Paper submitted to:
R&D Management Conference 2016 *"From Science to Society: Innovation and Value Creation"* 3-6 July 2016, Cambridge, UK

Factors and mechanisms affecting University-Industry interactions: evidence from Southern Italy

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Abstract (of 150-200 words): This paper aims to identify and analyze factors, motivations and mechanisms affecting collaborative forms of university-industry interactions in the context of the metropolitan area of Naples (Southern Italy). This work presents the results of a study designed and implemented through a partnership between University of Naples Federico II (UNF) and the Industrial Association of Naples (UIN). We used data retrieved from 88 firms that had interacted at least once with at least one Department of the University of Naples Federico II in the last 3 years. Firms belonged to different sectors and to different size categories, thus results will cover interactions activities based on those two elements. Results obtained during the field research were used to understand mechanisms and motives adopted by firms to collaborate with universities.

1. University-Industry interactions

Universities play a key role in any innovation system as they can be considered unique in their potential. Universities are a source of knowledge and technology, and their availability is seen as a particular advantage for local economic development (Garcia-Aracil and De Lucio, 2008; Slavtchev, 2013). University's role is changing progressively as they not only have to cope with research and teaching, but also are having to become poles of potential economic and social development (Jones-Evans et al., 1999, Shartinger et al., 2002; Muscio and Pozzali, 2013). Dramatic R&D cut spending all over the world reduced funds availability for universities. For this reason, universities are seeking to supplement public research funding (Etzkowitz et al., 2008).
On the other sides, the intense global competition, rapid technological change and shorter product life cycles increase the pressures on firms continually to advance their knowledge and technologies, thus firms increasingly source innovation by forming alliances with external partners, among which we can find universities (Garcia-Aracil and De Lucio, 2008; Hemmert et al. 2014; Perkmann et al., 2011). Perkmann et al. (2011) listed four main reasons why firms engage in alliances with universities: (1) they seek to leverage their R&D funding, (2) they are keen to access basic scientific knowledge, (3) they aim to improve their problem-solving capability through university advice and assistance in ongoing programmes, (4) working with universities results in generic benefits beyond the narrow objectives of specific alliances.
University-industry relationships are an important and increasingly innovation mode with which firms and universities are able to sustain their competitive advantages, to tap into complementary skills, to save costs and enhance research outcomes (Hemmert et al., 2014; Bruneel et al., 2010; Muscio and Pozzali, 2013).
University-industry relationships cover a broad are of interactions mode. D'Este and Patel (2007) categorizes such relationships in physical facilities, consultancy and contract research, collaborative research agreements, training, and meetings and conferences. Hemmert et al. (2014) defined university-industry research collaboration (UIC) as a project-based collaborative research relationship between universities and companies aiming at the generation or transfer of new products, technologies, or processes. Plewa et al. (2013) defined university-industry links (UILs) as bi-directional linkages between university and industry entities, "established to enable the diffusion of creativity, ideas, skills and

people with the aim of creating mutual value over time" (Plewa and Quester, 2007, p. 371). But, UIL collaboration is often pursued in an informal and decentralized manner. UILs take multiple forms, with interaction channels ranging from inter-organizational relationships (e.g., joint research or contract research) to spin-off companies, to IP transfer including patenting and licensing (Carayol 2003; D'Este and Patel 2007; Bonaccorsi and Piccaluga 1994; Schartinger et al. 2002; Cohen et al. 2002; Bercovitz and Feldman 2006).

Per each different typologies, channels used for transferring knowledge and technology depend of their characteristics, such as the degree of codification of the knowledge, and the tacitness or the embeddedness of the technology. Efficacy of such channels (and consequently positive results of the collaboration) strongly depend on several factors that represent obstacles to collaboration. Bruneel et al., (2010) identified orientation-related barriers and transaction-related barriers. The first are related to differences in the orientation of industry and universities, while the second are related to conflicts over intellectual property (IP), and dealing with university administration.

Universities and firms face major challenges when attempting work together due to a general "cultural divide" between theme in terms of goals and working styles (Hemmert et al., 2014). Universities are driven by cultures that emphasize scientific performance unrelated to profit or market considerations (Partha and David, 1994). Many academics view support and funding from industry as having strings attached that negatively influence their research. For industry, in contrast, the protection of proprietary information is necessary to the ultimate goal of financial return. Many firms view universities' demand for exclusive ownership of intellectual property rights as an impediment for working with universities.

Elements that can reduce the cultural divide can be identified in some way. Universities are seeking to reinforce their industry collaborations by establishing centres specializing in creating a bridge between university and industry. Hemmert et al., (2014) underlined the importance of innovation champions as individuals that 'are intensely interested and involved with the overall objectives and goals of the project and play a dominant role in many of the research-engineering interaction events, overcoming technical and organizational obstacles, and pulling the effort through its final achievement by the sheer force of their will and energy' (Chakrabarti, 1974,p.58).

Schaettgen and Werp (1996) described the industrial liaison office (ILO) acting as a formal function of the university in managing the interface between academia and various external institutions, including industry, government and other research organizations. Closely related to ILO are the technology transfer offices. According to Clark (1998, 6), universities that want to create and maintain linkages with the external world need to establish a complex infrastructure of 'professionalized outreach offices that work on knowledge transfer, industrial contact, intellectual property development, continuing education, fundraising, and even alumni affairs'. Many university TTOs were established to reduce cognitive distance by providing a bridge between academic research and industry needs and to broker university-industry interactions (Muscio 2010).

The role and the efficacy of such mechanisms to reduce the gap between academy and industry is still debated. Several authors analyzed structural issues influencing results and performances of U-I relationship. Petruzzelli (2011), Garcia-Aracil and De Lucio (2008), Muscio et al. (2013) analyzed the geographical proximity as enablers of interpersonal relationships and face to face contacts to exchange knowledge; Santoro and Chakrabarti (2002), Bekkers and Freitas (2008), analyzed the role of size and sector in enhancing collaborations, Santoro and Bierly (2006), Niedergassel and Leker (2011) analyzed the role of knowledge explicitness and different knowledge dimension in U-I relationship. D'Este et al. analyzed the role of organizational proximity as an important determinant of U-I relationships.

So far, U-I relationship still asks for further debate. Obstacles and barriers as previously discussed still reduce successful collaborations between academe and industry. To enhance the rate of success in these types of collaborations, the counterparts must acknowledge and work with these fundamental differences and the cultivation of trust is vital for reducing them (Mora-Valentin et al., 2004). Bruneel et al. (2010) and Muscio and Pozzali (2013) find that trust between partners reduces collaboration barriers. Trust allows partners to be confident that their collaborator will treat them fairly and in a consistent way, and will help to resolve any problems that may arise jointly (Rempel and Holmes, 1986; Zaheer et al., 1998).

Trust is strongly related to partner's reputation. Reputation can be characterized as the outcome of a competitive signalling process on the key characteristics in which organizations try to maximize their social status (Fombrun and Shanley, 1990). Hemmert et al. (2014) confirmed in their analysis how partner reputation enhance the chance of success in university-industry relationships although related to other mechanism such as contractual safeguards and tie strength.

University's reputation is a key determinant in collaborative linkages as the quality of the research is an element to highlight that the university is a reliable and effective partner (Higginns et al., 2008; Hewitt-Dundas, 2011).

2. Regional context

Peripheral regions of Europe, such as Italy, need to have a broader spectrum of R&D capabilities if they are to successfully exploit technologies in industry. Such countries must increasingly develop a comparative advantage based on the enhancement and exploitation of the national knowledge base. Policy makers within most peripheral regions

neglected the role that a vibrant indigenous technology-based sector may play in the development of an economy.

Results of the latest OECD charts reveal how Italy is far from the European average of Gross Domestic Spending in R&D as illustrated in figure 1:

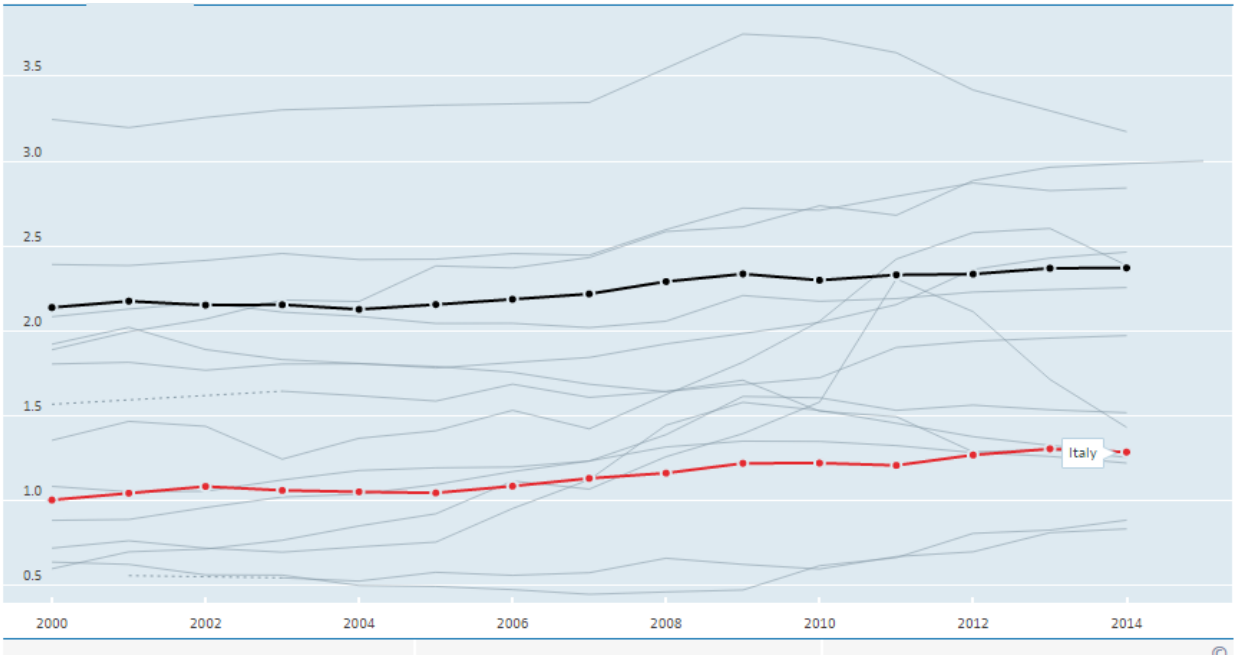

Figure 1 – Gross domestic Spending on R&D (OECD, 2016)

Our research is focused on a specific area of Italy, the Metropolitan area of Naples, characterized by the presence of the biggest and most prestigious university in southern Italy (University of Naples Federico II). The Neapolitan economy is based on small and medium-sized firm structures. 54% of industrial companies have fewer than 19 employees, 52% with more than 200 employees and 12% with more than 500 employees (Chamber of Commerce of Naples, 2010).

If we count the engagement of University of Naples Federico II (UNF) as number of spinoffs and patents, we can classify UNF as one of the latest in the whole Italy[1]. This is an indicator of the scarce ability of UNF to make it profitable the high level of research ability that see UNF as one of the most productive university in Italy (especially in the engineering field). One issue of the low ability of UNF to collaborate with firms in the province of Naples could be find in the absence of a TTO, as literature emphasised the strategic role of such office in enhancing the ability of academic centre to collaborate and transfer knowledge (Slavtchev, 2013; Jones-Evans et al., 1999; Muscio and Vallanti, 2014).

So far, the objective of this work is to analyze the relationships existing in a given territorial context between universities and firms. In context characterised by weak economic trends and by a diffused system of micro-firms with limited structures and resources for R&D and innovation, even in presence of relevant academic institutions and research centres, industry-university interaction are generally occasional and rarely in the framework of a systemic and institutional approach.

These contexts are characterized by small and medium enterprises (SMEs) which do not consider the scientific research as a possible answer to their requirements (Reams, 1986) and, in most cases, they are not informed about the researches done within the research centres or within the R&D departments of great enterprises (Gambardella, 1993).

Laursen et al. (2011) discovered how firms are most likely to collaborate with a top-tier university, and interestingly these findings also suggest that a local low-tier university may not act as a substitute; instead firms may collaborate with a non-local top-tier university.

This represents a missed opportunity on both sides. University departments, particularly science and technology ones, tend to develop collaborations with enterprises in other geographic locations, which results in a growing number of graduates and researchers being lost to the local enterprise system, and often to the research centres in which they were trained. For local enterprises, on the other hand, this is a missed opportunity to acquire relevant resources in terms of scientific and technological knowledge and competences needed to gain competitiveness. The result is an impoverishment of social capital in a specific territory. This is the case of regions like Southern Italy, which have been observed to have a lower social capital value than other regions in Italy (Beugelsdijk and Van Schaik, 2005; Laursen et al., 2012).

The necessity to overcome this social-cultural barrier of a poor cooperation between research and firm has led to

[1] http://patiris.uibm.gov.it/home , http://www.spinoffricerca.it/

reflect about how activities should be implemented to promote a greater integration. The actors involved in firm-research collaboration processes have to belong to the same technological community and share a whole of values, rules, technological experiences, in order to allow the transfer of specific scientific- technological knowledge from the research centers to the firms.

It becomes necessary to favour the construction of a common ground which can enhance knowledge exchange and creation, in particular of tacit knowledge (Wolfe and Lucas, 2001).

A possible analysis perspective on interaction management in less developed areas is to see this process as a set of activities in order to: i) help research teams and SMEs to perceive interaction as a process producing mutual benefits rather than a simple transfer of scientific research; ii) help SMEs and research teams to better know needs and capabilities of each other; iii) support SMEs to implement in their context the results of scientific research.

The extant literature have analyzed UIL by adopting a survey approach, both from academia and industry side, where large part of studies is focalized on the academic side. Brostrom (2010) first realized in depth interviews with 50 medium and large firms that collaborated with university in Sweden. He revealed 4 categories of rationales for formalized interaction with university: cooperation outcomes for product and process development, access to academic networks, human capital management, direct business opportunities. In doing this, he supported Lundvall (2007) alert about the existence of bias based on the location and industry analyzed.

Aim of this study is to analyze the context of UIL in the metropolitan Area of Naples to systematically explore factors and mechanisms driving firms to collaborate with the UNF, and to contribute to a more precise conceptualization of these factors and mechanisms. The point of view will be the one of the firms.

In order to reach this aim, we will investigate the followings as factors enabling firms to collaborate with universities;

- *Presence of internal research team*: presence of R&D department of technologists within the firm which can interact with research teams implies a positive influence on collaboration potential of interaction. (Seaton and Cordey-Hayes, 1993; Cohen and Levinthal, 1989)
- *Previous experiences of collaboration with universities/research centers*: a great experiences of collaboration with research centers implies a positive influence on collaboration potential of interaction. (Wolfe and Lucas, 2001)
- *Benefits perception*: perception of possible benefit derived by collaboration with research centers implies a positive influence on collaboration potential of interaction. (Wolfe and Lucas, 2001; Bonaccorsi and Piccaluga, 1994)
- *Environmental context*: operating in a context characterized by the proximity to great research centers and to universities, in which firms are membership of a network, of a firms' cluster, of an industrial district implies a positive influence on collaboration potential of interaction. (Deeds et al., 2000; Santoro and Gopalakrishnam, 2001; Saxenian, 1994).

3. Data collection

This research is part of a wider agreement signed by UNF and UIN to promote cooperation between university and companies at regional level. A sample of 120 firms coming from a total population of 1100 firms belonging to UIN were selected. 88 firms accepted to be involved in the survey.

The specific objective of the survey was to analyze the characteristics of collaborations in the past three years, the expected and the actual performances of these collaborations, factors and mechanisms firms adopted to establish a contact with UNF.

The survey was conducted by submitting a questionnaire, designed by a technical committee including representatives of UIN and of UNF The questionnaire was preliminary tested, through its submission to a selected group of entrepreneurs. Due to the complexity of the questionnaire and the time required for its compilation (about two hours), it was submitted through face-to-face interviews to entrepreneurs or their delegates. Interviews were performed by a group of 20 UNF post-graduate students, who were carefully selected from those attending the Master in Management Engineering, and adequately trained. The field analysis was performed during the period from November 2014 to February 2015.

All interviews, lasting between 45 and 100 minutes, were realized face-to-face with a top level manger of each firm, and were recorded and transcribed. Four researchers with different skills (economics, managerial, and operational research), all together with a selected number of students who realized the interviews, discussed the interpretations of the interviews. This ensured triangulation also with secondary data sources (such as firm's website and universities database of research contracts). All transcriptions were analyzed in detail and consistent theme are in the process of identification. In the next section, preliminary results will be presented, as large part of analysis are still under development, and will be next presented as they will be correctly systematized.

4. Results

About one third (33 out of 88) of the surveyed firms had had formal collaboration with UNF, mostly (9 out of 11) belonging to the mechanical sector, health care (4 out of 11), ICT (4 out of 11), publishing (3 out of 5) and fashion (3 out of 4).

The total number of collaborations signed in the period 20142011-2014 was 61 (almost 2 contracts per firm The Departments mostly involved were Industrial (15), ICT and Computer Science (10), Economics (9), Chemical and materials (7). Table 1 reports the kind of collaboration activated (more options were allowed for each collaboration), showing a significant cooperation related to students' activities, and to support activities which are useful to firms (research projects, training, consultancy), but pointing out the absence of long-term cooperation focused on patent license or spin-off.

Collaboration	Yes	No	Yes (%)
Internship of Master or PhD students	29	32	47,5%
Research projects	22	39	36.1%
Training	13	48	21.3%
Consultant contracts	7	54	11.5%
Research contracts	7	54	11.5%
Joint workshops and seminars	6	55	9.8%
Scientific publications	5	56	8.2%
PhD financing	5	56	8.2%
Patent licence	1	60	1.6%
Spin-Off	0	61	0.0%
Others	6	55	6.6%

Table 1 - Kind of the collaboration with UNF in the last 5 years

The "informal" channel of direct contacts, which is fundamentally determined by personal relationships between the firm management and single researchers, was largely prevalent.

In order to evaluate the degree of satisfaction about the performed collaborations, interviewees were asked to indicate the expected objectives of the collaboration, among a set of given alternatives, by assigning a weight associated to the importance attributed to each possible option in such a way that the total weights were 100. Furthermore, they were asked to evaluate , the results of the collaboration for each objective, through a score from 0 (definitely unsatisfactory) to 4 (totally satisfactory).

Analysing the results of the survey, the main aspect characterising the system of actual relationships between university and firms is the prevalence of informal contacts between UNF and entrepreneurs in the metropolitan area of Naples, which are based on personal networks and occasional meeting opportunities. However, despite this evidence, entrepreneurs clearly and strongly claim the need to develop a more articulated and stable system of relationships with research centres for the near future.

In this context, both the institutions are focused to make their collaboration more systemic, a policy to facilitate and fast-track the identification of relevant and fruitful collaboration opportunities was agreed and some actual initiatives were already implemented. The general objective was to intensify partnership activities, currently building on also intense spontaneous collaboration activities with some technology and science departments and to extend in order to cover wider areas of interests which appear fruitful for productive collaborations.

Table 2 and Table 3 report the characteristics of the firms involved in the study, in terms of economic sectors, sales volumes and number of employees. In relation to the trend in sales volumes in the last 5 years, more than half (53%) of the firms experienced an increase (22.9%) while 18.1% suffered a significant decrease. Their mid-term horizon strategies included process or product innovation (75%), production expansion (39%), and internationalization activities (26%).

Mechanical	Health care	ICT	Facility Managm	Food and beverage	Tourism	Logistics and transp.	Publishing	Utilities	Fashion	Chemical	Furniture	Others
11	11	9	8	8	7	7	5	5	4	4	4	5

Table 2 - Number of firms involved in the survey per sector

No. of employees				Sales volumes			
<10	11-50	51-220	>250	<2 M€	2-10 M€	10,1-50 M€	>50 M€
11,5%	36,8%	23,0%	28,7%	18,3	35,4	13,4	32,9

Table 3 - Characteristics of the firms involved in the survey per sector

About one third (33 out of 88) of firms had had formal collaboration with UNF, mostly (9 out of 11) belonging to the mechanical sector, health care (4 out of 11), ICT (4 out of 11), publishing (3 out of 5) and fashion (3 out of 4). Table 4

shows the characteristics of this subset of firms. As expected, it highlights that formal collaborations with UNF are more prevalent among bigger enterprises.

No. of employees				**Sales volumes**			
<10	11-50	51-220	>250	<2 M€	2-10 M€	10,1-50 M€	>50 M€
8,3%	27,8%	13,9%	50,0%	9,1%	30,3%	21,2%	39,4%

Table 4 - Characteristics of the firms which had formal collaboration with UNF in the last 5 years

The total number of collaborations signed in the period 2014-2014 was 61 (almost 2 contracts per firm The Departments mostly involved were Industrial (15), ICT and Computer Science (10), Economics (9), Chemical and materials (7). Table 5 reports the kind of collaboration activated (more options were allowed for each collaboration), showing a significant cooperation related to students' activities, and to support activities which are useful to firms (research projects, training, consultancy), but pointing out the absence of long-term cooperation focused on patent license or spin-off.

Collaboration	**Yes**	**No**	**Yes (%)**
Internship of Master or PhD students	29	32	47,5%
Research projects	22	39	36.1%
Training	13	48	21.3%
Consultant contracts	7	54	11.5%
Research contracts	7	54	11.5%
Joint workshops and seminars	6	55	9.8%
Scientific publications	5	56	8.2%
PhD financing	5	56	8.2%
Patent licence	1	60	1.6%
Spin-Off	0	61	0.0%
Others	6	55	6.6%

Table 5 - Kind of the collaboration with UNF in the last 5 years

Table 6 shows the answers provided to the question "Did you use any of these channels to activate the collaboration" (more options were allowed). The "informal" channel of direct contacts, which is fundamentally determined by personal relationships between the firm management and single researchers, was largely prevalent.

Channel	**Yes**	**Number**	**Yes (%)**
Direct contact with a member of the Department	41	20	67,2%
Internship of Master and/or PhD students	13	48	21,3%
Active initiative of the Department	10	51	16,4%
Through institutions operating in the field of technological transfer	4	57	6,6%
Knowledge of scientific publication of members of Department	2	59	3,3%
Department web sites or Internet	2	59	3,3%

Table 6 - Channel used to activate collaboration with UNF in the last 5 years

In order to evaluate the degree of satisfaction about the performed collaborations, interviewees were asked to indicate the expected objectives of the collaboration, among a set of given alternatives, by assigning a weight associated to the importance attributed to each possible option in such a way that the total weights were 100. Furthermore, they were asked to evaluate , the results of the collaboration for each objective, through a score from 0 (definitely unsatisfactory) to 4 (totally satisfactory). Table 7 summarizes the answers provided, reporting the average importance attributed to each objective and the average weighted score. In general, collaboration appeared adequate and satisfactory, with few exceptions.

Objectives of the collaboration	Average importance (%)	Average weighted score
Design of new prototypes or products	26.1%	3.0
Improvement of production process performances	16.6%	3.0
Proposal of new technological solutions	14.4%	3.1
Re-organization modelling and implementation	9.1%	3.1
Individuation of innovation strategy	9.0%	1.9
New markets identification	6.4%	2.0
Recruitment	6.0%	3.2
Research finance funding	4.4%	2.5
Management process performance improvement	3.0%	3.0
Others	2.0%	4.0
Implementation of new software systems and platforms	1.7%	2.0
Patent licence development	1.5%	3.0

Table 7 - Objective of the collaboration and level of satisfaction

As for perspectives on future collaboration, all the 88 firms involved in the study declared an interest to improve the linkage with UNF, highlighting the priority objectives reported in Table 8. Comparing the results with those of Table 7, there appears to be an increasing interest on "design of new prototypes or products" and on "recruiting".

Objectives for future collaboration	Average importance (%)
Design of new prototypes or products	12.0
Improvement of production process performances	17.2
Proposal of new technological solutions	12.4
Re-organization modelling and implementation	12.5
Individuation of innovation strategy	9.7
New markets identification	8.9
Recruitment	0.6
Research finance funding	4.2
Management process performance improvement	11.5
Others	0.5
Implementation of new software systems and platforms	7.9
Patent licence development	2.6

Table 8 - Possible objectives for future collaboration

In order to promote the intensification of the collaboration, interviewees were asked to indicate suggestions and possible initiatives.

Suggestions/initiatives	Yes	No	Yes (%)
Organization of periodical meetings between entrepreneurs and researchers	48	40	54,5%
Possibility of access to potential themes of collaboration through the official web sites	32	56	36,4%
Intensification of partnership for the participation in call for projects	23	65	26,1%
Definition of a catalogue showing possible themes of collaboration	19	69	21,6%
Individuation of support tool to integrate research demand and supply	9	79	10,2%
Use of Social Networks to promote scientific results of University research groups	8	80	9,1%
Publication of abstracts of Master and/or PhD thesis	4	84	4,5%
Reduction of bureaucracy obstacles for the finalization of formal collaborations	3	85	3,4%

Table 9 - Suggestions and initiatives to improve the linkage between system enterprises and University

5. Discussions and conclusions

Although this is an explorative research that does not allow a generalization of the results that is always acceptable, the findings of this study highlight some interesting elements about factors and mechanisms influencing UIL in the metropolitan area of Naples by interviewing top level managers from 88 local firms.
Analysing the results, the main aspect characterising the system of actual relationships between university and firms in the metropolitan area of Naples is the prevalence of informal contacts between UNF and entrepreneurs, which are based on personal networks and occasional meeting opportunities. However, despite this evidence, entrepreneurs clearly and

strongly claim the need to develop a more articulated and stable system of relationships with research centres for the near future.

What emerged from the data is that firms percept an high potential in collaborate with UNF, but still many obstacles limit the chance of fruitful collaboration. Firms are generally lacking and internal R&D team, and medium and large firms only have the power to contract with UNF as they can better benefit from the collaboration. The environmental context, anyway, does not play a critical impact in enhancing collaborations as literature stated (see Laursen et al., 2011 above all). Table 10 reports a synthesis of the interviews.

	FACTORS INFLUENCING RELATIONSHIP	**SURVEY RESULTS**
Presence of internal research team	Presence of R&D department of technologists within the firm which can interact with research teams implies a positive influence on collaboration potential of interaction.	GENERALLY NOT PRESENT ABOVE ALL IN SMALL FIRMS
Previous experiences of collaboration with universities/research centres	A great experiences of collaboration with research centres implies a positive influence on collaboration potential of interaction.	MORE FREQUENT IN LARGE AND MEDIUM FIRMS
Benefits perception	Perception of possibile benefit derived by collaboration with research centres implies a positive influence on collaboration potential of interaction.	LARGLY PRESENT
Environmental context	Operating in a context characterized by the proximity to great research centers and to universities, in which firms are membership of a network, of a firms' cluster, of an industrial district implies a positive influence on collaboration potential of interaction.	POOR IMPACT ALTHOUGH THE REPUTATION OF UNF

Table 10 – Factors influencing U-I relationships in the Metropolitan Area of Naples

In this context, both the institutions are focused to make their collaboration more systemic, a policy to facilitate and fast-track the identification of relevant and fruitful collaboration opportunities was agreed and some actual initiatives were already implemented. The general objective was to intensify partnership activities, currently building on also intense spontaneous collaboration activities with some technology and science departments and to extend in order to cover wider areas of interests which appear fruitful for productive collaborations.

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