Innovative startups in Italy. Managerial challenges of knowledge spillovers effects on employment generation

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Abstract

Purpose – *This paper aims to investigate the impact of knowledge spillover effects (KSE) on employment levels using a sample of 245 Italian Innovative startup companies created as a result of the legislative changes of Law Decree 179/12 introduced in Italy in 2012.*

Design/methodology/approach – *This study uses a parsimonious model with the employment level as the dependent variable. The paper tests for the impact that the measures of industry competition, specialization and diversity have on the level of employment in the Innovative Startup sector in Italy. The data uses a sample of 245 firms, across 20 geographic regions in Italy for three economic sectors at the 2-Dig NAICS classification.*

Findings – *The empirical results provide evidence in favor of regional specialization as the main force to create and transfer knowledge resulting in increased employment; while higher levels of competition and a more diverse regional production bases result in lower firm employment levels. Employment levels for these firms are also time-dependent, and thus mainly determined at the time of the firm's creation. This study also found a lack of technological convergence across regions, that are inherent regional differences are not bridged by knowledge spillover effects.*

Research limitations/implications – *This paper is based on a sample of Italian Innovative Startups and consequently, further research with a potentially larger sample and, perhaps, a sample across countries could also shed some light on the issues relating to KSE and their effects on employment generation and firm formation.*

Practical implications – *From a practical point of view, the results indicate that regional disparity and limited transmission of KSE across regions remain an impediment to the flow of knowledge. This in turn may limit the development of entrepreneurial activities and further development of new firms. Practical implications regarding knowledge management indicate that firms face time and spatial challenges when developing, transferring and acquiring knowledge. In sum, the evidence points out in favor of existent and persistent regional heterogeneity in terms of economic and technological specialization as sources of employment.*

Originality/value – *This research adds to the empirical evidence focusing on the effects of knowledge spillover effects in the Innovative Startup segment of the economy. This research highlights the applicability of knowledge spillover effects accounting for levels of industry competition, specialization and diversity. We also provide a measure of cluster formation and concentration at the sectoral and regional levels. Thus, the research provides a better understanding under which conditions knowledge is more likely to have positive or negative effects on employment generation.*

Keywords *Innovative startups, Knowledge spillover effects, Regional technological catch-up*

Paper type *Research paper*

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Introduction

Knowledge spillover effects (KSE) are considered a fundamental factor in the development of new business enterprises, their potential for growth and development of competitive advantage (Audretsch and Keilbach, 2007, 2008; Santoro *et al.*, 2019). In this regard,

however, there is a general consensus in the extant literature supporting the claim that KSE may affect employment generation in a non-symmetric non-homogenous way, with differentiated effects across firms and spatial units of observation and aggregation (Glaeser *et al.*, 1992; Ellison *et al.*, 2010; Pede *et al.*, 2020; Del Giudice *et al.*, 2019; Colombelli and Quatraro, 2017; Sedláček, 2017; among others). In this context, because of the geographic distribution of knowledge creation, spatial considerations of knowledge management across space and sectors of economic activity may also condition the flow, direction and extent of knowledge spillovers [1]. Consequently, the development of theoretical knowledge management and practices could be specific to regional/sectorial and spatially distributed firm development (Ferraris *et al.*, 2019; Audrestch and Keilbach, 2008).

From a theoretical perspective, understanding how, where and by whom knowledge is created and then successfully transferred, absorbed or kept isolated is a relevant research topic in the fields of entrepreneurial and knowledge management. The managerial implications of these alternate modeling considerations may be large, as differences across economic sectors and regional distribution of firms may differ largely. In this context, Santoro *et al.* (2019) note that knowledge related exploration and exploitation activities are very different topics. Also, Guerrero and Urbano (2014) study the presence of filters and the role that human capital and in particular academics play in start-ups and how the existence of filters limits the conversion of knowledge into economically useful knowledge. Thus, the rapport between the firm-leader and its followers in this context is fundamental as the leader becomes the generator of the initial ideas; and thus the source of possible knowledge spillovers. In this study, we pay particular attention to changes introduced in Italian Legislation in 2012, with the intention to promote the development of Innovative Startups. These are a new business structure capable of generating knowledge and facilitate its transmission across firms away from the traditional production and legislative settings. In particular, the changes introduced by the law are based on the assumption that new ventures can contribute to broadening business culture in the country by creating an environment which is more open to innovation and which attracts investment and talented individuals, either in the form of increase creativity or the capacity to applied otherwise tacit knowledge. If this correct, then the new Law serves as a mechanism to limit the presence of knowledge filters while increasing the generation and absorption capabilities of new firms. This case provides a very interesting opportunity to test existent theories of KSE, namely, the alternate MAR, Porters and Jacobs perspectives on Specialization, Competition and Diversity.

At the very core of the entrepreneurship knowledge spillover effect, the basic premise of the knowledge spillover theory of entrepreneurship (KSTE) is that knowledge creation and diffusion argumentation indicates that firms are very likely to benefit from the interaction with other firms through the commercialization of new knowledge (Audretsch and Keilbach, 2007, 2008; Audretsch and Belitski, 2013). Audretsch and Belitski (2013: 819) note that "the process of new knowledge commercialization through knowledge spillover becomes a key determinant of innovation and growth in industries and regions." However, the sources of these positive effects could be diverse on themselves and related to the availability of talented workers in specific regions. For instance, they might range from positive effects occurring in the same economic sector (2 Dig NAICS classification), same geographic region or alternately even as firms are located far away from the center of knowledge development [2].

Under these considerations, this paper takes particular aim at studying the effects deriving from KSE on firm employment generation. To accomplish this objective we use data from the Italian Innovative Startup sector and focus on its growth as a result of changes introduced in the Italian Civil Law Decree 179/12. While the Italian case may seem a specific and isolated case study, it actually provides a unique setting to study the effect of legislative changes to modify otherwise rigid conditions through the development of external

opportunities. In addition, it provides an interesting regional setting for comparison, all within the same country (Audretsch and Keilbach, 2007, 2008). Particularly it is feasible that legislative initiatives may serve as a mechanism to lower the thickness of knowledge filters (Audretsch and Belitski, 2013) and consequently promote entrepreneurial creativity. The Italian case serves as an interesting case study because the fundamental idea behind the legislative changes is to provide a new legislative/institutional framework conducive for entrepreneurship development in the innovation startup segment. Thus, issues relating to knowledge generation in the innovative startup sector and consequent KSE and related managerial implications are at the core of this paper. We aim at drawing both theoretical and practical managerial implications useful to better understand knowledge management at the firm, sector and regional level. To do this, and because of the importance that spatial distribution of knowledge may play, we also account for the geographic allocation of Innovative Startup firms in Italy across three major regions: North, Center and South [3]. More specifically, given the alternate nature of industry composition and possible differences at the regional and national level of firm interactions, we propose to study the role that cluster formation, industry competition, industry specialization and overall levels of diversity [4] in economic activity may play in the generation of employment in the innovative Startup segment of the market.

Based on our analysis and on our tentative results, we propose four stylized facts:

1. Fact 1: Employment created by Innovative Startups is highly related to the firm size as its origin.
2. Fact 2: Original differences in employment levels, persists as firms transition from young to older.
3. Fact 3: Variation in the industry's level of competition (negative), diversity (negative), specialization (positive), affect the overall level of employment by cohort.
4. Fact 4: The existence of Regional Technological Gap provides evidence of no convergence across firms in the same industrial cohort; that is KSE is limited to within regional dynamics.

The rest of the paper is organized as follows. The next section provides an extensive overview of the literature relating to employment and industry structures, with particular emphasis on the generation of KSE as they relate to industries' level of specialization, competition and diversity. We then provide a detailed description of the data and the approach to test for the presence of KSE on employment generation. We complete the analysis of our employment model and draw some relevant policy implications.

Literature review and background

The process by which technological innovation occurs is traditionally divided between exogenous and endogenous change. In the former, economies and subsequently, any other economic actors have no control over it and only take what the system gives them. In this setting, individuals engage in entrepreneurial activities taking opportunities as given (Audrestch and Keilbach, 2007). Under the latter – endogenous – work as early as Arrow (1962) and later Romer (1990), the argument indicates that economies have the capability to endogenously create technology that is based on ideas; these ideas are the result of individuals' characteristics leading to creativity development or human capital accumulation capable of absorption of ideas created by innovators. Audretsch and Feldman (2004) note that knowledge spillovers are an important mechanism for growth. In this context, Boom *et al.* (2017) state that growth that is generated by ideas is the basic result of research productivity times the number of researchers. More importantly this technology/knowledge could become available to many firms across economic sectors and eventually across

countries when the transmission mechanisms are available and barriers to transfer of knowledge are not existent. According to Audretsch and Feldman (2004), the transmission of this knowledge spillovers seem to be geographically located, and Audretsch and Keilbach (2008) argue that investment in knowledge in unbalanced and growth and competitiveness are not equally spread across firms and spatial units. In the process of trying to explain how knowledge occurs and how it affects firm development, employment generation and proliferation of entrepreneurial activities the most recent research has turned its focus on studying and explaining the role of dynamic knowledge spillover effects as fundamental for sustained growth (Santoro *et al.*, 2019; Ferraris *et al.*, 2018 for instance).

The interest of the most recent research has been in discovering these mechanisms and how they operate. As the research focus has moved progressively from countries to smaller units of analysis such as cities, regions and firms, it becomes evident the role that dynamic externalities concerning knowledge spillovers between firms within and across industries play in the growth process. More relevant issues relating to knowledge management have taken center stage in terms of entrepreneurship development and new firms' formation as well as effects on employment growth. Audretsch and Belitski (2013:821) argue that "the major point of KSTE is that entrepreneurs commercialize new knowledge available through incumbent companies." Beyond this point, KSE may also result in the formation of new firms provided that incentives are appropriate and knowledge filters are reduced. For instance, Colombelli and Quatraro (2017) note that "how the composition of local knowledge bases can influence the effects of knowledge spillovers on the formation of new firms remains a somewhat less explored issue." By the same token Guerrero and Urbano (2014) note that in the case of knowledge created by academics may suffer from the presence of filters limiting the development of new firms.

It has also become evident that there are significant differences relating to the level of data aggregation such as in regional and industry-specific data. From an empirical perspective, Feldman and Audretsch (1999) and Audretsch and Feldman (1996) are major contributions to the study of knowledge spillover effects as they incorporate geographic considerations to technological catch-up processes and innovation-related knowledge spillovers. Thus, at lower levels of data aggregation, issues relating to agglomeration, district clusters [5] and location economies become relevant as they may serve as mechanisms conducive to the proliferation of dynamic externalities of knowledge spillovers between firms within and across industries; this seems to be more relevant to within regional spillovers. Particularly, firm interaction and specifics of knowledge spillover effects may explain why industries tend to cluster in specific geographic locations as well (Porter, 1990; Krugman, 1991; Colombelli and Quatraro, 2017; Piergiovanni *et al.*, 1997 for instance). As Florida (2004) highlights the role that regions rich in ideas play in this process resulting in what is called Creative cities. To this end, Audretsch and Belitski (2013) further argue "a region with a higher concentration of new knowledge will generate more entrepreneurial opportunities."

According to the literature, the theoretical construct to explain the nature and sources of knowledge transfer and spillovers can be best represented by two structural elements, which are the degree of diversity versus specialization and the degree of monopoly versus local competition (Glaeser *et al.*, 1992 and Audretsch and Feldman, 2004). In this context, three alternate theories are brought forth [6]. First, the Marshall-Arrow-Romer (MAR) externalities approach indicates that regional specialization of local monopolies is more conducive to growth than local competition, that is knowledge is more easily transferred across firms that are very similar in productive nature but only for firms within the same industry. Second, Porter (1990) indicates that knowledge spillovers in specialized geographically concentrated industries – clusters – stimulates growth [7]. While both MAR and Porter argue in favor of industry specialization as a means to increase growth, the former argues in favor of monopolistic market structures while the latter promotes settings that are more competitive. A third approach places a pivotal role in inter-industry knowledge

spillovers. Here Jacobs (1969) theory emphasizes the importance of knowledge transfer across firms in different industries as a fundamental piece of the overall health of the economy. Jacobs proposes that growth is achieved through diversity from knowledge transfer outside the core industry. Jacobs argues that competition increases growth as Porter does. Because KSE is derived effects of some degree of interaction of pools of workers with particular knowledge-endowment within and across industries the role and importance of externalities are manifested through issues of specialization, competition and diversity. Knowledge, however, does not transfer easily and on a one-to-one relationship for a series of conditions of limitation, such as absorption capacity, filters, distance, levels of integration within firms for instance and in several cases just incapacity to commercialize knowledge.

As in Audretsch and Keilbach (2007), it is possible that KSE provides the context influencing entrepreneurship development as measured by employment growth (Glaeser *et al.*, 1992). In addition because of potential decay effects in the transmission of KSE entrepreneurship opportunities vary in relation to the degree of uncertainty generated from new ideas as well as the possible incomplete commercialization of new ideas from the incumbent firm. Because of the sound argumentation, overall rationale and empirical appeal of these theories we take particular interest in their applicability and implications at lower levels of data aggregation and spatial distribution of industries. We aim at providing strong empirical evidence to the field by using highly disaggregated data for the Innovative Startup sector in Italy. In this context, more recent developments in the field of Knowledge Spillover Entrepreneurship point out the importance that opportunities play in the development of new business ventures. For instance, a recent study by Del Giudice, Scuotto, Garcia-Perez, Petruzzelli (2019) note that "as stated by Audrestch and Belitski (2013), the knowledge spillover theory of entrepreneurship (KSTE) was developed as a response to the missing points in the knowledge production function and new growth theory (Audretsch and Lehmann, 2005; Acs and Armington, 2006; Acs *et al.*, 2009)." We argue that our study provides a unique opportunity to test these theories and advance knowledge management by contributing to the empirical evidence.

Early work by Plummer (2007) and later by Audrestch and Keilbach (2007) point out a lack of research focusing on the origins of opportunities as a driver of entrepreneurship development. More recent work by Audretsch and Belitski (2013) also points out that a complementary between opportunities and creativity need to be considered in terms of knowledge spillovers and entrepreneurial activity. As noted, our paper provides the opportunity to test the interaction of these two elements, opportunities and creativity, by focusing exclusively on the Innovative Startup sector, promoted by the Law Decree 179/12. In this context, a recent study by Colombelli and Quatraro (2017) indicates that newborn firms are drivers of innovation and provide radical technologies conducive to boost economic growth. In addition, the literature provides evidence that the promotion of regulations and economic structures conducive to the development of innovative private firms play a fundamental piece in the generation of employment. This in turn serves as an engine of sustained and prosperous economic growth. The literature states that of the utmost importance in this process is the assumption that the development of new technologies increases productivity and promotes the development and transfer of knowledge spillover effects [8]. How firms manage this newly developed or acquired knowledge is also a relevant piece in deriving positive effects. In some instances creating knowledge, silos may yield higher returns while in others knowledge sharing further creates positive spillover effects. However, the specific effects and related mechanisms deriving from the interaction among alternate economic units – such as firms from different economic sectors –on overall employment levels remain unclear and a relevant field of study. Our study provides an opportunity to advance the research in this field. In this context, the conditional settings of alternate economic sectors – differentiated degrees of specialization, competition and diversity – present interesting and useful approaches to better understand

firms' dynamics. To this end, the literature points out that knowledge, while being a fundamental piece for growth, is not necessarily homogeneous, it might not transfer on a one-to-one relationship from firm to firm and maybe conditional to geographic location (Glaeser *et al.*, 1992; Audretsch and Belistki, 2013; Pede *et al.*, 2020, among others).

For instance, Colombelli and Quatraro (2017) argue that accounting for the inherent heterogeneity nature of local available knowledge may be a relevant factor to consider when evaluating knowledge spillover effects. Thus, the process by which technological catch up occurs is highly related to the inner capacity that firms have in terms of their human capital associated with the capacity to absorb the technological change that is readily available to them. That is at lower levels of human capital firms should display less adaptation of external knowledge and catch up, and at higher levels higher capability to absorb and catch up. Furthermore, Colombelli and Quatraro (2017) hypothesize that higher levels of technological differentiation and relatedness result in reduced asymmetries and uncertainty related to knowledge, leading to a larger formation of new firms and higher employment at the local level [9]. This is the result of relatively lower barriers to the flow of resources within smaller geographic settings, such as cities or even geographically close regions. Piergiovanni *et al.* (1997) refer to this phenomenon as the *geography of innovation* (Porter, 1990; Krugman, 1991; Feldman, 1994 for further details). On a related issue, Guerrero and Urbano (2014) note that academics' knowledge generation may an important source of knowledge spillovers in startups formation if knowledge filters to develop entrepreneurial activities could be reduced. Ferraris *et al.* (2018) also note that knowledge transfer is conditioned by the level of internal and external embeddedness among firms and subsidiaries.

Each of the theories described presents a convincing argument for alternate mechanisms under which the knowledge spillover process may occur and how knowledge management practices may follow. As location factors could serve as either stepping-stones or stumbling-blocks for knowledge diffusion, these, in turn, could result in enhanced or restricted growth within and across industries (Feldman and Audretsch, 1999; Fritsch and Aamoucke, 2013; Magrini, 2004 for instance). This becomes more apparent, as the conditioning given by the spatial distribution of the firms' location and their interaction, supporting system and the presence of third parties such as universities or other research institutions may all have at the end potentially relevant effects in terms of the diffusion, generation and adoption of knowledge spillovers (Guerrero and Urbano, 2014).

Now from an empirical perspective, several studies provide robust evidence to some of these hypotheses. For instance, Feldman and Audretsch (1999) using data at the city level for the US, find strong evidence in favor of the diversity approach. Ellison, Glaeser and Kerr (2010) [10], however using data for the manufacturing sector in the USA found evidence in favor of the Marshallian forces (gains in transportation costs for inputs, labor and ideas) as an explanation for agglomeration, over the gains from natural advantages (p. 1210). In another paper, Audretsch and Feldman (1996, p. 638–639) found also that "industries, where new knowledge plays a more important role also tend to exhibit a greater geographic concentration of production [. . .] tendency to cluster spatially, is more attributable to the influence of knowledge spillovers and not merely the geographic concentration of production." Both studies find supporting evidence in favor of Jacobs' argumentation by indicating that in the USA innovations are found in cities, which are large enough to host entire industries, but diverse in the first place. For Italy Piergiovanni *et al.* (1997: 256) find that small firms find the largest knowledge benefits from within the geographic proximity, yet outside the industry system. In a recent study Sedláček and Sterk (2017: 3183) argue that "because of changes in startup composition, the number of jobs created by a cohort is largely determined by the cyclical state of the economy in the year of its entry." Using US county-level data, Pede *et al.* (2020) also provide an application of the specialization, competition and diversity theories and find evidence in support of significant differences

across sectors in their capacity to absorb knowledge spillovers. Particularly, in the US regional specialization hinders the prospects for employment growth. On the other hand, they find that regional diversity tends to promote its own growth. There remain, however, relevant gaps focusing lower levels of aggregation and much more focused on specific segments of the economic activity, such as Innovative Startups, as we do in this paper.

There are a series of studies focusing on the Italian case. For instance, Piergiovanni *et al.* (1997) studied the sources of innovative inputs in the Italian industry and argue that firm size is a relevant determinant of the efforts a firm brings forth in developing their own innovation or relying on spillover knowledge effects from external sources such universities or by other related – larger – firms. Elsewhere, argue that firms may invest instead in mechanisms to better absorb technology developed by others instead of developing their own technology. More recently, Colombelli and Quatraro (2017) study the rate of new firm formation and regional knowledge in Italy and find that "the availability of local knowledge spillovers is not sufficient *per se* to lead to the creation of new firms." Also, their results indicate that a high level of technological relatedness is the reflection of more homogeneity in terms of lower levels of asymmetries and uncertainty on the use of existent, out of the shelf technologies. In this context, Fritsch and Aamouche (2013; 867), argue that "the size and density of a region should have a positive effect on the number of innovative startups [...] due to the limited mobility of knowledge across space, the potential for knowledge spillovers in a region rises with the number of potential recipients located in spatial proximity."

Thus, current research still lacks analysis of the theories herein described particularly in relation to the Innovative Startup sector of the economy. Our study with a focus in the Italian case may provide useful information as to how, and if when, the KSE is present and result from the legislative changes introduced to propel the development of knowledge and consequent spillover in the form of entrepreneurial development as well as knowledge management issues [11]. As noted by Ferreira *et al.* (2018: 121) there is a strong need in the current knowledge economy for firms to create new business structures and new concepts for management of its resources to remain competitive.

We further argue that if combined with legislative-push-effects to modify the source of opportunities this may create an increased positive effect deriving from KSE. In fact, if KSE is seen as the result of incomplete commercialization of ideas created by other firms (perhaps, incumbent or competitors) the recently promoted institutional changes introduced by the Law Decree 172/12 in Italy – with the explicit intention to promote the development of innovative startups – could potentially provide a very interesting case study for KSE management and related issues. Thus, we believe that testing for KSE in the Innovative Startup sector could potentially yield very interesting results in relation to the effects the new legislation may play in the creation of opportunities for knowledge management issues to develop positive effects. It does appear that legislative changes may have/provide the necessary platform to lower the presence of knowledge filters and promote entrepreneurship development as well through spillover effects. As noted by Audretsch and Keilbach (2007) the presence of incomplete commercialization lead to organizational dimensions dealing with understanding the transmission mechanisms of KSE. We argue that efforts promoted through the Law Decree 179/12 may serve as the institutional mechanism to lower the uncertainty related to knowledge creation and reduce the knowledge filter effect [12] (Audretsch and Keilbach, 2007 for further details on this subject). According to Alvarez (2003) and Alvarez and Barney (2005, 2007), decision-making under uncertainty triggers entrepreneurship in the form of new organizations or firms.

Thus, the extant literature provides ample evidence of significant progress in understanding possible sources of knowledge and related mechanism for its transfer and adoption. Yet there are still several issues that remain ambiguous and in need of further study. Particularly

the study of how opportunities may be generated for entrepreneurship and regional and/or national growth. In this context, we aim to provide an empirical analysis with relation to the promotion of Innovative Startups in Italy as a result of legislative changes introduced by Law Decree 179/12 in October 2012. Innovative Startup Requirements per Law Decree 179/12-2010 below provides the general guidelines for a firm to be incorporated as an Innovative Startup. The specifics of what constitutes an Innovative Startup are clear to indicate its high knowledge content particularly per item 6) in Innovative Startup Requirements per Law Decree 179/12-2010 below:

1. its registered offices or be subject to taxation, in the Republic of Italy;
2. been established for no longer than 48 months;
3. turnover of fewer than 5m Euros;
4. owned directly and controlled (i.e. at least 51% of quotas as well as voting rights) by individuals;
5. does not distribute profits; and
6. its core business focused on innovative goods or services of high technological value.

Notes: The Law Decree further specifies that an "innovative start up" company fulfilling these requirements should either have 30% of its costs related to R&D or at least one third of its personnel consisting of individuals who hold either a PhD degree, or who are PhD candidates at an Italian or foreign university, and in either case who have conducted research activities for at least three years or are the owners or licensees of a patent.

Startup companies are exempt from certain duties and charges which are usually due in connection with their constitution and registration at the Chamber of Commerce.

Source: legalknowledgeportal.com

With these considerations, we proceed to elaborate on the method and empirical sections of the paper next, where we test for the effect of KSE on employment levels in the innovative startup sector because of its underlining high tech component.

Model and empirical approach

Based on the review of the literature and the growing body of empirical research on the role of knowledge spillovers as a propeller of entrepreneurial activity through the creation of opportunities, this paper aims at making an empirical contribution to the understanding of the KSE effects deriving from the development and implementation of Italian Law Decree 179/12. We use a data set of 245 Innovative Startup companies, covering 20 Italian geographic regions organized by the economic sector at the 2-Dig NAICS classification. Data comes from the AIDA database for the date of December 2015 [13].

The original data set includes variables such as total production value, the total cost of operation, non-monetary costs, years of operation, number of employees, firm region of origin and 2-Dig NAICS sector classification. Summary and descriptive statistics are presented in Table 1. Using this information we construct an empirical model and test for the existence of KSE deriving from externalities relating to specialization, competition and diversity. In addition, we test for cluster effects and technological catch-up effects as they relate to the level of employment generated by the firms.

In this conceptual framework, we use a parsimonious model where the level of employment is the dependent variable following a similar specification as in Glaeser *et al.* (1992) and Pede *et al.* (2020). In an early work Audretsch and Fritsch (1994) note in models like this, two alternate dependent variables could be selected: one defined as the ecological approach and the other the labor market approach. In our analysis, we, therefore, follow the

Table 1 Descriptive statistics. Italian innovative startups at 2-Dig NAICS classification, December 2015

Variables	*Mean*	*Median*	*Maximum*	*Minimum*	*SD*
2-Dig NAICS classification					
Information technology	0.314	0	1	0	0.47
Manufacturing	0.233	0	1	0	0.42
Services	0.445	0	1	0	0.50
Knowledge spillover effects					
Competition	1.330	0.996	7.262	0.414	0.98
Diversity	4.631	2.209	14.820	0.815	5.33
Specialization	1.338	1.204	10.994	0.071	0.95
Regional dummy variables					
Center	0.392	0	1	0	0.49
North	0.408	0	1	0	0.49
South	0.200	0	1	0	0.40
2-Dig NAICS cluster size	10.661	8	32	1	9.00
National technological gap	0.025	0.029	0.033	0	0.01
Regional technological gap	0.086	0.048	0.750	0	0.12
Number of employees	6.718	4	56	1	7.57
Employment per region	176.069	111	462	2	158.97
Regional number of firms	25.571	20	57	1	18.14
Value of production	8,39,772	5,15,598	60,96,820	12,154	987274.20
Non-monetary cost	63,341	28,870	16,75,205	86	130324.70
Years of operation	3.201	3	5	1	1.15

labor market approach and play a particular interest in the level of employment generated by the new innovative startups [14]. In general, the model specification form is given by:

$$y_{i,j}=\beta_0+\beta_j x_j+\rho_j d_{j+}\gamma_j z_j+e_i \quad (1)$$

where $y_{i,j}$ is the level of employment for firm *i in sector j*, x_j is a vector of explanatory variables included but not limited to the firm's value of production, non-monetary costs of operation (fixed cost of operation) [15] and the number of years of operation? In addition, d_j is a vector of additional dummy variables, including a sectorial dummy (we use the three most relevant economic sectors at 2-Dig NAICS classification, namely, S = services, IT = information technology and M = manufacturing). Manufacturing (M) is defined broadly as the supply of raw materials; production or transformation of primary goods into final or intermediate products cited above [16]. Service (S) includes all firms in the traditional group composed of companies involved in conventional service and by lately-born services, strictly related to technology and innovation [17]. The information and communication technology (IT) group is composed of firms that are in the assembly of methods and technologies, which realize transmission systems, reception and elaboration of information (digital technologies included) [18]. Furthermore, a geographic dummy variable between North, Center and South [19], [20] was created as well. The vector z_j includes the measures of KSE through the indices of competition, specialization and diversity; plus the additional measures of regional sectorial cluster size and regional technological gap. Finally, $e_i \sim N(\bar{x}, \sigma^2)$ are the errors, which we assume are normally distributed and independent. We use a simple OLS estimation procedure to conduct our empirical analysis of the cross-section sample of firms.

Because of its importance let us further explain data treatment and related hypotheses. Based on the information presented in the literature review we performed a few transformations to the original data to capture the presence of knowledge spillover effects on employment levels. More specifically, to test the role that knowledge spillover effects of

innovation (may) play under the three scenarios of specialization, competition and diversity; we construct three indicators *per* the definitions below and following closely the description presented first in Glaeser *et al.* (1992) and refined in Pede *et al.* (2020).

First, specialization in the industry within a region is measured as the fraction of the region's employment that this industry captures, relative to the share of the entire industry in national employment (Glaeser *et al.*, 1992; Pede *et al.*, 2020; Henderson, 1997; Feldman and Audretsch, 1999; Cingano and Schivardi, 2003; Suedekum and Blien, 2005 for further rationale in this topic). The specialization index, therefore, compares the relative size of a sector in a region to its relative size in the nation and it is expressed as:

$$S_{i,s} = \frac{E_{i,s}/E_i}{E_s/E}, \tag{2}$$

where $E_{i,s}$ is employment in region i in industry s, E_i is employment in region i, E_s is total employment in the nation in industry s and E is the total employment in the nation. Per the discussion in the literature review section, as in MAR high levels of specialization indicate the monopolistic type of industries where firms flourish in isolation:

H1. We expect the specialization variable to have a positive sign in line with MAR prescriptions if regional specialization increases growth through a high concentration in the form of monopolistic market structure, and therefore knowledge spillovers are appropriated by the same firm. Contrarily, if the coefficient were to be negative it follows that lower levels of specialization, i.e. higher levels of competition should lead to higher levels of employment growth.

Second, for the diversity measure, we consider the Relative Diversity Index (*RDI*) which is expressed as:

$$RDI_i = \frac{1}{\sum_s \left| \frac{E_{i,s}}{E_i} - \frac{E_s}{E} \right|}, \tag{3}$$

where all variables are defined as in equation (2). Intuitively a high value of the relative diversity index signals that the regional employment distribution resembles that of the national economy. Simply said, if all regions have a relatively close score then diversity is the norm across regions:

H2. A positive sign on the diversity variable would provide support to Jacobs' regional and inter-industry knowledge spillovers.

In this case, the evidence would also support the argumentation by Boom *et al.* (2017) and possibly Piergiovanni *et al.* (1997) that externalities relating to knowledge spillovers are scalable across industries, and firms can benefit from the production of new goods using already existent technologies or through alliances.

Third, we follow the definition of competition used by Glaeser *et al.* (1992) where competition within an industry in a region is defined as the number of establishments per worker in this industry in the region relative to the number of establishments per worker in this industry in the country. It is expressed as:

$$C_i = \frac{F_{i,s}/E_{i,s}}{F_s/E_s}, \tag{4}$$

where $F_{i,s}$ is the number of establishments in region i in industry s, $E_{i,s}$ is employment in region i in industry s, F_s is the number of establishments in the nation in industry s and E_s is total employment in the nation in industry s.

H3. A positive coefficient for the competition implies support to both Porter's and Jacobs' argumentation. That is growth is the result of within industry and across industry competition. Conversely, if the competition variable were to yield a negative coefficient, then the evidence would be in favor of the MAR approach to innovation and knowledge spillovers.

Furthermore, we define the Technological leadership TD_{it} where the technological distance to the technology leader defined as:

$$TD_{it} = \left(\frac{l_{it}^{s}}{L_{it}}\right)_{\max} - \left(\frac{l_{it}^{s}}{L_{it}}\right), \tag{5}$$

where l_{it}^{s} represents employment in region i, in sector s, at the initial time period t and L_{it} is total employment in region i at time t. It is relevant to note that the location quotient is only valid under relatively strong assumptions [21]. Intuitively, a value of zero indicates that the firm is the technological leader in the region. Conversely, higher values indicate that the gap between the leader and the rest is larger:

H4. If technological catch up is present then one would expect a positive coefficient of the estimated parameter; otherwise, technological catching is not present and firms will tend to diverge.

Finally, because the direct interaction among firms in the same cohort could potentially represent a major source of KSE, we compute the total size of the cluster in terms of the number of firms in the specific sector in each region. This cluster measure allows controlling for effects not captured by the measures of specialization, competition and diversity. We then test whether the KSE effects of cluster size are relevant in terms of employment formation:

H5. If the estimate for the cluster construct yields a positive coefficient, we take that as evidence in support of Porter's theory and weakly in favor of Jacobs' approach. Otherwise, the evidence would suggest that specialization in a monopolistic like setting (MAR) is more conducive for employment development.

Data analysis

In the next tables, we provide some basic yet necessary analysis of the general data (Table 1) and more specifically data decomposition on employment figures (Table 2), numbers of Innovative Startup Firms (Table 3) and data figures on Specialization, Competition and Diversity values; all data is by region and the economic sector at 2-Dig NAICS when applicable.

The descriptive statistics indicate that based on the random sample of firms selected the larger majority are in the Services sector followed by Information Technology and the least being Manufacturing. In addition, the data indicates an almost equal distribution of firms between the North and Center region with 40.8% and 39.2% of the sample coming from them, respectively; and consequently the South region falling behind with only 20%. We also observe that the average number of employees is roughly 7 people (median of 4) with a large dispersion between 1 and 56. At the regional level, Innovative Startups represent a large difference in employment generation with the largest region representing 462 jobs and lowest only 2. In addition, the relative cluster size has a large dispersion with the average cluster of about 11 firms and a minimum of 1 and a maximum of 32.

Table 2 provides a general picture of the levels of employment per region and the regional contribution to the total employment in the Innovative Startup segment of the market by the economic sector. In general, the initial evidence indicates the presence of a deep gap between North and South, both in terms of startups and more relevantly in the level of employment, these firms generate. Figure 1 provides information for the number of

Table 2 Employment in innovative startups Italy per sector per region, December 2015

Regions	*Total*	*Services*	*Information technology*	*Tourism*	*Manufacturing*
Abruzzo	52	42	9	0	1
	3.16%	81%	17%	0%	2%
Basilicata	2	1	1	0	0
	0.12%	50%	50%	0%	0%
Calabria	18	5	10	0	3
	1.09%	28%	56%	0%	17%
Campania	55	28	27	0	0
	3.34%	51%	49%	0%	0%
Emilia Romagna	222	53	59	0	110
	13.49%	24%	27%	0%	50%
Friuli Venezia Giulia	68	2	6	0	60
	4.13%	3%	9%	0%	88%
Lazio	131	40	81	7	3
	7.96%	31%	62%	5%	2%
Liguria	29	5	1	0	23
	1.76%	17%	3%	0%	79%
Lombardia	462	200	151	0	111
	28.07%	43%	33%	0%	24%
Marche	111	22	36	0	53
	6.74%	20%	32%	0%	48%
Molise	3	3	0	0	0
	0.18%	100%	0%	0%	0%
Piemonte	68	42	20	0	6
	4.13%	62%	29%	0%	9%
Puglia	45	6	19	0	20
	2.73%	13%	42%	0%	44%
Sardegna	48	37	11	0	0
	2.92%	77%	23%	0%	0%
Sicilia	114	96	7	0	11
	6.93%	84%	6%	0%	10%
Toscana	85	23	55	0	7
	5.16%	27%	65%	0%	8%
Trentino Alto Adige	32	18	9	1	4
	1.94%	56%	28%	3%	13%
Umbria	28	4	0	0	24
	1.70%	14%	0%	0%	86%
Val d'Aosta	3	3	0	0	0
	0.18%	100%	0%	0%	0%
Veneto	70	34	29	0	7
	4.25%	49%	41%	0%	10%
Total	1646	664	531	8	443

Notes: Data corresponds to a sample of 260 startup companies in December 2015. The tourism category is included in this table but not in the statistical analysis because of its little representation

Innovative Startups per region with darker regions indicating a larger generation of Innovative Startups.

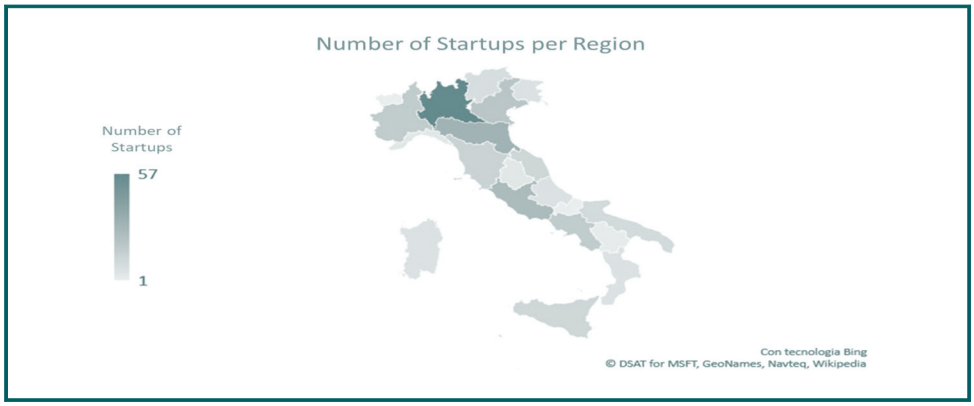
Table 3 illustrates the number of Innovative Startup companies by region at 2-Dig NAICS classification for Services, Information Technologies, Tourism and Manufacturing. As expected the larger number of innovative startups fall into the Services or ICT sector of the manufacturing sector. Notice that the evidence is consistent across all regions demonstrating that knowledge is more prevalent in some sectors. However, it is also evident that the geographic region with the highest number of Innovative Startups is the North, in confirmation of the hypothesis that the center of high economic activity is more likely to also create more entrepreneurship opportunities and in the case of analysis of this paper, more Innovative Startups. In addition, one clearly sees that the preexistent patterns of economic

Table 3 Number of innovative startup firms in Italy per sector per region, December 2015

Regions	*Region*	*Services*	*Information technology*	*Tourism*	*Manufacturing*
Abruzzo	Center	4	1	0	1
Basilicata	South	1	1	0	0
Calabria	South	2	3	0	1
Campania	South	8	9	0	0
Emilia Romagna	Center	11	7	0	13
Friuli Venezia Giulia	North	1	1	0	4
Lazio	Center	7	17	1	1
Liguria	Center	1	1	0	2
Lombardia	North	32	13	0	12
Marche	Center	2	5	0	5
Molise	Center	1	0	0	0
Piemonte	North	11	3	0	3
Puglia	South	3	3	0	4
Sardegna	South	3	2	0	1
Sicilia	South	7	2	0	3
Toscana	Center	6	6	0	2
Trentino Alto Adige	North	4	1	1	2
Umbria	Center	1	0	0	3
Val d'Aosta	North	1	0	0	0
Veneto	North	11	5	0	4
Total		117	80	2	61

Notes: Data corresponds to a sample of 260 startup companies in December 2015. The tourism category is included in this table but not in the statistical analysis

Figure 1 Number of startups per region



activity in Italy persist, and thus the region with the most innovative startups in the North, with the Center and South following. At first glance, it appears that KSE in the innovative startup segment of the economy follows already existent patterns of entrepreneurship development. That is, knowledge and more importantly, entrepreneurship activity seems to be geographically invariant to the sources of opportunities that the Law Decree may create. In other words, while initiating an Innovative Startup may now be easier, the generation of knowledge remains relatively neutral to already existing regional differences in knowledge endowments, which on themselves seem to be sticky to geographic dispersion across regions.

Table 4 presents the specialization, competition and diversity measures which also provide valuable information in the process of understanding the composition and dynamics of

Table 4 Regional level of industry specialization, level of competition and industry diversity

Regions	*Specialization*			*Competition*			*Industry*
	Services	*Information Technology*	*Manufacturing*	*Services*	*Information Technology*	*Manufacturing*	*Diversity*
Abruzzo	2.002	0.537	0.071	0.540	0.738	7.262	1.237
Basilicata	1.239	1.550	0.000	5.675	6.638	N/A	1.825
Calabria	0.689	1.722	0.619	2.270	1.991	2.421	2.146
Campania	1.262	1.522	0.000	1.621	2.213	N/A	1.825
Emilia Romagna	0.592	0.824	1.841	1.178	0.788	0.858	2.209
Friuli Venezia Giulia	0.073	0.274	3.278	2.838	1.106	0.484	0.815
Lazio	0.757	1.917	0.085	0.993	1.393	2.421	1.452
Liguria	0.427	0.107	2.947	1.135	6.638	0.632	0.954
Lombardia	1.073	1.013	0.893	0.908	0.571	0.785	14.820
Marche	0.491	1.005	1.774	0.516	0.922	0.685	2.380
Molise	2.479	0.000	0.000	1.892	N/A	N/A	0.838
Piemonte	1.531	0.912	0.328	1.486	0.996	3.631	2.334
Puglia	0.331	1.309	1.651	2.838	1.048	1.452	1.819
Sardegna	1.911	0.710	0.000	0.460	1.207	N/A	1.361
Sicilia	2.088	0.190	0.359	0.414	1.896	1.981	1.140
Toscana	0.671	2.006	0.306	1.480	0.724	2.075	1.541
Trentino Alto Adige	1.394	0.872	0.464	1.261	0.738	3.631	2.696
Umbria	0.354	0.000	3.185	1.419	N/A	0.908	0.850
Val d'Aosta	2.479	0.000	0.000	1.892	N/A	N/A	0.838
Veneto	1.204	1.284	0.372	1.836	1.144	4.150	2.874

Note: Values for specialization, competition and diversity indicators are computed using equations (2), (3) and (4)

possible knowledge spillover effects and the inherent regional differences as they relate to each industrial classification. By analyzing the data on competitiveness and specialization, we observe that there is no homogeneity of results by comparing regions belonging to different macro geographic areas. This evidence is similar to that presented by Colombelli and Quatraro (2017) in terms of the levels of asymmetry and heterogeneity across regions. Incidentally, the data changes significantly from one region to another, and differ greatly when taking into account different sectors within a single region. In addition, in terms of the level of diversity returns to the macro-geographic divisions, the north generally has a higher level of diversity than the corresponding Central and South Italy.

Results and discussion

Table 5 presents the results of the labor-market approach to KSE effects with employment levels for innovative startups as the dependent variable. We begin our analysis by describing the results from our control variables. Here there are several results to highlight. The first level of employment is positively related to the value of production; as we assume that the value of production is in direct relation to the market segment the firm is targeting its production and as such a reflection of the state of the overall economy. In this context, as in Sedláček and Sterk (2017), it is possible that cyclical fluctuations in the economy result in variations of the level of production, and hence in employment levels. Second, the Non-Monetary cost (firm size) notes that as non-monetary cost increases the level of employment also increases.

Table 5 Knowledge spillover effects determinations in Italian innovative startups with employment level as the dependent variable

	Models			
Variables	*I*	*II*	*III*	*IV*
Constant	5.743 (0.001)***	3.928 (0.601)	−3.495 (0.630)	−13.088 (0.090)*
Value of production	4.59E−06 (0.001)***	4.55E−06 (0.001)***	4.07E−06 (0.001)***	3.87E−06 (0.001)***
Non-monetary cost	9.59E−06 (0.003)***	9.53E−06 (0.003)***	8.71E−06 (0.004)***	8.85E−06 (0.003)***
Years of operation	−0.230 (0.477)	−0.243 (0.454)	−0.331 (0.283)	−0.373 (0.217)
Regional dummies				
North	−0.897 (0.447)	−0.802 (0.500)	−0.815 (0.469)	−0.717 (0.516)
Center	−0.246 (0.808)	−0.359 (0.728)	−1.379 (0.167)	−0.372 (0.716)
South (omitted)				
Industry structure				
Specialization	−0.007 (0.985)	0.075 (0.906)	1.245 (0.053)*	2.210 (0.002)***
Competition	−1.091 (0.010)***	−1.102 (0.019)**	−1.765 (0.001)***	−1.603 (0.001)***
Diversity	−0.175 (0.086)*	−0.171 (0.102)*	−0.271	0.076
			(0.008)***	(0.601)
Sectorial dummies				
Services		1.340 (0.834)	11.703 (0.066)*	21.530 (0.002)***
Information technology		2.169 (0.731)	11.453 (0.067)*	20.182 (0.003)***
Manufacturing		2.192 (0.725)	12.414 (0.046)**	20.543 (0.002)***
Technological gap				
Regional tech gap			−18.188 (0.001)***	−20.545 (0.001)***
Clusters				−0.230 (0.001)***
cluster size				
R-squared	0.469	0.472	0.529	0.550
Number of observations	244	244	244	244
Log-likelihood	−762.363	−761.618	−747.721	−742.158
F-statistic	25.942	18.869	21.623	21.626
Prob of *F*	(0.001)***	(0.001)***	(0.001)***	(0.001)***
Akaike information criteria	6.323	6.341	6.235	6.198

Note: ***, **, * represent statistical significance at the 1%, 5% and 10%, respectively

The evidence also indicates that years of operation, despite having a negative sign, are not statistically significant. This is actually a very interesting finding as the lack of statistical significance fails to reject the null hypothesis of the year no effect. This indicates that there is no difference between young and older firms. Our evidence agrees with the findings in Sedláček and Sterk (2017), who argue that the initial difference in employment generation for startups is highly determined by the year of choice of entering into the market and that these differences do not disappear as the firm gets older. Thus, plant size and employment levels appear to be time-dependent to the year of business origination. It is also feasible that the presence of natural-advantage factors (Ellison *et al.*, 2010; Ellison and Glaeser, 1999) play a larger role than the gains derived from KSE.

Concerning Regional Dummies the estimates yield no statistical difference in favor of any of the regions. The assumption was that firms in the North region would create more jobs than their Center and South counterparts would, everything else constant. However, the consistent lack of statistical significance in the regional dummy variables indicates otherwise. Thus, observed differences in employment levels across regions are explained for reasons other than the geographic location alone. We argue that the promotion of innovative startups provides similar opportunities across geographic regions as a means to generate employment. If this is an accurate assessment of the evidence then the initiative(s) promoting the development of innovative startup companies could serve as a positive mechanism for employment generation and regional development across all regions. This, however, does not equate with stating that KSE is present in the same fashion across economic sectors and regions as the evidence for the regional technological gap indicates otherwise.

For the Sectorial Dummies (2-Dig NAICS Classification), models III and IV provide robust statistical evidence in support of the hypothesis that there are no significant differences across sectors. This is to say that employment capabilities in the Innovative Startup segment of the economy seem to be relatively similar across 2-Dig NAICS classifications. The regional differences appear to be more present in the overall number of firms that are generated in each region and consequently on the overall level of employment. This information is valuable, as it continues to build upon the case that innovative startup companies are highly likely to be affected by the presence of knowledge spillover effects – positively from specialization and negatively from competition and diversity. Because this argument is a fundamental piece of our analysis and the overall contribution of our research, we now turn to this segment of the estimations.

Let us now turn our attention to studying the industry structure estimates more specifically the alternate theories of potential KSE. In this section of the estimations, we first observe that the Specialization indicator provides a positive and statistically significant coefficient in models III and IV. Here the evidence is in favor of the MAR approach when higher levels of industry specialization lead to higher levels of employment; and confirming our *H1*. In this context, the evidence indicates that industries with a much narrow focus on the production processes are more likely to gain more than otherwise in terms of knowledge spillover effects transfers leading to higher levels of employment [22]. This result is further complemented when we introduced our measure of cluster size (Model IV) and observed that the larger the cluster is, the lower level of employment is achieved at the firm level. Clusters in this setting, act as an impediment for firms to increase the number of employees they hire on a permanent basis. This result seems to be in line with the historical perspective of entrepreneurship development in Italy. Inner-clusters mechanisms specific to the Italian economy may be at play here, particularly where a temporary increase in demand for one firm implies shared-production with cluster members instead of increases in employment levels. This is to say that entrepreneurship opportunities may be channeled in the form of production expansion in cluster members holding excess capacity before direct

entrepreneurship expansion takes place. That is the firm instead of increasing the number of workers, decides to share the increase in demand with other members of the same cluster and does is capable to not hire more workers and use the cluster members as the excess production capacity needed to supply the demand. Colombelli and Quatraro (2017) note that local knowledge bases displaying high levels of technological relatedness tend to suffer from a lack of commercialization by incumbents. Furthermore, this positive effect of specialization seems to be in line with the local growth trajectories effects of Regional S3 smart specialization strategies (Colombelli and Quatraro, 2017).

The second element addresses the level of competition. In this case, the estimates are robust and consistently yield a negative and statistically significant coefficient at the 1% significance in favor of the MAR theory of KSE. This in turn confirms the second component of our *H3*. Colombo *et al*. (2006) report similar results. The estimates from our model provide evidence against Porter's hypothesis. In fact, we observe that the opposite actually holds true. Higher competition leads to lower employment levels in the Innovative Startup sector in Italy. That is knowledge spillover effects are not transmitted through higher levels of competition; instead, it is a specialization that leads the development of knowledge effects. This result is robust to the introduction of our Cluster measure, where larger Clusters in the same industry and same region, created a negative effect on employment levels in addition to the increased competition. In this regard, the question that remains unanswered is what are the inner dynamics of KSE within each regional cluster that promote the creation of larger clusters, to begin with? In other words, what region-specific elements are the founding and underpinning for entrepreneurial opportunities to be available in one region but not others?

The third component of the analysis is the degree of diversity in the region, where we obtain information against larger levels of diversity as creators of more employment. This result contradicts our *H2*. The evidence continues to support the argumentation along the lines of specialization, not only at the sectorial level but also at the regional level. An alternate way to see this is that knowledge spillovers from one sector to the next in the same region, does not occur. More specifically, based on the evidence drawn from the sample of firms we find that knowledge is firm-specific with little to limit transmission to other firms across economic sectors. This evidence contradicts the argumentation presented in Boom *et al.* (2017) and also by Colombo *et al.* (2006) as well. Particularly, our evidence tends to indicate that Innovative Startups work best alone with similar firms (same 2-Dig NAICS classification nearby). This result does align with the traditional concept of a family business in Italy. However, our results diverge from evidence found in Colombelli and Quatraro (2017), who find that "new firm formation is higher in contexts characterized by 'rich integration,' i.e. high technological variety." Clearly, more research is necessary to untangle the conundrum of how KSE could best create positive effects on employment growth at lower levels of data aggregation.

In terms of our measure for the technological gap, we observe a negative and highly statistically significant coefficient. This negativity indicates a lack of convergence at the regional level, and thus rejects our *H4* [23]. In fact, the coefficient is robust to alternate model estimations and results in an increase in the size of the negative effect of diversity from −0.171 to −0.271. The lack of convergence implies that regions are growing apart in terms of the potential to develop new businesses and allow for the transmission of knowledge across economic sectors across regions. In other words, entrepreneurial opportunities may be geographically constraint as knowledge spillover effects are limited to a within region effect. To be more specific, we observe that for the Specialization coefficient, the introduction of the regional technological gap produces an increase in the coefficient from 0.075 (not significant) to a 1.245 (significant at the 5%). Furthermore, the coefficient for Competition decreases from −1.102 to −1.765. The combination of all these elements provides evidence to argue that the regional technological gap persists and the regional

leader in the firm that will have higher levels of employment. In sum, more advanced firms using more people tend to do better when driven by specialization and while maintaining a larger technological regional gap than their competitors. Thus, the more competitors there are in the segment and in the region, the lower the overall level of employment is achieved. In the case of Colombelli and Quatraro (2017), they argue in favor of the hypothesis that technological heterogeneity may lead to further growth, which could be equated to a weak form of technological catch-up and convergence.

Finally, the results for the sectorial cluster size variable indicate a negative and statistically significant coefficient at the 1% level of confidence. This result provides evidence in favor of *H5* supporting the fact that KSE occurs along with the MAR theoretical perspective. As we already began to mention, this negative effect of regional clusters reinforces the argument in favor of specialization under less competitive settings. Accounting for clusters size also results in an increase in the positive effect of specialization, providing more robust evidence in favor of the MAR rationale. Ellison *et al.* (2010: 1210) found similar results for the US manufacturing sector, and argue "[i]deas and knowledge spillovers may be more important in very innovative sectors." Furthermore, the competition coefficient retains both economic and statistical significance across alternate models. The combined effect of competition and cluster (regional for same industry classification), denotes that being in the same sector and competing directly leads to lower levels of employment.

Based on our empirical results we argue and summarize the main findings of our paper are as follows. Knowledge spillover effects in the innovative Startup sector of the Italian economy provide robust evidence in favor of specialization as a means to promote the development and transfer of technology across firms, leading to higher employment levels. Higher competition and higher levels of industry diversity have negative effects on the levels of employment. This is to say, that technological related knowledge spillover effects are limited to industries with high levels of relatedness and low levels of heterogeneity. The evidence, thus points out in favor of existent and persistent regional heterogeneity in terms of economic and technological specialization as sources of employment. Learning seems to be regional in nature and strongly present in the form of industry specialization. This is to say that the sources and effects of KSE on entrepreneurial activity appear to be limited to within 2-Dig NAICS classification, and with limited effect across firms in other economic sectors. Furthermore, the derived KSE are regional in nature and do not transmit across other regions. To this end, regional disparities appear to remain and knowledge transmission is within cities and limited to cluster members (Del Giudice *et al.*, 2011 as well). In sum, local knowledge effects would have the largest positive effects on employment when regions emphasize on developing competitive advantages linked to specialization in related industries as in Boom *et al.* (2017) and Colombelli and Quatraro (2017).

Theoretical and practical contribution

Our research provides some very interesting contributions both at the theoretical and practical levels in the field of knowledge management. To this end, from a practical point of view the findings from our empirical analysis – using a sample of Innovative Startups from 3 different 2-Dig NAICS classification sectors – indicate that while KSE is present in this relatively new segment of the Italian economic productive structure, these effects are limited in scope. Particularly, following Ferreira *et al.* (2018) argumentation for the management of knowledge; our managerial implications indicate that innovative startups need to select the specific region (or even city) were to initiate their business on a one-to-one basis to maximize the benefits of specialization and related KSE. More specifically, to maximize the potential for knowledge development and transfer, those in charge of managerial decisions need to select their company location based on the already presence of firms sharing the same type of knowledge needed in their industry. This selection is further conditioned within

their region dynamics as the very limited transfer of knowledge appears to occur across geographic regions. Along these lines, we further argue that the lessons derived from the business opportunities created by the Law Decree 129/12 with the intention to further promote knowledge development and transfer from and for the Innovative Startups sector, serve the best purpose when this knowledge is mostly shared in industry contexts that are region and sector-specific.

Furthermore, the evidence indicates that managerial implications are affected by the existent knowledge, which conversely is region-specific and limited by the size of the present cluster. In addition, based on our evidence, firms face the managerial challenge to create and adopt knowledge that is most influential in less competitive settings and with higher levels of industry specialization. This is to say, that while knowledge may be available off the shelves, its adoption does not happen in a one-fits-all fashion. Firms, therefore, need to be selective as to what knowledge management practices best apply to each, accounting for the existent market competitive settings and the regional location of the firm. As was argued earlier in the paper, we hypothesize that the management of knowledge is regional specific as well. In some regions, knowledge transfers across firms in an easier and more fluid fashion, while in other regions knowledge provides the highest returns to investment while operating in silos, that is through specialization. Based on the empirical results of this study it would also be interesting to examine possible development of multi-level interdependencies of knowledge creation, transfer and management at the firm, industry and regional levels. One element that remains unclear from our results is that while knowledge is created its transfer is not openly available to other firms, and if it were it does not translate in a one-to-one relationship across firms. In other words, the same knowledge has differentiated effects across firms within the same economic sector and more so across sectors and regions. This poses an increasing challenge for those managing knowledge at the firm level.

From a theoretical point of view, our findings indicate that when modeling Knowledge Spillover Effects at the industry (2-Dig NAICS classification) and regional levels, one is more likely to observe the persistence of decaying effects. In other words, KSE in the Innovative Startup sector is sticky and geographically bounded, posing a further challenge for firms to acquire knowledge that is developed further away. Our theoretical implications indicate that KSE under the MAR theoretical approach is more likely to be present in the Innovative Startup sector than under Porter or Jacobs's theoretical prescriptions. This, of course, needs to be tested empirically and it is a subject of future research as more disaggregated data becomes available.

A further theoretical implication of our study provides challenging results against the KSTE propositions, that the generation of more opportunities might have asymmetric effects across firms and sectors, everything else constant. Instead, we find evidence in favor of the initial hypothesis that knowledge transfers occur in non-symmetric and non-homogenous fashion. This is so despite the fact that business opportunities created through the legislative reforms aim at being space and industry neutral. Consequently, we argue that modeling knowledge transfer within a spatial conditioned setting may provide a more realistic depiction of the actual relations observed in the data. By the same token, from a theoretical perspective, it appears that the commercialization of ideas decays with distance and it is stronger within industry settings. This may be the result of differentiated pools of human capital, both creative human capital and human capital capable of absorbing ideas generated by others, which in turn are regionally specific.

Limitations/caveats

The primary limitations are the data availability and that this paper is an empirical exercise. We do not claim to make any significant theoretical contribution to the field of KSE or KSTE.

In this context, an implicit assumption in our data is that labor productivity in the generation of research/ideas is somewhat constant and one unit of labor across different firms may have a relatively, stable and constant similar value. Mismeasurement on both the output and input sides are clearly a cause for concern in general. Furthermore, we are not able to separate human capital from creative capital.

Also, as the data we use does not include the number and overall qualifications of the firm's ownership structure, it becomes very difficult to measure the impact that owner(s) and founding members have on the overall productivity levels. We assume that a significant component of the potential knowledge spillover effects is specific to the owners' own human capital and own business management practices. We also recognize that given data limitations, we have only modeled a finite number of possible mechanisms for knowledge spillover effects and elements related to the possible natural advantages related to location. This remains as relevant fields of study for future research.

Conclusions

Spatial considerations as they relate to the regional levels of specialization, competition, diversity and technological catch-up provide significant contributions to the study of employment generation in the Startup Innovation companies in Italy. Results indicate that the formation of Innovative Startup companies under the recent Italian Civil Law, continue to favor the formation of relatively independent entities with limit exploitation of the assumed gains deriving from KSE, across economic sectors and regions. More specifically, the results in this paper find that the employment level in the Innovative Startup industries in Italy is negatively affected by the level of competition in the industry. Employment is negatively affected by the degree of economic diversity of the region. Perhaps, more importantly, levels of industry specialization play a statistically significant role in the level of employment across firms when controlling for levels of regional technological gaps. Finally controlling for the regional technological gap is an important element in the observed employment differences, as there is no evidence for technological catch-up across regions. This is to say, that regional disparity and limited transmission of KSE across regions remain an impediment to the flow of knowledge. This in turn may limit the development of entrepreneurial activities and further development of new firms.

These results reinforce the theoretical argumentation that knowledge spillover effects are more likely to have positive effects when firms interact in specific and closed economic sectors, along with specialization patterns of technological development. Under the existing conditions, the evidence also indicates that continuous efforts to provide a setting where the dynamic gains of knowledge spillovers across firms within and across regions, is a pending task to be undertaken to further promote the transfer of knowledge spillover effects. We argue that enhancing the role of local and regional supporting institutions, the role knowledge incubators and generators and developing a regulatory apparatus that facilitates knowledge generation and transfer may provide the necessary conditions for further knowledge spillover effects to derive. It is yet to be studied the role of natural advantages in the process of firm agglomeration and consequent local effects on employment levels.

We advise policymakers to further study and further incentivize the presence of creativity mechanisms conducive to the reduction of knowledge filters and the promotion of the entrepreneurial activity. The process should focus on the promotion of KSE and reduction of uncertainty related to innovation and knowledge creation and better transmission of across regions.

Notes

1. Shams *et al.* (2019) proves an excellent review on the topic of managing knowledge from an international perspective.
2. See Audretsch and Feldman (2004) for a complete review of the literature, in the Handbook of Regional and Urban Economics.
3. In the case of Italy, regional differences has marked the presence of clearly differentiated levels of economic activity, development and achievement; with the North region outperforming consistently the rest in all economic categories. We aim as well to test if these differences prevail after the Law Decree introduction and in the Innovative Startup sector.
4. Diversity is defined as the variety of industries within a geographic region that leads to the promotion of knowledge externalities. That is a much more diversified region is characterized by larger pools of differentiated labor.
5. Del Giudice *et al.* (2011) provides an excellent review of the literature regarding knowledge clusters and the role of cross-cultural knowledge management topics.
6. See Audretsch and Feldman (2004) for a thorough review of the literature in this regard.
7. Furthermore, in Porter's approach firms in related and supporting industries with high levels of rivalry at the industry level promote growth through high levels of competition.
8. Colombelli and Quatraro (2017) note "as far as the analysis of new firm formation at a regional level is concerned, the KSTE has gained momentum over the past decade."
9. Colombelli and Quatraro (2017) document that new firms in the medium-high and high technological sectors are more likely to flourish when lower technological asymmetries and high technological relatedness are present than otherwise. Among young firms, startups companies are able to create a high share of fixed-term jobs and they represent an important source of job creation.
10. Ellison *et al.* (2010) indicate that according to Marshall (1920) the benefits of agglomeration are related to lower transportation costs of moving goods, people and ideas. In addition, the authors argue that firms may agglomerate because of natural advantages associated with location in relation to access to inputs.
11. Durst and Edvardsson (2012) provide an excellent review of the literature relating to knowledge management in SMEs.
12. The knowledge filter effect indicates that not all knowledge available to firms may be adequately and completely absorbed given incapability of firms to internalize it either because of inherent firm specific conditions or decay effects related to geographic location and distance.
13. https://aida-bvdinfo-com.proxy.unimib.it
14. In a recent study, Colombelli and Quatraro (2017) use the ecological approach, and therefore have the number of new firm creation as their dependent variable.
15. Unlike monetary costs, non-monetary costs are costs which are not followed by a cash outflows. Among non-monetary costs we find: Provisions to risk funds, Severance packages, amortizations and unrealized losses. We use these non-monetary costs as an approximation for the scale of plant size.
16. Due to the creation of value-added, this phase is central and fundamental. The added value is either given by human capital or by machines, depending on the industry type; distribution of final goods on the market.
17. The Service sector includes firms in commercials, facility management, insurance and banking, marketing, legal, fiscal and analytical advice and R&D.
18. Thus, in this category we include all the society whose main aim is to operate in the information and communication fields.
19. A list of the regional dummies is available in Table 2 (see below).
20. Piergiovanni *et al.* (1997) use a similar dummy classification in their study of innovative inputs for small firms in Italy. Different than in our results, later exposed and explain, they find a significant difference in favor to those firms located in the NorthWestern industrialized region.
21. As mentioned, we acknowledge that this measure does not address in strict terms technological leadership, but rather more of specialization. The choice of this simplistic measurement is due to

the non-availability of data and as such the price that we have to pay for performing the analysis at this refined level of spatial aggregation.

22. As indicated earlier Colombelli and Quatraro (2017) arrive to similar results, however using a different dependent variable, defined as the firm count.

23. When conducting the estimation for the national level technological gap, the results of the estimation yield a near singular matrix, and thus it is inconclusive.

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