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Innovation performance in traditional industries: Does proximity to universities matter

Donato Iacobucci, Francesco Perugini *

Centre for Innovation and Entrepreneurship, Università Politecnica delle Marche, Via Brecce Bianche 12, 60131 Ancona, Italy

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ABSTRACT

Firms operating in traditional industries are characterized by low investment in R&D and little capabilities for autonomous innovation. This situation is changing given the increasing relevance of general purpose technologies, such as ICT. As a result, the innovative performance of firms in these sectors should be more dependent on the interaction with firms and institutions outside their production chain. The aim of this paper is to analyze to what extent the proximity to universities affects firms' capability to innovate as opposed to the other characteristics of the local context, such as specialization or variety, which motivated firms' location choice. The analysis focuses on Italian firms in traditional industries: agri-food, textile and clothing, leather and footwear. The empirical evidence suggests that the local context still plays a relevant role for the innovative performance of traditional firms while proximity to a university is not always statistically significant.

1. Introduction

Traditional industries (TIs hereafter), such as the agri-food industry, the textile and clothing industry, and the leather and footwear industry, represent a relevant part of the European industry. They are specifically relevant in the Italian manufacturing sector in terms of person employed, value added, and export.[1] According to Eurostat data, in 2015 firms in TI employed >1 million people (about 24 % of the manufacturing sector), produced a value added of over 49 billion Euro (about 22 % of the manufacturing sector) and had an export value of about 84 billion Euro.

However, over the last few decades the contribution of TI to the Italian economy declined, caused by the increasing international competition coming especially from emerging countries. Entrepreneurs and policy maker agree that to slow down this decline and increase competitiveness, firms in TIs need to improve their innovation activities. According to a recent report by EURATEX (the European Apparel and Textile Confederation) for the EU Commission: “It is therefore of great importance for the textile and clothing industry in the Mediterranean zone to adopt advanced manufacturing processes and technologies, invest in the skills and knowledge of their staff, explore new management and business models based on innovation…”.[2]

The innovation model prevailing in TIs firms, labelled as ‘suppliers dominated' (Pavitt, 1984) is characterized by low investment in R&D and little capabilities for autonomous innovation. This innovation model is labelled as the DUI mode, i.e. a model based on learning by doing, using and interacting (Jensen et al., 2007). Firms rely on internal processes or on the interaction with suppliers and customers for the introduction of innovations, which are mostly incremental innovations. Indeed, the competitive advantage of TIs firms relies on the location in specialized territorial clusters where spatial proximity between firms facilitates the interactions within the production chain and the diffusion of new knowledge (Porter, 1998). In the case of the textile and clothing industry and in the leather and footwear industry firms are generally located in specialized clusters; while in the case of the agri-food sector the location of firms is driven by the proximity to consumers or raw material suppliers. In both cases the location choices are mainly driven by the proximity to other actors within the production chain.

This situation is changing given the increasing role played by the so-called transversal or general purpose technologies (GPTs), which have a significant impact for innovation in all sectors including the traditional ones (Jovanovic and Rousseau, 2005; Teece, 2018). A prominent

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* Corresponding author.
E-mail addresses: d.iacobucci@univpm.it (D. Iacobucci), f.perugini@staff.univpm.it (F. Perugini).

[1] In this paper traditional industries are defined as those industries grouped under Section C, Divisions: 10, 11 (agri-food); 13, 14 (manufacture of textiles and manufacture of wearing apparel) and 15 (leather and footwear) of the NACE REV.2, Statistical Classification of Economic Activities in the EU.

[2] The report is available at: http://www.enpicbcmed.eu/sites/default/files/texmed_study_innovation_and_technology.pdf.

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example of GPTs, which is driving the so-called Industry 4.0 revolution, is the information and communication technology (ICT) (Frank et al., 2019). Other prominent GTPs are those identified by the EU as key enabling technologies (European Commission, 2011). The increasing role of GPTs means that firms are more and more dependent for their innovative activity on the collaboration with firms in different sectors and with research centres.

As a result, we expect that the interaction of TIs firms with universities and with firms in different sectors is playing an increasing role for their innovation capabilities. In the case of universities, this interaction may take several forms, from the collaboration in joint research programs to the knowledge spillovers provided by the hiring of young graduates. In both cases, spatial proximity is expected to enhance those mechanisms. In the case of interactions with other firms we expect that innovation performance is enhanced by industry variety rather specialization at local level. This means that the location advantages of TIs firms are changing from the location in specialized clusters to the location in areas where firms may interact with research centres and firms belonging to different production chains.

The main aim of this paper is to empirically assess whether the innovation performance of TI firms is influenced by the proximity to a university and by the industry variety of the local context as opposed to the clustering in specialized districts.

The innovative performance of firms is measured in two ways: a) the number of patents; b) the participation to EU funded projects on research and innovation. We are aware of the limitations of using patents as an indicator of innovation performance, especially in traditional industries where the innovation model is characterized by low investment in R&D and little capabilities for autonomous innovation (Evangelista et al., 2001; Hervas-Oliver et al., 2011). However, patents are becoming more and more important in the new innovation context characterized by the presence of GPTs. The use of patents allows us to measure to what extent TIs firms are adopting these new models and the role played by universities and the local context within this process.

Moreover, to overcome the above-mentioned limitations we take advantage of another useful measure of firms' innovation activity, by looking at the firms that received financial support for innovation projects within regional programs sustained by EU structural funds. We consider the projects financed under the priority axis 1 of ERDF (European Research and Development Funds) which is focused on strengthening research, technological development and innovation. This allows us to consider a more comprehensive picture of innovation activity of TI firms. In both cases, patents and EU funded projects involve a small percentage of firms; however, they capture the type of innovation we are interested in this study.

The proximity to a university is measured in terms of physical distance. Proximity is expected to facilitate interactions and the acquisition of knowledge spillovers (Boschma, 2005). Moreover, proximity to a university is expected to facilitate the hiring of graduated students, which is one of the main factors fostering innovation performance (Diebolt and Hippe, 2019). For the characteristics of the local context, we use an index of unrelated variety and an index of industry specialization, both measured at provincial level. We also consider the belonging of firms to specialized industrial districts, which characterize the organization of traditional industries in Italy (Bellandi et al., 2009). We also take into account other general characteristics of the local context such as the overall economic development and the quality of institutions.

Our empirical results show that the characteristics of the local context in terms of industrial structure remain among the key factors to explain the innovative performance of TIs firms. However, the role of specialization and variety is not robust across industries and types of innovation measures. This means that the innovation performance in traditional sectors is still highly dependent on firm's characteristics and does not show a clear move towards the new models of innovation. Being located near a university is also beneficial for TIs firms, however the impact on innovation is relatively modest and not always statistically significant. The latter effect is dependent on the intensity of technology transfer activities, and specifically on the presence of university spin-offs. We find that the quality of institutions at local level plays a positive and robust role on the innovation performance of firms thus confirming the recent literature on the relevance of institutional quality at local level (Rodríguez-Pose and Di Cataldo, 2014).

The paper is organized in the following sections. Section 2 provides a discussion about the innovation model of TI firms and put forward the research questions about the role of universities and the local context. Section 3 presents the sources of data and the methodology adopted in the empirical analysis. Section 4 discusses the results and Section 5 draws the main conclusions.

2. Background literature and research hypotheses

Over the last two decades, the Italian manufacturing sector has undergone significant changes in order to maintain its competitiveness in the global market. This is especially true for traditional industries, such as the agri-food industry, the textile and clothing industry, and the leather and footwear industry, which are more than others exposed to the competitive pressure arising from emerging countries. Firms within these industries undertook substantial restructuring and modernization efforts, and relocated the production to lower wage countries within and outside the EU with the aim of increasing productivity and reorienting production towards innovative products (Kastelli et al., 2018; Taplin, 2006). More specifically, they turned to a variety of strategies, including improving efficiency at home, outsourcing production abroad, supplying clients on a just-in-time basis, and branding their products (McCaffrey, 2013).

Traditionally, the competitive advantage of TI firms relied on the location in specialized territorial clusters where spatial proximity facilitates the interactions within the production chain and the diffusion of new knowledge (Bellandi et al., 2009; Porter, 1998). The spatial concentration of firms belonging to the same industry (specialization) promotes knowledge spillovers between firms and facilitates innovation (Caragliu et al., 2016). Indeed, an important contribution to the innovation of TIs firms is provided by firms within the same supply chain (McAdam and McClelland, 2002). In fact, in terms of innovation model these sectors were identified as supplier-dominated sectors (Pavitt, 1984). For example, in the case of the textile and clothing industry most of the innovations originate from the R&D laboratories of medium and large textile companies, suppliers of in-line quality control, fiber producers, machinery and component manufacturers and the suppliers of dyes and other chemicals or treatments for textile finishing. These innovations are then marketed to downstream firms, including the smaller firms that cannot carry out their own R&D (Camagni and Rabellotti, 1992; Shishoo, 2012).

However, over the last decades, the need for introducing technological innovations has increased among TI firms (Hirsch-Kreinsen, 2015). The introduction of new materials and environmentally sustainable products and processes, the increasing role played by brands (Mohr, 2013, and Sorescu et al., 2011), the pace of product renewal (Cachon and Swinney, 2011), and the changes required in the organization of production and distribution (Capello and Ravasi, 2009; Gockeln, 2014; Mustonen et al., 2013; Vale and Caldeira, 2008), are some of the driving elements that have exhorted firms to take on innovation.

The diffusion of technological innovation in TI firms has been facilitated by the increasing importance for the production and organizational processes of the so-called transversal or general purpose technologies (GPTs), such as ICT. To adopt these technologies TI firms are more and more dependent on the collaboration with firms in different sectors for their innovative activity. This is a major change compared with the traditional innovation model that relied on learning by doing and interactions within the production chain, the so-called DUI mode (Jensen et al., 2007). Given these changes, we aim at investigating if and to what extent industry specialization (i.e., the location in a local system characterized by the presence of firms belonging to the same industry) and industry variety (i.e., the location in a local system characterized by the presence of different industries) has an impact on the innovation performance of TI firms. Our expectation is that both characteristics play a positive role for the innovative performance of firms; however, given the changes in the innovation models outlined above we expect that the industry variety is gaining importance compared to local specialization.

As a result, we set the first two hypotheses as follows:

H_1. The innovation performance of TI firms is positively affected by the belonging to a specialized cluster (traditional model of innovation).

H_2. The innovation performance of TI firms is positively affected by industry variety at local level (new model of innovation).

Another relevant channel that is having a positive impact on TI firm innovation refers to the knowledge transfer from universities and research centers. The empirical and theoretical literature on knowledge and technology transfers between universities and industries is extensive (for a review of the literature see, for instance, Agrawal, 2001, Djokovic and Souitaris, 2008, and Miranda, 2018). It is generally recognized that universities play a central role in the process of knowledge creation and dispersion, and are able to leverage multidimensional skills and capabilities, create synergies, promote value cocreation and act as a proper economic and firm productivity engine (Marrocu et al., 2021).

Both the knowledge spillovers stemming from the production of knowledge, but also the development of human capital are assumed to be important attractors for firm innovation activities. For instance, Adams (2002) argues that localized academic spillovers encourage firms to work with local universities, while Petruzzelli (2011) found that technological relatedness, prior collaboration ties, and geographical distance may influence the value of the university–industry innovations. However, other studies found that university research intensity and research quality are negatively associated with firm participation in university-industry collaboration at local level (Atta-Owusu et al., 2021).

The role or universities and research institute for TI firms is expected to increase, given the changes in the innovation model of firms (McKelvey and Ljungberg, 2017). For example, firms in TI must rely on advanced technologies and materials to deliver high quality products. Much of the academic research is not innovation-driven and consequently we observe a relatively small number of innovative products appearing in the TI as a result of university projects (McAdam and McClelland, 2002). However, according to Shishoo (2012) all major European academic institutions involved, for instance, in textile-related research are making strong efforts to interact with textile companies and to effectively contribute to innovation and technology transfer. Italian universities have also significantly increased their technology transfer activities during the last two decades (NetVal, 2016). There are indications that this trend is also observed in the relations between universities and TI firms. One of these indication is the number of academic patents that are related to the TI (Forti et al., 2013).

A large body of this literature has focused the attention on the Italian case too. This literature looked on various aspect of the university-industry relationship, and underlined the positive impact of geographical, cognitive and industry distance on the occurrence of university–industry partnerships (see Carboni, 2013; Cardamone, 2018; Fantino et al., 2015; Muscio and Pozzali, 2013, among others).

For instance, Leten et al. (2011) found a strong positive relationship between industrial technological performance and the presence of nearby universities.

Overall, while the literature on the effect of the university knowledge spillover on firm innovation performance is widespread, there is a lack of empirical evidence on how these changes are affecting the role of universities on the innovation activity in TI. One example is Shishoo (2012), which discusses the role of universities and research institutes in the innovation process of textile and clothing firms. His analysis confirms that most of the innovations in textile materials and technologies have come, with some notable exceptions, from the textile industry itself rather than academic research. However, this does not mean that the latter does not have a role to play in innovation for new product development, particularly in supporting small firms.

Another study that looks at how university knowledge spillovers affect the innovation performance of TI firms is Maietta (2015), which examines the determinants of university–firm R&D collaboration and of innovations for the Italian food industry. The author tried to quantify the impact of research, education and technology transfer-related activities at universities on local firms and found that university–firm R&D collaboration only affects process innovation. Product innovation seems to be more tacit knowledge-driven since geographical proximity to a local university is a positive and highly significant determinant of product innovation, whereas faculties' research quality, as measured by bibliometric and research assessment indicators, is a negative and highly significant determinant.

Finally, a strand of the literature investigated the joint impact that university and regional specificities might have in fostering the innovation performance of firms (Cardamone, 2018; D'Ambrosio et al., 2017), but also the creation of academic spin-offs, start-ups and university patenting (Baldini et al., 2006). For instance, Hervás-Oliver et al. (2021) found that firms innovation capacity is largely influenced by the local context. Small firms in more innovative European regions benefit to a far greater extent from a combination of internal R&D, external collaboration of all sorts, and non-R&D inputs, while small firms in less innovative European regions rely fundamentally on external sources and, particularly, on collaboration with other firms.

In the empirical part of the paper we test to what extent the proximity to universities along with other characteristics of the local context impact the innovation performance of TI firms. The competitive advantages of TIs firms were traditionally associated with the location in specialized clusters. This is especially true for textile and clothing firms and for the leather and footwear producers that show a high level of territorial concentration in specialized clusters. This is less true in the case of the food industry in which the location of firms is more often dependent on the supply of raw materials. For all TI firms the location in large and diversified urban areas or the proximity to a university were not considered within the location advantages. Our hypothesis is that this is changing, given the increasing importance of innovations based on the adoption of advanced technologies.

Our third hypothesis is then:

H_{3a}. The proximity to a university plays a positive role on the innovation performance of TI firms (through knowledge spillover and human capital improvement);

H_{3b}. The technology transfer activity of the closest university plays a positive role on the innovation performance of TI firms (technology transfer).

3. Data and methodology

In this section, we describe the data sources and examine some of its basic empirical regularities. We provide detailed description of the main explanatory variables, and describe the methodology and the empirical model used for estimation. The descriptive statistics of the data are in Table A1 in the Appendix.

3.1. Data sample

Our final sample, obtained by merging different data sources, contains information on 12,604 TI firms owning 5408 international patents and participating in 1167 EU projects. Table 1 shows that on average since 2011 only a modest 2.9 % and 7.6 % of firms within the sample have respectively an international patent application or a financed project. On average each firm owns about 15 patents, however for all industries the distribution of patents is highly concentrated within firms. For instance, the first 10 firm in the leather and footwear industry own >78 % of the patents in that industry. This is also the reason why we consider an additional indicator of the innovation activities of firms since the participation to EU funded projects is more equally distributed across firms.

Regarding the geographical distributions, Fig. 1 shows that there is spatial concentration of both patents and projects in all industries. However, patents tend to be more spatially concentrated within the North-Center area within the more innovative regional ecosystems. In the case of innovative projects funded by EU programs, they are present also in Southern regions, which are the major recipients of EU structural funds. The leather and footwear industry is the industry with the highest territorial concentration; innovation activity mirrors the presence of the main territorial clusters in the Veneto, Tuscany, Marche and Apulia regions. The textile and clothing and the food industries are less spatially concentrated. The food industry shows a significant presence in the Southern regions as a result of the importance of agricultural productions in those regions.

As mentioned before, the location within industrial districts is relevant in the case of textile and clothing industry and in the leather and footwear industry, while in the case of the agri-food industry only 258 out of 5977, i.e. 4 % of the total sample, are located in industrial districts.[3]

3.2. Dependent variables

We use two measures of innovation performance of TI firms. The first measure is the number of patent applications by TI firms. The source of firms' patent data is the Amadeus database from Bureau Van Dijk (BvD), which provides data about the patent applications by firms together with other information about the sector of activity, the location and the size of firms. We collected data on patents and firms for the period 2011–2016.

The Amadeus BvD database also provides detailed information on patent technology based on the International Patent Classification (IPC 1999), a complex hierarchical classification system comprising sections, classes, subclasses, and groups. A single patent can be codified by more than one IPC code. Table 2 shows the first 10 most used IPC classes of patents owned by firms in our sample by industry.[4] For the Textile and clothing industry patents, one third of the IPC are under the "D: Textiles, Paper" IPC section and about 20 % of the cases under the "A: Human Necessities" IPC section, which means that they are mainly addressed to solve wearable needs of people. Also, in the agri-food industry, the majority of the IPC codes used to identify the technological domain of the patent are under the "A: Human Necessities" IPC section, followed by the "B: Performing Operations, Transporting" section. For the Leather and Footwear industry the IPC are more concentrated in few classes: the first 10 IPC classes are used to codify >88 % of the cases within this industry. For instance, the A43 IPC class (Footwear) alone is used to codify patents in more than half of the cases.[5]

Patents remains one of the main indicators for the innovation performance and it is generally used in the literature about firms' innovation (see, for instance, Bergquist et al., 2017; Gambardella et al., 2008). Moreover, data on other proxies of innovation activity, such as R&D expenditure, are not available at firm level. We must also consider that the changes in the innovation model of traditional firms discussed in the previous sections are increasing the importance of patenting also in these industries. However, we are aware of the limitations of using patents as an indicator of innovation performance, especially in traditional industries where the innovation model is characterized by low investment in R&D and little capabilities for autonomous innovation (Hervas-Oliver et al., 2011).

Given the limitations of patents as an indicator of innovation activity in TI firms, in the empirical analysis we use a second measure of firm innovation performance, based on the consideration of innovation activities rather than innovation output. Specifically, we use the number of innovation projects financed under the European Regional Development Fund (ERDF) and approved by Italian regions for the period 2011–2018. These data have been made available by OpenCoesione, an open government initiative promoted and coordinated by the Department of Cohesion Policy at the Presidency of the Council of Ministers. We consider the projects financed under the priority axis 1 of ERDF which is focused on strengthening research, technological development and innovation. The advantage of considering ERDF projects at regional level is that those funds are accessible by small and medium sized firms which characterize TI. Therefore, this allows us to consider a broader picture of the innovation activities carried out by TI firms.

Table 3 shows that on average one third of the projects are about innovations of product and process and about 30 % of the total projects are services to firm, including vocational training. A large share of projects, almost one fourth of the total, are instead dedicated to the purchase, upgrading and restructuring of machinery, equipment and facilities. Across industries, the Textile and clothing industry are more involved in projects about innovations of product and process, while for the agri-food industry about one third of the total projects aimed at the upgrading and the restructuring of machineries. Such heterogeneity allows us to consider a wider span of innovation activities, which are not merely R&D based but they are specifically relevant in TIs (Hervas-Oliver et al., 2011; Hirsch-Kreinsen, 2015).

3.3. Independent variables

The independent variables can be grouped into three categories. The first group contains variables about university proximity and university characteristics, i.e., the research quality, the third mission activities, university patents, and spin-offs. The second group includes structural indicators about the area where TI firms are located. Specifically, we use measure of specialization, and variety. Finally, the third group consists of controls variable about the size of the local system and of the firms, about agglomeration economies and institutional quality. The variables at territorial level are measured at NUTS-3 provincial level.[6] The number of provinces for which data are available are 103.[7]

3.3.1. University proximity

At present, the Italian university system is made up of 96 legally

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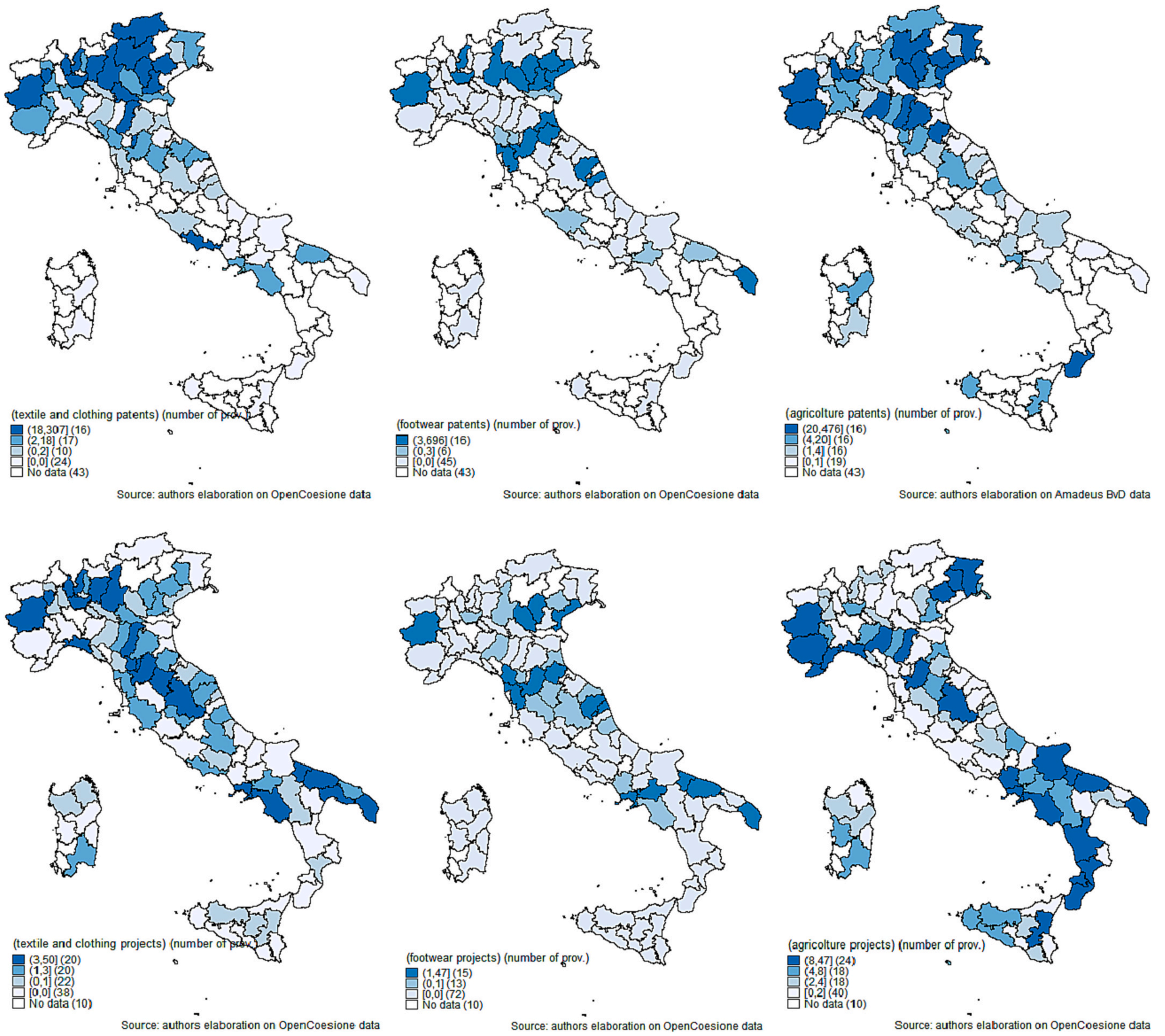
[3] Industrial districts are identified by ISTAT as local labor systems that fulfill the following criteria: a prevalence of employees in manufacturing; a specialization in a specific industry; the prevalence of employees in small and medium sized companies (ISTAT, 2014).

[4] The latest edition of the IPC contains 8 sections, about 120 classes, about 630 subclasses (which symbols consist of the class symbol followed by a capital letter), and approximately 69,000 groups (group symbols consist of the subclass symbol followed by a one- to three-digit number) (IPC, 1999).

[5] A detailed description of the first 10 IPC classes by industry is in Table A1 in the Appendix.

[6] NUTS (Nomenclature of Territorial Units for Statistics) is the geocode standard for referencing the subdivision of countries for statistical purposes, adopted by the EU. NUTS-3 delimit areas with a population between 150,000 to 800,000. In Italy NUTS-3 corresponds with the administrative provinces with and average population of about 600,000 people.

[7] The number of Italian provinces in 2010 were 110.



Source: authors elaboration on OpenCoesione data

Source: authors elaboration on OpenCoesione data

Source: authors elaboration on Amadeus BvD data

Source: authors elaboration on OpenCoesione data

Source: authors elaboration on OpenCoesione data

Source: authors elaboration on OpenCoesione data

Fig. 1. Geographical distribution of patents and projects by industry. Top panel: patents by textile and clothing industry (left), footwear industry (centre), and agri-food industry (right). Bottom panel: projects by textile and clothing industry (left), footwear industry (centre), and agri-food industry (right). Darker areas denote higher values.

recognized institutions.[8] For our analysis we focus on 75 institutions, which are in 52 NUTS-3 provinces.[9] These institutions are almost equally distributed between the Northern, the Centre and the South of Italy, with few exceptions (the provinces of Rome, Milan and Naples host eight, seven and four universities, respectively). Following previous literature (Laursen et al., 2011) we measure university proximity as physical linear distance between each TI firm and the closest university. Proximity can be measured in various forms, such as cognitive, social, or institutional proximity (Boschma, 2005). In the case of university-industry collaboration for innovation, these forms of proximity are as important as physical proximity for enabling successful knowledge exchange. However, it is rather geographical proximity that strongly facilitates other forms of proximity such as cognitive or social proximity, especially when knowledge is accessible through direct physical interaction or requires extensive personal contact (Morgan, 2004). This is also the case for codified knowledge as patents. Indeed, for the interpretation and application of the technology build in a patent, it is usually required a certain degree of tacit knowledge, which can be easily transferred with face-to-face contacts (Storper and Venables, 2004). For these reasons we use physical distance, which is calculated using geographic coordinates (latitude and longitude) computed through the Google Geocoding API process. For robustness we also use alternative measures of physical distances: we generate a dummy that takes the value of 1 if the closest university is >25, 50 or 100 km away from the firm. We also include a dummy variable that is equal to 1 if there is more than one university within the 50 km distance from the firm location.

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[8] The 96 institutions include 77 traditional universities, 11 online universities, five institutions of higher education for graduates and postgraduates, and three universities for foreigners. 66 institutions are state-owned and 30 are not state-owned.

[9] This is because data on university research quality and on the third-mission activities are not available for all universities.

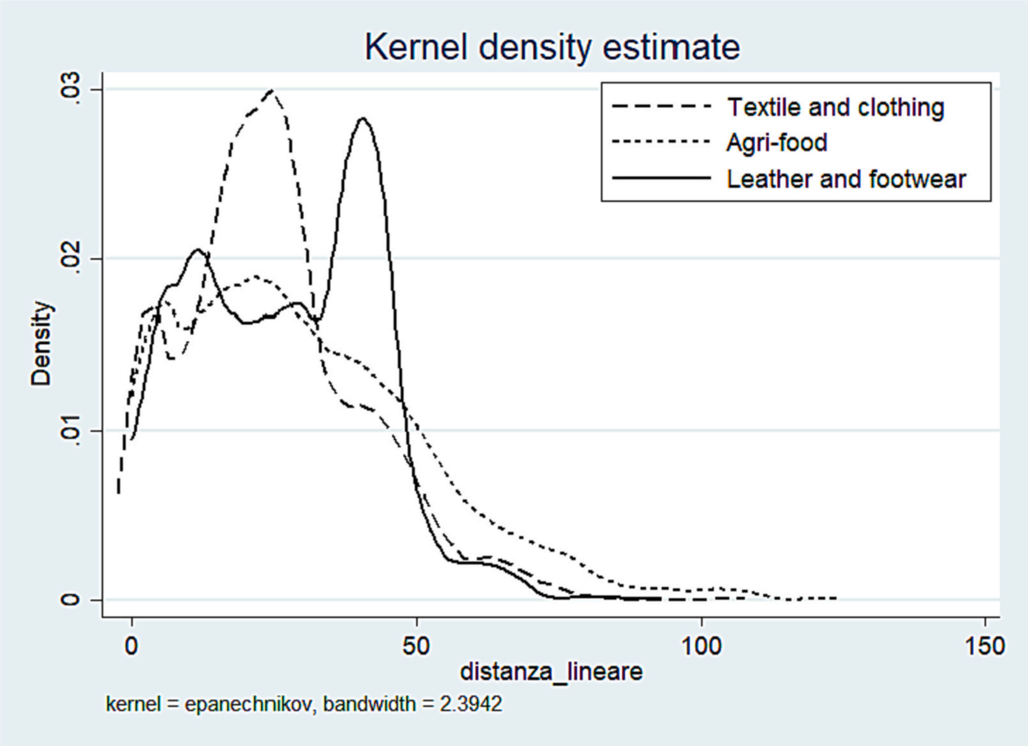

Fig. 2. Kernel density estimate of firm distance to closest university (in km) by industry.

On average, firms are 27.6 km away from the closest university, while the median distance is 25.2 km (Table 1).[10] Also, firms in the textile and clothing industry on average tend to be less distant to the closest university while firms in the agri-food industry are generally located more distant as they are more likely located in rural areas. Distances are plotted in Fig. 2, which provides the kernel density estimations of distances by industry. Finally, if we consider only firms with patents and firms with projects, the average distance is about 25 km for the former and 31.4 km for the latter. This distance gap between firms with patents and firms with projects is larger for the agri-food industry.

3.3.2. University research quality and third-mission activities

Data on university research quality and on the third-mission activities were taken from the 2004–2010 VQR (Research Assessment Exercise) report compiled by the Italian National Agency for the Evaluation of Universities and Research Institutes (ANVUR, 2013), which provides a detailed picture of the quality of 133 research and academic institutions. The level of significance, originality and internationalization of a total of 184,878 research products (such as articles, books, critical editions, patents, software, etc.) were assessed, through both a bibliometric analysis, based on journals' impact factor and citations, as well as a peer review analysis. The VQR report classifies several indicators of research quality, among which we selected the Final Indicator of University Research (IRFS2) that considers the qualitative and quantitative characteristics of university research. The VQR report also shows a set of indicators related to the university third mission activities. ANVUR defined 8 indicators, some related to the economic exploitation of knowledge, such as research and collaboration agreements, patents, spin-offs, participation in incubators and consortia to promote technology transfer. Other indicators include activities improving societal well-being, such as the management of archaeological sites, museum centers and other third-mission activities. For our purposes we use a concise third mission indicator (ITMFS), which is calculated as a weighted sum of 6 indicators.[11]

3.3.3. University patents

Data concerning university patents are extracted from PATIRIS database (Forti et al., 2013), which includes all patent applications by Italian universities or national research agencies based in Italy, filed nationally and abroad, both directly or as extensions of patents filed elsewhere.[12] We selected patents applications that relates to TI using the International Patent Classification (IPC). Also, we selected only patents that have been published between 1996 and 2010. The total number of patents over this period is 2793. These have been registered by 62 university or research agencies located in 44 provinces. This is a clear indication of a high degree of spatial concentration of patent activity by universities: the University of Milan, the Polytechnic of Milan, and the University of Siena have the highest number of registered patents related to TI.

3.3.4. University spin-offs

Academic scientific knowledge is also created and transfer to the market through spin-offs, i.e., companies that originated within universities (Fini et al., 2017). We use the stock of academic spin-off established before 2010. Data are taken from the spin-off database

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[10] Both the average (37.8 km) and the median (33.6 km) street distances between firms and the closest university are very similar to the linear distance, so in the empirical analysis we use the latter measure.

[11] In the concise indicator ITMFS, we did not include “IMTS2: number of patents” and “IMTS3: number of spin-offs” as third mission activities. The former is explicitly measured by the number of patents by university, which is taken from the Patiris database (see the “University patent” description within this Section), while the latter is measured by the variable “spin-off”, that is the number of academic spin-offs. For more details on the computation of the ITMFS indicator see ANVUR (2013).

[12] As indicated by Forti et al. (2013) the database does not include all Italian academic inventors, as many academic inventors have filed patents with companies or under their own name.

Table A3
Correlation matrix for variables used in the empirical model.

Textile and clothing industry	1	2	3	4	5	6	7	8	9	10	11
2	−0.245***										
3	−0.0186	0.383***									
4	0.0238	0.318***	0.804***								
5	0.0348*	0.302***	0.711***	0.519***							
6	−0.287***	0.0452**	−0.255***	−0.457***	−0.0879***						
7	0.208***	0.0175	0.295***	0.485***	0.115***	−0.977***					
8	−0.360***	0.109***	−0.243***	−0.376***	−0.248***	0.465***	−0.395***				
9	−0.0248	0.0332*	−0.115***	−0.156***	−0.0383*	0.132***	−0.124***	0.0783***			
10	−0.287***	0.221***	0.139***	0.187***	0.151***	0.185***	−0.0561***	0.147***	0.0433**		
11	−0.271***	0.365***	0.0529***	0.0278	0.0945***	0.181***	−0.0446**	0.129***	0.116***	0.696***	
12	−0.400***	0.235***	0.168***	0.113***	−0.130***	−0.0279	0.142***	0.425***	−0.0588***	0.194***	0.185***

Agri-food industry	1	2	3	4	5	6	7	8	9	10	11
2	−0.0600***										
3	−0.0993***	0.334***									
4	−0.0600***	0.186***	0.714***								
5	−0.0262	0.281***	0.629***	0.516***							
6	−0.384***	0.166***	0.219***	0.155***	0.182***						
7	0.0770***	−0.0660***	0.0549***	0.0821***	0.0898***	−0.483***					
8	−0.372***	−0.0406**	0.0288*	−0.0394**	−0.0512***	0.334***	−0.017				
9	−0.0752***	0.016	0.023	0.0216	0.0239	0.0919***	0.0297*	0.0428**			
10	−0.194***	0.164***	0.205***	0.283***	0.267***	0.481***	0.180***	0.171***	0.145***		
11	−0.197***	0.165***	0.150***	0.177***	0.193***	0.463***	0.189***	0.0909***	0.147***	0.736***	
12	−0.397***	0.0451**	0.227***	0.0928***	−0.0288*	0.457***	0.0124	0.512***	0.0611***	0.235***	0.145***

Leather and footwear industry	1	2	3	4	5	6	7	8	9	10	11
2	−0.0769***										
3	−0.0382	0.423***									
4	0.174***	0.272***	0.584***								
5	0.214***	0.429***	0.736***	0.629***							
6	−0.240***	0.161***	0.146***	0.180***	0.166***						
7	0.168***	0.0448*	0.0166	−0.0844***	−0.0027	−0.766***					
8	−0.443***	−0.0633**	−0.171***	−0.463***	−0.308***	0.114***	−0.161***				
9	−0.014	0.012	0.0175	−0.115***	0.019	0.0486*	−0.000309	0.0724**			
10	0.014	0.404***	0.336***	0.485***	0.472***	0.487***	−0.0446*	−0.193***	0.0470*		
11	0.0781***	0.254***	0.101***	0.0964***	0.244***	0.351***	0.146***	−0.258***	0.0533*	0.647***	
12	−0.524***	0.0475*	0.193***	−0.111***	−0.166***	0.280***	−0.0601**	0.310***	0.00716	−0.0662**	−0.00494

1 = Distance to University; 2 = University patents; 3 = Univ. research quality; 4 = Third mission; 5 = Spin-offs; 6 = UV; 7 = Balassa Index; 8 = Dummy univ-prov; 9 = Firm size; 10 = Per-capita VA; 11 = Institutional quality index; 12 = Population density.

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

jointly developed by NetVal, Sant'Anna School of Business and Università Politecnica delle Marche.[13]

In the case of the characteristics of the local context we consider the following variables.

3.3.5. *Specialization*

We measured the geographic concentration of firms belonging to the same sector using the Balassa specialization index calculated using the number of employees at two-digit level of the NACE classification (Balassa, 1965). Data are from the ISTAT (the National Institute of Statistics) Population Census and refers to 2011. Given the relevance of industrial districts in Italy, as an alternative to the specialization at provincial level we also consider a dummy variable detecting the belonging of our sample firms to an industrial district specialized in the same industry.

3.3.6. *Variety*

We follow Frenken et al. (2007) and consider unrelated variety at local level as the presence of different sectors identified as different 2-digit codes of the NACE classifications. Unrelated variety is measured as the entropy index calculated on the number of employees in different 2-digit sectors excluding the traditional industry under observation. Data are from the ISTAT Population Census and refers to 2011.

3.3.7. *Local context control variables*

Following previous literature, we include some control variables at province level. Among possible determinants we select per-capita Value Added to capture the economic development of the local system (Hudson and Minea, 2013). We also use a composite index to measure the quality of the local institutions (Canh et al., 2018). More specifically, this index measures the endowment of social and economic structures in Italian provinces and the administrative capacity of provincial and regional governments in relation to policies concerning health, waste management and the environment (quality of public services) (government effectiveness index in Nifo and Vecchione, 2014). Finally, we use population density as a proxy for agglomeration economy.

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[13] The database is accessible on www.spinoffitalia.it.

Table 1
Description of firms, patents (2011–2016) and projects (2011–2018).

	All traditional industries	Textile and Clothing	Agri-food	Leather and Footwear
FIRMS				
Number of firms	12,604	4390	5977	2237
Firms within an industrial district	2983	1718	258	1007
Firms with patents	366	165	122	79
Firms with patents (%)	2.9 %	3.8 %	2.0 %	3.5 %
Firms within an industrial district with patents	2.7 %	2.6 %	1.9 %	3.1 %
Firms with projects	963	296	536	131
Firms with projects (%)	7.6 %	6.7 %	9.0 %	5.9 %
Firms within an industrial district with projects	6.6 %	5.8 %	10.5 %	7.0 %
Distance between firm and university (in km)				
Average (all firms)	27.6	24.7	30.0	27.1
Median (all firms)	25.2	23.3	26.6	24.8
Average (only firm with patents)	25.1	24.5	22.9	29.5
Median (only firm with patents)	23.7	22.5	19.8	29.1
Average (only firm with projects)	31.4	29.9	32.2	31.6
Median (only firm with projects)	28.1	27.1	27.7	32.2
PATENTS				
Number of patents	5408	1695	2191	1522
Average number of patents per firm	14.8	10.3	18.0	19.3
Share of patents by first 10 firms	48.3 %	53.3 %	71.0 %	78.3 %
PROJECTS				
Number of projects	1167	359	660	148
Average number of projects per firm	1.21	1.21	1.23	1.13
Average amount per project (in Euro)	108,530	64,180	135,729	97,452

Source: authors elaboration on Amadeus BvD, ISTAT, MIUR and OpenCoesione data.

3.3.8. *Firm level control variables*

Finally, we control for firm size measured as the number of employees, and we include sector dummies to control for sector-specific effects (each of the textile and clothing industries and the agri-food industry comprise two industries). Empirical model.

To test our hypotheses, we estimate a negative binomial regression model at firm level. The negative binomial model is used to consider the large share of firms with no patents. The Wald test performed on all specifications suggests that the use of a negative binomial model is preferred to a Poisson model.[14] To account for excessive zeros and overdispersion in the dependent variable, we also estimate a zero-inflated negative binomial model. However, the Vuong (1989) test suggests that the negative binomial model is still preferred. Moreover, we test whether a multilevel regression model, which account for the hierarchical structure of the data, was more appropriate. The likelihood ratio tests used to compare the negative binomial regression models to the multilevel specifications, are in favor of the negative binomial regression model.[15] The negative binomial model specify the dependent variable as a count variable. More formally:

$$P_{i,t} = \alpha_0 + \alpha_1 \sum_{k=1}^{N} X^{k}_{i,t-1} + \varepsilon_i \tag{1}$$

where $P_{i,\,t}$ measures either 1) the number of patents by firm i at time t, or 2) the number of projects by firm i at time t, $X^{k}_{i,\,t-1}$ is a vector of k patents determinants that includes firm distance to the closest university, university spillovers, regional and industry characteristics, and other control variables discussed above. Finally, ε_i is an error term. Variables on the right-hand side of Eq. (1) are taken at the beginning of the period in order to alleviate the endogeneity problem. In addition, since errors for firms close to the same university may be correlated, we use cluster standard errors in the empirical estimation. The source of the data and the description of the variables are in Table 4. The descriptive statistics and the correlation matrix of the variable used in Eq. (1) are in Tables A2 and A3 in the Appendix, respectively.

4. Estimation results

Tables 5 and 6 show the results of the estimates based on the negative binomial model, with the dependent variables being the number of patent and the number of projects respectively. Results for model in Eq. (1) are reported according to the three industries considered in the analysis. The Balassa index and the UV variable are highly correlated so that these two variables are added one at a time (in columns 1a, 2a and 3a we add the Balassa index to the other variables while in columns 1b, 2b and 3b we added the UV variable). In columns 1c, 2c, and 3c we instead add the dummy industrial district to the UV variable. Therefore, for each industry we report three estimation results: columns 1a-1c refer to the textile and clothing industry, 2a-2c to the agri-food industry, and 3a-3c to the leather and footwear industry. In Tables 5 and 6 distance is measured in km.[16]

When considering patents, Table 5 shows that estimation results are mostly industry specific. In general, the innovation performance in the textile and clothing industry and the agri-food industry is more affected by the characteristics of the local context, while this is not the case for the leather and footwear industry. Proximity to a university seems to have an impact only within the agri-food industry: being closer to a university increases the agri-food firms' probability to patent. Also, measures of university characteristics and technology transfer activities, i.e., the research quality, the third mission activities, university patents, and spin-offs, are not always statistically significant across industries. These differences within industries may be explained in part by the presence of different innovation models and different location patterns. However, a common result is that patenting is strongly associated to firms' idiosyncratic variables: firm size is positive and strongly significant across industries.

Going into more details, in the case of textile and clothing industry, specialization exerts a negative effect on the innovation performance of firms. This result is robust to different specifications in terms of the Balassa index or the belonging to a specialized district. On the contrary,

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[14] The Wald test is more appropriate than the Likelihood-ratio chi-square test when data are clustered (Winkelmann, 2008, p.80).

[15] Results are available from the authors upon request.

[16] Results are robust to alternative measures to the continuous distance variable. Overall, general results do not significantly change when we use a dummy that takes the value of 1 if the closest university is >25, or 50 km away from the firm.

Table 2
First 10 IPC classes by industry. Share of IPC occurrences on total (1).

	Textile and clothing		Agri-food		Leather and footwear	
1	12.3 %	D04	19.1 %	A23	50.4 %	A43
2	11.3 %	D06	17.9 %	B65	12.3 %	D04
3	11.2 %	A41	10.1 %	A21	11.3 %	B29
4	4.6 %	A47	9.9 %	A47	4.1 %	A41
5	4.2 %	D03	5.8 %	B60	2.5 %	A63
6	4.1 %	A61	5.5 %	B29	2.2 %	A45
7	3.7 %	B32	4.0 %	A61	1.9 %	B62
8	3.4 %	F16	2.4 %	B62	1.5 %	B32
9	3.3 %	B65	2.0 %	F16	0.9 %	B60
10	3.1 %	B60	1.4 %	B21	0.9 %	A61
Total	61.4 %		78.1 %		88.0 %	

IPC Section classification: A: Human Necessities, B: Performing Operations, Transporting, C: Chemistry, Metallurgy, D: Textiles, Paper, E: Fixed Constructions, F: Mechanical Engineering, Lighting, Heating, Weapons, G: Physics, H: Electricity.
Source: authors elaboration on Amadeus BvD, and World Intellectual Property Organization (1989). (1) See Table A1 in the Appendix for a definition of the IPC Classes.

Table 3
Project category according to Single Project Code (CUP) system[a].

	All traditional industries	Textile and clothing	Agri-food	Leather and footwear
Research and innovation projects at firms	33 %	43 %	29 %	28 %
- of which: innovation of product and process	5 %	4 %	6 %	3 %
Services to industrial firms	31 %	33 %	28 %	35 %
- of which: purchase of real services (including professional training)	17 %	13 %	22 %	3 %
Works, plants and equipment for industrial activities and handicraft	24 %	13 %	32 %	15 %
Total	87 %	89 %	89 %	78 %

Source: OpenCoesione. (1) 29 % of the projects in this category are classified under “others”.

[a] http://www.programmazioneeconomica.gov.it/wp-content/uploads/2014/12/Classificazione_CPV_a_parte_.pdf

variety at local level plays a positive and statistically significant role on innovation performance. This means that in the textile and clothing industry the ‘new model of innovation’ (*H2*) is somehow replacing the traditional model of innovation (*H1*). However, proximity to universities and the characteristics of the latter do not show any statistically significant role for the innovation performance of firms.

In the agri-food industry we observe a different pattern as variety at local level plays a negative role while specialization is not relevant in influencing the innovation performance of firms. This result may be in part explained by the fact that many of these food processing firms are located in rural areas, which are characterized by less industry variety. This means that these firms continue to prefer the proximity to the suppliers of raw materials and ingredients rather than the belonging to specialized clusters. Differently from the other traditional industries, for firms in the agri-food industry proximity to universities seems to play a relevant role, given that the coefficient of the variable that measure the distance from the closest university shows a negative and statistically significant value. This confirms our hypothesis (H_{3a}). However, there is no statistically significant impact of the variables that proxy university characteristics (the research quality, the third mission activities, university patents, and spin-offs), therefore hypothesis (H_{3b}) is not confirmed.

Still different is the innovation model of the leather and footwear industry for which none of the characteristics of the local context play a significant role, nor do the variables that we use to characterize the type of innovation model, i.e., specialization and industry variety. In addition, university characteristic variables show contradictory results: the quality of academic research have a negative impact while the presence of spin-offs have a positive effect on firms' innovative performance. Moreover, being distant from a university has a statistically and significant impact on innovation for these firms. These results may be explained by considering the high territorial concentration of firms in specialized cluster that are generally located far from large urban areas.

The estimates obtained by considering the innovation projects financed through EU funds can partly overcome the limitations of using patents as a measure of the innovative performance of firms in those industries. These estimates are presented in Table 6. Overall, results suggest that even when using the number of projects as dependent variable, the local context plays a significant role, even within the leather and footwear industry. Moreover, there is no clear evidence

Table 4
Labels, data source, and variable descriptions.

Variable	Definition	Unit of measure	Source	Time period
Firm patent	Cumulated number of patents registered by an Italian firm	number	Amadeus BvD	2011–2016
Firm projects	Cumulated number of ERDF projects in R&D	number	OpenCoesione	2011–2018
Distance to University	Linear distance between firm and the closest university	km (log)	Googlemaps	
University patents	Stock of patent applications by Italian universities or national research agency based in Italy	hundreds	PATIRIS	1996–2010
Univ. research quality	Tot IRFS2: Indicator of final assessment for the research quality of the structure	index	ANVUR	2004–2010
Third mission	Indicator of final assessment for third-mission activities, obtained as a weighted sum of the six third mission indicators by area (IMTS2: number of patents, and IMTS3: number of spin-offs, are not included)	index	ANVUR	2004–2010
Spin-offs	Cumulated number of academic spin-offs	number	NETVAL	1996–2010
UV	Unrelated Variety	index	ISTAT (Census)	2011
Balassa index	Balassa specialization	index	ISTAT (Census)	2011
Dummy ind. District	=1 if firm is located within the corresponding industrial district		ISTAT	2011
Dummy univ-prov	=1 when the closest university is located within the same province of the firm		ISTAT - Amadeus BvD	
Firm size	Number of employees (period average)	log	Amadeus BvD	2011–2016
Per-capita VA	Per-capita Value Added at constant prices	euro	ISTAT	2010
Institutional quality index	Government effectiveness. Measure a) endowment of social and economic facilities; b) Regional health deficit; c) Separate waste collection; d) Urban environment index.	index	Nifo and Vecchione (2014)	2010
Population density	Inhabitant per squared kilometer	log	ISTAT	2010

Table 5
Negative binomial estimation. Dependent variable: firm patents (2011–2016).

	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
	Textile and clothing industry	Textile and clothing industry	Textile and clothing industry	Agri-food industry	Agri-food industry	Agri-food industry	Leather and footwear industry	Leather and footwear industry	Leather and footwear industry
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Distance to Univ.	0.196	0.187	0.257	−0.315	−0.320*	−0.327*	0.446*	0.472*	0.511*
	(0.162)	(0.161)	(0.157)	(0.208)	(0.191)	(0.187)	(0.266)	(0.270)	(0.300)
Dummy university	−0.256	−0.316	−0.061	0.644	0.537	0.509	−0.145	−0.189	−0.116
	(0.428)	(0.434)	(0.430)	(0.484)	(0.459)	(0.457)	(0.896)	(0.854)	(0.882)
Univ. research quality	0.015	0.008	0.018	0.297	0.355	0.345	−0.586*	−0.620*	−0.625*
	(0.197)	(0.198)	(0.192)	(0.293)	(0.273)	(0.275)	(0.304)	(0.317)	(0.334)
Third mission	−0.064	−0.050	−0.031	−0.002	−0.090	−0.091	−0.126	−0.120	−0.138
	(0.142)	(0.142)	(0.140)	(0.259)	(0.234)	(0.231)	(0.140)	(0.149)	(0.150)
Spin-offs	0.021	0.021	0.014	−0.038	−0.031	−0.029	0.065***	0.067***	0.073**
	(0.019)	(0.019)	(0.018)	(0.023)	(0.020)	(0.021)	(0.024)	(0.025)	(0.031)
University patents	−0.034	−0.034	−0.037	−0.003	−0.003	−0.003	−0.355**	−0.330**	−0.373**
	(0.022)	(0.022)	(0.024)	(0.003)	(0.003)	(0.003)	(0.161)	(0.161)	(0.163)
Balassa	−0.083**			0.346			−0.071		
	(0.041)			(0.287)			(0.089)		
Dummy ind. district			−0.772*			0.388			−0.661
			(0.460)			(0.882)			(0.648)
UV		0.884**	0.356		−4.612**	−4.845**		2.316	1.220
		(0.414)	(0.603)		(2.324)	(2.409)		(2.612)	(2.432)
Quality of public service	−0.249	−0.627	−0.117	3.684***	5.040***	4.919***	0.798	−0.389	0.655
	(2.162)	(2.194)	(2.097)	(1.354)	(1.427)	(1.401)	(3.986)	(3.667)	(4.641)
Per-capita Value Added	0.099*	0.093*	0.094*	−0.040	0.046	0.051	0.180*	0.164	0.158
	(0.052)	(0.051)	(0.051)	(0.054)	(0.071)	(0.073)	(0.101)	(0.107)	(0.112)
Firm size	0.903***	0.904***	0.911***	0.911***	0.929***	0.940***	1.604***	1.617***	1.647***
	(0.099)	(0.099)	(0.099)	(0.165)	(0.163)	(0.168)	(0.171)	(0.177)	(0.180)
Population density	0.147	0.114	0.104	−0.381	−0.095	−0.051	0.405	0.352	0.372
	(0.185)	(0.182)	(0.185)	(0.305)	(0.325)	(0.343)	(0.559)	(0.542)	(0.545)
Constant	−7.295***	−11.533***	−9.279***	−5.780***	15.526	16.668	−10.837***	−22.018*	−16.849
	(1.404)	(2.297)	(3.238)	(1.800)	(10.233)	(10.599)	(1.645)	(13.364)	(12.607)
Number of observations	3926	3926	3926	5286	5286	5286	1995	1995	1995
Adj.R2	0.054	0.054	0.056	0.051	0.053	0.053	0.101	0.101	0.103
Wald test	335.693	306.633	662.463	94.585	82.999	79.702	177.475	175.900	414.082
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Clustered standard errors in parentheses.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

Table 6

Negative binomial estimation. Dependent variable: firm projects (2011–2018).

	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
	Textile and clothing industry	Textile and clothing industry	Textile and clothing industry	Agri-food industry	Agri-food industry	Agri-food industry	Leather and footwear industry	Leather and footwear industry	Leather and footwear industry
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Distance to Univ.	0.080	0.073	0.084	−0.055	−0.071	−0.078	−0.245**	−0.257**	−0.197*
	(0.088)	(0.090)	(0.091)	(0.056)	(0.056)	(0.057)	(0.102)	(0.110)	(0.110)
Dummy university	0.073	0.109	0.087	−0.182	−0.109	−0.105	−0.065	0.016	0.131
	(0.198)	(0.210)	(0.200)	(0.140)	(0.138)	(0.140)	(0.280)	(0.247)	(0.237)
Univ. research quality	−0.038	−0.030	−0.017	−0.357***	−0.354***	−0.357***	−0.203**	−0.220**	−0.264**
	(0.170)	(0.167)	(0.159)	(0.106)	(0.105)	(0.105)	(0.093)	(0.104)	(0.108)
Third mission	0.131	0.124	0.122	0.028	0.019	0.026	0.114*	0.149**	0.189***
	(0.085)	(0.084)	(0.089)	(0.059)	(0.066)	(0.066)	(0.065)	(0.063)	(0.053)
Spin-offs	0.004	0.004	0.003	0.023***	0.027***	0.026***	0.025**	0.024**	0.025**
	(0.013)	(0.013)	(0.013)	(0.006)	(0.007)	(0.007)	(0.011)	(0.011)	(0.011)
University patents	0.032*	0.031*	0.024	0.003*	0.003	0.003	−0.033	−0.081	−0.122
	(0.018)	(0.018)	(0.017)	(0.002)	(0.002)	(0.002)	(0.072)	(0.123)	(0.170)
Balassa	0.039			−0.010			0.113*		
	(0.035)			(0.170)			(0.058)		
Dummy ind. district			−0.419*			0.048			−0.467*
			(0.219)			(0.217)			(0.264)
UV		−0.430	−0.567		−1.242**	−1.243**		−2.309	−2.692*
		(0.364)	(0.378)		(0.633)	(0.632)		(1.462)	(1.529)
Quality of public service	2.701*	2.861*	2.826**	2.173**	2.439***	2.395***	3.134**	5.225***	5.482***
	(1.571)	(1.549)	(1.434)	(1.042)	(0.801)	(0.800)	(1.506)	(1.291)	(1.623)
Per-capita Value Added	−0.195***	−0.192***	−0.184***	−0.150***	−0.133***	−0.131***	−0.150***	−0.157***	−0.161***
	(0.032)	(0.031)	(0.032)	(0.035)	(0.035)	(0.035)	(0.044)	(0.045)	(0.044)
Firm size	0.287***	0.288***	0.278***	0.215***	0.218***	0.214***	0.318***	0.322***	0.323***
	(0.049)	(0.049)	(0.050)	(0.042)	(0.043)	(0.044)	(0.061)	(0.062)	(0.063)
Population density	−0.638***	−0.637***	−0.555***	−0.166	−0.070	−0.070	−0.176	−0.259	−0.317*
	(0.158)	(0.152)	(0.143)	(0.127)	(0.121)	(0.121)	(0.180)	(0.165)	(0.164)
Constant	−2.496***	−0.439	0.343	−0.838*	4.948	4.965	−2.717***	8.341	
	(0.720)	(2.108)	(2.231)	(0.442)	(3.059)	(3.057)	(0.599)	(6.811)	
Number of observations	3993	3993	3993	5439	5439	5439	2005	2005	2005
Adj.R2	0.065	0.065	0.068	0.052	0.054	0.054	0.096	0.093	0.096
Wald test	211.027	231.153	260.143	138.026	146.408	136.898	303.208	332.176	306.281
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Clustered standard errors in parentheses.

* $p < 0.10$.

** $p < 0.05$.

*** $p < 0.01$.

about the prevailing model of innovation as already observed in the case of patents. Also, there is a rather weak impact on firm innovation performance from being close to a university. Indeed, proximity is a relevant factor for the leather and footwear industry only.

Going into more details at industry level, in the case of textile and clothing firms they confirm the pattern already observed when considering the patenting activity: the characteristics of the local context show a statistically significant role in explaining the innovation performance of firms. However, only the coefficient on the dummy district is statistically significant and with a negative sign. We may recall that industrial districts are specialized cluster characterized by the presence of small and medium sized firms. These territorial clusters are very effective in the production and spreading of incremental innovation while reducing the incentives for engaging in more formal innovation activity as represented by patenting and the application to EU funded projects.

As for the agri-food industry, the estimates based on innovation projects confirm the irrelevance of specialization and the negative role of variety at local level observed in the case of patents. The explanation is again associated with the location preferences of those firms in rural areas, closed to raw material suppliers. The proximity to universities maintains the expected sign although now it is not statistically significant. However, the presence of university spin-offs plays a positive and significant role as most of these companies are set up with the aim of providing innovation services to small firms (Iacobucci and Micozzi, 2015).

The role of university proximity is more relevant in the case of the leather and footwear industry. Indeed, as expected, increasing the distance from universities reduce the ability of firms to propose innovative projects. We suggest that these results may be explained by considering that the participation to innovation projects is more widespread across firms and more representative of innovation activity than patents. Moreover, in the case of the leather and footwear industry the characteristic of the local context plays a role in explaining the innovation performance of firms, but there is no clear indication regarding the prevailing model of innovation within this industry. Third mission activities and the presence of spin-offs have also a positive impact on firm's innovation performance within this industry. On the contrary, the quality or research of the closest university plays a negative role. This result was already observed in other studies (Maietta, 2015) and seems to demonstrate the presence of a trade-off between excellence in research and the commitment in technology transfer activity. Also, the characteristic of the local context plays a role: the belonging to an industrial district has a negative impact on innovation projects. The reasons are similar to those discussed referring to textile and clothing firms.

Finally, it is worthwhile mentioning that in the case of innovative projects within EU funded programs the quality of public services at local level shows a positive and significant effect for firms in all industries. This is also the case in Table 5 (with patents as the dependent variable) but only for the agri-food industry). This positive role was already observed when considering the patenting activity but was significant only in the case of agri-food firms. The EU funded projects considered in the empirical analysis are proposed and administered by institutions at local level. As a result, they are highly dependent from the quality of those institutions as the results of our estimates clearly demonstrate. These results is in accordance with the recent debate about the relevance of institutional quality for the innovation performance of firms (Rodriguez-Pose and Di Cataldo, 2015). It is also a confirmation of the increasing importance of the triple helix model in which innovation performance is the result of an effective interaction between firms, universities and public institutions (Etzkowitz, 2008).

5. Conclusions

The aim of this paper is to measure whether and to what extent the innovation model of firms in traditional industries (Tis) is changing as a result of the increasing importance of general purpose technologies (GPTs). We expect an increasing importance of variety at local level and proximity to universities in explaining the innovation performance of firms in TIs.

The increasing importance of GPTs is expected to reduce the advantages arising from the location in specialized clusters while favouring the interaction with firms belonging to different sectors and the collaboration with research institutions. As a result, we expect that the innovation performance of TIs firm is positively related to industry variety at local level and proximity to universities.

To test these hypotheses, we consider the proximity of firms to universities and the characteristics of the latter in terms of research and technology transfer activity. Moreover, we take into account the degree of specialization and industry variety of the local context in which firms are located. We consider firms belonging to the three main traditional industries: textile and clothing, agri-food, and leather and footwear. These industries are still very relevant in Italy which is the country considered in the empirical analysis.

In the empirical estimates we use two measures of innovation performance. The first is based on patents, which is the most widely used indicator of innovation performance. However, in traditional industries only a minority of firms apply for patents as product and process innovations are mostly based on non R&D activities. For this reason, we use another measure of innovation activity based on the participation of firms to innovation projects sustained by the EU structural funds. These funds are allocated on the basis of programs developed at national and regional level.

The empirical estimations show that in the case of patents proximity to universities does not always have a significant impact on the innovative performance of firms. Rather, the characteristic of the local context seems relatively more important, although firms respond to different location incentives. Textile and clothing firms seem more reliant on industry variety than specialization, as expected from the new model of innovation. However, this is not the case for the leather and footwear firms and for the agri-food firms. For the former, the characteristic of the local context is not relevant in influencing their innovation performance. For the agri-food firms, variety plays a negative role, most likely because of the preferred location of these firms in rural areas to take advantage of the proximity to suppliers of raw materials. Overall, these results also show that, besides the lack of a prevailing model of innovation, firm patenting activity is strongly associated with firms' idiosyncratic variables. Indeed, the patenting activity refers to a small share of firms (around 3 % of total) and the phenomenon shows a high level of concentration.

The estimation results using the innovation projects proposed by firms under EU funded programs generally confirms the above results, although with some exceptions. Indeed, results indicate that firms in traditional industries have not experienced dramatic changes in their innovation model, still mainly reliant on the traditional model of innovation, based on learning by doing and the relations with firms within the production chain. Only within the textile and clothing industries there are some signs of changes towards a new model of innovation, as firms in these industries seem more reliant on industry variety than specialization. Proximity to universities plays a relevant role only for firms in the leather and footwear industry. The commitment of universities in technology transfer activity and the presence of spin-offs are also important factors for these firms.

Finally, we find that the innovative performance of firms in our sample is influenced by the quality of public services at local level. This positive role is particularly relevant in all industries when considering the EU funded projects and is also relevant in the patenting activity of agri-food firms. The debate around the role of institutional quality on firm performance has increased during the last few years. It will be worthwhile to investigate this issue further to understand the mechanisms influence such relation, as well as the interactions with the other variables influencing the innovation performance.

Most of the literature on innovation in low-tech, traditional industries, stressed the importance of non-formal R&D activities and of organizational and process innovations as opposed to technological innovation (René and Hugo, n.d.; Robertson et al., 2009; Santamaría et al., 2009). We think that this approach underestimates the increasing importance of so-called general purpose or transversal technologies, such as ICT, which are becoming more and more relevant in driving innovation activities also in traditional industries. This is becoming even more relevant with the changes in product design and in production and distribution processes induced by the digital and environmental transitions. As a result, we suggest that also the location advantages of firms in traditional industries, generally associated with the belonging to specialized (Maskell, 1998) clusters are changing. The empirical results of our study suggest that the changes are more evident when considering industry variety at local level rather than the proximity to universities. This may indicate that TI firms are increasingly dependent from suppliers of different types of technology but still not much from knowledge producing institutions (such as universities); this could be justified by the low level of commitment to R&D investment that still characterizes traditional industries.

Besides, the paper has several limitations that could be addressed in future research. A first limitation refers to the complexity of innovation which is a multi-facet concept especially in traditional industries where creativity and non-technological innovations are important factors. We tried and overcome this limitation by using different measures of innovation. We are aware that they do not fully account for the entire innovation activity of firms. A second limitations is that we do not directly observe the interactions between firms and universities. Those interactions are presumed as a result of the spatial proximity between the two. However, this is a common way to detect potential relations between subjects in innovation studies, given the role played by spatial proximity in influencing the frequency and efficacy of interactions between people and organizations.

Declaration of competing interest

On behalf of all other authors, we declare that we have no conflicts of interest. We certify that the submission is original work and is not under review at any other publication.

Data availability

The data that has been used is confidential.

Appendix A

Table A1
IPC Classes definition.

Textile and clothing	
D04	BRAIDING; LACE-MAKING; KNITTING; TRIMMINGS; NON-WOVEN FABRICS
D06	TREATMENT OF TEXTILES OR THE LIKE; LAUNDERING; FLEXIBLE MATERIALS NOT OTHERWISE PROVIDED FOR
A41	WEARING APPAREL
A47	FURNITURE; DOMESTIC ARTICLES OR APPLIANCES; COFFEE MILLS; SPICE MILLS; SUCTION CLEANERS IN GENERAL
D03	WEAVING
A61	MEDICAL OR VETERINARY SCIENCE; HYGIENE
B32	LAYERED PRODUCTS
F16	ENGINEERING ELEMENTS OR UNITS; GENERAL MEASURES FOR PRODUCING AND MAINTAINING EFFECTIVE FUNCTIONING OF MACHINES OR INSTALLATIONS; THERMAL INSULATION IN GENERAL
B65	CONVEYING; PACKING; STORING; HANDLING THIN OR FILAMENTARY MATERIAL
B60	VEHICLES IN GENERAL

Agri-food	
A23	FOODS OR FOODSTUFFS; THEIR TREATMENT, NOT COVERED BY OTHER CLASSES
B65	CONVEYING; PACKING; STORING; HANDLING THIN OR FILAMENTARY MATERIAL
A21	BAKING; EQUIPMENT FOR MAKING OR PROCESSING DOUGHS; DOUGHS FOR BAKING
A47	FURNITURE; DOMESTIC ARTICLES OR APPLIANCES; COFFEE MILLS; SPICE MILLS; SUCTION CLEANERS IN GENERAL
B60	VEHICLES IN GENERAL
B29	WORKING OF PLASTICS; WORKING OF SUBSTANCES IN A PLASTIC STATE IN GENERAL
A61	MEDICAL OR VETERINARY SCIENCE; HYGIENE
B62	LAND VEHICLES FOR TRAVELLING OTHERWISE THAN ON RAILS
F16	ENGINEERING ELEMENTS OR UNITS; GENERAL MEASURES FOR PRODUCING AND MAINTAINING EFFECTIVE FUNCTIONING OF MACHINES OR INSTALLATIONS; THERMAL INSULATION IN GENERAL
B21	MECHANICAL METAL-WORKING WITHOUT ESSENTIALLY REMOVING MATERIAL; PUNCHING METAL

Leather and footwear	
A43	FOOTWEAR
D04	BRAIDING; LACE-MAKING; KNITTING; TRIMMINGS; NON-WOVEN FABRICS
B29	WORKING OF PLASTICS; WORKING OF SUBSTANCES IN A PLASTIC STATE IN GENERAL
A41	WEARING APPAREL
A63	SPORTS; GAMES; AMUSEMENTS
A45	HAND OR TRAVELLING ARTICLES
B62	LAND VEHICLES FOR TRAVELLING OTHERWISE THAN ON RAILS
B32	LAYERED PRODUCTS
B60	VEHICLES IN GENERAL
A61	MEDICAL OR VETERINARY SCIENCE; HYGIENE

Source: authors elaboration on Amadeus BvD and World Intellectual Property Organization (1989).

Table A2
Descriptive statistics.

Textile and clothing industry	N	min	max	mean	p50	sd
Distance to University	3926	−2.733	4.657	2.857	3.144	1.059
University patents	3926	0.000	42.000	3.684	0.000	6.825
Univ. research quality	3926	0.024	6.018	1.947	1.486	1.559
Third mission	3926	0.000	6.695	2.025	1.682	1.770
Spin-offs	3926	0.000	65.000	12.736	12.000	12.900
UV	3926	3.749	5.280	4.808	4.972	0.460
Balassa index	3926	0.088	14.004	3.516	1.754	4.438
Firm size	3926	0.000	7.838	2.859	2.773	1.139
Per-capita VA	3926	0.013	0.661	0.453	0.450	0.091
Institutional quality index	3926	10.581	27.592	20.730	20.712	3.903
Population density	3926	−3.016	0.952	−0.926	−1.093	0.821

Agri-food industry	N	min	max	mean	p50	sd
Distance to University	5286	−3.430	5.349	2.990	3.285	1.147
University patents	5286	0.000	311.000	35.001	13.000	59.191
Univ. research quality	5286	0.002	6.018	1.541	1.440	1.299
Third mission	5286	0.000	6.695	1.491	1.190	1.355
Spin-offs	5286	0.000	65.000	11.260	6.000	13.101
UV	5286	3.749	5.280	4.979	4.981	0.162
Balassa index	5286	0.083	14.004	1.011	0.647	1.142
Firm size	5286	0.000	9.043	2.742	2.657	1.165
Per-capita VA	5286	0.000	1.000	0.397	0.414	0.126
Institutional quality index	5286	10.061	27.592	18.943	20.336	4.814
Population density	5286	−3.247	0.952	−1.417	−1.440	0.910

Leather and footwear industry	N	min	max	mean	p50	sd
Distance to University	1995	−1.741	4.533	2.989	3.305	1.008
University patents	1995	0.000	17.000	0.870	0.000	1.554
Univ. research quality	1995	0.002	6.018	2.165	1.884	1.508
Third mission	1995	0.000	6.695	2.619	2.014	2.341
Spin-offs	1995	0.000	65.000	14.138	6.000	14.531
UV	1995	3.749	5.280	5.020	5.027	0.133
Balassa index	1995	0.088	14.004	1.258	1.297	1.062
Firm size	1995	0.000	8.274	2.928	2.890	1.050
Per-capita VA	1995	0.000	0.641	0.453	0.432	0.107
Institutional quality index	1995	10.581	27.592	19.704	20.324	4.292
Population density	1995	−2.685	0.952	−1.214	−1.284	0.847

References

Adams, J.D., 2002. In: Comparative Localization of Academic and Industrial Spillovers, 2, pp. 253–278.

Agrawal, A.K., 2001. University-to-industry knowledge transfer: literature review and unanswered questions. Int. J. Manag. Rev. 3, 285–302. https://doi.org/10.1111/1468-2370.00069.

ANVUR, 2013. Rapporto sullo stato del sistema universitario e della ricerca 2013.

Atta-Owusu, K., Fitjar, R.D., Rodríguez-Pose, A., 2021. What drives university-industry collaboration? Research excellence or firm collaboration strategy? Technol. Forecast. Soc. Chang. 173, 121084 https://doi.org/10.1016/j.techfore.2021.121084.

Balassa, B., 1965. Trade liberalisation and "revealed" comparative advantage. Manchester Sch. 33, 99–123. https://doi.org/10.1111/j.1467-9957.1965.tb00050.x.

Baldini, N., Grimaldi, R., Sobrero, M., 2006. Institutional changes and the commercialization of academic knowledge: a study of Italian universities'patenting activities between 1965 and 2002. Res. Policy 35, 518–532. https://doi.org/10.1016/j.respol.2006.01.004.

Bellandi, M., De Propris, L., Becattini, G., 2009. A Handbook of Industrial Districts. Edward Elgar Publishing, Cheltenham.

Bergquist, K., Raffo, J., Fink, C., 2017. Identifying and Ranking the World's Largest Clusters of Inventive Activity.

Boschma, R., 2005. Proximity and innovation: a critical assessment. Reg. Stud. 39, 61–74. https://doi.org/10.1080/0034340052000320887.

Cachon, G.P., Swinney, R., 2011. The value of fast fashion: quick response, enhanced design, and strategic consumer behavior. Manag. Sci. 57, 778–795. https://doi.org/10.1287/mnsc.1100.1303.

Camagni, R., Rabellotti, R., 1992. Technology and organization in the italian textile-clothing industry. Entrep. Reg. Dev. 4, 271–285. https://doi.org/10.1080/08985629200000016.

Canh, N.P., Schinckus, C., Thanh, S.D., 2018. Do economic openness and institutional quality influence patents? Evidence from GMM systems estimates. Int. Econ. https://doi.org/10.1016/j.inteco.2018.10.002.

Capello, P.V., Ravasi, D., 2009. The variety and the evolution of business models and organizational forms in the Italian fashion industry. In: Bus. Hist. Conf. Bus. Econ. Hist. On-line Pap. Present. BHC Annu. Meet, 7, pp. 1–19.

Caragliu, A., De Dominicis, L., De Groot, H.L.F., 2016. Both Marshall and Jacobs were right! Econ. Geogr. 92, 87–111. https://doi.org/10.1080/00130095.2015.1094371.

Carboni, O.A., 2013. Spatial and industry proximity in collaborative research: evidence from Italian manufacturing firms. J. Technol. Transf. 38, 896–910. https://doi.org/10.1007/s10961-012-9279-2.

Cardamone, P., 2018. Firm innovation and spillovers in Italy: does geographical proximity matter? Lett. Spat. Resour. Sci. 11, 1–16. https://doi.org/10.1007/s12076-017-0193-y.

D'Ambrosio, A., Gabriele, R., Schiavone, F., Villasalero, M., 2017. The role of openness in explaining innovation performance in a regional context. J. Technol. Transf. 42, 389–408. https://doi.org/10.1007/s10961-016-9501-8.

Diebolt, C., Hippe, R., 2019. The long-run impact of human capital on innovation and economic development in the regions of Europe. Appl. Econ. 51, 542–563. https://doi.org/10.1080/00036846.2018.1495820.

Djokovic, D., Souitaris, Æ.V., 2008. In: Spinouts From Academic Institutions: A Literature Review With Suggestions for Further Research, pp. 225–247. https://doi.org/10.1007/s10961-006-9000-4.

Etzkowitz, H., 2008. The Triple Helix: University-Industry-Government Innovation in Action. Routledge, London.

European Commission, 2011. High-level Expert Group on Key Enabling Technologies. Final Report.

Evangelista, R., Iammarino, S., Mastrostefano, V., Silvani, A., 2001. Measuring the regional dimension of innovation. Lessons from the Italian Innovation Survey. Technovation. https://doi.org/10.1016/S0166-4972(00)00084-5.

Fantino, D., Mori, A., Scalise, D., 2015. Collaboration between firms and universities in Italy: the role of a firm's proximity to top-rated departments. Ital. Econ. J. 1, 219–251. https://doi.org/10.1007/s40797-014-0003-2.

Fini, R., Fu, K., Mathisen, M.T., Rasmussen, E., Wright, M., 2017. Institutional determinants of university spin-off quantity and quality: a longitudinal, multilevel, cross-country study. Small Bus. Econ. 48, 361–391. https://doi.org/10.1007/s11187-016-9779-9.

Forti, E., Franzoni, C., Sobrero, M., 2013. Bridges or isolates? Investigating the social networks of academic inventors. Res. Policy 42, 1378–1388. https://doi.org/10.1016/j.respol.2013.05.003.

Frank, A.G., Dalenogare, L.S., Ayala, N.F., 2019. Industry 4.0 technologies: implementation patterns in manufacturing companies. Int. J. Prod. Econ. 210, 15–26. https://doi.org/10.1016/j.ijpe.2019.01.004.

Frenken, K., Van Oort, F., Verburg, T., 2007. Related variety, unrelated variety and regional economic growth. Reg. Stud. 41, 685–697. https://doi.org/10.1080/00343400601120296.

Gambardella, A., Harhoff, D., Verspagen, B., 2008. The Value of European Patents.

Gockeln, L., 2014. In: Fashion Industry Analysis From the Perspective of Business Model Dynamics. Univ. Twente, P.O. Box 217, 7500AE Enschede Netherlands, p. 17.

Hervas-Oliver, J.-L., Albors Garrigos, J., Gil-Pechuan, I., 2011. Making sense of innovation by R&D and non-R&D innovators in low technology contexts: a forgotten lesson for policymakers. Technovation 31, 427–446. https://doi.org/10.1016/j.technovation.2011.06.006.

Hervás-Oliver, J.-L., Parrilli, M.D., Rodríguez-Pose, A., Sempere-Ripoll, F., 2021. The drivers of SME innovation in the regions of the EU. Res. Policy 50, 104316. https://doi.org/10.1016/j.respol.2021.104316.

Hirsch-Kreinsen, H., 2015. Innovation in low-tech industries: current conditions and future prospects. In: Som, O., Kirner, E. (Eds.), Low-Tech Innovation. Springer International Publishing, Cham, pp. 17–32. https://doi.org/10.1007/978-3-319-09973-6_2.

Hudson, J., Minea, A., 2013. Innovation, intellectual property rights, and economic development: a unified empirical investigation. World Dev. 46, 66–78. https://doi.org/10.1016/j.worlddev.2013.01.023.

Iacobucci, D., Micozzi, A., 2015. How to evaluate the impact of academic spin-offs on local development: an empirical analysis of the Italian case. J. Technol. Transf. 40, 434–452.

ISTAT, 2014. I sistemi locali del lavoro 2011. Roma.

Jensen, M., Johnson, B., Lorenz, E., Lundvall, B.A., 2007. Forms of knowledge and modes of innovation. Res. Policy 36, 680–693. https://doi.org/10.1016/j.respol.2007.01.006.

Jovanovic, B., Rousseau, P.L., 2005. In: Aghion, P., Durlauf, S.N. (Eds.), General Purpose Technologies. Elsevier B.V., pp. 1181–1224. https://doi.org/10.1016/S1574-0684(05)01018-X

Kastelli, I., Tsakanikas, A., Caloghirou, Y., 2018. Technology transfer as a mechanism for dynamic transformation in the food sector. J. Technol. Transf. 43, 882–900. https://doi.org/10.1007/s10961-016-9530-3.

Laursen, K., Reichstein, T., Salter, A., 2011. Exploring the effect of geographical proximity and university quality on university-industry collaboration in the United Kingdom. Reg. Stud. 45, 507–523. https://doi.org/10.1080/00343400903401618.

Leten, B., Landoni, P., Van Looy, B., 2011. Developing technology in the vicinity of science: do firms benefit? An overview and empirical assessment on the level of Italian provinces. In: Science and Innovation Policy for the New Knowledge Economy. Edward Elgar Publishing.

Maietta, O.W., 2015. Determinants of university–firm R&D collaboration and its impact on innovation: a perspective from a low-tech industry. Res. Policy 44, 1341–1359. https://doi.org/10.1016/j.respol.2015.03.006.

Marrocu, E., Paci, R., Usai, S., 2021. Direct and Indirect Effects of Universities on European Regional Productivity, Working Paper CRENoS. Centre for North South Economic Research, University of Cagliari and Sassari, Sardinia.

Maskell, P., 1998. Low-tech competitive advantages and the role of proximity: the Danish wooden furniture industry. Eur. Urban Reg. Stud. 5, 99–118. https://doi.org/10.1177/096977649800500201.

McAdam, R., McClelland, J., 2002. Sources of new product ideas and creativity practices in the UK textile industry. Technovation 22, 113–121. https://doi.org/10.1016/S0166-4972(01)00002-5.

McCaffrey, S.J., 2013. Tacit-rich districts and globalization: changes in the Italian textile and apparel production system. Socio-Econ.Rev. 11, 657–685. https://doi.org/10.1093/ser/mwt005.

McKelvey, M., Ljungberg, D., 2017. How public policy can stimulate the capabilities of firms to innovate in a traditional industry through academic engagement: the case of the Swedish food industry. R&D Manag. 47, 534–544. https://doi.org/10.1111/radm.12224.

Miranda, F.J., 2018. Review and a research agenda. J. Technol. Transf. 43, 1007–1038. https://doi.org/10.1007/s10961-017-9647-z.

Mohr, I., 2013. The impact of social media on the fashion industry. J. Appl. Bus. Econ. 15, 17–23. https://doi.org/10.4018/978-1-4666-4197-6.ch019.

Morgan, K., 2004. The exaggerated death of geography: learning, proximity and territorial innovation systems. J. Econ. Geogr. 4, 3–21. https://doi.org/10.1093/jeg/4.1.3.

Muscio, A., Pozzali, A., 2013. The effects of cognitive distance in university-industry collaborations: some evidence from Italian universities. J. Technol. Transf. 38, 486–508. https://doi.org/10.1007/s10961-012-9262-y.

Mustonen, M., Pal, R., Mattila, H., Mashkoor, Y., 2013. Success indicators in various fashion business models. J. Glob. Fash. Market. 4 (2), 74–92. https://doi.org/10.1080/20932685.2013.763476.

NetVal, 2016. Ricerca, valorizzazione dei risultati e impatto. In: XIII Rapporto Netval sulla Valorizzazione della Ricerca Pubblica Italiana. Milano.

Nifo, A., Vecchione, G., 2014. Do institutions play a role in skilled migration? The case of Italy. Reg. Stud. 48, 1628–1649. https://doi.org/10.1080/00343404.2013.835799.

Pavitt, K., 1984. Sectoral patterns of technical change: towards a taxonomy and a theory. Res. Policy 13, 343–373.

Petruzzelli, A.M., 2011. The impact of technological relatedness, prior ties, and geographical distance on university–industry collaborations: a joint-patent analysis. Technovation 31, 309–319. https://doi.org/10.1016/j.technovation.2011.01.008.

Porter, M.E., 1998. Clusters and the new economics of competition. Harv. Bus. Rev. 77–90.

René, W., Hugo, H., 2023. Promoting innovation, capabilities and impact for SMEs in traditional industries calls for variety in innovation support. Industria 45–74. https://doi.org/10.1430/94059.

Robertson, P., Smith, K., von Tunzelmann, N., 2009. Innovation in low- and medium-technology industries. Res. Policy 38, 441–446. https://doi.org/10.1016/j.respol.2008.10.019.

Rodríguez-Pose, A., Di Cataldo, M., 2014. Quality of government and innovative performance in the regions of Europe. J. Econ. Geogr. 15, 673–706. https://doi.org/10.1093/jeg/lbu023.

Rodriguez-Pose, A., Di Cataldo, M., 2015. Quality of government and innovative performance in the regions of Europe. J. Econ. Geogr. 15, 673–706. https://doi.org/10.1093/jeg/lbu023.

Santamaría, L., Nieto, M.J., Barge-Gil, A., 2009. Beyond formal R&D: taking advantage of other sources of innovation in low- and medium-technology industries. Res. Policy 38, 507–517. https://doi.org/10.1016/j.respol.2008.10.004.

Shishoo, R., 2012. The importance of innovation-driven textile research and development in the textile industry. In: The Global Textile and Clothing Industry: Technological Advances and Future Challenges, pp. 55–76. https://doi.org/10.1016/B978-1-84569-939-0.50004-6.

Sorescu, A., Frambach, R.T., Singh, J., Rangaswamy, A., Bridges, C., 2011. Innovations in retail business models. J. Retail. 87 https://doi.org/10.1016/j.jretai.2011.04.005.

Storper, M., Venables, A.J., 2004. Buzz: face-to-face contact and the urban economy. J. Econ. Geogr. 4, 351–370. https://doi.org/10.1093/jnlecg/lbh027.

Taplin, I., 2006. Restructuring and reconfiguration: the EU textile and clothing industry adapts to change. Eur. Bus. Rev. 18, 172–186. https://doi.org/10.1108/09555340610663719.

Teece, D.J., 2018. Profiting from innovation in the digital economy: enabling technologies, standards, and licensing models in the wireless world. Res. Policy 47, 1367–1387. https://doi.org/10.1016/j.respol.2017.01.015.

Vale, M., Caldeira, J., 2008. Fashion and the governance of knowledge in a traditional industry: the case of the footwear sectoral innovation system in the northern region of Portugal. Econ. Innov. New Technol. 17, 61–78. https://doi.org/10.1080/10438590701279318.

Vuong, Q.H., 1989. Likelihood ratio tests for model selection and non-nested hypotheses. Econometrica 57, 307–333.

Winkelmann, R., 2008. Econometric Analysis of Count Data, 5th ed. Springer Publishing Company, Incorporated.

Donato Iacobucci: He is Full Professor of Applied Economics at the Università Politecnica delle Marche (Faculty of Engineering) where he teaches courses on the economics and organization of firms and on industrial economics. Before joining Università Politecnica delle Marche in 2001, he was researcher of applied economics and assistant professor of business economics at the University of Urbino. From 1985 to 1994 he did research and consulting activities for private and public institutions in the field of industrial economics with specific regard to the management of small firms and business planning. He holds a B. A. from the University of Urbino (Italy) an MBA from ISTAO (Ancona, Italy) and a PhD from the University of Stirling (UK).

Francesco Perugini: He is Assistant Professor at the Università Politecnica delle Marche (Center for Innovation and Entrepreneurship), where he teaches Microeconomics. Previously, he was Post-doc at the Department of Economics, Society and Politics, University of Urbino Carlo Bo. He is also a Research Associate at the Liverpool Research Group in Macroeconomics. His research interests focuses on innovation and regional economics. He holds a B.A. from the Università Politecnica delle Marche (Italy), an MScEcon from Birkbeck College (UK), and a PhD from Cardiff University (UK).