and, as a consequence, internal people who also were involved in external activities were no longer perceived as "off-air" researchers.

Behaviours

The implementation of the legal framework at the University level, together with the matching events and other minor widespread activities organised during 2016 greatly increased University commitment towards technology transfer activities and also enhanced the importance assigned to these activities by internal and external members. We observed a significant change in the approach used by academic researchers in dealing with technology transfer issues. For example, a professor of informatics spontaneously contacted the members of the Knolwedge Transfer Platform to discuss and ask for advise about the possibility of patenting and founding a spinoff based on inventions derived by the research he was conducting. An extract of one email he wrote to a member of the Platform is as follows:

> *Suddenly, it seems that also the University has started to consider technology transfer as an important strategic asset for its mission…the effort you* [the Knowledge Transfer Platform] *made in the last years for diffusing this culture has been finally repaid* […] *Do you have time to discuss about some ideas that I go to discuss them with the Rector and the Director?*

This changed behaviour with respect to technology transfer issues on the part of the University was observed and recognised by many internal and external stakeholders. Some

colleagues from different Faculties started to ask, in an autonomous way, about the possibility to organise and participate in a matching event on their area of expertise. Also, the indifference of academics that was observed during the first stage changed towards a clear willingness to better understand the relationship between the Knowledge Transfer Platform and the University. Some researchers approached members of the Platform at the canteen in order to ask if pushing and supporting technology transfer activities at the administrative level was something in which the University wanted to really invest in in the future. This new interest manifested by researchers clearly originated because the University started to recognise the importance of technology transfer activities as a third mission mechanism for contributing to the external environment in a formal way and, therefore, to allocate internal resources to this purpose. A professor form the Faculty of Economics and Management reported the following during a matching event:

> *After many years, I am really happy that the central administration has finally understood that technology transfer activities deserve greater attention if we want to establish our University as a reference point for innovative projects in the region.*

The same change in behaviours was observed with respect to external stakeholders. All the external partners participating in the matching events were very much surprised that, eventually, the University opened its doors to local firms and institutions to start a discussion on topics of common interest, and expressed interest for the whole region. An entrepreneur in the wine sector said:

> *It is really a pleasure to be here today because the perception in the region has been for a long time to have a good University in providing knowledgeable graduates, but completely close and detached from the environment. I think that starting discussion and collaboration could bring to even more effective results due to a better matching between competences and specific needs.*

It was at this stage that (a) the University, as an institution, started to look outside its internal environment to better position itself in the local context and to offer support for technology transfer activities internally, (b) the researchers became more interested in technology transfer activities as possible source of research funds and innovative outcomes and (c) the external institutions began to

consider the University as a partner for improving entrepreneurial competences in the region.

Third period, 2017-2018: Emergence of an innovation ecosystem

2017 represented the actual turning point towards the emergence of an IE in the South Tyrol region. The greater commitment and interest showed by the University towards technology transfer activities was perceived in a positive way by local institutions and enterprises, allowing innovative and collaborative initiatives to be initiated in a more structured and formal manner. This third phase showed a completely new approach from the University: much more open to the external context and intended to contribute in a real way to the advancement of knowledge within the local society. In reaction, external stakeholders started to manifest their interest in beginning joint activities that increased their impact and visibility, as well as their innovative relevance in the region.

Key actions undertaken

Starting from 2017, the University supported and participated in many initiatives aimed at establishing new links between different actors in the area. There was formal recognition at the central level that innovation is facilitated when new links are formed, when ideas and information race within a network, and new possibilities are investigated through collaborative projects. Accordingly, the University continued to act – and even in a more structured way – as a key player in the creation of this ecosystem with a series of relevant actions.

BITZ Fablab, established by the University at the end of 2017, is a space for meetings and collaboration that is open to a wide range of people, including students, professionals, artists, researchers, private citizens, and entrepreneurs. It is located in the city centre and occupies a space of 300 square metres. The idea leading to the establishment of the Fablab was to provide an open space where everyone can manufacture models and prototypes through digital technologies and manual processes. Promoting the interaction among different players with different skills and capabilities has been considered a key step towards the generation of innovative ideas and the diffusion of a new approach in discovering innovative solutions to complex problems. Fablab is not only the place where people from different fields can pose a question hoping to find a new answer,

but it is also the place for increasing competencies through ad-hoc and specialised training courses. It has stimulated great curiosity, and local stakeholders use Fablab's spaces daily for their activities.

Beyond direct interaction and collaboration, Fablab has started to promote a series of initiatives intended to combine new ways of working and incentivize innovative thinking. A workshop, "Hands On", was organised by Fablab at the beginning of April 2018 to explore new ways to create knitted wool accessories, combining them with simple electrical circuits. Citizens of all ages, designers, engineers, artists and researchers participated in the event to produce wearable prototypes and explore new potential applications. In May 2018, different activities aiming at supporting social interaction were organised, one of them being "Arduino Day" where, in addition to learning about this successful case, participants could bring and present their projects for collective discussion. Fablab is equipped with at-the-vanguard machines, such as 3D printers, laser cutting machines, milling machines, cutting plotters, and many others. The University thus, for the first time, made possible the creation of a physical space whose specific objective was that of establishing a network of different local actors interested in knowledge exchange for innovation purposes.

NOI (Nature Of Innovation) Techpark was inaugurated in October 2017. It is the actual 'proof' of the establishment of an IE in the South Tyrol region. The University had an important part in this process, but the important turning point was represented by the very first combined attempt by different local stakeholders to have a shared place for their activities. University, research institutes, companies, local and international start-ups work and innovate closely, increasing the potential for innovative discoveries. The idea behind NOI Techpark is to focus mainly on those sectors that are considered excellent in South Tyrol, in which the University has enough competencies and in which entrepreneurs have established businesses - renewable energy, alpine technologies, food technologies and ICT and automation. In this environment, companies are able to exploit synergies with the University and five other research institutes: Fraunhofer Institute Italy, Eurac Research, Laimburg Centre, Eco Research and CasaClima Agency. Moreover, IDM

Alto Adige, an agency of the Autonomous Province of Bolzano and the Chamber of Commerce, helps in the management of more than 20 research laboratories.

The University established itself as a fundamental partner for the achievement of this outcome, as it was responsible for establishing those labs where business-relevant research is conducted. This, of course, involved the extension of those technology transfer mechanisms set up during the previous phases described above. As for May 2018, more than one hundred University researchers and technicians work daily at NOI Techpark. The main objective is to attract all companies that want to develop innovative ideas in synergy with the local environment.

How the different actors have trusted in this new concept of multi-side collaboration for innovation is shown by the investment of over 100 million euros by South Tyrol region, which has been doubled thanks to private co-investment. Multinational companies such as Huawei, Maccaferri, Leitner and Grandi Salumifici Italiani have chosen to install their own research centres in NOI Techpark and to work in cooperation with the University and other companies in order to initiate R&D activities in the green, alpine, food, automation and welfare sectors. NOI Techpark is the first big intentional outcome of a process that was initiated a few years ago by the University and was centred on the recognition of some important nodes within the environment and on building relationships among them. Science and industry have been finally brought together with the aim of fostering knowledge transfer mechanisms and enhancing cross-field collaboration for the development of new products, services and processes. Huawei, for example, has already established a technological cooperation with Alperia – a local public institution for energy provision – and the University for the elaboration of ICT infrastructures in the fields of safe and smart cities, as well as in the Internet of Things.

Behaviours

This last phase, which saw the emergence of a real IE in the area under investigation, highlighted a more sensible and advanced approach, not only on the part of the University, but also in the other local stakeholders. A relevant example in this respect has been the proposal of the President of the

Chamber of Commerce to adopt the scheme of "matching events" to be reproduced in his institution. This open behaviour of making the University part of activities organised by the Chamber of Commerce was never observed before. Even more, it was previously absolutely inconceivable to consider the University's initiatives as good practices to be copied and supported. The President of the Chamber of Commerce told us:

> *We would have never thought to take some activities organized by the University as a best practice for improving the services that we offer to local enterprises. The University has always fed the image of an institution completely detached from the concrete problems of this territory. It seems that in the last period this approach has changed considerably and greater effort has been made to give voice to external actors' needs. This is not just our opinion but we have now many feedbacks in this respect also from our associates. There have really worked in the direction of building and strengthening the relationship between different players here.*

The important change in external and internal behaviours was proved with the *25 written feedbacks* that were collected at the beginning of 2018. An entrepreneur who participated in the matching event on 'Big data and data science' reported the following in his feedback:

> *In our case, the University acted as an important intermediary for making possible the collaboration with important local firms. After the matching event, we started collaborations with 3 firms and relevant cross-sector, applied projects have been initiated with very high innovative potential.*

Similarly, an internal researcher wrote:

> *We are assisting to a sort of "revolution" in the approach used by the University with respect to technology transfer activities…the internal environment is incredibly more open and supporting for those researchers who decide to invest in this direction. In this sense you are much more incentivized, also because entrepreneurs have changed their opinion about the University and are more willing to establish relationships. I can say that the whole local context is going in the same direction…*

It is clear that the different stakeholders have learned that a collaborative approach, rather than an individualistic one, is more likely to lead to innovative outcomes. The change of the University's perspective and the promotion of activities intended to meet external requirements, as well as to open up to the ideas of others, played a huge role in navigating the establishment of an

IES. Within this ecosystem, each actor has now a more defined position with respect to the network and is much more connected with the other nodes present in the local environment. Strengthening the network has also meant putting effort into reinforcing every day trust and reliability in each relationship. In this respect, the University has done a good job in enhancing its reputation in technology transfer issues. This was possible thanks to a demanding process initiated a few years ago – with very low expectations – which has led, instead, to the diffusion of a completely different image of the University and the promotion of an important IE. A manager of the Autonomous Province of Bolzano explained:

> *The "optimal" innovative processes needs to adapt to the surrounding environment, and not vice versa, exploiting the strengths of South Tyrol and starting from the skills already present in the area. For many years the problem has been that of having the skills, but keeping them separate. The University made a huge work in this respect and, you know, when something starts to move, then everything is moving. We have now a strong network in terms of private and public competencies for innovation.*

From the feedback we collected, we learned that more than 20 contacts between academic researchers and local enterprises have been stimulated by the University's activities since 2017, 5 research projects on different topics have been started, and local institutions are asking more and more for formal University support and collaboration for strengthening their relationships with local enterprises.

We report in Figure 2 the process model about the emergence of an IE by a young university.

Insert Figure 2 about here

Discussion and Conclusions

The general assumption of our argumentation is that IES exist. This means that they are comprised of different actors, different material, cultural and relational resources and that they are more than the sum of the actors and elements involved (Thompson et al., 2018). Indeed, the functioning of IES

depends on the contingencies of actions by these different players and their embeddedness in the IE. Therefore, IES cannot be reduced to an isolated study of actors and their resources, as the relational social aspect becomes essential in understanding them (Adner, 2017; Spiegel, 2017). But, the presence of the relational dimension is not sufficient per se. The functioning of IES demands also that the actions of the various actors are regulated in order to achieve the system's inherent goals (Cooke et al., 1997). Regulation is to be understood from a system's perspective, meaning that the actions and behaviour of an element are modified by information provided within the system (Luhmann 1995).

The general approach adopted so far for describing the emergence of ecosystems has been based on top-down processes with varying degrees of authoritative action (by governments or powerful other actors), where the necessary actors were already present in the concerned region (Mack and Meyer, 2016), and the exploration of some effects on efficiency and value-creation potential were being explored (Spigel and Harrison, 2018). Instead, very little is known about the formation of ecosystems over time through practices of interactions between actors that are not driven by top-down policy interventions (Thompson et al., 2018). Accordingly, understanding IE as a complex, organized field, and, therefore, focusing on the stages of development of the IE by paying in-depth attention to relational ties, the type of regulation of actors' behaviours and actions and the main mechanisms for structuring it, potentially represents an important contribution to existing literature on the topic.

The starting point in the case of the ecosystem analysed in our study was a situation of systemic inertia: a region with low levels of innovation activity (lack of culture), and a single public actor put in charge to act as the technology incubator for startups, innovation coordinator and finance provider (lack of actors), leading to a context in which interdependencies between activities and actors were not yet generally recognised and thus characterised by low connectivity (lack of relations). It is exactly from this starting condition - i.e., lack of culture, lack of actors, lack of relations - that we can reflect on the role of a (young) university to disrupt that inertia (which can be

understood as a form of low level equilibrium) and navigate the evolution of an IE. A significant point in this regard relates to the recognition of the role of the university within the IE. Whereas the university sees itself as part of it from the very beginning, this might not be the point of view of the other actors. Looking at the university as something distant from practical issues, other players actually have a different perception about it, and this different view constitutes the basis of the first important actions that the university has to undertake in order to gain recognition within the territory (Cesaroni and Piccaluga, 2016; Spigel, 2017).

The three steps described below discuss our findings at a higher level of abstraction, by highlighting the *bottom-up process* of the emergence of an IE and the role that the university plays in it (Thompson et al., 2018). As a consequence, whether or not these three steps have to be intended as strictly linked to the different phases described in the findings, they are logically independent and separated. They are grounded on our empirical evidence, but they build a more general framework for understanding the different steps included in the purposeful process initiated by a university for the establishment of an IE. In any case, since the IE cannot be reduced to actors in isolation (Luhmann 1995), the following arguments need to be seen in their contingencies, neither under-evaluating nor over-evaluating the role of the university.

How an IE takes shape when the university is one key player: a process perspective

Step 1: Individual relationships and institutional void. This step represents the very early moment in the creation of an IE. It is the moment when the institutional level is completely absent and the willingness to change things is left to the initiative of single people. This is the case of our small KTP team at the university in charge of organising TTO-activities. At this stage there was neither an officially communicated endorsement by the university to its members nor to external stakeholders about the role of this group. The group acted basically autonomously in a sort of institutional void. Accordingly, relationships inside and outside the university are established on an individual, dyadic level but not on an institutional level. All the activities intended to build new and reinforce existing relationships are driven by single projects and do not refer at all to an official,

institutional mission. Relationships are established on the basis of the shared idea to promote actions that favour innovation and technology transfer aspects of institutional settings. This clearly explains how the establishment of an IE can be driven by a bottom-up approach (Thompson et al, 2018).

At this stage, the engagement of more actors and the creation of more relationships are both a matter of explicit self-selection and the exclusion of individuals. When asked about the approach adopted, the Head of the KTP team noted that "*there are believers, agnostics and atheists. We will get the believers on board as the pioneers; we will mix them with the agnostics with the hope to transform some of them into believers. We will not waste out time with the atheists".* This approach is favoured by the institutional void: rules and institutions are based on generalised expectations and, thus, complete inclusion through setting standards (e.g., standards for publications are designed to make all faculty members publish at least according to the standards, unless exceptions are specified). Therefore, this is the stage where it becomes important to just focus on those who strongly believe on TTO-activities in order to attract an initial set of dedicated actors, while excluding all the others both inside and outside the university. The initial self-selection is based on the willingness to participate rather than on the level of reputation. This is why, for example, in our case most of the deans of the different faculties did not participate in the initial activities and events, but a variety of junior and senior faculty did. Some individuals openly opposed joining and questioned the project's reason for existence. Important aspects at this stage are trying to attract interests, receiving support and stimulating interaction. Accordingly, the lack of institutional commitment and the voluntarily nature of people-to-people relationships make it impossible for negative voices to have a place to voice protest, signal disengagement and build resistance. Shielded from negative forces, the group of 'believers' has more resources for attracting 'agnostics' and get them involved with the hope of transforming some of theme into committed actors. This finally leads to the recognition that an institutional void allows getting more actors involved, by facilitating the creation of more spontaneous relationships. This viral approach is effective, as

positive voices increase while negative voices leave the system unaffected.

The setup of activities and events, however, needs to be always negotiated with individuals outside the university, even in the absence of an institutional engagement by the university. For instance, in order to develop the matching events, the organisers need to rely on the willingness of outside actors to participate (managers, public servants, etc.), as well as their availability and willingness to share data and personal contacts. The issue about who to include and who not, very much relies on the distinction between believers, agnostics and atheists: whether or not believers' support has be examined in order to incentivise positive word of mouth and, therefore, approach new actors, agnostics and atheists has to be avoided in order to keep negative preconceptions and thoughts from circulating around. This is why, for example, the attentive selection of people to be included in the focus groups and in the matching events helps to reinforce the existing relationships, spread communication and increase the potential contagion for future events, taking advantage of a grass roots marketing approach. This goes exactly in the direction of understanding how different actors start developing shared understandings and doing things together (Thompson et al., 2018; Ventresca and Kaghan, 2008) This finding refines the view that collective beliefs emerge through interactions (Hinings, et al. 2003), as it shows how not only the selection but also the explicit exclusion of interaction partners facilitates the emergence of these collective beliefs.

Step 2: Institutionalising relationships and external regulation. Step 1 in the process of IE emergence observes an increase of individual, connected actors in different institutions. The institutional void at the university excludes pursuing other options. We have seen that relying on people-to-people interactions, individual relationships, and believers' commitment, allow the number of people who organise or are involved in an increasing number of activities and events (focus groups, matching events, startup weekends, global entrepreneurship week, etc.) to increase.

Going ahead in the process, in a second step actions and behaviours get institutionalised moving up the level of interaction from dyadic and individual to institutional in a transition phase (Padgett and Powell, 2012). In our case, this is when internal rules and directives for IP, TT and

external research collaborations were developed and approved by the University council, the highest governance body. Also, larger internal projects that involved all faculties, and that were officially endorsed by the university's top management, were launched under the interim leadership of the KTP team. The University's Fablab is one example of these projects. Thus, whereas the first step is usually characterised by a certain focus on speed to action, in this second step long and open discussion and negotiations with the governing bodies of the university concerning the appropriate governance of the activities and their integration within the official rules and directives of the university. For the BITZ Fablab, for example, a structure of official ambassadors of each faculty was established, formal academic leadership was eventually allocated to one faculty and the operations were institutionalised as an administrative service with formally approved regulations.

Thus, within the second step activities and projects related to innovation become institutionalised after lengthy processes of negotiations and adjustments. While we can describe Step 1 as boundaryless, in Step 2 the scope of actions and responsibilities are established, boundaries are drawn and action spaces delimited on the basis of negotiations with internal stakeholders. This institutionalisation process actually moves the relational level from individual to institutional. Going forward, meeting with external institutions is based on formally delegated roles and responsibilities. For instance, for the FabLab the general director of the University, as its official representative, met in the first place with the general director of the technology incubator, and memorandums of understanding were drafted. At this stage, the scope of activities and the action spaces start to be negotiated with the other members of the IES. Again, in the case of the Fablab, after an initial attempt to develop a common Fablab with the regional incubator (that already had one), the university decided to run its own. This decision exactly addressed an initial need for roles definition and delimitation: while the university Fablab was mainly targeted to students and citizens, for non-commercial use, the Fablab of the regional incubator was enlarged, but mostly focused on targeting firms, industrial uses and more sophisticated prototyping. This negotiation process reached even down to the selection of the machines in order to assure

complementarity. Similar 'negotiations' occurred for the definition of other entrepreneurship and innovation activities and events with other institutions, such as the Chamber of Commerce, the regional incubator, the regional innovation office – for finance support – and an emerging business angel network.

In sum, in this second step, we observe, in line with other research, a significant shift in relations from an individual to an institutional level as a necessary condition for the emergence of an IE (Thompson et al., 2018). This implies a subsequent definition of organisational boundaries, as well as the scope of actions of the actors, in a process of negotiation with internal and external stakeholders (Hoffman and Ventresca, 2002). This means that the elements of the IE are externally regulated on an institutional level, in a way that the behaviour of each actor is mutually adjusted by looking at what others do. The emergence of the university as a new institutional and connected actor leads to a modification not only of its own scope, but also to a modification of the action spaces of the other actors of the IE. Accordingly, the university is formally acknowledged as an actor of the IE for its proactive and determinant role in the creation and institutionalisation of relationships.

Step 3: Institutionalised relations, internal regulation and specialisation. With step 3, the roles and actions defined in step 2 become structured and defined within the IE, with a subsequent decrease in the degree of discretion of each actor for what concerns negotiations and actions to be undertaken. Given their increasing embeddedness, the relational obligations of actors increase (Burt, 1992). This implies that the action space becomes much more delimited and the role specialisation of each actor much higher. Whereas in step 2 we observe a process through which roles and action spaces start to be defined over time through interactions (Hinings et al., 2003), in step 3 increasing institutional agreements constitute the basis for defining the activities to be carried out by each player (Hoffmann and Ventresca, 2002). Indeed, it is at this stage that much more attention is being paid to the optimisation of IE functioning, by avoiding duplication of roles and the ineffective replications of actions among the different actors.

This step eventually leads to another important adjustment and to a final change in the establishment of the IE and its subsequent functioning. With step 1 an increasing number of actors from different sectors and institutions become connected according to individual relationships; then, in a second stage these connections start to be organised around more formal agreements, which begin to define clearer action spaces, even though the level of action autonomy of the actors remains relatively high. Only at the end of the process, with step 3, does the increasing embeddedness of the actors lead to binding obligations and reduced action autonomy (Burt, 1992). Therefore, the big change from step 2 to step 3 actually relates to the different regulation of actors' actions (Luhmann, 1995): whether or not those actions and behaviours are externally regulated in the first case, when they are very much affected by the actions and behaviours of other actors, in the second case the increasing embeddedness, together with a precise definition of the roles, brings a greater specialisation that in turn leads each actor to auto-regulate. In our case, for instance, the activities carried on by the university Fablab are directed towards increasing the number of students and citizens using the it without taking into account the actions and activities of the other actors within the IE. This finding complements recent findings about IE emergence (Thompson 2018) as it links increasing actor embeddedness to institutionalised expectations of behaviour (Suchman 1995), reduced action autonomy (Burt 1992), and to a phase transition (Padgett and Powell 2012) towards internal regulation of actors (Luhmann 1995).

So, accepted role definition drives a form of complementary specialisation, allowing for internal regulation of the system's actors and thus internally driven optimisation.

Final conclusions

What roles do universities play in IES? We have been focusing on a specific case: a young university in a region lacking innovation activity or, even better, in a region where the innovation system appeared somehow frozen. We have identified three separated but interrelated steps through which an IE takes shape and gets established. The University, from being a disregarded actor in the region, developed its reputation by personally promoting activities related to innovation and

technology transfer, and finally made its role accepted and legitimated for the creation of the IE. While the bottom-up process that we have described might be atypical (Thompson et al., 2018), a few implications can be drawn.

First, the entry of the university as a key actor in a regional system potentially unfreezes the existing equilibrium with respect to innovation activities. This highlights the key role of the university in terms of establishing social interactions as a resource for and catalyst to IE formation (Thompson et al., 2018; Spigel, 2017). Thus, with our study, we provide evidence of the impact that a university may have in navigating the emergence of an IE in a small area populated by many family-owned SMEs which also is very far away from innovation hubs (Giunta et al., 2016; Camuffo and Grandinetti, 2011). Moreover, we show that the role of the university in an IE depends on the spaces already claimed by the other actors and by its negotiation potential. In other words, it depends on the distribution of competences and may vary from region to region. In any case, the active role of the university in an IE is a new discovery, which demonstrates the university's potential for disrupting established relationships, creating new ones and, thus, playing an active role in designing IES through shifting collective understanding (Wooten and Hoffman, 2008).

Second, we contribute to the existing literature on IE by providing a temporal aspect of IE development (Spigel and Harrison, 2018). In particular, we add a process lens for understanding IES formation by stressing the evolution of several important dimensions, such as interactions, roles definition and activities, that identify several evolutionary phases before becoming more defined in the final functioning of the IE. Accordingly, an increase of individual actors and individual relationships is critical in this first phase of the process. We found that an institutional void – which potentially seems a disadvantage - turns out to be an advantage in allowing the gathering of dedicated individuals to the overall project. Thus, the institutional void reduces barriers of adoption otherwise created by institutional obligations. Only subsequently, institutionalisation sets in motion a negotiation and adjustment phase over the activity spaces of the actors present within the IE. Actions and behaviours of actors are mutually influenced and, therefore, largely externally

regulated. Once the roles of actors are largely defined, additional institutional regulations are facilitated but role renegotiation is limited. This allows actors to focus on the real mission and to optimise their activities. Thus, the process dimension detects a shift from individual relationships and external regulation of actions, to institutionalised relations and internal regulation by each actor (as displayed in the process showed in Figure 2). Our research complements and extends IE theory from an organisational field perspective (Thompson et al., 2018), as we do not only explore in more depth bottom-up approaches but also argue that top-down processes might be detrimental at the beginning in certain contexts.

Third, the community of specialised and complementary actors that enable network formation in IES is extremely important. Negotiation processes create the basis for the mutual awareness of the actors' respective roles (Adner, 2012; Gulati et al., 2012). In this sense, common goals emerge, and the evolution of institutional relationships is strictly interrelated with the development of IES. The mutual awareness of the members of the IE should increase collective value creation (i.e., more innovation in IES). Institutional theory (DiMaggio and Powell, 1983) assumes that organisations become structurally more similar either because the environment selects those actors that fit best with it, or because of isomorphism, since actors copy legitimacy-granting procedures and structures. As IES are made up of socialised and complementary actors, they and their actors need to co-evolve and adapt, which at times requires the mutation of individual actors through negotiation processes (Hoffman and Ventresca 2002). Thus, we conceive IES as the sum of specific and complementary actors bounded together by mutual awareness driven by durable interactions (Dorado, 2005). The higher the mutual awareness of roles, the stronger the system will be (Wooten and Hoffman 2008). External regulation of the IE, which means actions of one specific actor are mainly determined by other actors as part of the environment, is thus an essential part for developing an effectively functioning IE.

A fourth implication is that an individual actor has self-interest in maximising complementarity. Specialisation can be a path to increased complementarity when an IE comprises

a high number of other specialised actors. Diversification can be another path in the case in which certain activities are not performed by other actors. Complementarity is therefore related to activity spaces created by the other members of an IE. Accepted roles of an actor are related to filling an appropriate activity space in mutual awareness of other actors' activity spaces. This proposition is novel, as acting in self-interest (maximising complementarity), leading also to internal regulation of actions and behaviours of an actor in an IE, is usually not considered as driving innovation activity (Hoffman and Ventresca, 2002).

The notion of internal and external regulation of an IE is an additional contribution as current research considered the increase in durable interactions, the shift from an individual level to an institutional level of the interaction, as vital for a functioning IE (Thompson et al. 2018). From a system perspective, a system is successfully designed and functioning if all elements become self-regulated (Luhmann 1995). We therefore propose that external regulation is a necessary process for creating mutual awareness, while, once established, internal regulation of actors' activities increases the value and function of the IE.

The implications of our research need to be understood in light of its limitations. Case studies allow theoretical knowledge to be extended but not tested. Our analysis was limited to a single case in a specific region and is thus context specific. We consider this case an extreme case as initially characterised by a lack of culture, lack of actors and lack of relations. Future research could investigate in a more comparative way variations of only one of these lacks in a chosen region. Our analysis was also actor specific, investigating the specific role of the university. In order to understand processes of mutual adjustments, research on IE could focus more on dyads and triads and study specifically the mutual influences between players. Finally, we propose that actor embeddedness, legitimacy, action autonomy and internal regulation of actors are interrelated. This combination of network, systems and legitimacy theory appears a fruitful route of inquiry for research on IE.

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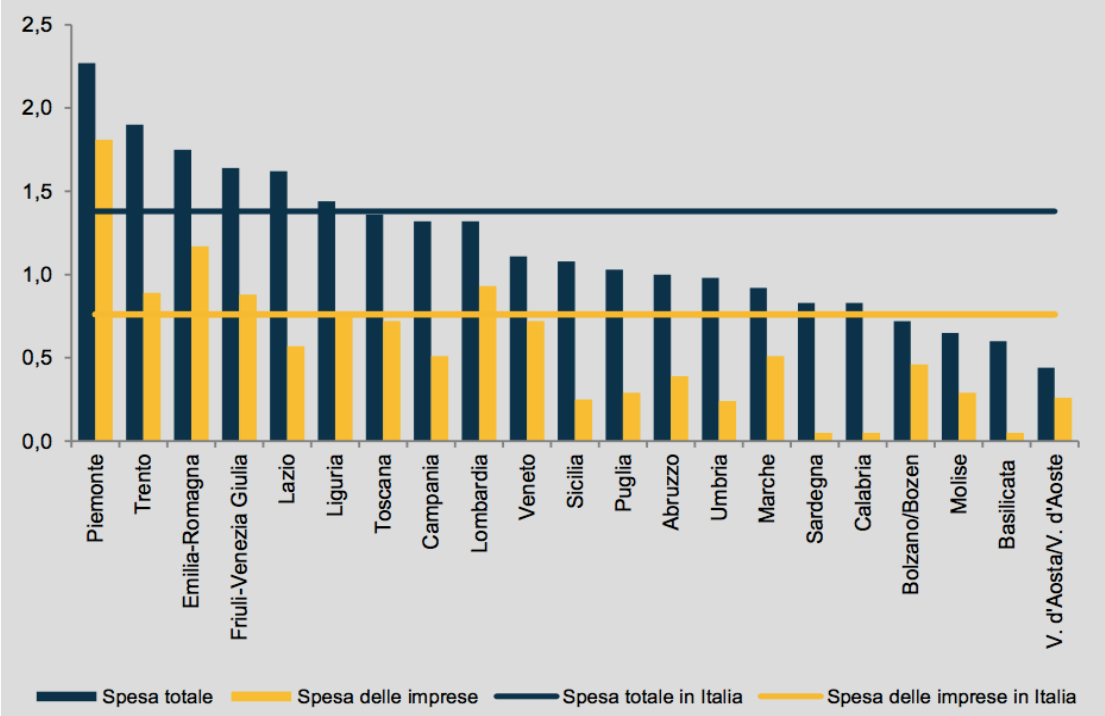
Figures and Tables

Figure 1. Total expenditure in R&D activities and expenditure in R&D activities by region

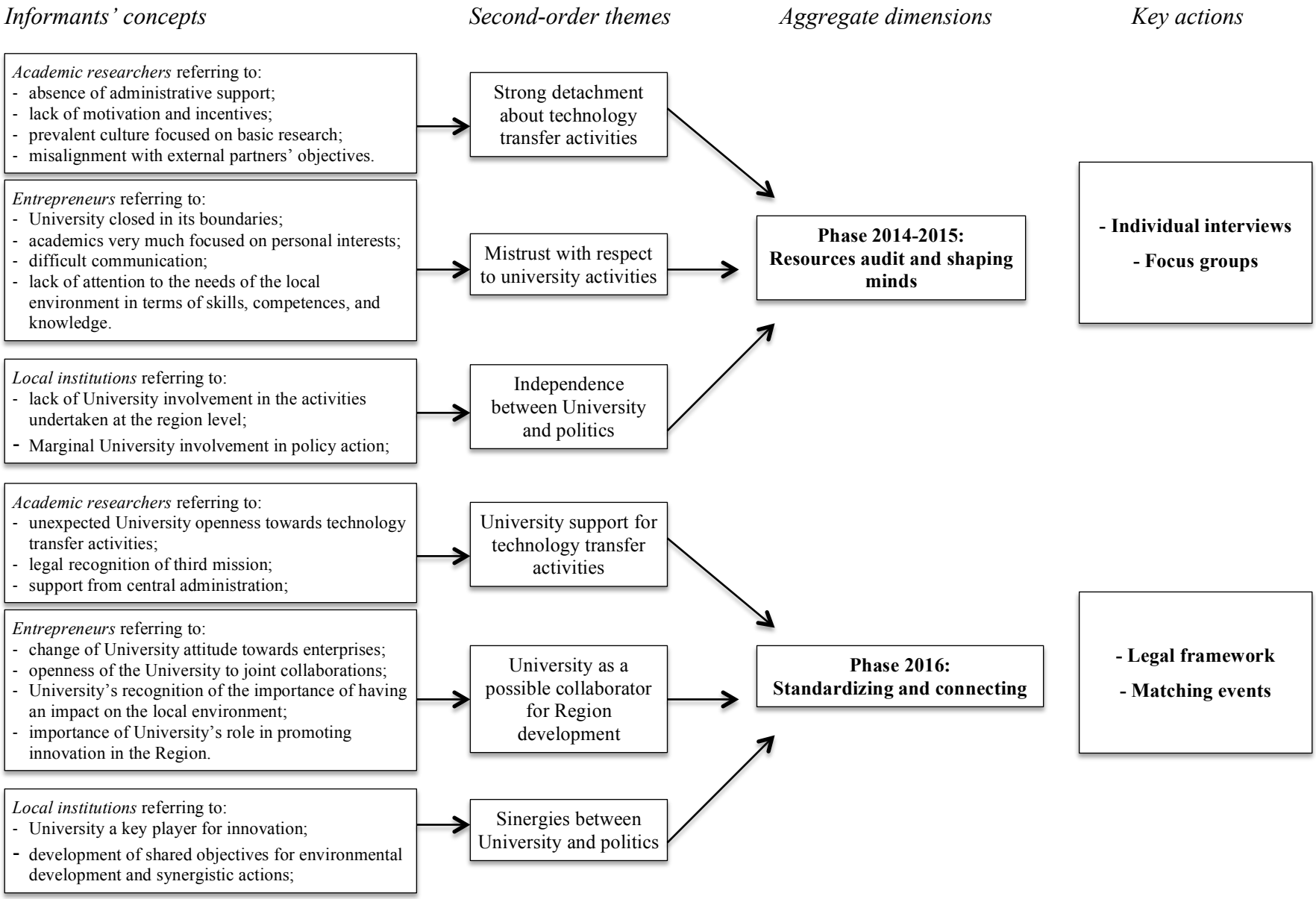


Source: Istat

Table I. Typology of data and their use

Sources	Typology of data	Data use
Interviews in 2014-2018 *431 pages double-spaced*	*Semi-structured interviews (43)* with academic researchers	To understand their perceptions and behaviors with respect to technology transfer and innovation activities
	Semi-structured interviews (25) with entrepreneurs	To understand their perceptions and behaviors with respect to technology transfer and innovation activities
	Semi-structured interviews (9) with representatives of local institutions	To understand their perceptions and behaviors with respect to technology transfer and innovation activities
Focus groups *55 pages*	*Minutes and field observation (15 focus groups)* with 4-7 participants each	To put around the same table people with similar background but heterogeneous experiences to foster discussion and stimulate original thinking
Matching events *37 pages*	*Minutes and field observation (4 matching events)* with 10-15 participants each	To foster university-industry interaction and stimulate joint collaborations for innovation
Written feedbacks *30 pages*	*Written documents (25)*	To collect opinions, perceptions and experiences about interactions and collaborations with external players (for academics) and with academic researchers (for enterprises).
90 pages	*Documents* about previous university-industry collaborations, ongoing projects, etc.	Triangulate data and support information obtained through the other sources

Table II. Data structure



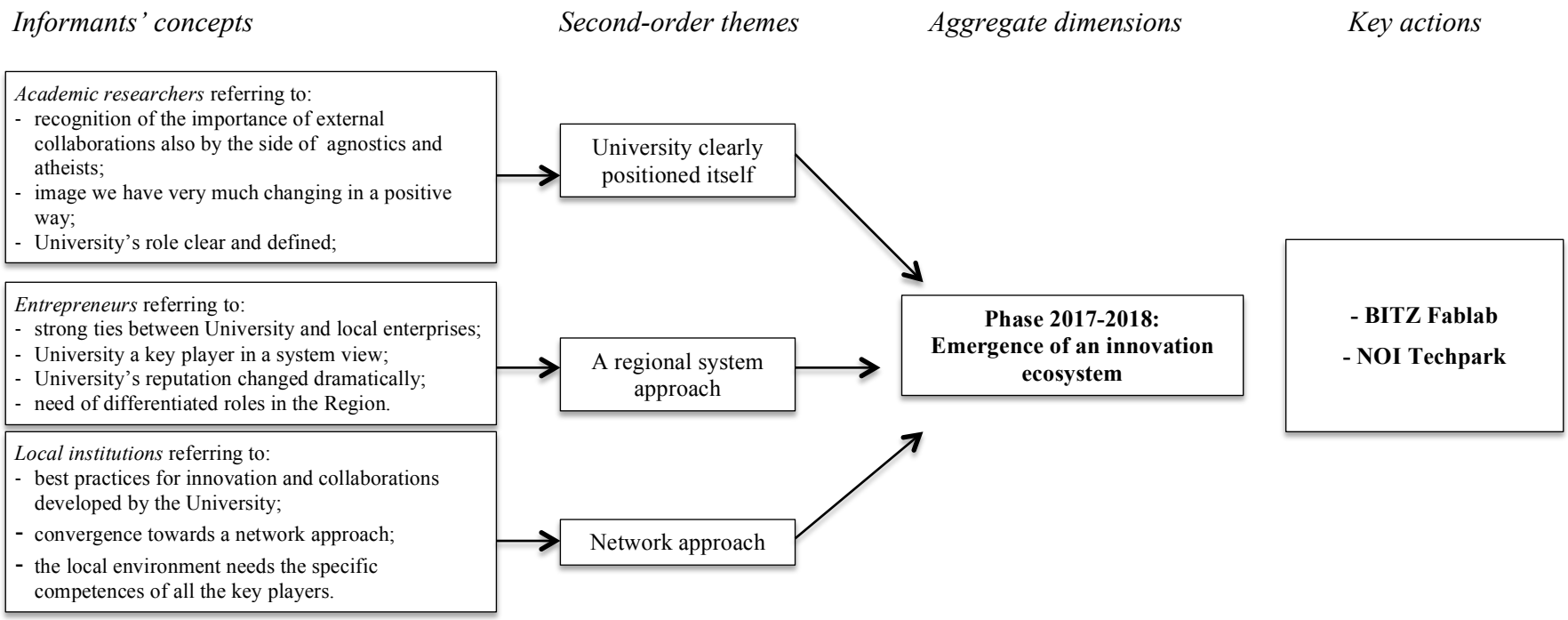

Informants' concepts
Second-order themes
Aggregate dimensions
Key actions
Academic researchers referring to:
- recognition of the importance of external collaborations also by the side of agnostics and atheists;
- image we have very much changing in a positive way;
- University's role clear and defined;
Entrepreneurs referring to:
- strong ties between University and local enterprises;
- University a key player in a system view;
- University's reputation changed dramatically;
- need of differentiated roles in the Region.
Local institutions referring to:
- best practices for innovation and collaborations developed by the University;
- convergence towards a network approach;
- the local environment needs the specific competences of all the key players.
University clearly positioned itself
A regional system approach
Network approach
Phase 2017-2018: Emergence of an innovation ecosystem
- BITZ Fablab
- NOI Techpark

Figure 2. The process model about the emergence of an innovation ecosystem by a young university