Knowledge, innovation and collective learning: theory and evidence from three different productive areas in Italy

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1. Introduction[1]

Innovative capacity of firms has traditionally been explained through intra-firm characteristics, being firms size the most important. A wave of empirical studies identifies small firms as the engines of technological change and innovative activity, at least in certain industries (Acs and Audretsch, 1993; Audretsch and Vivarelli, 1994; Pavitt et al., 1987 and Rothwell, 1989). This statement and these empirical findings constrast the well known observation that, since R&D expenditure is concentrated in large firms, and that innovative output strongly depends on R&D inputs (Scherer, 1991), large firms are expected to drive the technological process.

These contrasting results have pushed industrial economists to look for other explanatory variables. In the recent literature much emphasis has been put to determinats which are external to the firm; these external factors are called *knowledge spillovers*, and refer to the positive externalities that firms receive in terms of knowledge from the environment in which it operates[2].

Both industrial and regional economists underline the importance of knowledge spillovers. As this paper underlines, the main difference between the two groups is that regional economists identify in a clear way the channels through which knowledge spills over a local area. The concept of relational capital is fundamental in this respect. Relation capital is in fact defined as the set of all relationships – market relationships, power relationships, co-operation – established between firms, institutions and people, which stem from a strong sense of belonging and a highly developed capacity of cooperation typical of culturally similar people and institutions. The existence of high relational capital in an area generates stable cooperation between firms and their local suppliers and customers, an efficient local labour market

[1] Though the work is the result of a joint effort of the two authors R. Capello is responsible for the writing of sec. 1, 2.2, 4.3 and 5, while A. Faggian of sec. 2.1, 2.3, 3, 4.1 and 4.2.
[2] See Anselin et al, 1997; Anselin et al., 2000; Acs and Audretsch, 1990; Audretsch and Feldman, 1996, Feldman, 1994; Feldman and Audretsch, 1999; de Groot et al, 2001.

with a high internal mobility of employees and spin-offs from local firms, which are considered as the main channels through which knowledge spreads over a local area[3].

Thus regional economists provide a new insight in the way knowledge develops over space; from the empirical point of view, some qualitative case studies exist which stress collective learning mechanisms, but a real need exists for solid quantitative empirical analyses.

The main aims of the present paper are twofold. The first aim is o underline the main differences between industrial and regional economists. The second aim is to provide a quantitative empirical approach using econometric techniques to verify the existence and importance of relational capital on the innovation activity of firms. Proxies are found to represent the channels of collective knowledge and therefore indirectly of relational capital. The different regional, sectoral and firms' characteristics will also be analysed, in order to understand whether they influence the role relational capital has on firms' innovation. It is, indeed, reasonable to expect that relational capital will play a different role in different regional, sectoral and firm's contexts.

The structure of the paper is as follows. Section 2 summarises the main points of industrial and regional economists on the determinants of innovation. Section 3 describes the methodology used. Section 4 presents the results of our empirical analysis. Finally, section 5 suggests some conclusions and policies.

2. Space as an input for innovation activity

2.1 The determinants of innovation: regional vs. industrial economists

In the last two decades, several authors focused their attention on the innovation phenomenon and its determinants. So many contributions were produced that the term "Innovation Economics " was even coined to gather them under a common label. On one side, this huge interest was the precondition necessary for big steps to be taken forward on the subject, but, on the other side, confusion was created on the use and meaning of some concepts. The confusion was fostered by the fact that the economists, analysing the phenomenon of innovation, belonged to different economic fields.

It is not the aim of this paper to classify all the different contributions belonging to "Innovation Economics", but it is important to underline that, as far as the determinants of innovation are concerned, two main schools of thought can be identified. The first is part of industrial economics, the second belongs to regional economics. A brief theoretical excursus on the main points of the two schools is crucial to the understanding of where our contribution must be located and why.

The industrial economists' starting point is the consideration of so-called "intra-firm" determinants of innovation. Among these determinants a crucial role is played by firm size and R&D expenditure, both internal and external to the firm. Empirical analyses

[3] See GREMI (Groupe de Recherche Européen sur les Milieux Innovateurs). Cfr. Aydalot (1986), Aydalot and Keeble (1988), Camagni (1991), Camagni *et al.* (1999), Maillat *et al.* (1993), Ratti *et al.* (1997), RERU (1999), Crevoisier and Camagni (2000)

led in the past to some contrasting results, underlining some limitations of this approach and the need for introducing other variables which are vital in fostering the innovation process. Both large and small firms can proved to be very innovative due to certain factors, which are completely exogenous to the firm itself, such as their sector and location.

As Geroski (1995) underlines, the proximity to other firms can be essential in increasing the innovation capacity of a firm, independently of internal firm characteristics. There is agreement on the fact that "knowledge spillovers" among firms located in close proximity to each other play a crucial role in improving the innovative capacity of firms, but industrial economists have some difficulty in clearly defining these knowledge spillovers. They remain a vague concept, a sort of "black box", the content of which is not known. It is in this respect, as we will discuss in section 2.2, that the contribution of regional economists becomes crucial.

Regional economists have always focused on the importance of "space" in economic phenomena. Introducing the variable "space" into the analysis of the determinants of innovation helped to solve some of the unclear results of industrial economists and brought them closer to regional economists.

The convergence between the ideas of industrial economists and regional economists is, nevertheless, incomplete. Still many differences remain between them, especially in the interpretation of the concept of space. In the industrial economic view, space is a pure physical variable, while regional economists perceive space in a more complex way. Physical space is coupled with "relational" space, made by all the different relationships built among local actors.

The well-known concept of "milieu innovateur" refers to this more complex concept of space. The "milieu" is a place capable of maintaining a long-term competitiveness thanks to its adaptability to external changes. It is a dynamic concept, which partly overlaps with the static industrial district view. The firms belonging to the milieu are not only close in geographical terms; they are also, and above all, close in terms of culture. As Maillat and Lecoq (1992) underline "though the milieu has a spatial dimension, it does not correspond to a well defined geographical area; the milieu is an organic framework including market and non-market links".

The concept of "innovative milieu" is extremely interesting. Nevertheless, mainstream economists did not immediately accept it. In the 1990s many authors refined the concept of milieu. In particular there are two currents of thought that can be identified.

On one side, some authors tried to show the similarities between the concept of milieu and some concepts belonging to mainstream economics, in order to give a more formalised nature to the milieu concept and also to attempt an empirical measurement of its effects. The reason for doing so was basically to answer some of the first criticisms of the milieu innovateur. Some authors, indeed, noticed how the milieu innovateur was a sort of "abstract entity", an ideal archetype, not applicable to reality. The contribution of Capello (2001a) shows how the milieu innovateur concept can be integrated into a neo-classical endogenous growth model à la Romer (1986) and Lucas (1988), without distorting its initial hypotheses or its conclusions. Also, some

empirical tests of the milieu innovateur concept have been published recently (see Capello 1999a and 1999b).

On the other side, other authors tried to draw a parallel between the milieu innovateur and some concepts borrowed from the biological sciences. In this respect the contribution of Garnsey (1998), for instance, underlines that the correct theoretical approach to the milieu should be "systematic". The reasons for the success of a milieu are not simply additive. There are feedbacks and reciprocal causality relationships between the factors of success of a milieu. It seems, therefore, that the best approach to stud a milieu is a non-linear one, a "study of complexity" (Prigogine and Stengers, 1984), which stresses that the milieu is a system in continuous evolution, not in equilibrium, and is strongly dependent on its past. This second current of thought, more heterodox than the first, makes some very good points on the concept of milieu, but does not answer the criticism of abstractness, which has been moved to the concept.

Our paper can be included in the first stream of thougth, since its main purpose is to formalise the milieu concept, allowing us to test the importance of relational space on the innovativeness and economic performance of firms and to analyse the best conditions under which relational capital maximises its incentive to innovation.

The next section will focus on the definitions of relational capital, collective learning and the channels which make collective learning possible. It is essential to define these concepts clearly before proceeding, because they are the starting points of the following empirical analysis.

2.2 Geographical and relational knowledge spillovers: similarities and differences

As already noted in sec. 2.1, the concept of knowledge spillovers has long been recognised as essential in studying the innovation process. Many authors address the problems in their contributions. Audretsch and Vivarelli (1996), for instance, try to measure the effect of knowledge spillovers on innovation – measured in terms of new patents (using data on Italian firms) - and they find a significant effect of these spillovers on small and medium sized firms. The definition they use of spillovers, though, is not very wide, including only the physical proximity (physical distance) to universities or research centres.

Autant-Bernard (1999) extends the definition of spillovers to include also the proximity of a high number of firms belonging to the same sector. Again, as in Audretsch and Vivarelli (1996), he finds a significant positive relationship between knowledge spillovers – measured in terms of R&D expenditure and researchers of firms in the local area – and the innovative performance of firms.

Despite recognising that proximity to universities, research centres and other firms – belonging both to the same or different sectors - in the local area is important, the phenomenon of knowledge spillovers is much more complex. A high concentration of firms belonging to the same sector in an area is not enough to explain the high innovation of the area itself. It is necessary to define which channels convey these knowledge spillovers and allow them to spread over the territory.

The concept of relational space, first introduced in the milieu theoretical framework, becomes crucial in this respect. Relational space is defined as the set of all relationships – market relationships, power relationships, co-operation – established between firms, institutions and people, which stem from a strong sense of belonging and a highly developed capacity of cooperation typical of culturally similar people and institutions. The concept of relational capital helps in underlining the difference between the approach of the industrial economists and that of regional economists. Figure 1 undelines the comparison between the two approaches. On one side, if we start from a concept of pure physical space, the precondition for knowledge spillovers is the physical proximity to firms of the same sector (to exploit specialisation economies), to firms of different sectors (to exploit economies coming from diversification) and to Universities and research centres, typical places where knowledge is produced. Physical proximity increases the probability of contacts between the economic actors, therefore allowing knowledge to spread easier and produce useful spillovers.

On the other side, if we take into account the concept of relational space, the precondition for the creation of knowledge spillovers becomes the cultural proximity of actors that is, their sense of belonging to the area, their capability of interacting and the sharing of common values. This cultural proximity is the basis for the existence of relational capital, which in turn is formed by:

- explicit co-operation among actors
- implicit co-operation among actors
- public and private partnership.

Relational capital is therefore the "substratum" of collective learning exactly like physical space is the necessary condition for the "traditional" knowledge spillovers described by industrial economists (we defined these traditional spillovers "*geographical knowledge spillovers*" to distinguish them from the general term "knowledge spillovers" that, in our view, includes both the geographical and the relational spillovers).

It can be noticed by observing Figure 1, that the parallel between the two approaches is almost complete, but an important difference must be emphasised. In the industrial approach, there is no clear definition of the channels through which physical proximity materialises into geographical knowledge spillovers (from now on simply GKS). All that is known is that the proximity to other firms or research centres positively influences the performance and the innovativity of a firm, but it is not clear how this happens. Everything is due to pure probabilistic mechanisms.

Conversely, in the regional approach the channels through which the relational capital becomes collective learning are clearly defined:

- a high mobility of local labour force
- stable and fruitful relationships with local customers and suppliers
- spin-offs.

Camagni (1995) defines collective learning as the " dynamic and cumulative process of production of knowledge, which is due to interaction mechanisms typical of an area

characterised by a strong sense of belonging and relational synergies". The internal cohesion promotes the introduction of new products or production techniques and reduces the uncertainty linked to innovations. The space is not just "physical", it is something more. It is a space created by men, both the result of and the precondition for collective learning, an active input, rather than a passive surface (Coffey and Bailly, 1996).

2.3 Towards an empirical analysis: testable propositions

It is simple, at this point, to formulate some theoretical hypotheses to be tested by using our database.

The first hypothesis we want to test is the importance of relational capital and collective learning channels in promoting innovation. There are, indeed, very few empirical works, which try to assess the effects of relational capital on the innovative activity of firms. This scarcity of contributions is due mainly to the fact that the concepts used are very abstract. It is therefore difficult to find the empirical counterpart of these concepts. The real challenge to regional economists is to find a way to make these concepts empirically verifiable. If relational capital does exist, there must be a way to evaluate its effects on firms.

Our first aim is to show that relational capital has a significant positive effect on the innovative performance of firms. Independent of their location, sector and intra-firm characteristics, all firms benefit from the presence of relational capital.

The second step was then to understand if the effect of relational capital on innovation varies according to the characteristics of the different areas considered. It is reasonable to hypothesise that different areas with different productive structures can benefit from different aspects of relational capital.

For this reason, the empirical analysis includes two different areas of analysis: Milan, a large city with a high degree of diversification and Piacenza, a medium sized city with more specialised sectors.

Last, but not least, we tested how the size of a firm and its sector can influence the capability of exploiting relational capital. The results appeared quite interesting, since, as we will briefly see, they support our initial hypotheses.

3. The data and the sample

3.1 The database and the variables

The empirical analysis is based on microdata taken from direct interviews to firms' managers via a questionnaire jointly prepared by three research groups belonging to three different Italian universities. The database includes 217 firms located in three different areas: Milan, Piacenza and the Cadore area in the Veneto region.

The questionnaire, which has been used, can be divided into different sections. The first section includes general questions about firms such as its age, sector, dimensions

(both in terms of employees and turnover), exports and competitive position in the local and global market.

Figure 1.
Physical vs. relational space

The second section focuses on the innovative capacity of the firm, which is the core of our analysis. As already noted, one of the basic hypotheses of our paper is that knowledge spillovers turn into a higher innovative capacity. It is essential, therefore, to have detailed information on this variable both in terms of its dynamics over time and its distribution in space.

The rest of the questionnaire is devoted to specific features which can influence the learning process of firms and consequently its innovative behaviour. These features include: local labour market characteristics, relationships with local suppliers and customers, spin-offs and cooperation with other firms both locally and non locally.

There are several advantages to using the common questionnaire as described above. First of all, the joint effort of three different universities facilitated the interviewing of a larger number of firms making it possible to obtain more robust econometric estimations. Secondly, the larger sample allowed the innovation process to be studied from different angles. Our sample, indeed, includes firms which differ in size, sector and location. All previous studies, based on microdata, focused on only one of these three dimensions due to the limits imposed by the sample size. Widening the sample we were able to analyse the subject in its entirety[4].

In Table 1 we summarised the variables used in the empirical analysis. As input of innovation we chose the percentage of turnover spent in R&D. As a proxy for the innovation we chose the percentage of turnover due to sales of innovative products. This last variable seemed to have a very high degree of reliability as reported by the interviewers. It was more difficult to build a variable representing relational capital.

We decided to use some variables representing so-called "collective learning channels" (see Capello 1999a and 1999b). Three are the channels described in the literature: the local labour market, cooperation with local suppliers and customers and spin-offs. In our research, though, we focused on the first two, since spin-offs are less common and would have restricted our sample considerably. A good proxy for the importance of local labour market was the percentage of new employees coming from firms[5] belonging to the local area. The importance of cooperation with local suppliers and customers was represented by the average of the scores attributed by managers to the contribution of local customers and suppliers to innovative activity. A dummy variable was introduced for high-tech sectors[6] to test if firms belonging to this sector had considerably different behaviour. In Table 1 we summarise the variables and the method used to build them.

3.2 The areas of analysis

Our sample includes firms belonging to three different geographical areas: Milan, Piacenza and Belluno (Cadore). The three areas have been chosen for both theoretical and practical reasons.

From a theoretical point of view, there are two reasons for this choice. On one hand, the three areas are located in three successful Italian regions, which have had good

[4] A firm approach to such issues is presented in Oerlemans, 2000.
[5] Both belonging to the same or to a different sector
[6] High-tech sectors include: electronics, IT, telecommunications, electric and optical machinery

economic performance in the last decade. This ensures that the three areas have a comparable macroeconomic background. On the other hand, the three areas have very different productive structures, which allows us to test if our hypotheses hold under different territorial and productive conditions.

From a practical point of view, the choice has been favoured by the location of the three research groups, which could exploit their specific knowledge of the territory to better select the sample.

Table 1. The variables used

Variables	Method used to build the variables
Degree of innovativity	Percentage of turnover due to sales of innovative products
Dimension	Turnover (millions lire)
R&D expenditure	Percentage of turnover invested in R&D expenditure
Relational Capital (measured via collective learning channels):	
- Local labour market	Percentage of employees coming from local firms
- Specialised local labour market	Percentage of employees coming from local firms belonging to the same sector
- Diversified local labour market	Percentage of employees coming from local firms belonging to different sectors
- Innovative cooperation with local suppliers and customer	Importance of local suppliers and customer in fostering product innovation (average of scores)
High-tech sectors	Dummy variable (1 = high-tech firm)

In Table 2 we report the location quotients of the different sectors in the three analysed areas. As can be seen, each area has its own specialisation. The Milanese area reports very high location quotients in high-tech sectors (2.01 with respect to Italy, 1.32 with respect to Lombardy) and in the chemical industry (respectively 2.68 and 1.37). High location quotients are also exhibited in some advanced tertiary sectors, such as monetary and financial brokerage, real estate, it services and research activities.

The fields of specialisation in Piacenza are completely different. More traditional sectors play an important role in the Emilia Romagna region, especially the food industry. The location quotient in this sector for Piacenza is close to one with respect to the Emilia Romagna region, but it is 1.32 with respect to Italy.

Table 2. Location quotients by sector in the three areas analysed

	Milan		Piacenza		Belluno	
Sector	QL with respect to Italy	QL with respect to Lombardia	QL with respect to Italy	QL with respect Emilia	QL with respect to Italy	QL with respect to Veneto
MINERALS EXTRACTION	**1,63**	**1,38**	**1,12**	**1,80**	0,86	**1,84**
FOOD, DRINK AND TOBACCO INDUSTRY	0,57	0,75	**1,32**	0,88	0,57	0,62
TEXTILE INDUSTRY	0,53	0,42	0,40	0,47	0,67	0,44
LEATHER INDUSTRY AND SIMILAR	0,29	0,67	0,21	0,37	0,06	0,03
TIMBER INDUSTRY	0,39	0,50	0,78	0,89	**1,86**	**1,36**
PAPER INDUSTRY; PRESS	**1,79**	**1,30**	0,79	0,88	0,45	0,46
COKE INDUSTRY, REFINERIES, NUCLEAR FUEL	0,60	0,97	0,70	**3,07**	0,09	0,19
CHEMICAL INDUSTRY, ARTIFICIAL AND SYNTHETIC FIBRES AND SIMILAR	**2,68**	**1,37**	0,22	0,29	0,24	0,33
PLASTIC AND RUBBER PRODUCTS	**1,22**	0,76	0,92	0,96	0,62	0,57
NON METALLIFEROUS MINERALS PRODUCTS	0,40	0,67	**1,71**	0,85	**1,21**	0,93
METAL INDUSTRY	0,91	0,62	**1,28**	**1,14**	**1,04**	0,89
MECHANICAL INDUSTRY	**1,17**	0,86	**1,81**	0,97	**1,53**	**1,13**
ELECTRONIC AND OPTICAL INDUSTRY	**2,01**	**1,32**	0,61	0,67	**6,25**	**5,33**
TRANSPORTATION	0,48	0,71	0,83	**1,29**	0,03	0,07
OTHER MANUFACTURING ACTIVITIES	0,91	0,96	0,45	0,66	0,66	0,32
ELECTRICITY, WATER AND GAS	0,82	**1,08**	**1,85**	**2,77**	0,80	**1,16**
BUILDING	0,63	0,74	0,99	**1,10**	**1,11**	**1,20**
RETAIL AND WHOLESALE TRADE	0,94	**1,08**	**1,00**	**1,07**	0,72	0,83
HOTELS AND RESTAURANTS	0,75	**1,02**	**1,06**	0,89	**1,80**	**1,84**
TRASPORTI MAGAZZINAGGIO E COMUNICAZIONI	0,95	**1,25**	**1,14**	**1,29**	0,60	0,78
MONETARY AND FINANCIAL BROKERAGE	**1,49**	**1,38**	0,94	**1,06**	0,51	0,67
REAL ESTATE, IT SERVICE AND RESEARCH ACTIVITY	**1,66**	**1,41**	0,80	0,83	0,44	0,52
OTHER PUBLIC SERVICES	0,92	**1,08**	**1,35**	**1,30**	0,61	0,75

Source: Our elaboration on Istat data, 1996

The same holds for the mechanical sector and the production of non-metal products. Higher location quotients are exhibited in the production of energy, gas and water (1.85 with respect to Italy, 2.77 with respect to Emilia Romagna) and oil refinery (only 0.7 with respect to Italy, but 3.07 with respect to the region). The chemical and electronic industries, which are so strong in the Milanese area, show incredibly low values in Piacenza (respectively 0.22 and 0.61 with respect to Italy and 0.29 and 0.67 with respect to Emilia).

Belluno, the province where the Cadore area is located, has a dichotomised productive structure. On one hand, there are some non-specialised sectors with location quotients lower than 0.5 such as press, textile industry, transportation and refineries. On the other hand, there is one sector with a surprisingly high location quotient, i.e. the electrical and optic sector (6.25 with respect to Italy, 5.33 with respect to Veneto). This is due to the Cadore area being an industrial district specialising in the production of glasses, which belong to the category "electrical and optical sector" according to the National Statistical Office (Istat). Other sectors with high location quotients, though much lower than the electrical and optical sector, are the timber industry (1.86 and 1.36), hotels and recreation (1.8 and 1.84).

The brief description of the productive structure of the three areas shows how the empirical analysis aims to compare a diversified metropolitan area specialised in more advanced sectors, such as Milan, with a middle sized town more specialised in traditional industries – Piacenza - and a typical industrial district such as the Cadore.

3.3 Description of the sample

As already mentioned, the database includes 217 observations: 62 firms located in Milan, 65 in Piacenza and 90 in the Cadore district in the Belluno province.

The firms differ for internal characteristics (dimensions, R&D expenditure) and for the sectors they belong to. Table 3 summarises some of the main characteristics of the samples in the three different areas.

The firms in Piacenza are on average larger than those in Milan and the Cadore area, but they seem less innovative. The percentage on turnover due to sales of innovative products is, indeed, only 20% in Piacenza, 25% in Cadore and 32% in Milan. R&D expenditure on average is higher in Piacenza in absolute value (1212 million lira), but lower than Milan in terms of percentage on turnover (6% in Milan compared to 2% in Piacenza). In all the considered areas local labour market plays a crucial role. In Milan and Piacenza around one third of new employees come from local firms, in Cadore the percentage is even higher, 48%[7]. Milan, though, differs from the other two areas for the origin sector of new employees. Indeed, while in Piacenza and Cadore a high percentage of new employees come from local firms belonging to the same sector as the new firm (21% in Piacenza and 37% in Cadore), in Milan 20% of new employees come from local firms belonging to different sectors of origin and only 18% from firms belonging to the same sector.

[7] This is not surprising since the Cadore is an industrial district.

Table 3. Characteristics of the sample by geographical area (average values)

	Milan	Piacenza	Cadore (Belluno)
Innovativity (% of positive answers)	**32% (60)***	20% (65)	25% (27)
Turnover (in millions lira)	9785 (62)	60226 (65)	14371 (68)
R&D expenditure (in millions lira)	639 (60)	1212 (65)	79 (65)
Importance of local labour market (% of positive answers)	38% (62)	33% (65)	48% (90)
Importance of diversification of local labour market (% of positive answers)	**20% (62)**	12% (65)	11% (90)
Importance of specialisation of local labour market (% of positive answers)	18% (62)	**21% (65)**	**37% (90)**
Importance of suppliers on innovation (scores from 1 to 10)	3.9 (62)	1.8 (65)	4.9 (54)

**the number of valid observations are reported in brackets*

As far as the importance of local suppliers on innovation is concerned, the average scores are low. The minimum is 1.8 in Piacenza, followed by Milan (3.9) and Cadore (4.9). The problem is in understanding if these low values reflect the actual unimportance of suppliers or rather the misperception of their importance by the interviewed managers.

4. The empirical results

4.1 The role of relational capital in fostering innovation

The first aim of our paper is to test the importance of relational capital for innovation activity. According to regional economists, relational capital plays a crucial role in fostering innovative activities irrespective of location, internal characteristics of a firm and sector.

The starting point of our analysis, therefore, was the estimation of the same econometric model for all firms included in our database without any distinction of location, size or sector.

The first step was to estimate the relationship between "intra-firm" characteristics and innovativity[8]. The second step was then to introduce, in the same model, some

[8] The hypothesis that intra-firm characteristics play a different role in fostering innovation has been discussed in several papers by industrial economists

relational capital variables to test their significance. In Table 4 we report the results obtained. Both the variables representing relational capital have a positive effect and are statistically significant. The R-squared value rises from 0.19 to 0.28 with the introduction of relational capital factors. An F-test has also been carried out to verify that the higher R-squared value is not only due to the introduction of two extra variables. The F-test shows that the marginal contribution of each of the two new variables is statistically significant and that their inclusion in the model is therefore justified.

Table 4. The role of relational capital on innovative activity (all sample)

Variable	***Mod. 1***	***Mod. 2***	***Mod. 3***	***Mod. 4***	***Mod. 5*** *(only Milan and Piacenza)*
Constant	1.97 (2.54)*	2.02 (2.70)	1.49 (1.5)	0.91 (1.02)	0.93 (1.0)
Firm size (turnover in ln)	-0.32 (-4.32)	-0.30 (-4.13)	-0.23 (-3.08)	-0.21 (-2.59)	-0.21 (-2.36)
R&D expenditure in % of turnover (ln)	0.24 (4.08)	0.23 (3.99)	0.22 (3.84)	0.21 (3.66)	0.18 (2.53)
Local labour market (ln)		0.14 (3.27)	0.14 (3.4)	0.14 (3.31)	0.20 (4.5)
Cooperation with local suppliers and clients (ln)			0.21 (2.9)	0.20 (2.68)	0.22 (3.02)
High-tech sector				*0.21* *(0.87)*	0.46 (1.79)
R-square	0.19	0.24	0.28	0.29	0.40
Number of valid cases	148	148	148	146	122

Dependent variable: Innovativity (% of turnover coming from sales of new products)

*T-student into brackets

Note: The values of F test is 56 when passing from model 1 to 2 and 42 from model 2 to 3. Both values are significant at 0,01level.

This result confirms our initial hypothesis, i.e. the importance of relational capital variables in fostering the innovative performance of a firm. Regional economists are therefore correct in underlining that not only are intra-firm characteristics crucial for innovation, but also (and maybe most of all) the location of firms in an area where the local labour market and the tight links with suppliers foster the exchange of local knowledge vital for innovation.

This seems to hold no matter where firms are located, although, as we will briefly see, with different features from one case to the other.

The last two columns in Table 4 report two further models in which a dummy variable for high-tech firms was introduced to test if there was a substantial difference between high-tech and traditional firms. The dummy is statistically insignificant when the model is tested on the all sample, but becomes significant if we drop the Cadore case and consider only Milan and Piacenza. This may be partly due to the lack of variance in the sectorial composition of the firms in the Cadore area, almost all belonging to the same sector.

4.2 Relational capital and innovative activity in the three different areas

Once we show that relational capital does play a crucial role in innovation, it becomes interesting to better understand the differences among the areas analysed. Is it possible to identify specific territorial characteristics which allow the relational capital to be more effective? To answer this question we can start by estimating separate models for the different geographical areas. Tables 5 and 6 show the results of the estimations.

Table 5. The role of relational capital on innovative activity: Milan

Variable	***Mod. 1***	***Mod. 2***	***Mod. 3***	***Mod. 4***	***Mod. 5***
Constant	3.4 (2.07)*	3.26 (2.15)	3.67 (2.30)	3.51 (2.27)	3.93 (2.53)
Firm size (turnover in ln)	-0.40 (-2.44)	-0.39 (-2.50)	-0.42 (-2.61)	-0.41 (-2.60)	-0.51 (-3.17)
R&D expenditure in % of turnover (ln)	0.30 (3.04)	0.30 (3.09)	0.29 (2.89)	0.29 (2.94)	0.23 (2.279
Local labour market (ln)	0.14 (2.37)	0.14 (2.38)	-	-	-
Cooperation with local suppliers and clients (ln)	*-0.04* *(-0.22)*	-	-	-	-
Diversified local labour (ln)	-	-	0.12 (2.36)	0.12 (2.33)	0.12 (2.38)
Specialised local labour (ln)	-	-	*0.02* *(0.48)*	-	-
High-tech sector	-	-	-	-	0.57 (2.06)
R-square	0.24	0.24	0.24	0.24	0.29
Number of valid cases	59	59	59	59	57

Dependent variable: Innovativity (% of turnover coming from sales of new products)
*T-student into brackets

In the Milan area the intra-firm characteristics, i.e. small size and high R&D expenditure, are crucial in fostering innovation. As far as the relational capital variables are concerned, the most surprising result is that co-operation with local

suppliers no longer plays an important role in Milan. Local labour market is the most important collective learning channel with a coefficient of 0.14 in both models 1 and 2 and a t-student value of 2.37 and 2.38 respectively (see Table 5).

Furthermore, a more detailed analysis of the components of local labour market shows something very interesting. In Milan the innovation performance is positively linked to the diversification of the local labour market rather than to its specialisation. As models 3 and 4 in Table 5 show, the variable "diversified local labour market" has a coefficient of 0.12 and is highly significant (2.36 in model 3 and 2.33 in model 4), while the variable "specialised labour market" is insignificant in model 3 and has been removed in model 4 to test the robustness of the other coefficients. The economic meaning of this seems clear. In Milan there are urbanisation economies that foster innovation. Also the dummy variable for the high-tech sector is statistically significant in the Milan area. Because of the high specialisation encountered in these sectors in Milan, one can easily draw the conclusion that these sectors are organised around filières.

Table 6. The role of relational capital on innovative activity: Piacenza

Variable	***Mod. 1***	***Mod. 2***	***Mod. 3***
Constant	0.51 (0.35)	1.64 (1.13)	1.65 (1.13)
Firm size (turnover in ln)	-0.16 (-1.22)	-0.16 (-1.24)	-0.16 (-1.23)
R&D expenditure in % of turnover (ln)	0.15 (1.51)	0.21 (2.12)	0.21 (2.10)
Local labour market (ln)	0.25 (4.04)	-	-
Cooperation with local suppliers and clients (ln)	0.28 (3.05)	0.25 (2.40)	0.25 (2.37)
Diversified local labour (ln)	-	0.18 (2.8)	0.18 (2.85)
Specialised local labour (ln)	-	0.18 (3.02)	0.18 (3.00)
High-tech sector	-	-	*-0.08* *(-0.11)*
R-square	0.37	0.42	0.42
Number of valid cases	65	63	63

Dependent variable: Innovativity (% of turnover coming from sales of new products)

T-student tra parentesi

Piacenza has some similarities to Milan, but also some peculiar characteristics. In the Piacenza area, as in Milan, the local labour market is the most effective collective

learning channel with a coefficient of 0.25 (even higher than that of Milan) highly significant (4.04). Unlike Milan, though, the co-operation with local suppliers is significant with a coefficient of 0.28 with a T-student of 3.05 (see Table 6 model 1). Moreover, intra-firm characteristics do not play an important role in Piacenza. Model 2 and 3 show the results, once we decomposed the local labour market into "diversified" and "specialised". Surprisingly enough, in Piacenza, it is the specialised component that is significant. Both components, indeed, have the same coefficient of 0.18, but the diversified one is statistically more significant (around 3 in both models). It seems therefore that in the Piacenza area specialisation economies[9], rather than urbanisation economies are at work.

4.3 Relational capital and innovation activity: a comparison between firm size and sectoral specialisation

The last aspect to be considered is how the size of a firm and the degree of specialisation of a sector can affect the effectiveness of relational capital in fostering innovation. The following model has been estimated, separately for Milan and Piacenza, to analyse the problem

$$I = \alpha + \beta DIM + \gamma CR * DIM + \delta CR * QL + \varepsilon \qquad (1)$$

Where
I = degree of innovation of a firm
DIM = size of a firm (turnover)
CR = relational capital (local labour market)
QL = sectorial location quotient

As proxy for the relational capital (CR) we chose the most significant variable in the regressions presented above, i.e. the diversified local labour market in Milan and the specialised local labour market in Piacenza. The results of the estimation of equation 1 are presented in Table 7.

Differentiating equation 1 with respect to size (DIM) and the location quotient (QL), it is possible to evaluate the effect of relational capital on innovative capacity of a firm for different dimensional levels of a firm and different sectorial specialisation. The calculation result in the following two equations, for Piacenza and Milan respectively:

$$(\partial I / \partial CR)_{PIACENZA} = 0.02DIM + 0.12QL \qquad (2a)$$

$$(\partial I / \partial CR)_{MILANO} = 0.01DIM - 0.27QL \qquad (2b)$$

The equations are represented graphically in Figure 1 for different levels of location quotients.

[9] Although the terms specialisation economies and urbanisation economies are well known in urban economics, it is worth just remembering that for specialisation economies we mean economies, which are external to the firm, but internal to the sector, while urbanisation economies are external to both the firm and the sector. The latter arise from the fact that they are located in a big city.

In the Piacenza area the importance of specialised local labour market on innovation becomes more and more important as the value of location quotients increases (Figure 1a). It seems reasonable that firms belonging to more specialised sectors can exploit the specialised local labour market more efficiently to increase their innovation. Moreover, as we see in Figure 1a, the larger the firm, the better it can exploit the local labour market.

In Milan, conversely, the capacity to exploit the diversified local labour market decreases as location quotients increase. Firms belonging to less specialised sectors can exploit better the "variety" of the local labour market. They localise in the Milan area to exploit a wider pool of potential employees with differentiated characteristics and abilities[10]. Moreover, as in the previous case, the larger the firm, the better it can exploit the relational capital. As we can see in Figure 1b, indeed, location quotients being equal, larger firms exploit better the diversified local labour market.

Similar results are presented in Figure 2, where equations 2a and 2b were calculated for different levels of location quotients. The importance of relational capital on innovation increases as size increases both in Milan and Piacenza. The difference is that, given a certain firm's dimensions, the importance of relational capital increases with location quotients in Piacenza (specialisation economies) and decreases in Milan (urbanisation economies).

Table 7.
Interaction among relational capital, firm size and location quotients

Variable	**Piacenza**	**Milan**
Constant	*-1.38*	*1.19*
	(-0.84)	*(0.88)*
DIM (Turnover in ln)	*-0.03*	*-0.16*
	(-0.20)	*(-1.3)*
CR (Div. local labour mkt) *SIZE	-	0.01 (2.22)
CR (Div. local labour mkt) *LQ	-	-0.27 (1.8)
CR (Spec. local labour mkt) *SIZE	0.02 (3.39)	-
CR (Spec. local labour mkt) *LQ	0.12 (1.5)	-
R-square	0.22	0.14
Number of valid cases		

Dependent variable: Innovativity

[10] This is a typical advantage offered by large cities and it is part of what regional economists call "urbanisation economies"

Figure 1. The role of sectoral specialisation

a) Piacenza

b) Milan

Figure 2. The role of firm size

a) Piacenza

b) Milan

5. Conclusions

The aim of this paper was to present a theoretical and empirical analysis of the role of relational capital on innovation activity. Relational capital - in the sense of capacity of interaction among local actors due to a strong sense of belonging and a close cultural proximity – is, indeed, the basis for local collective learning.

From a theoretical point of view, we focused on the differences between the industrial economists and regional economists in defining the local externalities generated by innovation activity referred to as "knowledge spillovers". Regional economists have the benefit of having defined the channels through which knowledge spills over space and of having introduced the concept of relational space – rather than the purely physical one – as the key to understand collective learning.

From an empirical point of view, the paper shows the importance of relational capital on the innovative capacity of firms. The presence of relational capital is indirectly measured via the collective learning channels, which represent the contents of the knowledge spillovers "black box".

Identifying the mechanisms through which knowledge spills over the space is not only important from a theoretical point of view. It is fundamental when formulating useful and effective policies.

The paper, indeed, underlines the crucial role of the local labour market as a channel for spreading knowledge. It is therefore desirable to implement policies which both improve the quality of local labour market and foster the internal mobility of employees.

Last, but not least, policies to encourage the cooperation with local suppliers and customers should be implemented, since both are important to the innovative capacity of firms.

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